

Fault tracing of vehicles

BACKGROUND OF THE INVENTION AND PRIOR ART

The present invention relates generally to troubleshooting of motor vehicles, in particular troubleshooting of road vehicles such as cars and trucks. In particular, the invention relates to a system for troubleshooting of a motor vehicle and a method for troubleshooting of a motor vehicle, according to the preamble of claim 1 and 21, respectively. The invention also relates to a computer based system for troubleshooting according to claim 27 and a computer program according to claim 28.

Troubleshooting of motor vehicles is often carried out manually by a mechanic. In recent years, however, systems for guided troubleshooting with the help of computers have been created. Such a computer may contain for example a diagnostic model of the motor vehicle, which is used to provide the mechanic with an estimation of the probability for different errors, based on registered error observations.

Warnquist, 2011, (see reference list at the end of the description) describes a computer based troubleshooting system for motor vehicles such as trucks comprising:

- a diagnostic unit that uses a Bayesian network to make a diagnosis for the motor vehicle, and
- a planner to recommend measures, such as observations or tests and repairs, based on the diagnosis.

The planner is configured to carry out a cost estimate of a number of possible measures and selects a measure based on the cost estimate. The cost that is estimated is the total expected cost for troubleshooting, if the troubleshooting starts with a specific measure from among the possible measures. The troubleshooting system recommends the selected measure to a mechanic via a user interface.

DISADVANTAGES OF PRIOR ART TECHNOLOGY

However, the above described prior art technology regarding troubleshooting systems does not provide any guidance to the driver of the motor vehicle when the driver discovers an error, or
5 when the motor vehicle lights a warning light. The driver's only options in this case are to book an appointment at a garage, or to call and ask for example a garage mechanic for advice.

SUMMARY OF THE INVENTION

10 There is thus a need for a system to support a driver who is facing a problem, before the motor vehicle is taken to a garage for repair.

One objective is to improve recommendations of measures
15 provided to a driver, in the event the driver discovers a problem with the motor vehicle and contacts somebody for advice.

Another objective is to make it easier for the driver to make a financially sound decision.
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For these objectives, the invention provides a troubleshooting system, a method for troubleshooting, a method for recommending measures, and an arrangement for guidance comprising a help desk.
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The invention is particularly suitable for troubleshooting of modern motor vehicles with many components, and complex connections between components and errors in the components.

30 According to a first aspect, the invention provides a system for troubleshooting of motor vehicles. The troubleshooting system is configured to receive operating data, such as error codes, from the motor vehicle and, in response to the error codes, to recommend measures to remedy errors in the motor vehicle.

35 The troubleshooting system comprises a diagnostic unit and a planner. The diagnostic unit is configured to achieve, based on

the error codes, a vehicle-specific diagnosis for the motor vehicle, which comprises a probability distribution of errors in the motor vehicle. The planner is configured to achieve a set of possible measures, based on measure models for the motor vehicle and the probability distribution of errors, and is configured to achieve a cost estimate for each one of the possible measures, with the use of an estimated cost for the respective possible measure and the probability of errors. The planner is configured to select measures based on the cost estimates. The troubleshooting system is characterised in that the measure models used comprise measures to carry out remote testing on the motor vehicle, and at least one measure, from among a group of measures, in order to connect the motor vehicle with a mechanic.

The troubleshooting system may thus both provide recommendations to remedy errors intended for a mechanic and recommendations to a driver, regarding suitable measures before the motor vehicle has arrived at a mechanic. The troubleshooting system provides the driver with a possibility of carrying out troubleshooting tests when the motor vehicle is not yet in the garage, which results in lower troubleshooting and repair costs at the garage.

According to one embodiment, the troubleshooting system is configured to collect calendar data relating to booked garage appointments for the motor vehicle, and the group of measures to connect the motor vehicle with a mechanic comprises at least one measure comprising driving or towing of the motor vehicle to a booked garage.

Thus, the troubleshooting system helps a driver avoid unnecessary garage visits, if there is already a booked garage appointment.

According to one embodiment the troubleshooting system comprises more than one measure, comprising driving of the motor vehicle to a booked garage. These measures comprise a first measure to continue using the motor vehicle until the time
5 of the booked garage visit, and a second measure to stop using the motor vehicle and wait for the time of the booked garage visit.

Thus the troubleshooting system helps the driver avoid taking
10 unnecessary risks, while also avoiding unnecessary downtime.

According to one embodiment of the troubleshooting system, the cost estimate of the first measure, which is to continue using the motor vehicle, comprises an estimated cost of continuing to use
15 the motor vehicle when it has possible errors resulting in a poorer performance, and the probability of these possible errors.

Thus, the troubleshooting may value the use of continuing to use the motor vehicle in relation to other alternatives, such as
20 connecting the motor vehicle with a mechanic.

According to one embodiment of the troubleshooting system, the cost estimate of the second measure comprises an estimated cost of not using the motor vehicle during the time up to the
25 booked garage visit.

Thus, the troubleshooting system may improve its valuation of the usefulness for the driver of not taking unnecessary risks.

30 According to one embodiment the troubleshooting system is configured to obtain the position of the motor vehicle, and the group of measures to connect the motor vehicle with a mechanic comprises at least one of the following measures:

- transport of the motor vehicle to a garage, in particular the
35 nearest garage, and
- driving a service vehicle to the motor vehicle.

Thus, the troubleshooting system makes it easier for the driver to select a cheaper repair alternative.

- 5 According to one embodiment of the troubleshooting system the group of measures to connect the motor vehicle with a mechanic comprises at least one first measure, comprising towing of the motor vehicle to the garage, and a second measure, comprising driving the motor vehicle to the garage.

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Thus, the troubleshooting system helps the driver to select a cheaper repair alternative, while at the same time limiting the risk of a breakdown.

- 15 According to one embodiment the troubleshooting system is also configured to create a description of the motor vehicle's state, such as a state vector, based on error codes received or symptoms.

- 20 This contributes to a description of the motor vehicle's state, which is suitable for further calculations. The troubleshooting system may treat symptoms from a driver as results of remote tests, with the difference that the symptoms may be registered without a prior recommendation.

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According to one embodiment the troubleshooting system is also configured to receive information from a user, such as the driver or a mechanic, relating to observations of the motor vehicle, and to use the observation information to create and update the description of the motor vehicle's state.

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According to one embodiment of the troubleshooting system the information from the user comprises observations of symptoms and results of a completed measure, such as a completed remote test.

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The troubleshooting system is thus adapted, during the ongoing troubleshooting process, to receive observations from the user both in the form of symptoms and results of completed tests. New recommendations may be prepared as observations are registered.

According to one embodiment the troubleshooting system is also configured to obtain operating data, such as error codes, from the motor vehicle when a measure is carried out, and to update the description of the motor vehicle's state in accordance with the collected error codes.

The troubleshooting system may thus obtain information directly from the motor vehicle without the driver, or another user, needing to carry out tests, which is particularly useful as the troubleshooting system may benefit from the motor vehicle's ability to update operating data, in order to decide the effect of a completed measure on the motor vehicle.

According to one embodiment of the troubleshooting system the planner is configured to request an update of the vehicle specific diagnosis from the diagnostic unit, when the description of the motor vehicle's state has been updated.

Thus, the vehicle specific diagnosis is kept updated as the motor vehicle's state, or the knowledge about the motor vehicle's state, change.

According to one embodiment of the troubleshooting system the planner is configured to create descriptions of fictitious states in the motor vehicle, such as fictitious state vectors, based on the respective expected outcome of possible measures, to request fictitious diagnoses from the diagnostic unit, wherein each fictitious diagnosis comprises a probability distribution of errors, and to use the fictitious diagnoses to carry out cost estimates of

an expected total cost of the troubleshooting, if either one of the possible measures were selected as a first measure.

Thus, the troubleshooting system may evaluate the
5 troubleshooting one or several steps into the future, where possible alternatives are cost estimated.

According to one embodiment the troubleshooting system is also configured to obtain configuration data relating to the motor
10 vehicle from a vehicle database, comprising registered data including the respective configuration of several motor vehicles, and the diagnostic unit is configured to obtain diagnostic models from a database comprising diagnostic models and, based on
15 the motor vehicle's configuration data, to achieve a vehicle specific diagnostic model, and furthermore, the diagnostic unit is configured to use the vehicle specific diagnostic model to achieve the vehicle specific diagnosis.

This is particularly useful for motor vehicles that are available in
20 many versions, and thus different measure models and diagnostic models may be used for the different motor vehicles.

According to one embodiment of the troubleshooting system the planner comprises a measure unit, configured to provide the
25 possible measures, and a cost estimator, configured to provide the cost estimates, wherein the measure unit is configured to obtain measure models from a database with measure models.

This division is preferred in order to simplify the design of the
30 troubleshooting system.

According to one embodiment the cost estimate comprises, for each one of the possible measures, an estimation of the total
35 expected cost of troubleshooting the motor vehicle, with selection of the relevant measure as the first measure in

accordance with a first calculation method, when the motor vehicle is not at a garage.

5 Thus, the troubleshooting system may have regard for further measures, for example repair measures, both outside and inside a garage, at the selection of possible measures before the motor vehicle is at a garage.

10 According to one embodiment the cost estimate comprises, for each one of the possible measures, an estimation of the total expected cost of troubleshooting the motor vehicle, with selection of the relevant measure as the first measure in accordance with a second calculation method, when the motor vehicle is at a garage.

15 Thus, different cost estimates may be used inside and outside a garage. For modern motor vehicles with many components, the calculations become extensive. Since the troubleshooting system also is adapted to carry out calculations before the
20 motor vehicle has reached a garage or a mechanic, the complexity increases further. Through selection of different calculation methods, the calculation capacity may be used in a more optimal manner both inside and outside a garage.

25 According to one embodiment the first calculation method comprises:

- a determination of the garage that is nearest the motor vehicle's position;
- an evaluation of the expected cost to troubleshoot the motor
30 vehicle according to the following alternatives:
 - connecting the motor vehicle with a mechanic in the cheapest possible way, in order to subsequently continue the troubleshooting; and
 - for each one of the possible remote tests, carrying out the
35 remote test, and depending on the outcome of the remote test,

connecting the motor vehicle with a mechanic in the cheapest possible way, in order to continue the troubleshooting.

Thus, the troubleshooting system may recommend remote tests, whose different outcomes impact on the selection of possible measures to connect the motor vehicle with a mechanic. This makes it possible to recommend a cheaper alternative to connect the motor vehicle with a mechanic, with the help of the increased knowledge obtained from the remote test.

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According to one embodiment the troubleshooting system is also configured to provide, based on the probability distribution of errors, error information in the form of a list of at least a part of the possible errors, in particular the most likely, and a probability for each one of the possible errors.

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Thus, a user such as the driver, an operator at a help desk or a mechanic, may, in addition to suggested measures, obtain a more detailed description of the motor vehicle's error state. This error information makes it easier for the user to select the recommended measure(s) to be carried out.

