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(54) VEHICLE DIAGNOSTICS

(57) A method of providing a vehicle diagnostics data from a vehicle 10 having a Wi-Fi interface 11 to a diagnostics tool 18, 20 is described. The method comprises at a vehicles communications interface, VCI 22 having a Wi-Fi access point, Wi-Fi AP, 54 providing a VCI Wi-Fi network configured with a system set identifier, SSID, at least in part recognisable by the vehicle, accepting a connection request generated by the vehicle to use a wire-

less connection over the VCI Wi-Fi network, establishing a wireless connection between a Wi-Fi interface of the vehicle and the Wi-Fi AP of the VCI adapter over the VCI Wi-Fi network and relaying data between the vehicle and the vehicle diagnostics tool over the established wireless connection, wherein the relayed data includes vehicle diagnostics data.

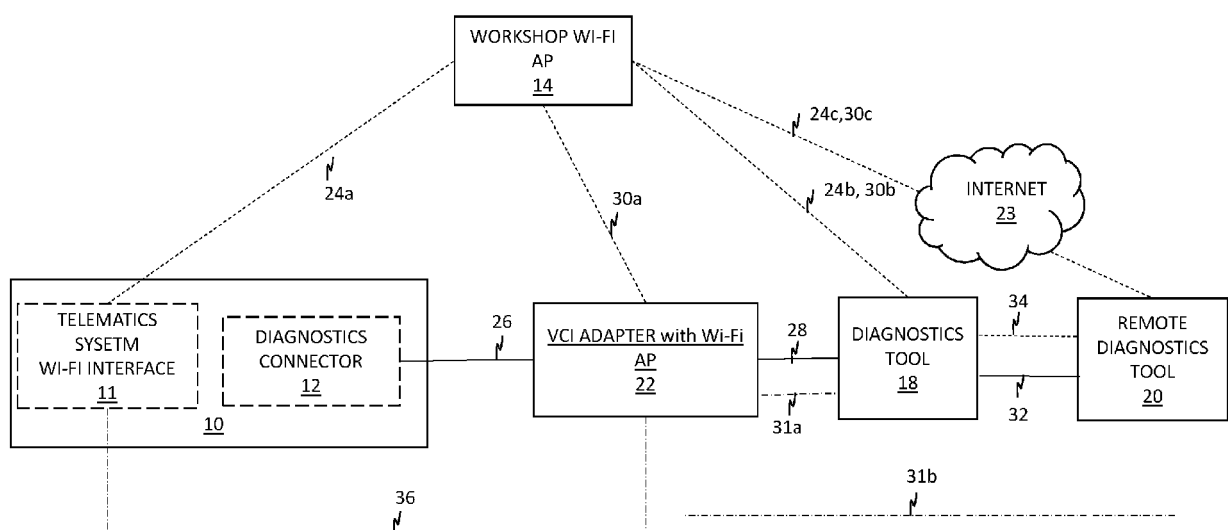


FIGURE 2

Description

TECHNICAL FIELD

[0001] The present disclosure relates to a method of providing vehicle diagnostics data via a vehicle communications interface, VCI, adapter configured to provide a wireless communications network which uses a system set identifier, SSID, as its network name which is recognisable by a vehicle and to various related aspects.

[0002] In particular, but not exclusively the disclosed technology relates to a method of providing vehicle diagnostics data over a high-bandwidth wireless connection from a vehicle using its telematics Wi-Fi interface with a vehicle communications interface, VCI, adapter which is configured to provide a Wi-Fi access point. The VCI access point is configured to allow wireless communications channels to be provided between the vehicle and at least one other device. This allows vehicle diagnostics data to be relayed via the VCI adapter between the vehicle and apparatus hosting a local or remote vehicle diagnostics tool.

[0003] The disclosed invention will be described mainly with respect to vehicles, however, such vehicles may include heavy-duty vehicles, such as semi-trailer vehicles and trucks as well as other types of vehicles such as cars. The vehicles may be autonomous or semi-autonomous vehicles in some embodiments.

