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(54) **SYSTEM AND METHOD OF INTELLIGENT AGENT MANAGEMENT USING AN AGENT INTERFACE FOR USE IN VEHICLE DIAGNOSTICS**

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See application file for complete search history.

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(57) **ABSTRACT**

A system and method of intelligent agent management using an agent interface within a vehicle intelligent agent system is provided. The system includes a host system, and a local system in communication with the host system via a communications means. The system includes an intelligent agent that carries instructions or information regarding a task to be performed by the agent. The system further includes an interface having a processor and memory. The methodology includes the steps of the interface facilitating the transfer of instructions carried by the agent to the interface, copying predetermined information from the host system database into the interface memory, and assembling, by the interface processor, the agent instructions and stored information. The methodology further includes the steps of transferring the assembled instructions from the interface to the local processor, and transferring the assembled instructions from the local processor to the agent for execution.

8 Claims, 2 Drawing Sheets
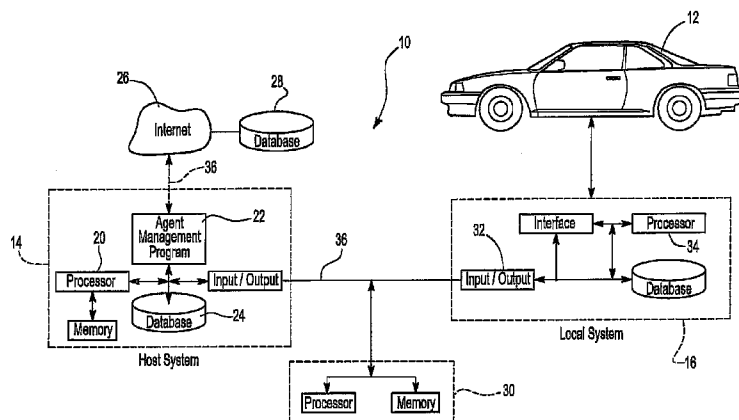
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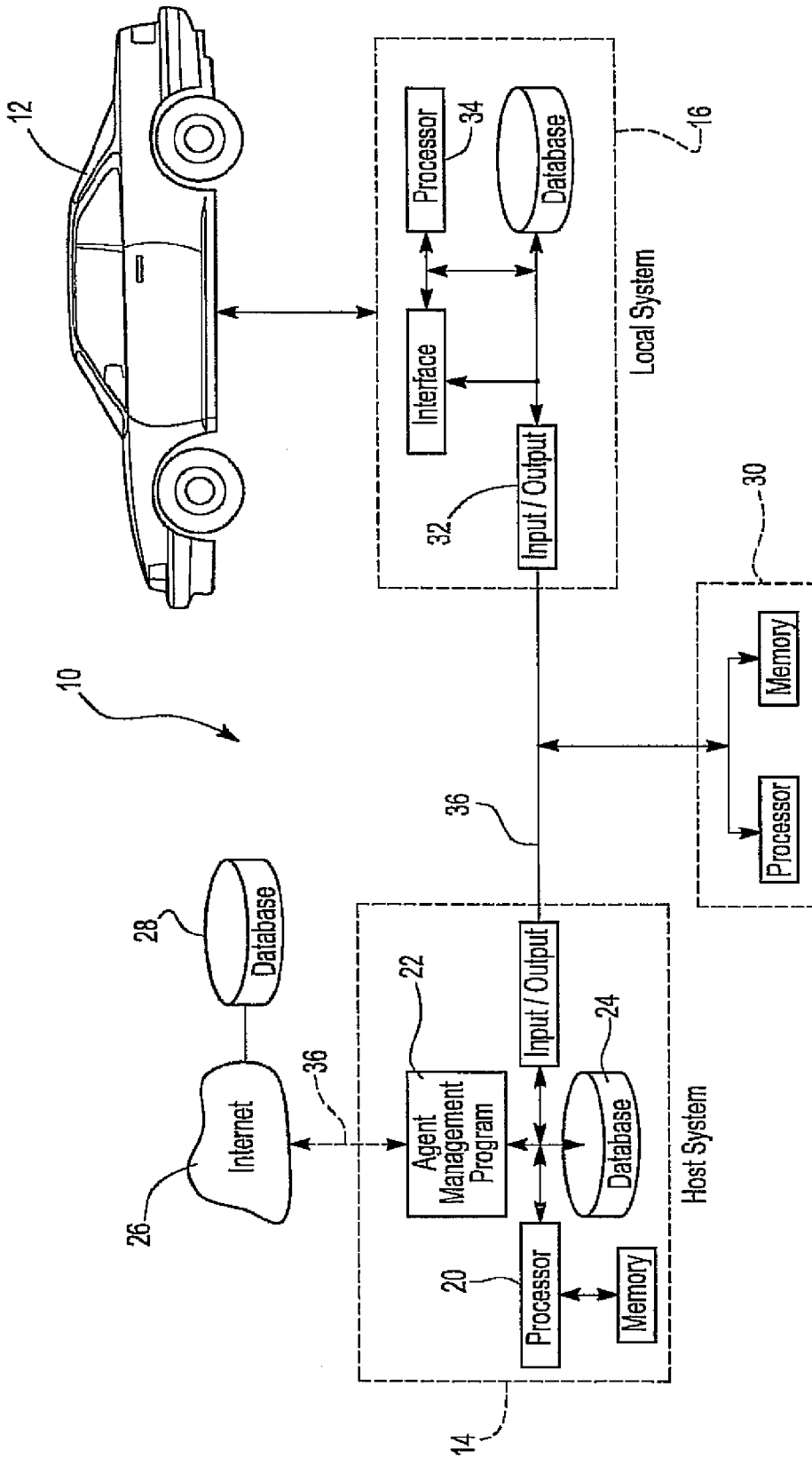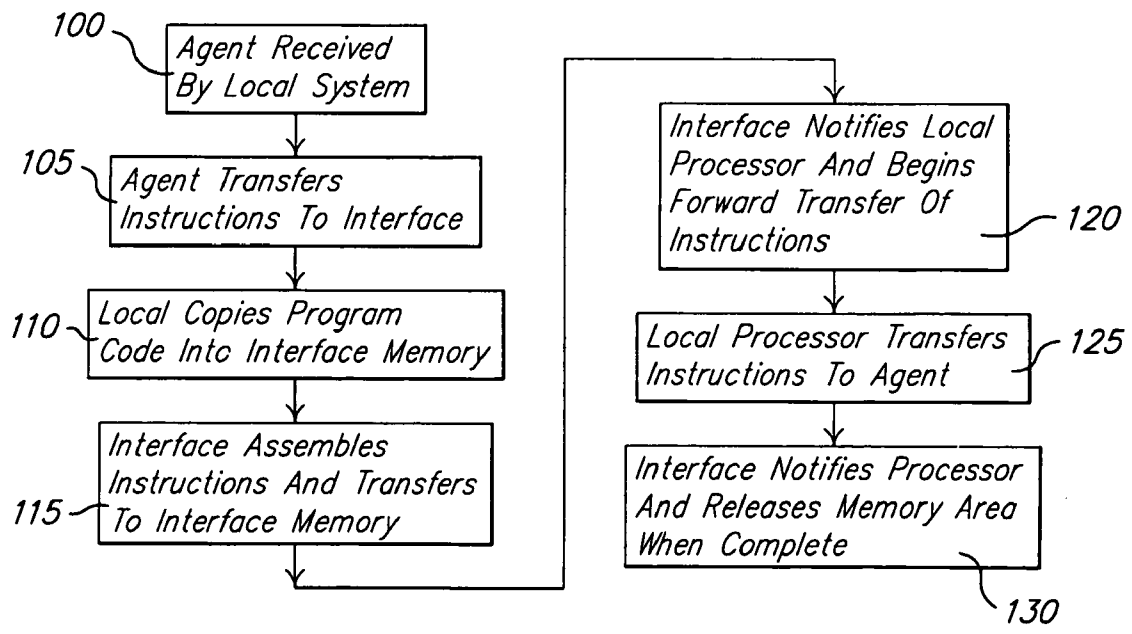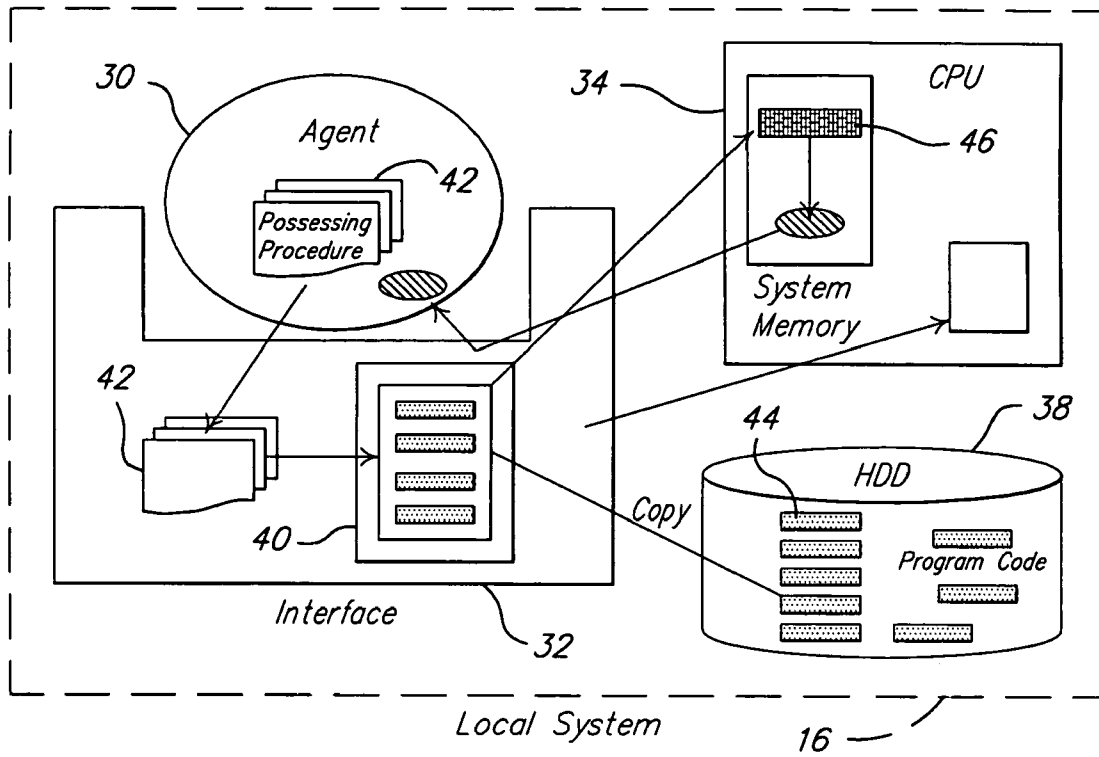
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Fig-1