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According to a second aspect the invention provides a guidance arrangement, comprising the troubleshooting system and a help desk, comprising a computer and a monitor equipped with a user interface, configured for registration of symptom information and the results of completed measures, in particular completed remote tests.

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The invention provides a computer based system for a help desk, with a possibility of improved guidance for a driver, based on the motor vehicle's error and the symptoms observed by the driver, and may also recommend remote tests, whose outcome further facilitates the choice of measures to recommend in an emergency situation, especially relating to whether or not the assistance of a mechanic is required.

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According to a third aspect the invention provides a method for troubleshooting of a motor vehicle. The method comprises:

- initiation of troubleshooting of the motor vehicle, which
5 initiation comprises registration of error codes from the motor vehicle, and creation of a vehicle specific measure model;
- creation of a description of the motor vehicle's state, such as a state vector, and creation of a vehicle specific diagnosis for the motor vehicle, comprising a probability distribution of errors;
- 10 - determination of one or several possible measures, based on the vehicle specific diagnosis and the vehicle specific measure model,
- estimation of an expected total cost of the troubleshooting for each one of the possible measures,
- 15 - selection of at least one measure from among the possible measures, based on the expected total cost; and
- recommendation of the selected measure or the selected measures to a user.

20 The method is characterised in that it comprises a determination as to whether the motor vehicle is in a garage or with a mechanic, and in that the determination of one or several possible measures is based on whether or not the motor vehicle is located in a garage or with a mechanic.

25 Even before the motor vehicle is at a garage, the recommendations are based on an expected total cost of remedying the errors in the motor vehicle through the troubleshooting.

30 According to one embodiment the estimation of an expected total cost of the troubleshooting is carried out according to

- a first calculation method, when the motor vehicle is at a garage or with a mechanic, and
- 35 - a second calculation method, when the motor vehicle is not at a garage or with a mechanic.

- The troubleshooting is therefore adapted to especially adapted calculation methods for the estimation of the total cost for the different cases, when the motor vehicle either has no access to a mechanic or a garage, or when it has access to a mechanic or a garage. By using different calculation methods the calculations may be optimised for both cases, and the increased complexity when the motor vehicle is not at a garage or with a mechanic need not result in an increased complexity of the calculations.
- According to one embodiment the first calculation method comprises:
- a determination of the garage that is nearest the motor vehicle's position;
 - an evaluation of the expected cost to troubleshoot the motor vehicle according to the following alternatives:
 - connecting the motor vehicle with a mechanic in the cheapest possible way, in order to subsequently continue the troubleshooting; and
 - for each one of the possible remote tests, carrying out the remote test, and depending on the outcome of the remote test, connecting the motor vehicle with a mechanic in the cheapest possible way, in order to continue the troubleshooting.
- One advantage is that a cheaper way of connecting the motor vehicle with a garage, or a mechanic, may be selected by carrying out one or several remote tests before the motor vehicle is connected with the garage or the mechanic.
- According to one embodiment, when the motor vehicle is not at a garage or with a mechanic, the determination of one or several possible measures comprises at least one measure from among the group of measures comprising:
- completion of a remote test;

- booking of a garage visit, comprising a suggested garage and times for the garage visit, and subsequently towing of the motor vehicle to the relevant garage;
 - booking of a garage visit, comprising a suggested garage and times for the garage visit, and subsequently driving of the motor vehicle to the relevant garage;
 - interruption of use of the motor vehicle and subsequently waiting for an already booked garage visit, and driving the motor vehicle to the booked garage;
 - interruption of use of the motor vehicle, and subsequently waiting for an already booked garage visit, and towing of the motor vehicle to the booked garage;
 - continued use of the motor vehicle, and subsequently waiting for an already booked garage visit, and driving the motor vehicle to the booked garage; and
 - ordering and waiting for a service vehicle with a mechanic; and preferably also
 - completing the troubleshooting.
- 20 The method herewith provides for an evaluation of several new measures. The method is suitably adapted to evaluate all of these measures in the group of measures, at least measures comprising remote tests and booking of a garage, preferably in combination with one or several measures comprising transport of the motor vehicle to an already booked garage.

- According to one embodiment, when the motor vehicle is an a garage or with a mechanic, the determination out of one or several possible measures is carried with at least measures selected from among the group of measures comprising:
- completion of a garage test;
 - completion of repair measures followed by a functional check, in order to check whether the problem is solved; and
 - completion of troubleshooting.

This means that the cost of repair measures may be limited through the completion of garage tests, whose outcome impact the total cost.

- 5 According to one embodiment the creation of the state vector comprises the obtaining of registry data from a vehicle database, and also comprises registration of outcomes of completed measures in the registry data in the vehicle database.
- 10 According to a fourth aspect, the invention provides a computer based system for troubleshooting of motor vehicles. The computer based troubleshooting system is configured
- to receive error codes from a motor vehicle (2) and, in response to the error codes or the symptoms, to recommend
- 15 measures to remedy errors in the motor vehicle (2), and
- to calculate an expected total cost of the troubleshooting for each one of a number of possible measures, and to select recommending a measure, based on the calculated expected total cost. The computer based troubleshooting system is
- 20 characterised in that it is configured to:
- determine whether or not the motor vehicle is in a garage or with a mechanic, wherein the estimation of the expected total cost of the troubleshooting is carried out according to a first calculation method when the motor vehicle is not in a garage or
- 25 with a mechanic. The first calculation method comprises:
- a determination of the garage that is nearest the motor vehicle's position;
 - an evaluation of the expected cost to troubleshoot the motor vehicle according to the following alternatives:
- 30 - connecting the motor vehicle with a mechanic in the cheapest possible way, in order to subsequently continue the troubleshooting; and
- for each one of the possible remote tests, carrying out the remote test and, depending on the outcome of the remote test,
- 35 connecting the motor vehicle with a mechanic in the cheapest possible way, in order to subsequently continue with the

troubleshooting. Preferably, the possible measures in the computer based troubleshooting system comprise measures to carry out remote tests on the motor vehicle and measures to connect the motor vehicle with a mechanic.

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According to a fifth aspect the invention provides a computer program product for troubleshooting of motor vehicles, comprising a computer program, which, when executed in a computer or several computers, makes it possible for the computer or computers to:

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- function in accordance with the computer based system according to the fourth aspect of the invention;
- function in accordance with the method for troubleshooting according to the second aspect of the invention; or

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- function in accordance with the troubleshooting system according to the first aspect of the invention.

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The computer program product preferably also comprises a storage medium, preferably a non-transitory storage medium, so that the computer program is stored in the storage medium.

BRIEF DESCRIPTION OF THE DRAWINGS

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The present invention will now be explained in more detail through embodiments which are described as examples, and with reference to the enclosed drawings.

Figure 1 shows a schematic image of a motor vehicle and an arrangement for troubleshooting of a motor vehicle;

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Figure 2 illustrates a method for troubleshooting in accordance with a preferred embodiment;

Figure 3 shows a schematic image of an arrangement for troubleshooting, including a garage system;

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DESCRIPTION OF EMBODIMENTS

The invention is particularly suitable for troubleshooting of modern motor vehicles with many components, and complex connections between components and errors in the components.

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In figure 1, a vehicle system 1 is displayed, comprising a motor vehicle 2, such as a truck, and a driver 6. The motor vehicle 2 is equipped with an electronic control system 4. Such electronic control systems 4 usually comprise a number of electronic control devices, so-called ECUs ("Electronic Control Unit"), connected to each other via a data bus, such as a CAN-bus ("Controller Area Network"). The ECUs are also connected to sensors and actuators. The example embodiment shows an electronic control system 4, which comprises an electronic control device 5, equipped with a communication interface 8, and a user interface 3. Further, the driver 6 has a communication device 7, such as a mobile phone, e.g. a smart-phone, equipped with a user interface. The electronic control system 4 is configured to register errors arising in the system in error codes, such as so-called DTC ("Diagnostic Trouble Codes"), and may inform the driver about errors via the user interface 3. The electronic control system 4 is configured to register other operating data, such as vehicle position data, and may also be configured to register vehicle calendar data, comprising booked garage visits including time and garage, such as a garage identity.

The electronic control system 4 is configured to use the electronic control device 5, which is equipped with a communications interface 8, to transfer operating data, in particular comprising error codes, vehicle position data and vehicle calendar data from the motor vehicle. The communication interface 8 is preferably configured to communicate in accordance with a mobile remote communication system such as GSM, 3G, or 4G or a short-range system such as Wi-Fi connected to a fixed network such as

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Internet. One preferred embodiment is 3G, which exists in many markets. In one alternative embodiment it is possible to connect a motor vehicle equipped with an "OBD port" (On-board diagnostic port) via cable to an external computer unit, and then
5 to the Internet over a fixed or mobile network.

Figure 1 also shows an arrangement 10 to guide a driver 6, when an error occurs in the motor vehicle 2. The guidance arrangement 10 comprises a help desk or help central 20 and a
10 troubleshooting system 30.

The help desk 20 comprises a computer 21 and a monitor 22, equipped with a user interface for an operator at the help desk 20. The help desk 20 also comprises elements, such as a
15 telephone 23 or an Internet connection, for communication with the driver 6 via the driver's 6 communication device 7. The help desk 20 is also configured to register, via the user interface, information from the driver 6, in particular the vehicle identity of the motor vehicle 2, symptoms relating to errors in the motor
20 vehicle 2, and the results of remote tests carried out by the driver 6. The help desk 20 is also configured for communication with the troubleshooting system 30, for example via the Internet, and the computer 21 comprises elements for such data communication.

25 Briefly, the function of the guidance arrangement 10 may be described as the driver 6 contacting the help desk 20 and informing the operator about the vehicle identity of the motor vehicle and potential symptoms, when the driver 6 experiences
30 an error in the motor vehicle 2, such as a symptom or a lit warning lamp. The operator registers the vehicle identity and the symptoms in the computer 21. The help desk 20 also forwards this information to the troubleshooting system 30. The troubleshooting system 30 is configured to return
35 recommendations for measures to the help desk 20, which the operator at the help desk presents to the driver 6. Specifically,

the troubleshooting system 30 is configured to provide recommendations relating to remote tests and garage visits to the driver 6. When the driver 6 has completed a remote test, the driver 6 reports the result of the remote test to the help desk 20, where the result is registered by the operator, following which the troubleshooting system 30 comes back with a new recommendation, such as a remote test or a garage visit. The guidance via the help desk 20 ends, for example, when a garage visit has been agreed with the driver 6.

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In further detail, the troubleshooting system 30 is configured, on receipt of the vehicle identity and potential symptoms, to initiate a communication with the motor vehicle 2, i.e. its electronic control system 4, via the communications interface 8, and to request the transfer of operating data, in particular the error codes that have been registered. The troubleshooting system 30 is preferably also configured to request, in addition to the error codes, vehicle position data from the motor vehicle 2. The troubleshooting system 30 is also configured to repeat, during an ongoing troubleshooting process, the request relating to error codes, such as via a request for operating data, and to update the information, which the troubleshooting system 30 has regarding the motor vehicle 2, with such error codes or operating data.