30 Agent

42 Possessing Procedure

42

40

32 Interface

34

CPU

46

System Memory

44

Copy

HDD *38*

Program Code

Local System

16

FIG. 2.

100 Agent Received By Local System

105 Agent Transfers Instructions To Interface

110 Local Copies Program Code Into Interface Memory

115 Interface Assembles Instructions And Transfers To Interface Memory

120 Interface Notifies Local Processor And Begins Forward Transfer Of Instructions

125 Local Processor Transfers Instructions To Agent

130 Interface Notifies Processor And Releases Memory Area When Complete

FIG. 3.

SYSTEM AND METHOD OF INTELLIGENT AGENT MANAGEMENT USING AN AGENT INTERFACE FOR USE IN VEHICLE DIAGNOSTICS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to computer-assisted vehicle diagnostics and, more specifically, to a system and method of intelligent agent management using an agent interface, for use in vehicle diagnostics.

2. Description of the Related Art

Vehicles, and in particular motor vehicles, frequently incorporate monitoring systems that function to monitor the status of various vehicle components. An on-board diagnostic system (OBD) is frequently utilized in monitoring the engine, emissions, transmission or other key vehicle systems. The information obtained by such a monitoring system may be useful in detecting a vehicle condition, such as a malfunction, or other such abnormal operating condition. A key feature of the on-board diagnostic system is the ability to notify the vehicle operator of the detected vehicle condition. Early detection, diagnosis, or notification of a malfunction is important to the continued operation of the vehicle.

While the on-board diagnostic systems work well, they may not provide information regarding causation. Intelligent agent diagnostic systems are known to collect and transfer data within an electronic system that may be relevant to causation. An example of a multi-agent diagnostic system for a vehicle that can detect and isolate a fault is described in commonly assigned U.S. patent application Ser. No. 10/629,035, which is incorporated herein by reference.

The above-described system works well for fault isolation. A system and method of intelligent agent identification is disclosed in commonly assigned U.S. patent application Ser. No. 11/282,925, which is incorporated by reference. Agent identification provides security for the ingress and egress of an agent at the vehicle level. Another example of a system and method of intelligent agent management for an intelligent agent system improves the security of the intelligent agent system by searching for a malicious agent using an overseer agent, as is disclosed in commonly assigned U.S. patent application Ser. No. 11/411,289, which is incorporated herein by reference. A further example of a system and method of intelligent agent management provides for self-repair of the agent, as disclosed in commonly assigned U.S. patent application Ser. No. 11/430,382, which is also incorporated herein by reference.