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The troubleshooting system 30 is also configured to evaluate measures related to the error codes and the symptom information. The troubleshooting system 30 is configured to evaluate each measure by estimating the total expected cost to troubleshoot the motor vehicle 2, with selection of the relevant measure as the first measure.

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The troubleshooting system 30 is preferably configured to transfer error information, comprising a list of possible errors, to the driver 6 via the help desk 20, which error information preferably comprises a calculated probability for each one of the

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possible errors. The troubleshooting system 30 is preferably configured to use a threshold value for error probabilities, and only to transfer the possible errors whose probability exceed the threshold value. Thus, only the most relevant possible errors are displayed.

The troubleshooting system 30 is also configured to request signal values, measured by the motor vehicle's 2 electronic control system 4 at remote tests and garage tests.

The troubleshooting system 30 is configured to suggest measures comprising:

- carrying out a remote test;
- completing the troubleshooting and continue to use the motor vehicle 2;
- and measures belonging to a group of measures intending to connect the motor vehicle with a mechanic, comprising:
 - booking a garage visit, comprising a suggested garage and times for the garage visit, and subsequently towing the motor vehicle 2 to the relevant garage;
 - booking a garage visit, comprising a suggested garage and times for the garage visit, and subsequently driving the motor vehicle 2 to the relevant garage;
 - stop using the motor vehicle 2, waiting for the next already booked garage visit, and driving the motor vehicle 2 to the booked garage;
 - stop using the motor vehicle 2, waiting for the next already booked garage visit, and towing the motor vehicle 2 to the booked garage;
 - continue using the motor vehicle 2, waiting for the next already booked garage visit, and subsequently driving to the garage; and
 - ordering and waiting for a service vehicle with a mechanic.

The troubleshooting system 30 is preferably configured to suggest booking of a garage visit and at the same time suggest

ordering one or several spare parts, which spare parts are selected based on the probability distribution of errors.

5 The troubleshooting system 30 is preferably also configured to suggest repair measures. The troubleshooting system 30 is preferably configured also to function as a guide for a mechanic (46 in Figure 3), for example when a service vehicle has been driven to the motor vehicle 2, or when the motor vehicle 2 has arrived at a garage. The troubleshooting system 30 is therefore
10 also configured to communicate, in the same manner as the communication with the help desk 20, with a computer (41 in Figure 3) in a garage. Such a garage computer 41 may be configured similarly as the help desk 20, so that the vehicle identity, perceived symptoms and tests may be registered. The
15 troubleshooting system 30 is also configured to register completed repair measures, wherein the mechanic 46 may register completed repairs via the garage computer 41. The troubleshooting system 30 is, in this respect, also adapted to suggest measures to mechanics, comprising:
20 - carrying out garage tests;
- carrying out a repair measure followed by a functional check, in order to check whether the problem is solved; and
- completing the troubleshooting and returning the motor vehicle 2 to the driver 6.

25 One example embodiment of the troubleshooting system 30, illustrated in Figure 1, will now be described in more detail, wherein the example embodiment is described, in particular, with the functions which are specifically intended to help a driver
30 6.

The troubleshooting system 30 may suitably be adapted with one or several computers, comprising a combination of hardware, such as processors and memories, and software.
35 Figure 1 illustrates the troubleshooting system's 30 component parts such as functional units, each one comprising a

combination of hardware and software, which software is adapted to facilitate the troubleshooting system's 30 functions, when the software is executed by the computer or computers.

5 The troubleshooting system 30 according to the example embodiment in Figure 1 comprises a service handler 31, a planner 32, a diagnostic unit 33 and a number of databases. The databases consist of a database 35, comprising diagnostic models, a database 36, comprising measure models, a garage
10 database 38 and a vehicle database 39, which vehicle database 39 comprises registry data concerning several motor vehicles, such as the motor vehicle 2.

The garage database 38 contains the geographical location of
15 several garages, spare part costs of components, and suitably also a spare part availability for each garage.

The troubleshooting system 30, such as the service handler 31 or the planner 32, is configured to obtain information about
20 garages, in particular their geographical position, to facilitate the selection of a garage.

The vehicle database 39 comprises registry data, including the specific configuration of a number of motor vehicles, identified
25 by their respective vehicle identity. Thus, the registry data consists of several vehicle identities, connected to the components of which each motor vehicle consists. The registry data preferably also comprises space to save diagnostic information. The diagnostic information comprises, in this
30 respect, error codes, symptom information, test results and completed repairs. The service handler 31 is configured to save the error codes and symptom information received from the motor vehicle 2 and the driver 6, respectively, in the diagnostic information. The service handler 31 is also configured to save
35 the results of tests, such as remote tests and garage tests, and repair measures, in the diagnostic information.

The motor vehicle 2 may be configured to report to the troubleshooting system 30, via a communication interface 8, error codes which arise between garage visits.

- 5 The service handler 31 is equipped with a communication interface for communication with the users, such as receipt of error codes, symptoms, results of measures, and transfer of recommendations to the users.
- 10 The service handler 31 is configured to save error codes, which have been reported between garage visits in the diagnostic information.

- 15 The registry data of the vehicle database 39 also comprises the planned garage visits of the motor vehicle 2, which garage visits are defined by a garage identity and a time.

- 20 The service handler 31 is configured to create a state vector for the motor vehicle 2, based on the diagnostic information, the motor vehicle's 2 position data, and booked garage visits from the registry data or the motor vehicle's 2 calendar data.

- 25 The service handler 31 is preferably also configured to create the state vector in such a way that it facilitates registration of whether or not the motor vehicle 2 is at a garage, and is configured to register this in the state vector. Alternatively, the planner 32 is configured to obtain and register booked garage visits in the state vector.

- 30 It is suitable to time stamp all diagnostic information in the registry data of the vehicle database 39, and to specify each error code's state as active or inactive.

- 35 It is suitable to adapt the service handler 31 to creating the state vector by obtaining the most recently registered state in each error code, and the test result since a functional check was

registered with the result that the problem is solved, i.e. the motor vehicle was unimpaired at the time.

5 The service handler 31 is configured to create, during an ongoing troubleshooting, a new state vector when the service handler 31 has changed the diagnostic information.

10 The service handler 31 is also adapted to obtain, based on the motor vehicle's 2 identity, configuration data from the vehicle database 39, describing the relevant motor vehicle's 2 specific set of components.

15 The diagnostic unit 33 is configured, based on the configuration data obtained from the vehicle database 39 by the service handler 31, to create a vehicle specific diagnostic model, using the diagnostic models in the database 35 with diagnostic models.

20 The database 35 with diagnostic models comprises diagnostic models consisting of one or several Bayesian networks. Preferably, the database 35 comprises several partial models, each one of which is a Bayesian network for an individual component. The partial models are intended to be connected to each other, since they comprise common nodes. The diagnostic
25 unit 33 is configured to create a vehicle specific diagnostic model, by combining only the partial models which relate to the components present in the relevant motor vehicle. The diagnostic unit 33 is preferably configured to select only those partial models containing nodes related to active error codes
30 and symptoms when the diagnostic unit 33 creates the vehicle specific diagnostic model. Partial models that are not connected to active error codes or symptoms may thus be excluded, which facilitates the creation of a smaller Bayesian network.

35 The Bayesian network must be configured in such a way that it has at least one node describing the state of each component

(whole or broken) and each observation that may be made by error codes, symptoms, remote tests or garage tests.

It is suitable to include, in each partial model, additional nodes describing the motor vehicle's construction, even if these may not be observed by a user. The parameters of the Bayesian network are set with probability distributions, describing the probability that a node has a state given the state in the node's parent nodes. In order to be able to use partial models it is suitable to set the parameters of the common nodes with distributions permitting that the number of parent nodes is increased. Preferably a distribution of the type Noisy-Or is used for the setting of parameters. The parameters of nodes for component errors are preferably set with a probability for errors in such component, described by the cumulative probability in an exponential distribution according to equation 1:

$$1 - e^{-\lambda t} \quad \text{equation 1}$$

where λ is the error frequency per km and t is the age in operating kilometres of the component.

The diagnostic unit 33 is also configured to create, based on the vehicle specific diagnostic model, vehicle specific diagnoses, comprising a probability distribution of possible errors based on the state vector, in particular diagnostic information in the state vector. The diagnostic unit 33 is also configured to create a probability distribution of possible errors at the request of the planner 32. The calculation of a probability distribution in a Bayesian network is carried out with a so-called inference algorithm. In a preferred embodiment, the invention is adapted to use the so-called Junction Tree Clustering algorithm. This inference algorithm is efficient, accurate and well proven. The Junction Tree Clustering algorithm is described in detail in Jensen et. al. 1990.

The planner 32 is configured to obtain the vehicle specific diagnosis in the form of a probability distribution of possible errors, which is created by the diagnostic unit 33. The planner 32 is also configured to produce, based on the measure models
5 obtained from the database 36 with measure models, a set of possible measures based on the state vector, and the probability distribution of possible errors.

The planner 32 is also configured to evaluate measures related
10 to the state vector and the probability distribution of errors. The planner 32 is configured to evaluate each measure by estimating the total expected cost to troubleshoot the motor vehicle 2, with a selection of the relevant measure as the first measure. The planner 32 is preferably configured to provide the cost
15 estimates, and/or the total expected cost for the possible measures.

In a preferred embodiment the planner 32 is configured to estimate the total expected cost by estimating the cost of a first measure, and estimating the expected cost for the remaining
20 measures to remedy the error, and to add up the cost of the first measure and the expected cost of the remaining measures.

In more detail, the planner 32 comprises a measure unit 34 and a cost estimator 37, and comprises, or alternatively is
25 configured, to obtain information from the database 36 with measure models. In the embodiment illustrated in Figure 1, the planner 32 comprises a database 36 with measure models, from which the measure unit 34 is configured to obtain and use measure models. The measure model 34 is configured to use
30 the measure models, in order to create a vehicle specific measure model.

The database 36 with measure models comprises measure models, each one of which comprises the effects which the
35 measure has when carried out, i.e. how they impact the state vector, the duration of the measure, and an estimated cost. The

measure model preferably comprises a subcondition, which specifies whether or not the motor vehicle must be at a garage in order for the measure to be executable.

- 5 The measure model may also comprise a set of additional subconditions required for the measure to be executable, e.g. that one or several parts need to be fitted or dismantled in order for the measure to be executable, or that the garage must be equipped with special tools.

10

Each measure model described in the database 36 with measure models may be one of the following types:

- carrying out a remote test;
- booking a garage visit, comprising a suggested garage and
15 times for the garage visit;
- stop using the motor vehicle 2 and waiting for the next already booked garage visit;
- continue using the motor vehicle 2 and waiting for the next already booked garage visit;
- 20 - towing the motor vehicle 2 to a specific garage;
- driving the motor vehicle 2 to a specific garage;
- ordering and waiting for a service vehicle with a mechanic;
- carrying out a garage test;
- carrying out a repair measure followed by a functional check,
25 in order to check whether the problem is solved; and
- completing the troubleshooting.