SUMMARY OF THE INVENTION

Accordingly, the present invention is a system and method of intelligent agent management using an agent interface within an intelligent agent system of a vehicle. The system includes a host system having a processor, a memory associated with the processor and an input/output means and a local system having a processor, a memory associated with the processor and an input/output means. The system also an agent operatively in communication with the local system and host system via a communication network. The system further includes an interface that includes a processor and a memory, and is in communication with the rest of the local system and the agent via the communications means.

The method includes the steps of receiving an agent by a local intelligent agent system for the vehicle and transferring instructions carried by the agent to the interface within the

local system, and the instructions includes information regarding a task to be performed by the agent. The method still also includes the steps of copying predetermined information from the host system database into the memory portion of the interface via a communications network, and assembling the agent instructions together with the stored information by the interface processor. The methodology further includes the steps of transferring assembled instructions from the interface to the local system processor and transferring the assembled instructions from the local system processor to the agent. The methodology still includes the steps of executing the assembled instructions by the agent.

One advantage of the present invention is that a system and method of intelligent agent management for an intelligent agent system is provided that improves communication within the system. Another advantage of the present invention is that a system and method of intelligent agent management is provided that reduces the amount of program information carried by the agent by improving the allocation of resources within the electronic system for the vehicle. Still another advantage of the present invention is that a system and method of intelligent agent management is provided that utilizes an interface between the agent and the local system to allocate and better utilize the resources of the local system. Other features and advantages of the present invention will be readily appreciated as the same becomes better understood after reading the subsequent description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view of a system for use in conjunction with a method of agent management using an agent interface in an electronic system, according to the present invention.

FIG. 2 is a further diagrammatic view of the slave system of FIG. 1, according to the present invention.

FIG. 3 is a flowchart illustrating the method of agent management using an agent interface in an electronic system using the system of FIG. 1, according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

Referring to FIGS. 1 and 2, a system 10 for intelligent agent management using an agent interface in an electronic system is provided. In this example, the electronic system is incorporated in a vehicle 12, and in particular an automobile. The vehicle electronic system includes an intelligent diagnosis and repair feature. Expert agents, each having a specific function, are dispersed within the electronic system of the vehicle in order to monitor its behavior.

The system 10 for agent management using an agent interface includes at least one intelligent agent 30 disposed within the vehicle electronic system in a predetermined manner. For example, the agents 30 may be arranged in hierarchical layers. The intelligent agent 30 includes a microprocessor, a memory, a database, an input, an output and necessary operating software. The intelligent agent 30 encompasses many forms. For example, the intelligent agent 30 may be a sensing means, such as a sensor, or an electronic control. The intelligent agent 30 may also be an Application Specific Integrated Circuit (ASIC) incorporated into a computer controller. As such, the system may simultaneously include various types of agents, depending on the diagnostic task to be performed. One function of the agent 30 is to carry information 42 or instructions in the form of executable program code to a

particular component in the electronic system of the vehicle. The executable program code may contain instructions directing the agent to perform a particular function. One function is to obtain data that is analyzed and utilized by the vehicle. Another function of the agent **30** is to gather new information or knowledge through data logging, user input or output or diagnostics or the like. In this example, the collected data is used for intelligent vehicle diagnostics. The instructions may be stored within the agent processor. The size of the agent **30** depends on the function and executable instructions carried by the agent **30**.

It should be appreciated that recognition of the agent **30** is advantageous in preserving the integrity of the information. A non-identified agent or a non-conforming agent **30** may carry information that could have a negative impact on the vehicle **12**. The agent **30** may be identified within the system **10** using an identification code, or other identification information useful for identification verification purposes. The type of identification information may be a name or number or the like and the format is non-limiting. An example of a method of identifying the agent **30** is disclosed in commonly assigned U.S. patent application Ser. No. 11/282,925, which is incorporated by reference.

The system for agent management **10** includes a communication network **36** that selectively receives, transmits or monitors data communications between the various components within the system **10**. Various different types of communication means may be simultaneously incorporated within the communication network **36**. The communication means may be wired or wireless type connection, or the like. An example of a wired communication means is a data bus. An example of a LAN/WAN communication means is an intranet or internet **26**. The communication network **36** may include other types of linked communication devices, such as facsimile, telephone, pagers or cellular phones or the like.