The measure model for a remote test comprises an identifier of the observation node in the diagnostic model to which the
30 remote test must correspond, and the outcome which the test may have, and the time it takes to carry out the remote test. Each remote test's outcome in the measure model corresponds to the observation node's outcome in the diagnostic model. In one alternative embodiment the measure model does not include
35 the outcome of the remote test, but instead the planner 30 is adapted to request the outcomes from the diagnostic unit, which

is adapted to obtain the outcomes in the corresponding diagnostic model.

5 The measure model to book a garage visit comprises a booking cost, corresponding to the cost which a vehicle owner incurs in needing to make an unplanned garage visit.

10 The measure model to stop the use of the motor vehicle 2 and wait for the next already booked garage visit comprises a standard cost per 24 hours, which corresponds to the cost a vehicle owner incurs in not being able to use his vehicle.

15 The measure model to continue to use the motor vehicle and wait for the next already planned garage visit comprises a standard cost per 24 hours for each component, corresponding to the level of severity in using the motor vehicle for a 24 hour period with an error in the relevant component. One way is to specify a level out of a limited number of standard levels for the severity degree of errors.

20 The measure model to tow the motor vehicle 2 to a specific garage comprises a fixed standard cost to begin towing, and a variable standard cost per km, being the cost of towing a motor vehicle.

25 The measure model to drive the motor vehicle 2 to a specific garage comprises a variable standard cost per km to drive the motor vehicle 2, and a variable standard cost per km for each component, which corresponds to the severity degree of continuing to drive 1 km with an error in the relevant component.

30

The measure model to request and wait for a service vehicle with a mechanic comprises a fixed standard cost to send out a service vehicle with a mechanic, and a variable standard cost per km of sending out a service vehicle with a mechanic.

35

The measure model for a garage test comprises an identifier of the observation node in the diagnostic model to which the garage test must correspond, and the outcomes which the test may have, and the time it takes to complete the garage test.

- 5 Each garage test's outcome in the measure model corresponds to the observation node's outcome in the diagnostic model.

- 10 The measure model for a repair measure comprises an identifier for a component, which the measure relates to, and a fixed cost, which corresponds to the spare part cost for the component and the time it takes to complete the repair measure and the subsequent functional check.

- 15 The measure model for the measure to complete the troubleshooting comprises a standard cost for each component, which corresponds to the severity of recommending continued use and later discovering that there was an error in the relevant component.

- 20 The database 36 with measure models also comprises parameters describing the standard cost per working hour in the garage, and at remote tests.

- 25 For each measure in the database 36 with measure models, subconditions are suitably specified, describing whether or not they may be carried out in a garage. It is suitable to define the state where a service vehicle with a mechanic is at the motor vehicle 2, as the motor vehicle 2 being in a garage.

- 30 Preferably, it is specified that the following measures may only be carried out in the garage:
- carrying out a garage test; and
 - carrying out a repair measure followed by a functional check, in order to check whether the problem is solved.

Thus, the troubleshooting system 30 is adapted to only recommend a measure that may only be carried out in a garage, when the motor vehicle 2 is in a garage.

- 5 Preferably, it is specified that the following measures may only be carried out outside of a garage:
- continue using the motor vehicle 2;
 - booking a garage visit, comprising a suggested garage and times for the garage visit, and subsequently towing the motor
 - 10 vehicle 2 to the relevant garage;
 - booking a garage visit, comprising a suggested garage and times for the garage visit, and subsequently driving the motor vehicle 2 to the relevant garage;
 - stop using the motor vehicle 2, waiting for the next already
 - 15 booked garage visit, and driving the motor vehicle 2 to the booked garage;
 - stop using the motor vehicle 2, waiting for the next already booked garage visit, and towing the motor vehicle 2 to the booked garage;
 - 20 - continue using the motor vehicle 2, waiting for the next already booked garage visit, and subsequently driving to the booked garage; and
 - towing the motor vehicle 2 to a specific garage;
 - driving the motor vehicle 2 to a specific garage;
 - 25 - ordering and waiting for a service vehicle with a mechanic; and
 - completing the troubleshooting and continue using the motor vehicle 2.

30 Thus the troubleshooting system 30 is adapted to only recommend a measure belonging to the group of measures relating to connecting the motor vehicle with a mechanic, when the motor vehicle 2 is not located in a garage.

35 Thus, the troubleshooting system 30 is adapted to only recommend a measure which may only be carried out outside a garage, when the motor vehicle 2 is not located in a garage.

Preferably, it is specified that the following measures may be carried out both inside and outside of a garage:

- carrying out a remote test; and
- 5 - completing the troubleshooting.

Thus, the troubleshooting system 30 is adapted to recommend measures which may be carried out inside and outside of a garage, both when the motor vehicle 2 is located at a garage and also when the motor vehicle 2 is not located at a garage.

10

It is suitable for the measure model for each measure to also contain a description of the measure, and an instruction about how the measure should be completed. The troubleshooting system 30 is configured to transfer the description and the instruction to the user, via a user interface 3 in the motor vehicle 15 2, the communication unit 7 in the vehicle system 1, the monitor 22 in the help desk 20, and the monitor 42 in the garage system 40 in Figure 3.

- 20 The cost estimator 37 is configured to use predetermined equations to calculate costs of measures, configured to make cost estimates for possible measures specified by the measure unit 34 with the predetermined equations, the measure model for each possible measure, the probability distribution of errors in the vehicle specific diagnosis, the state vector including the 25 the vehicle calendar data and the motor vehicle's 2 position data, and the position data of the garages.

- 30 The cost estimator 37 is preferably adapted to prepare a cost estimate of the measure to carry out a remote test as the product of the duration of the remote test and the cost parameter per working hour for a remote test.

- 35 The cost estimator 37 is preferably adapted to calculate costs of connecting the motor vehicle 2 with a mechanic, based on one or several from among the group of

standard costs, comprising the standard cost of booking a garage, the standard cost per 24 hours of using the motor vehicle 2, the standard cost of towing, the standard cost of driving out a service vehicle, and the standard cost of driving
5 with the motor vehicle 2.

The cost estimator 37 is preferably adapted to prepare a cost estimate of measures, comprising booking of a garage visit, which comprises the use of the booking cost in the measure
10 model for booking of a garage.

The cost estimator 37 is preferably adapted to prepare a cost estimate of the measures, comprising interrupting the use of the motor vehicle 2 and waiting for the next already booked garage visit, with a cost estimate comprising the product of the standard
15 cost per 24 hours in the measure model and the number of days remaining until the next already planned garage visit, based on vehicle calendar data.

20 The cost estimator 37 is preferably adapted to prepare a cost estimate c_2 of measures, comprising continuing to use the motor vehicle 2 and waiting for the next already planned garage visit, based on the standard cost per 24 hours for each component from the measure model, the probability of an error in the
25 respective components from the probability distribution of errors, and the time remaining until the next already planned garage visit according to equation 2:

$$c_2 = t_{ws} \sum_i p_i a_i \quad \text{equation 2}$$

where:

- 30 - t_{ws} is the number of days remaining until the already planned garage visit, according to the vehicle calendar data;
- p_i is the probability of errors in the component i ; and
- a_i is the standard cost per day of continued use of a component i .

35

The cost estimator 37 is preferably adapted to prepare a cost estimate of measures, comprising towing of the motor vehicle 2 to a specific garage as a cost estimate comprising the sum of:

- the fixed standard cost to begin towing from the measure model, and
- the product of the distance in km, calculated from the position of the motor vehicle 2 from the state vector, and the position of the relevant garage according to the position data of the garages, and the variable standard cost per km, which is the cost of towing a motor vehicle from the measure model.

The cost estimator 37 is preferably adapted to prepare a cost estimate c_3 of measures, comprising driving the motor vehicle 2 to a specific garage, based on:

- the variable standard cost per km to drive the motor vehicle 2, and the variable standard cost per km for each component, which corresponds to the severity degree of continuing to drive 1 km with an error in the relevant component;
- the distance in km, calculated from the position of the motor vehicle 2 from the state vector, and the position of the relevant garage according to the position data of the garages; and
- the probability of errors in the respective component, according to the probability distribution of errors according to equation 3:

$$c_3 = d_{ws}(b_{km} + \sum_i p_i b_i) \quad \text{equation 3}$$

where:

- d_{ws} is the number of km to the relevant garage;
- b_{km} is the variable standard cost per km of driving the motor vehicle 2;
- b_i is the standard cost per km of continuing to use the component i ; and
- p_i is the probability of errors in the component i .

The cost estimator 37 is preferably adapted to prepare a cost estimate of the measure to order and wait for a service vehicle with a mechanic, based on:

- the fixed standard cost of sending out a service vehicle with a mechanic according to the measure model, and
 - the product of the distance in km, calculated based on the position of the motor vehicle 2 from the state vector, and the position of the relevant garage according to the position data of the garages, and the variable standard cost per km, which is the cost of sending a service vehicle with a mechanic, from the measure model.
- 10 The cost estimator 37 is preferably adapted to prepare a cost estimate of the measure to perform a garage test as the product of the time it takes to perform the garage test according to the measure model, and the cost parameter per working hour in the garage according to the database 36 with measure models.
- 15 The cost estimator 37 is preferably adapted to carry out a cost estimate of the measure of carrying out a repair measure as the sum of:
- the spare part cost according to the measure model; and
 - the product of the time it takes to carry out the garage test according to the measure model, and the cost parameter per working hour in a garage according to the database 36 with measure models.
- 25 The cost estimator 37 is preferably adapted to prepare a cost estimate c_4 of the measure to complete the troubleshooting, based on:
- the standard cost of each component, corresponding to the severity of recommending continued use and later discovering that there was an error in the relevant component according to the measure model, and
 - the probability of errors in the respective component according to the probability distribution of errors, according to equation 4:
- 35
$$c_4 = \sum_i p_i d_i$$
 equation 4
- where:

- p_i is the probability of errors in the component i ; and
- d_i is the standard cost of continued use of the component i .

The measure unit 34 is configured to use the state vector, which
5 is created by the service handler 31. The measure unit 34 is
also configured to create fictitious state vectors based on the
state vector, in particular to change, at the evaluation of a
measure, the fictitious state vector, in accordance with each one
of the possible outcomes of the state vector that is obtained
10 from the measure model.

The measure unit 34 is preferably configured to provide a
fictitious state vector for each one of the possible outcomes of a
remote test or a garage test, by registering the relevant
15 outcomes in the corresponding fictitious state vector.

The measure unit 34 is preferably configured to provide two
fictitious state vectors for each repair measure with subsequent
functional checks. A first fictitious state vector, where the
20 outcome of the subsequent functional check is that the problem
is not solved, which is provided by way of registering that there
is no error in the relevant component in the fictitious state
vector. A second fictitious state vector, where the outcome of
the subsequent functional check is that the problem is solved,
25 which is provided by way of removing all diagnostic information
in the fictitious state vector.

The measure unit 34 is preferably configured to provide a
fictitious state vector for measures where the motor vehicle 2 is
30 connected with a mechanic, by way of registering that the motor
vehicle 2 is located at a garage in the fictitious state vector.