The intelligent agent management system **10** includes a host system **14** operatively in communication with a local system **16** or the agent **30** via the communication network **36**. The local system **16** is also operatively in communication with the agent **30** via the communications network **36**. The host system **14** includes a processor **20** having a memory means, a data storage device **24**, an input/output interface means, and operational software programs **22**. The host data storage device may be a fixed memory device having a database or the like, or a removable memory device **24**. In this example, the host system **14** is a server. It should be appreciated that various other peripheral devices may be connected to the host system **14**, such as another remotely located data storage device **28**, or another computer system (not shown). Preferably, the host system **14** is a central computer facility remotely located from the vehicle.

The local system **16** is typically located at the vehicle level. An example of a local system **16** for a vehicle is an electronic control unit, or ECU. The local system **16** includes an input means, a processor **34** having a memory means, a communication means, an output means and a local data storage device **38**. For example, the processor is a CPU having a controller and a memory. The local data storage device **38** may be a fixed memory device having a database or the like, or a removable memory device.

The host computer system **14** and the local computer system **16** each maintain various software programs necessary to the operation of the system. For example, an agent management software program **22** coordinates the functions of the various agents **30** disposed within the system. An example of an agent management program **22** is disclosed in commonly assigned U.S. patent application Ser. No. 11/282,925, which

is incorporated by reference. In particular, the agent management software program **22** coordinates activities such as the addition of an agent, the deletion of an agent, the education of an agent and the generation of identification code for the agent, or the like. The agent management program **22** also coordinates communications within the system **10**.

The local system **16** further includes an interface **32**, as shown in FIG. **2**, that facilitates the processing of the instructions carried by the agent **30**. The interface **32** is operatively in communication with the agents **30**, as well as the rest of the system **10** via the previously described communication network **36**. The interface **32** may include a processor or controller **40**. In this example, the processor is a central processing unit (CPU) **40**. The interface stores data **42**, such as a process plan, process sequence for implementing the instructions and process content of the instructions. The use of the interface **32** advantageously reduces the size of the program instructions carried by the agent **30**. Therefore, the agent utilizes the resources of the local system **16**, including program code, system memory, database **38** or the like as necessary to carry out its responsibilities.

The system **10** may include other components or features relevant to the above-described system and the method to be described. For example, the system **10** may include an indicator means (not shown) for providing a message to the vehicle operator. The indicator means may be a visual means, such as an LED, CRT or LCD display or the like; or an audio means, such as a voice alarm or sound alarm or the like; or any other means of alerting the vehicle operator. The system **10** may include an interactive means for transmitting an input from a vehicle operator to the intelligent diagnostic system.

Referring to FIG. **3**, a method of intelligent agent management using an agent interface **32** is provided. The method is implemented by the system **10** described with respect to FIGS. **1** and **2**. The methodology assists in maintaining the size of the agent at a predetermined size that coincides with the load on the communication environment. The agent uses the interface **32** in executing the instructions carried by the agent **30** to the destination or local system **16**. The methodology takes place in the destination environment, which in this case is at the vehicle level.

The methodology begins in block **100** when called for. It should be appreciated that the methodology may be called for as part of the execution of the agent management software program. In block **100** the agent is received within the local system **16** by the interface **32**. It should be appreciated that the agent was previously identified. The interface **32** coordinates information and activities of the agent within the local system, and provides access to various resources within the local system **16**. The methodology continues to block **105**.

In block **105**, the agent **30** transfers the instructions **42** that it carries over to the interface **32**. The instructions **42**, as previously described, includes detailed information regarding the task to be executed by the agent **30** within the local system **16**.

In block **110**, the interface copies predetermined information **44** maintained in the local system database **38** into the interface memory **40**. For example, the stored information **44** may include program code or other data relevant to the agent and the instructions carried by the agent.

The methodology advances to block **115** and the interface processor **40** assembles together the stored information **44** from the local database **38** and processing procedure or instructions **42** from the agent into a single set of operating instructions **46**. Per the agent **30**, these operating instructions **46** may be forwarded to a memory portion of the processor.

The methodology advances to block **120** and the interface **32** notifies the local system processor **34** that the assembled operating instructions **46** are available and begins the forward transfer of such operating instructions **46** to the local system processor **34**. Preferably, the operating instructions **46** includes complete instructions for work to be executed by the agent **32**. The instructions may be in the form of executable program code. One example of a work instruction is to sense a temperature of a predetermined component. Another example of a work instruction is to sense a speed of the vehicle. The local system processor **34** may further process the information for use by the agent **30**.