The measure unit 34 is configured to use the diagnostic unit 33,
to calculate the probability of a fictitious outcome in a fictitious
35 state vector for measures with more than one possible outcome
in the measure model.

The measure unit 34 is configured to use the diagnostic unit 33 to create fictitious vehicle specific diagnoses for each fictitious state vector. The cost estimator 37 is also configured to use the fictitious state vectors and the fictitious vehicle specific diagnoses at the cost estimate of measures, in particular at the calculation of the expected total cost of troubleshooting for each one of the possible measures

10

The measure unit 34 is configured to evaluate a probability distribution for each fictitious state vector, where the motor vehicle 2 is registered to be in a garage, with a formula described in equation 5 which is taken from Heckerman and Breese, 1996:

15

$$h(s) = \sum_{i=1}^n \left[\left(1 - \sum_{j=1}^{i-1} p_j \right) C_i^o + p_i C_i^r \right]$$

equation 5

where:

- $h(s)$ is an estimate of the total expected troubleshooting cost, until all errors have been remedied for a fictitious state vector s ;
- 20 (I Heckerman and Breese, 1996 $h(s)$ is referred to as $CR(I)$, and I as s)
- p_i is the probability of errors in the component i ;
- p_j is the probability of errors in the component j ;
- C_i^o is the cost of observing whether or not the component i is broken; and
- 25 - C_i^r is the cost of repairing the component i and performing the subsequent functional check.

It is not necessary to create measure models for observation of each component. The measure model 34 is preferably configured to replace C_i^o with the cost of repairing the component and setting C_i^r at zero for the components i , where there is no observation in the measure model.

30

The measure unit 34 is preferably configured to sort the components in a descending quota p_i/C_i^o :

$$\frac{p_1}{C_1^o} \geq \frac{p_2}{C_2^o} \geq \dots \geq \frac{p_n}{C_n^o}$$

equation 6

- 5 and to use this order in the calculation of $ECR(I)$ according to equation 5.

10 The troubleshooting system 30 is configured to operate, during troubleshooting, in accordance with a method for troubleshooting. Figure 2 illustrates a preferred embodiment of the method for troubleshooting.

The method for troubleshooting begins with initiation 100 of troubleshooting of the motor vehicle 2. The initiation comprises:

- 15 - registration of error codes and symptoms in the registry data in the vehicle database 39;
 - creation of a vehicle specific diagnostic model, via the database 35 with diagnostic models and registered error codes and symptoms; and
 20 - creation of a vehicle specific measure model, via the database 36 with measure models and the vehicle specific diagnostic model.

25 The method continues after the initiation 100 of troubleshooting of the motor vehicle 2 with the creation 101 of a state vector and a vehicle specific diagnosis.

The state vector comprises:

- diagnostic information from the registry data in the vehicle database 39;
 30 - the position data of the motor vehicle from the electronic control system 4 of the motor vehicle 2;
 - booked garage visits according to the motor vehicle's 2 calendar data or registry data.

The vehicle specific diagnosis is created via the vehicle specific diagnostic model and the state vector, and comprises a probability distribution of errors.

- 5 The method continues after the creation 101 of a state vector with the determination 102 of whether or not the motor vehicle 2 is located at a garage. It is suitable to define the state where a service vehicle with a mechanic is at the motor vehicle 2 as the motor vehicle 2 being in a garage.

10

If the motor vehicle 2 is outside the garage, the method continues with a determination 103 of possible measures, comprising selection of all measures according to the vehicle specific measure model that may be performed outside the garage, for example by way of identifying a subcondition relating to whether or not the measure may be carried out at a garage.

15

After the determination 103 of possible measures, the method continues with an estimate 104 of the total expected cost of each of the possible measures of troubleshooting the motor vehicle 2, with selection of the relevant measure as the first measure according to a first calculation method.

20

The first calculation method comprises a determination of the garage which is nearest the motor vehicle's position. The first calculation method also comprises an evaluation of the expected cost of troubleshooting the motor vehicle 2 according to the following alternatives:

25

- connecting the motor vehicle with a mechanic in the cheapest possible way, in order to subsequently continue the troubleshooting; and
- for each one of the possible remote tests, carrying out the remote test and, depending on the outcome of the remote test, connecting the motor vehicle with a mechanic in the cheapest possible way, in order to continue the troubleshooting.

30

35

The first calculation method comprises a determination of a measure a_{ws} , from among the group of measures to connect the motor vehicle 2 with a mechanic for the state vector and the vehicle specific diagnosis, by selecting the measure with the lowest estimated cost according to the cost estimator's calculation of the measures:

- booking a garage visit at the nearest garage at the earliest possible time, and subsequently towing the motor vehicle 2 to the relevant garage;
- booking a garage visit at the nearest garage at the earliest possible time, and subsequently driving the motor vehicle 2 to the relevant garage;
- stop using the motor vehicle 2, waiting for the next already booked garage visit, and driving the motor vehicle 2 to the booked garage;
- stop using the motor vehicle 2, waiting for the next already booked garage visit and towing the motor vehicle 2 to the booked garage;
- continue using the motor vehicle 2, waiting for the next already booked garage visit and subsequently driving to the garage; and
- ordering and waiting for a service vehicle with a mechanic.

The first calculation method comprises an identification of the repair measure a^* relating to the component with the highest quota p_1/C_1^o . It is not necessary to create measure models for observation of each component. The estimation comprises compensation for the cost of observation C_i^o of the component i with the cost of repairing the component i and setting of C_i^r at zero for the components i , where there is no observation in the measure model.

The first calculation method comprises a determination, for each remote test r , of amounts S_r of fictitious state vectors, with associated vehicle specific diagnoses corresponding to the possible outcomes of the respective remote tests.

- The first calculation method comprises a determination of other measures $a_{ws|s_r}$, from among the group of measures in order to connect the motor vehicle 2 with a mechanic for each remote test r and each fictitious state vector with the associated vehicle specific diagnoses $s_r \in S_r$, by selecting the measure which has the lowest estimated cost according to the cost estimator's calculation of the measures:
- booking a garage visit at the nearest garage at the earliest possible time, and subsequently towing the motor vehicle 2 to the relevant garage;
 - booking a garage visit at the nearest garage at the earliest possible time, and subsequently driving the motor vehicle 2 to the relevant garage;
 - stop using the motor vehicle 2, waiting for the next already booked garage visit, and driving the motor vehicle 2 to the booked garage;
 - stop using the motor vehicle 2, waiting for the next already booked garage visit, and towing the motor vehicle 2 to the booked garage;
 - continue using the motor vehicle 2, waiting for the next already booked garage visit, and subsequently driving to the garage; and
 - ordering and waiting for a service vehicle with a mechanic.
- The first calculation method also comprises a cost estimate for the measure a_{ws} , another cost estimate for each remote test, and a cost estimate to complete the troubleshooting.
- For the measure a_{ws} , equation 7 is used to estimate the total expected cost c_7 of troubleshooting the motor vehicle 2, with selection of the measure a_{ws} of connecting the vehicle with a mechanic as a first measure:

$$c_7 = c(a_{ws}|s) + \min \left(\right.$$

$$c(a^*, s_{ws}) + \sum_{s_{a^*} \in S_{a^*}} \Pr(s_{a^*} | s_{ws}) \min_{a \in A} \left(c(a, s_{a^*}) + \sum_{s_a \in S_a} \Pr(s_a | s_{a^*}) h(s_a) \right),$$

$$\min_{a \in A} \left(c(a, s_{ws}) + \sum_{s_a \in S_a} \Pr(s_a | s_{ws}) h(s_a) \right)$$

equation 7

where:

- s is the state vector and the vehicle specific diagnosis, prepared at the creation 101 of the state vector and the vehicle specific diagnosis;
- s_{ws} is a fictitious state vector with associated vehicle specific diagnosis, calculated by the measure unit 34 for the measure a_{ws} and the state vector i s ;
- $c(a^*, s_{ws})$ is the estimate, which is calculated by the cost estimator 37 for the measure a^* and the fictitious state vector, and a corresponding vehicle specific diagnosis s_{ws} ;
- S_{a^*} is the number of fictitious state vectors and the corresponding fictitious vehicle specific diagnoses, which are calculated by the measure unit 34 for all possible outcomes of the measure a^* and the fictitious state vector in s_{ws} ;
- $\Pr(s_{a^*} | s_{ws})$ is the probability of the outcome of the measure a^* that leads to the state vector i $s_{a^*} \in S_{a^*}$;
- A is the number of all measures that may be carried out in a garage;
- $c(a, s_{a^*})$ is the estimate, calculated by the cost estimator 37 for each measure $a \in A$ and each fictitious state vector $s_{a^*} \in S_{a^*}$;
- S_a is the number of fictitious state vectors with associated vehicle specific diagnoses, calculated by the measure unit 34 for all possible outcomes of the measure a and the fictitious state vector s_{a^*} ;
- $\Pr(s_a | s_{a^*})$ is the probability of the outcome of the measure a that leads to the fictitious state vector in $s_a \in S_a$, from the fictitious state vector i s_{a^*} ;

- $\Pr(s_a|s_{ws})$ is the probability of the outcome of the measure a leading to the fictitious state vector in $s_a \in S_a$, from the fictitious state vector $i s_{ws}$; and
- $h(s_a)$ is an estimate of the total estimated troubleshooting cost, until all errors have been remedied for the fictitious state vector and the corresponding fictitious vehicle specific diagnosis s_a according to equation 5.

For each remote test r equation 8 is used to estimate the total expected cost c_8 of troubleshooting the motor vehicle 2, with selection off the remote test r as the first measure:

$$c_8 = c(r, s) + \sum_{s_r \in S_r} \Pr(s_r|s) (c(a_{ws|s_r}, s_r) + h(s_{ws|s_r}))$$

equation 8

where:

- s is the state vector and the vehicle specific diagnosis, prepared at the creation 101 of the state vector and the vehicle specific diagnosis;
- $s_{ws|s_r}$ is a fictitious state vector with associated vehicle specific diagnosis, calculated by the measure unit 34 for the measure $a_{ws|s_r}$ and the state vector in s_r ;
- $c(a_{ws|s_r}, s_r)$ is the estimate which is calculated by the cost estimator 37 for the measure $a_{ws|s_r}$ and the fictitious state vector, and a corresponding vehicle specific diagnosis s_r ;
- $\Pr(s_r|s)$ is the probability of the outcome of the measure r that leads to the state vector $i s_r \in S_r$;
- $c(r, s)$ is the estimate calculated by the cost estimator 37 for each remote test r and the state vector $i s$;
- S_r is the number of fictitious state vectors with associated vehicle specific diagnoses, calculated by the measure unit 34 for all possible outcomes of the measure r and the state vector $i s$;
- $h(s_{ws|s_r})$ is an estimate of the total estimated troubleshooting cost, until all errors have been remedied for the fictitious state

vector and the corresponding fictitious vehicle specific diagnosis $s_{ws|s_r}$ according to equation 5.