In block **125**, the instructions are transferred from the local system processor **34** to the agent **30**. The agent **30** executes the instructions and collects the data. The data may be stored in the local agent's database **38**. Preferably, the data or information maintained in an agent database **31** is adaptively updated. That is, the newly learned information is added to the database and modifies the existing information in the database. The methodology may encrypt the information obtained by the agent through the local application program, using an encryption technique, as previously described. It should be appreciated that the encryption steps improve the security of the system **10**.

In block **130**, the interface **32** notifies that local system processor **34** that the agent's work is complete, and the local system **16** releases the memory area of the processor for other activities. The memory area deletes the information stored in the reserved memory area of the processor **34** when it is no longer needed. For example, the information is deleted when the receiving agent **30** completes execution of its program instruction **46**. It should be appreciated that this memory space is now available for other uses.

Advantageously, the consistency and accuracy of the information is improved through management of communications within the system. An advantage of this methodology is that it utilizes existing hardware.

It should be appreciated that the methodology may include other steps necessary for the implementation of the method. Further, the steps may be executed in another order, while achieving the same result. It should also be appreciated that the methodology may be implemented in an iterative manner.

The present invention has been described in an illustrative manner. It is to be understood that the terminology which has been used is intended to be in the nature of words of description rather than of limitation.

Many modifications and variations of the present invention are possible in light of the above teachings. Therefore, within the scope of the appended claims, the present invention may be practiced other than as specifically described.

The invention claimed is:

1. A method of intelligent agent management using an agent interface within an intelligent agent system for a vehicle, said method including the steps of:

receiving an agent by a local intelligent agent system for the vehicle, wherein the agent includes a processor and a memory associated with the processor and the local system includes a processor having a memory and a database;

transferring instructions carried by the agent to an interface within the local system via a communication network, wherein the interface includes a memory and a processor and the instructions includes information regarding a task to be performed by the agent;

copying predetermined information from a host system database to the interface via the communications network;

assembling together the agent instructions and information stored in the local system memory by the interface processor to produce assembled operating instructions;

transferring the assembled operating instructions from the interface to the local system processor;

transferring the assembled operating instructions from the local system processor to the agent; and

executing the assembled operating instructions by the agent.

2. A method as set forth in claim **1** further including the step of the interface notifying the local system processor that the memory of the processor can be released for other uses.

3. A method as set forth in claim **1** wherein the assembled operating instructions includes executable code for the task to be performed by the agent.

4. A method as set forth in claim **1** further including the step of using the assembled operating instructions by the agent for vehicle diagnostics.

5. A method of intelligent agent management using an agent interface within an intelligent agent system for a vehicle, said method including the steps of:

receiving an agent by a local intelligent agent system for the vehicle, wherein the agent includes a processor and a memory associated with the processor and the local system includes a processor having a memory and a database;

transferring instructions carried by the agent to an interface within the local system via communications network, wherein the interface includes a memory and a processor and the instructions includes information regarding a task to be performed by the agent;

copying predetermined information from a host system database to the interface via the communications network;

assembling together the agent instructions and information stored in the local system memory by the interface processor to produce assembled operating instructions;

transferring the assembled operating instructions from the interface to the local system processor;

transferring the assembled operating instructions from the local system processor to the agent;

executing the assembled operating instructions by the agent; and

notifying the local system processor that the memory of the processor can be released for other uses.

6. A method as set forth in claim **5** wherein the assembled operating instructions includes executable code for the task to be performed by the agent.

7. A method as set forth in claim **5** further including the step of using the assembled instructions by the agent for vehicle diagnostics.

8. A system of intelligent agent management using an agent interface within an intelligent agent system for a vehicle, comprising:

a host system within the intelligent agent system, wherein the host system includes a processor, a memory associated with the processor, means for input/output communication, and a database;

a local system in communication with the host system via a communications network, wherein the local system includes a processor, a memory associated with the processor, a means for input/output communication, and a database;

an intelligent agent in communication with the host system and the local system via the communication network, wherein the intelligent agent include a processor and a

memory associated with the processor, and instructions stored within the processor memory regarding a task to be performed by the agent;

an interface within the local system, wherein the interface includes a processor and a memory associated with the processor and the interface;

wherein the interface copies predetermined information from the host system database into the memory portion of the interface via the communication network, the interface processor assembles the agent instructions together with the information stored in the local system memory to produce assembled operating instructions, the interface transfers the assembled operating instructions to the local system processor, and the local system processor transfers the assembled operating instructions to the agent for execution by the agent.

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