5 For the measure to complete the troubleshooting, the estimated measure cost, calculated by the cost estimator 37 for the relevant measure and the state vector, prepared at the creation 101 of the state vector and the vehicle specific diagnosis is used.

10 If the motor vehicle 2 is at the garage, the method continues with a determination 203 of possible measures, comprising selection of all measures according to the vehicle specific measure model, which may be performed at the garage, for example by way of identifying a subcondition relating to whether
15 or not the measure may be carried out at a garage.

After the determination 203 of possible measures, the method continues with an estimate 204 of the total expected cost of each of the possible measures of troubleshooting the motor
20 vehicle 2, and the measure of completing the troubleshooting with selection of the relevant measure as the first measure, according to a second calculation method.

25 The second calculation method comprises an identification of the repair measure a^* , related to the component with the highest quota p_1/C_1^o . It is not necessary to create measure models for observation of each component. The estimate 204 comprises compensation of the cost of observation C_i^o of the component i with the cost of repairing the component i and setting of C_i^r at
30 zero for the components i , where there is no observation in the measure model.

The second calculation method also comprises a cost estimate for the repair measure a^* and another cost estimate for other
35 measures, which may be carried out in the garage.

For the repair measure a^* with the highest quota equation 9 is used to estimate the total expected cost c_9 of troubleshooting the motor vehicle 2, with a selection of the repair measure a^* as the first measure:

5

$$c_9 = c(a^*, s) + \sum_{s_{a^*} \in S_{a^*}} \Pr(s_{a^*} | s) \min_{a \in A} \left(c(a, s_{a^*}) + \sum_{s_a \in S_a} \Pr(s_a | s_{a^*}) h(s_a) \right)$$

equation 9

where:

- s is the state vector and the vehicle specific diagnosis, prepared at the creation 101 of the state vector and the vehicle specific diagnosis;
- $c(a^*, s)$ is the estimate calculated by the cost estimator 37 for the measure a^* and the state vector, and the corresponding vehicle specific diagnosis s ;
- S_{a^*} is the number of fictitious state vectors and the corresponding fictitious vehicle specific diagnoses, calculated by the measure unit 34 for all possible outcomes of the measure a^* and the state vector i s ;
- $\Pr(s_{a^*} | s)$ is the probability of the outcome of the measure a^* that leads to the state vector i $s_{a^*} \in S_{a^*}$;
- A is the number of all measures that may be carried out in a garage;
- $c(a, s_{a^*})$ is the estimate calculated by the cost estimator 37 for each measure $a \in A$ and each fictitious state vector $s_{a^*} \in S_{a^*}$;
- S_a is the number of fictitious state vectors, calculated by the measure unit 34 for all possible outcomes of the measure a and the fictitious state vector s_{a^*} ;
- $\Pr(s_a | s_{a^*})$ is the probability of the outcome of the measure a leading to the fictitious state vector in $s_a \in S_a$ from the fictitious state vector i s_{a^*} ; and
- $h(s_a)$ is an estimate of the total estimated troubleshooting cost, until all errors have been remedied for the fictitious state vector

and the corresponding fictitious vehicle specific diagnosis s_a according to equation 5.

For each other measure a that may be carried out at a garage,
 5 equation 10 is used to estimate the total expected cost c_{10} of
 troubleshooting the motor vehicle 2, with selection of the repair
 measure a^* as a first measure:

$$c_{10} = c(a, s) + \sum_{s_a} \Pr(s_a | s) h(s_a)$$

equation 10

10 where:

- s is the state vector and the vehicle specific diagnosis, prepared at the creation 101 of the state vector and the vehicle specific diagnosis;
- $c(a, s)$ is the estimate calculated by the cost estimator 37 for
 15 the measure a and the state vector, and the corresponding vehicle specific diagnosis s ;
- S_a is the number of fictitious state vectors and the corresponding fictitious vehicle specific diagnoses, calculated by the measure unit 34 for all possible outcomes of the measure a
 20 and the state vector i s ;
- $\Pr(s_a | s)$ is the probability of the outcome of the measure a leading to the state vector i $s_a \in S_a$; and
- $h(s_a)$ is an estimate of the total estimated troubleshooting cost, until all errors have been remedied for the fictitious state vector
 25 and the corresponding fictitious vehicle specific diagnosis s_a according to equation 5.

For the measure to complete the troubleshooting, the estimated measure cost calculated by the cost estimator 37 for the
 30 relevant measure and the state vector, prepared at the creation 101 of the state vector and the vehicle specific diagnosis, is used.

- The cost c_9 has an equivalent of what is termed $ECR_{A,Q}$ in Langseth and Jensen (2002). The cost c_{10} has an equivalent of what is termed ECR_{now} in Langseth and Jensen, 2002. Langseth and Jensen, 2002, is aimed at repairers of electromechanical systems, but their mathematical method may be adapted to giving recommendations to a vehicle driver. Langseth and Jensen, 2002, is a further development of Heckerman, 1996, where the measure with the higher quota p/c is evaluated with another cost estimate than other measures.
- The method continues, after the cost estimates 104, 204, with the selection 105 of one or several measures.
- In a first embodiment, only one measure is selected 105, which is the measure with the lowest estimated total expected cost of troubleshooting the motor vehicle 2, with selection of the relevant measure as a first measure.
- In a second embodiment, a predetermined number of measures is selected 105, each of which has a lower estimated total expected cost of troubleshooting the motor vehicle 2 with selection of the relevant measure as a first measure, than have the remaining measures.
- The method continues, after the selection 105 of a measure, with a recommendation 106 of a measure comprising transfer of the selected measures to the user, via the service handler 31.
- The method may also comprise, at the recommendation of measures that may be carried out automatically by the motor vehicle 2, transfer directly to the vehicle that carries out the measure, without any recommendation being transferred to the user.
- The method continues, after the recommendation 106 of the measure, with carrying out 107 of a measure.

The method continues after a measure is carried out 107, with registration 108 of outcomes. The registration may occur both automatically, by way of a request for operating data from the motor vehicle 2, and manually by the user as the help desk's operator or mechanic 46. At the registration 108 of outcomes, the outcome is saved in the registry data in the vehicle database 39 for the relevant motor vehicle.

10 The method continues after the registration 108 of outcomes, with a check 110 of whether the troubleshooting is completed, i.e. whether the measure of ending the troubleshooting has been selected, completed and registered.

15 If the troubleshooting is completed, the method ends.

If the troubleshooting is not completed, the method reverts to creating 101 a state vector and vehicle specific diagnosis.

20 The method thus continues after the check 110 of whether the troubleshooting is completed, with the creation 101 of a new state vector and a new vehicle specific diagnosis, where the new state vector comprises:

- diagnostic information from the registry data in the vehicle database 39;
- 25 - the position data of the motor vehicle from the electronic control system 4 of the motor vehicle 2;
- booked garage visits according to the motor vehicle's 2 calendar data or registry data.

30 The new vehicle specific diagnosis is created via the vehicle specific diagnostic model and the state vector, and comprises a probability distribution of errors.

35 Figure 3 shows a schematic image of an arrangement for troubleshooting, wherein the motor vehicle 2 is located at a garage or a service vehicle. A mechanic 46 and a garage system 40 has been connected with the motor vehicle 2. The

garage system comprises a computer 41 and a monitor or computer screen 42. The function of the garage system 40 is the same as the function of the help desk 20. The garage system 40 comprises a computer 41, configured for remote communication
5 with the troubleshooting system 30. The computer 40 is preferably also configured to communicate with the motor vehicle 2, such as via cable or wireless. In particular, the garage system 40 is configured to receive error codes from the motor vehicle 2, to register symptoms and test results and to forward
10 the error codes, the test results and symptom-related information to the troubleshooting system 30. Thus, the transfer of error codes to the troubleshooting system 30 is facilitated even in the event where a direct transfer between the motor vehicle 2 and the troubleshooting system 30 is not possible. The
15 troubleshooting system 30 is, however, in this case also configured to set up a communication with the motor vehicle 2 and request error codes. Further, the garage system 40 is configured to receive recommendations and error information, such as a list of probable errors including probabilities, from the
20 troubleshooting system 30, and to show recommendations and error information to the mechanic 46 via the computer screen 42. The garage system 40 may constitute a part of the equipment in a service vehicle, and is adapted to register that the motor vehicle 2 is at a mechanic 46 or in a garage. The
25 recommended measures that the garage system 40 receives from the troubleshooting system 30 also comprise repair measures and garage tests, as opposed to the recommendations that the help desk 20 receives from the troubleshooting system, when the motor vehicle 2 is not in a
30 garage or with a mechanic.

The troubleshooting system 30 described above is configured to register (108 in Figure 2) the outcomes of measures carried out. A troubleshooting started by a driver 6, who has contacted the
35 help desk 20, may thus be continued when the mechanic 46 and the motor vehicle 2 have been connected.

A system (30) and method for troubleshooting of motor vehicles has been described with example embodiments. The system (30) is configured to receive operating data, such as error codes, from a motor vehicle (2) and, in response to the error codes, to recommend measures to remedy errors in the motor vehicle (2). The troubleshooting system comprises a diagnostic unit (33) and a planner (32). The diagnostic unit (33) is configured to achieve a vehicle specific diagnosis for the motor vehicle (2). The planner (32) is configured to achieve a set of possible measures, and is configured to achieve a cost estimate of the possible measures. The planner (32) selects measures based on the cost estimates.

The system (30) comprises measures to carry out remote tests on the motor vehicle (2), and measures to connect the motor vehicle (2) with a mechanic.

The method comprises registration of operating data error codes from the motor vehicle (2), creation (101) of a vehicle specific diagnosis, determination (103, 203) of possible measures, estimation (104, 204) of an expected total cost of the possible measures, and recommendation (106) of measures. The method comprises, in particular, determination (102) of whether the motor vehicle (2) is in a garage, where the determination (103, 203) of possible measures is based on whether or not the motor vehicle (2) is in a garage.

The method and the system may use a first calculation method when the motor vehicle (2) is in a garage, and a second calculation method when the motor vehicle (2) is not in a garage. The invention is not limited to the embodiments described with reference to the figures, but may be freely varied within the scope of the following patent claims.

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CLAIMS

1. System (30) for troubleshooting of a motor vehicle, which troubleshooting system (30) is configured to receive operating
5 data, such as error codes, or symptoms from a motor vehicle (2) and in response to the error codes or symptoms, to recommend measures to remedy errors in the motor vehicle (2), wherein the troubleshooting system comprises a diagnostic unit (33) and a planner (32), which diagnostic unit (33) is configured, based on
10 the error codes, to achieve a vehicle specific diagnosis for the motor vehicle (2), which vehicle specific diagnosis comprises a probability distribution of errors in the motor vehicle (2), which planner (32) is configured to achieve a set of possible measures based on measure models for the motor vehicle (2) and the
15 probability distribution of errors, is configured to achieve a cost estimate for each one of the possible measures via an estimated cost of the respective possible measure and the probability of an error, and is configured to select measures based on the cost estimates,
- 20 **characterised in that**
the measure models comprise measures to carry out remote testing on the motor vehicle (2), and at least one measure, from among a group of measures, in order to connect the motor vehicle (2) with a mechanic.
- 25
2. System (30) for troubleshooting of a motor vehicle according to claim 1, also configured to collect calendar data relating to booked garage appointments for the motor vehicle (2), and wherein the group of measures to connect the motor vehicle (2)
30 with a mechanic comprises at least one measure comprising driving or towing of the motor vehicle to a booked garage.
3. System (30) for troubleshooting of a motor vehicle according to claim 2, comprising more than one measure, comprising
35 driving of the motor vehicle to a booked garage, which measures comprise a first measure to continue using the motor vehicle (2)

until the time of the booked garage visit, and a second measure to stop using the motor vehicle (2) and wait for the time of the booked garage visit.

- 5 4. System (30) for troubleshooting of a motor vehicle according to claim 3, wherein the cost estimate of the first measure comprises an estimated cost of continuing to use the motor vehicle (2) with possible errors, resulting in a poorer performance, and the probabilities of these possible errors.
- 10 5. System (30) for troubleshooting of a motor vehicle according to claims 3 or 4, wherein the cost estimate of the second measure comprises an estimated cost of not using the motor vehicle (2) during the time up to the booked garage visit.
- 15 6. System (30) for troubleshooting of a motor vehicle according to one of claims 1 to 5, also configured to collect the position of the motor vehicle (2), and wherein the group of measures to connect the motor vehicle (2) with a mechanic comprises at
- 20 least one from among the following measures:
- transport of the motor vehicle (2) to a garage, in particular the nearest garage, and
 - delivery of a service vehicle to the motor vehicle (2).
- 25 7. System (30) for troubleshooting of a motor vehicle according to claim 6, wherein the group of measures to connect the motor vehicle (2) with a mechanic comprises at least one first measure, comprising towing of the motor vehicle (2) to the garage, and a second measure, comprising driving the motor
- 30 vehicle (2) to the garage.
- 35 8. System (30) for troubleshooting of a motor vehicle according to any of claims 1 to 7, also comprising a service handler (31) configured to create a description of the motor vehicle's (2) state, such as a state vector, based on received error codes or symptoms.

9. System (30) for troubleshooting of a motor vehicle according to claim 8, wherein the service handler (31) is configured to receive information from a user, such as the driver (6) or a mechanic (46), relating to observations of the motor vehicle (2), and to use the observation information to create and update the description of the motor vehicle's (2) state.
10. System (30) for troubleshooting of a motor vehicle according to claim 9, wherein the user information comprises observations of symptoms and results of a completed measure, such as a completed remote test.
11. System (30) for troubleshooting of a motor vehicle according to any of claims 8 to 10, wherein the service handler (31) is configured to collect operating data, such as error codes, from the motor vehicle (2) when a measure has been completed, and to update the description of the motor vehicle's (2) state in accordance with obtained operating data, such as error codes.
12. System (30) for troubleshooting of a motor vehicle according to any of claims 9 to 11, wherein the planner (32) is configured to request an update of the vehicle specific diagnosis from the diagnostic unit (33), when the description of the motor vehicle's state is updated.
13. System (30) for troubleshooting of a motor vehicle according to claim 12, wherein the planner (32) is configured to create fictitious descriptions of the motor vehicle's state, such as fictitious state vectors, based on the respective expected outcome of possible measures, to request fictitious diagnoses from the diagnostic unit (33), wherein each fictitious diagnosis comprises a probability distribution of errors, and to use the fictitious diagnoses to prepare cost estimates of an expected total cost of the troubleshooting at the selection of each one of the possible measures as a first measure.

14. System (30) for troubleshooting of a motor vehicle according to any of claims 1 to 13, also configured to collect configuration data relating to the motor vehicle (2) from a vehicle database (39), comprising registry data, including the respective configurations of several motor vehicles, and wherein the diagnostic unit (33) is configured to collect diagnostic models from a database (35) comprising diagnostic models and, based on the motor vehicle's (2) configuration data, to achieve a vehicle specific diagnostic model, and wherein the diagnostic unit (33) is configured to use the vehicle specific diagnostic model to achieve the vehicle specific diagnosis.

15. System (30) for troubleshooting of a motor vehicle according to any of claims 1 to 14, wherein the planner (32) comprises a measure unit (34), configured to provide the possible measures, and a cost estimator (37), configured to provide the cost estimates, and wherein the measure unit (34) is configured to collect the measure models from a database (36) with measure models.

16. System (30) for troubleshooting of a motor vehicle according to any of claims 1 to 15, wherein the cost estimate for each one of the possible measures comprises an estimate of the total expected cost of troubleshooting the motor vehicle (2), with selection of the relevant measure as the first measure in accordance with a first calculation method, when the motor vehicle (2) is not located in a garage.

17. System (30) for troubleshooting of a motor vehicle according to claim 16, wherein the cost estimate for each one of the possible measures comprises an estimate of the total expected cost of troubleshooting the motor vehicle (2), with selection of the relevant measure as the first measure in accordance with a second calculation method, when the motor vehicle (2) is not located at a garage.

18. System (30) for troubleshooting of a motor vehicle according to any of claims 16 or 17, wherein the first calculation method comprises:

- 5 - a determination of the garage which is nearest the motor vehicle's position;
- an evaluation of the expected cost of troubleshooting the motor vehicle (2) according to the following alternatives:
- connecting the motor vehicle (2) with a mechanic (46) in the
- 10 cheapest possible way, in order to subsequently continue the troubleshooting; and
- for each one of the possible remote tests, carrying out the remote test and, depending on the outcome of the remote test, connecting the motor vehicle (2) with a mechanic (46) in the
- 15 cheapest possible way, in order to subsequently continue the troubleshooting.

19. System (30) for troubleshooting of a motor vehicle according to any of claims 1 to 18, further configured to, based on the

20 probability distribution of errors, provide error information in the form of a list of at least a part of the possible errors, in particular the most probable, which error information comprises a probability for each one of the possible errors.

20. Guidance arrangement 10, comprising a troubleshooting system according to any of claims 1 to 19, and a help desk (20), comprising a computer (21) and a monitor (22), equipped with a user interface to register symptoms information and results of completed measures, in particular completed remote tests.

21. Method for troubleshooting of a motor vehicle (2) comprising:

- initiation (100) of troubleshooting of the motor vehicle 2, which initiation comprises registration of operating data, such as error
- 35 codes from the motor vehicle (2), and creation of a vehicle specific measure model and a vehicle specific diagnostic model;

- creation (101) of a state description of the motor vehicle (2), such as a state vector, and a vehicle specific diagnosis for the motor vehicle (2) via the vehicle specific diagnostic model, which vehicle specific diagnosis comprises a probability distribution of errors;
 - determination (103, 203) of one or several possible measures, based on the vehicle specific diagnosis and the vehicle specific measure model,
 - estimation (104, 204) of an expected total cost of the troubleshooting for each one of the possible measures,
 - selection (105) of at least one measure from among the possible measures, based on the expected total cost;
 - recommendation (106) of the selected measure or the selected measures;
- characterised in** comprising
- determination (102) as to whether the motor vehicle (2) is in a garage or at a mechanic, and wherein the determination (103, 203) of one or several possible measures is based on whether or not the motor vehicle (2) is located in a garage or with a mechanic (46).

22. Method for troubleshooting of a motor vehicle (2) according to claim 21, wherein the estimate (104, 204) of an expected total cost of the troubleshooting is carried out:
- according to a first calculation method, wherein the motor vehicle (2) is not at a garage or with a mechanic (46), and
 - according to a second calculation method, wherein the motor vehicle (2) is at a garage or with a mechanic.

23. Method for troubleshooting of a motor vehicle (2) according to claim 22, wherein the first calculation method comprises:
- a determination of the garage which is nearest the motor vehicle's position;

- an evaluation of the expected cost of troubleshooting the motor vehicle (2) according to the following alternatives:
- connecting the motor vehicle (2) with a mechanic (46) in the cheapest possible way, in order to subsequently continue the troubleshooting; and
- for each one of the possible remote tests, carrying out the remote test and, depending on the outcome of the remote test, connecting the motor vehicle (2) with a mechanic (46) in the cheapest possible way, in order to subsequently continue the troubleshooting.

24. Method for troubleshooting of a motor vehicle (2) according to any of claims 21 to 23, wherein, when the motor vehicle (2) is not located at a garage or with a mechanic, the determination (103, 203) of one or several possible measures comprises at least one measure selected from among the group of measures comprising:
- completion of a remote test;
 - booking of a garage visit, comprising a suggested garage and times for the garage visit, and subsequently towing of the motor vehicle(2) to the relevant garage;
 - booking of a garage visit, comprising a suggested garage and times for the garage visit, and subsequently driving of the motor vehicle (2) to the relevant garage;
 - interruption of the use of the motor vehicle (2), and subsequently waiting for an already booked garage visit and driving the motor vehicle (2) to the booked garage;
 - interruption of the use of the motor vehicle (2), and subsequently waiting for an already booked garage visit and towing the motor vehicle (2) to the booked garage;
 - continue using the motor vehicle (2), and subsequently waiting for an already booked garage visit and driving the motor vehicle (2) to the booked garage;
 - ordering and waiting for a service vehicle with a mechanic.
 - completion of troubleshooting.

25. Method for troubleshooting of a motor vehicle (2) according to any of claims 21 to 24, wherein, when the motor vehicle (2) is at a garage or with a mechanic, the determination (103, 203) of one or several possible measures comprises at least one measure selected from among the group of measures comprising:
- completion of a garage test;
 - completion of a repair measure followed by a functional check; and
- 10 - completion of troubleshooting.

26. Method for troubleshooting of a motor vehicle (2) according to any of claims 21 to 25, wherein the creation (101) of the state vector comprises obtaining of registry data from a vehicle database (39), and further comprising registration 108 of outcomes of completed measures in the registry data of the vehicle database (39).

27. Computer based system (30) for troubleshooting of a motor vehicles, which computer based troubleshooting system (30) is configured:
- to receive error codes from a motor vehicle (2) and, in response to the error codes, to recommend measures to remedy errors in the motor vehicle (2),
 - 25 - to calculate an expected total cost of the troubleshooting for each one of a number of possible measures, and to select recommending a measure based on the calculated expected total cost,
- characterised in that:**
- 30 the possible measures comprise measures to carry out remote tests on the motor vehicle (2) and measures to connect the motor vehicle (2) with a mechanic, wherein the computer based troubleshooting system (30) is also configured to:
- 35 - determine (102) whether or not the motor vehicle (2) is in a garage or with a mechanic, wherein the calculation (104, 204) of

the expected total cost of the troubleshooting is carried out according to a first calculation method when the motor vehicle (2) is not in a garage or with a mechanic (46), which first calculation method comprises:

- 5 - a determination of the garage which is nearest the motor vehicle's position;
- an evaluation of the expected cost of troubleshooting the motor vehicle (2), comprising:
 - connecting the motor vehicle (2) with a mechanic (46) in the
 - 10 cheapest possible way, in order to subsequently continue the troubleshooting; and
 - for each one of a number of possible remote tests, carrying out the remote test and, depending on the outcome of the remote test, to connect the motor vehicle (2) with a mechanic (46) in the
 - 15 cheapest possible way in, order to subsequently continue the troubleshooting.

28. Computer program product for troubleshooting of a motor vehicle, comprising a computer program which, when executed
- 20 in a computer or several computers, makes it possible for the computer or computers to:
 - function in accordance with the computer based troubleshooting system (30) according to claim 27;
 - function in accordance with the troubleshooting method
 - 25 according to any of claims 21 to 26; or
 - function in accordance with the troubleshooting system (30) according to any of claims 1 to 20.

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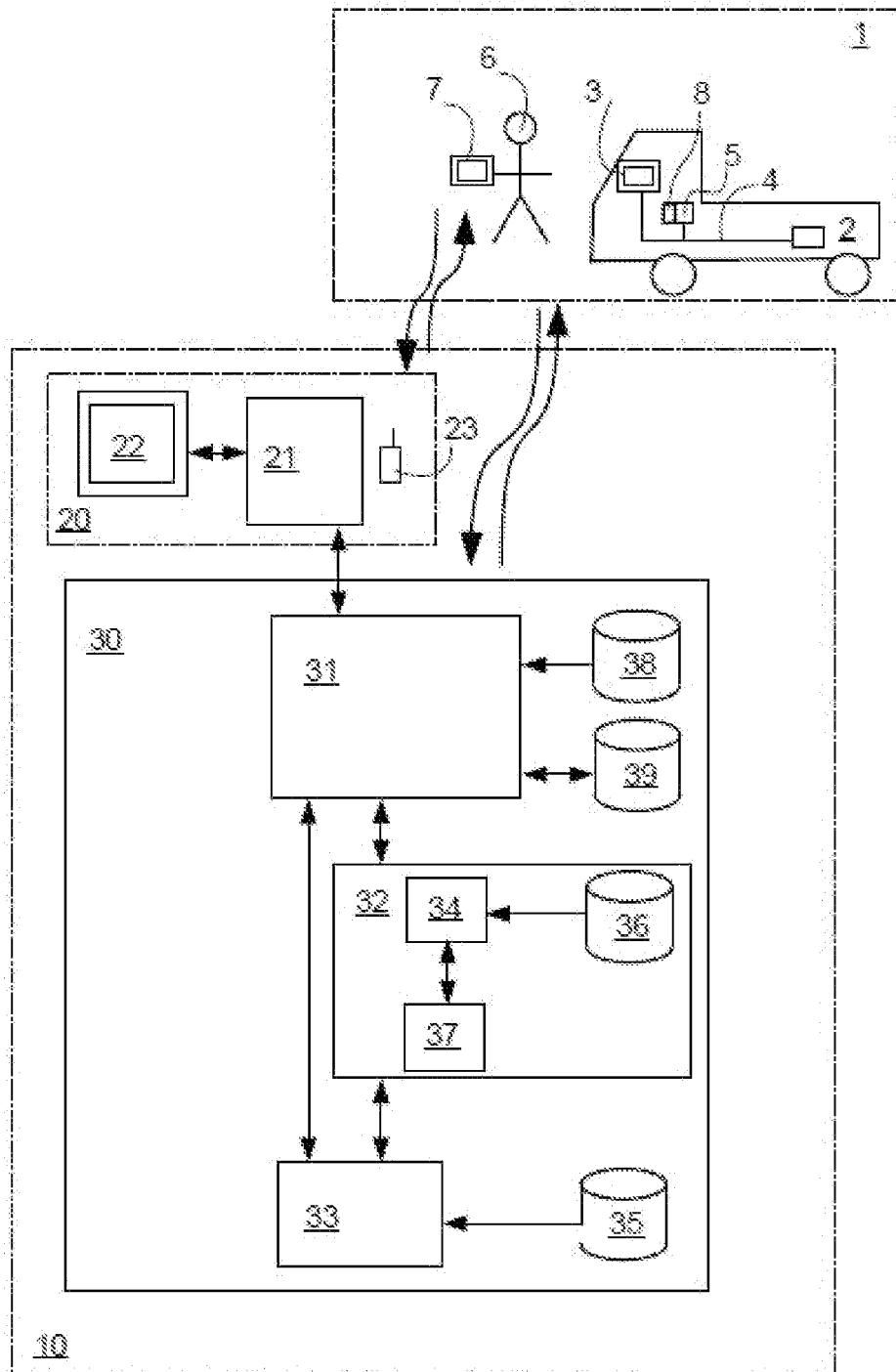


Fig. 1

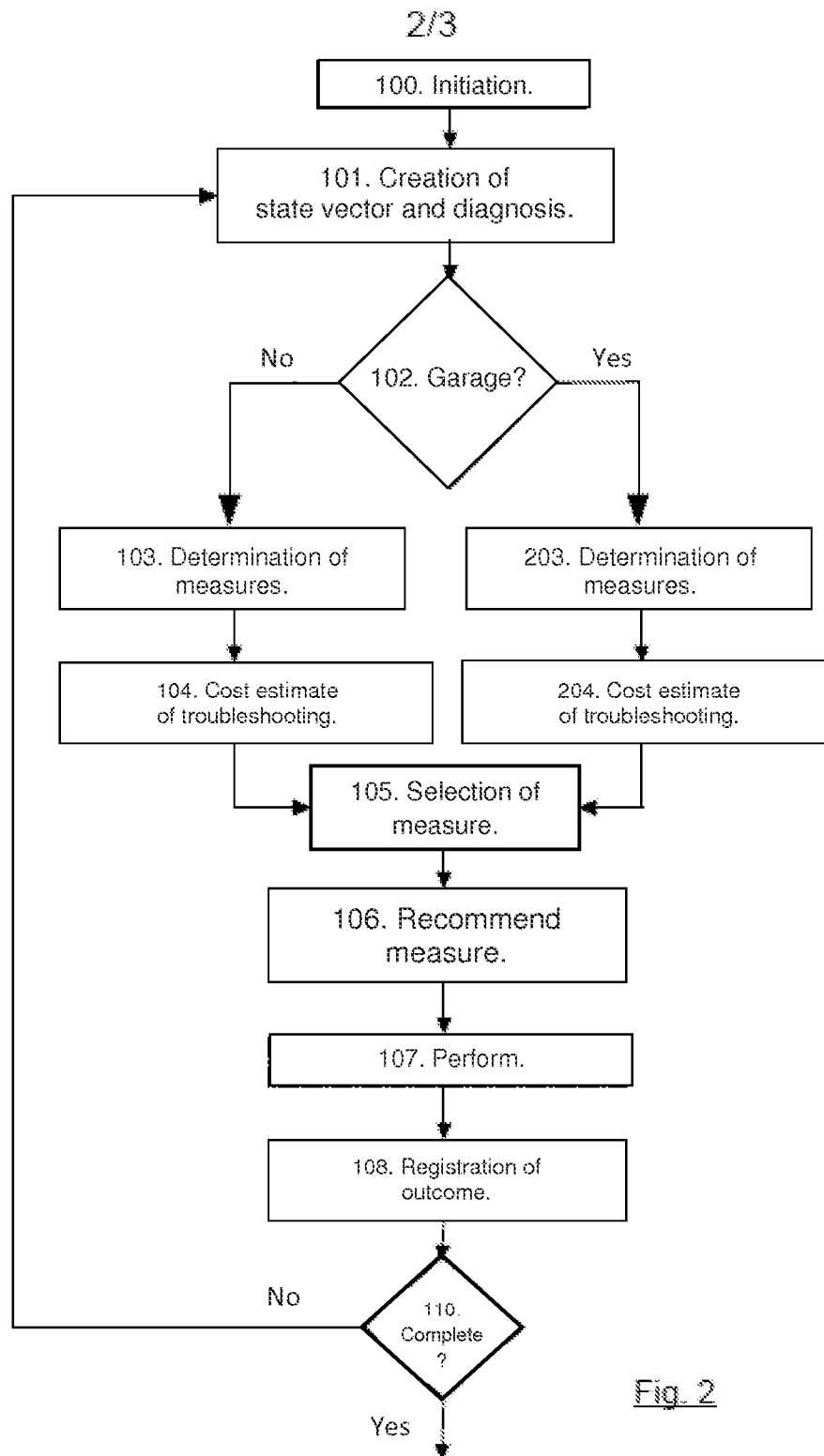


Fig. 2

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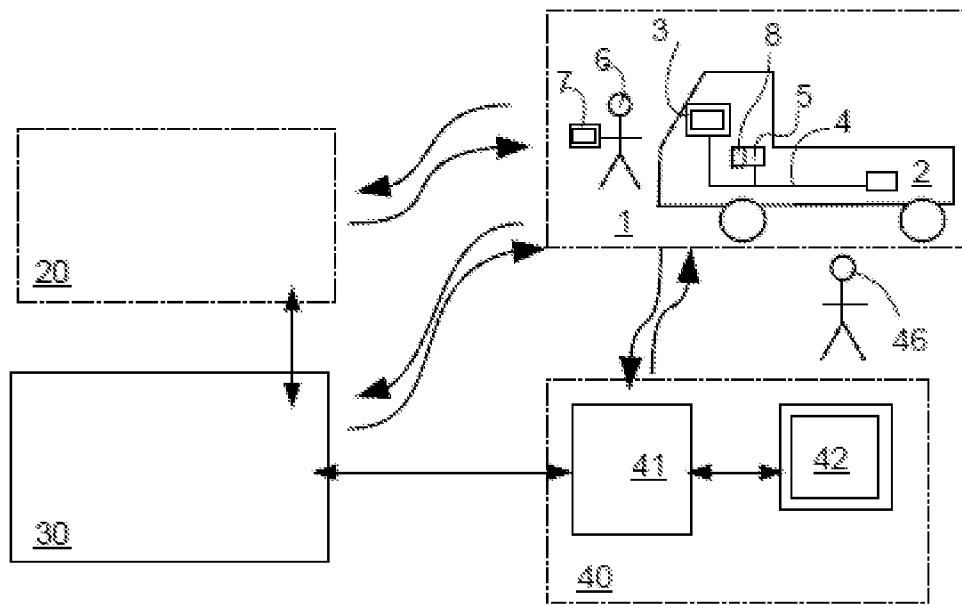


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No
PCT/SE2015/050381

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06Q10/04 G06Q10/00 G06Q30/00
ADD.

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)
G06Q

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/271256 A1 (SIEBEL ULRICH [DE] ET AL) 30 November 2006 (2006-11-30) abstract paragraph [0001] - paragraph [0023] claims 1-13 -----	1-28
X	DE 199 48 663 A1 (BAYERISCHE MOTOREN WERKE AG [DE]) 10 May 2001 (2001-05-10) abstract column 1, line 3 - column 3, line 38 claims 1-5 -----	1-28
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Date of the actual completion of the international search

30 June 2015

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08/07/2015

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INTERNATIONAL SEARCH REPORT

International application No

PCT/SE2015/050381

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
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Information on patent family members

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