BACKGROUND

[0004] The transfer of diagnostics data from a vehicle to a vehicle diagnostics tool is usually performed under the control of the vehicle's electronic control unit, ECU. A vehicle which needs to be repaired or updated, and/or have a new item of equipment installed or reconfigured may need to provide diagnostics data to allow the repair/update/installation/reconfiguration to be completed correctly. Such repairs/updates/installations/reconfigurations etc. are vulnerable to failure and the ECU and other parts of the vehicle may be compromised if corrupted data is transferred. This means that workshops which require diagnostics data from vehicles will normally provide security credentials so that the vehicle is able to safely establish a secure connection with the workshop's diagnostic equipment. The secure connection may be physical and uses the diagnostics connector on the vehicle to form a wired connection via a VCI adapter with a local diagnostics tool (as in located in that workshop) or remote (as in located in the cloud) diagnostics tool.

[0005] The VCI adapter is configured to provide a suitable interface which takes into account the operating system and software supporting the vehicle diagnostics tool, for example, it may support diagnostics tools running on one or more of Windows, Android, or OS operating system based software.

[0006] A wired connection, for example, such as a controller area network (CAN) connection, between the ve-

hicle's diagnostics connector and the VCI adapter however cannot support very high data transfer rates to allow for rapid data transfers in either direction between the vehicle and the vehicle diagnostics tool. This is problematic as the volume of data to be transferred from the vehicle to the vehicle diagnostics tool is increasing as vehicles become equipped with ever more sophisticated equipment requiring software diagnostics for their maintenance and/or repair. The time a vehicle spends in a workshop for repairs reduces its availability for work and the availability of the workshop to handle other vehicles requiring attention and diagnostics.

[0007] Although it is possible to use higher bandwidth wired connections, for example, 100 Mbps Ethernet connections, eventually these will not be sufficient fast for the very large volume data transfers which will be required in future, for example, to update the ECUs of autonomous heavy-duty vehicles and the like or other vehicles which have complex internal parts and/or download diagnostic data from such vehicles to a diagnostic tool via the VCI adapter.

[0008] One solution suitable for vehicles which already have telematics systems and so are already equipped with an on-board Wi-Fi interface is to use this as Wi-Fi interface as a diagnostic interface. However, this Wi-Fi interface cannot be the sole connection relied upon as the Wi-Fi interface itself may not always be available or operational in which case if that is the only form of access to the diagnostics data a repair, installation or update would not be possible unless a wired connection was also available. Such a situation could easily occur as, for example, an antenna or modem could be damaged, or the Wi-Fi software could be corrupted or become out of date. Another scenario where relying only on the Wi-Fi interface occurs if the ECU which controlled the Wi-Fi interface was replaced by a new ECU without any Wi-Fi configuration.

[0009] Accordingly, it is desirable to allow vehicles to still be able to use physical connections as back-ups. The VCI adapters used in workshops ideally should still be able to use a physical diagnostics cable connection with a vehicle's diagnostics connector.

[0010] The disclosed technology seeks to mitigate, obviate, alleviate, or eliminate various issues known in the art which affect how vehicles are able to share data for diagnostic purposes, such as, for example, those mentioned above.

SUMMARY STATEMENTS

[0011] Whilst the invention is defined by the accompanying claims, various aspects of the disclosed technology including the claimed technology are set out in this summary section with examples of some preferred embodiments and indications of possible technical benefits.

[0012] The disclosed technology relates to a vehicle diagnostics system in which a vehicle having a Wi-Fi interface, for example, one used for telematics, uses a wire-

less connection via a VCI adapter having a Wi-Fi access point, AP, to provide vehicle diagnostic data to a vehicle diagnostics tool. The method comprises at the VCI adapter: implementing, using the VCI adapter, a wireless, for example Wi-Fi, access point and using this to relay data between the vehicle and a vehicle diagnostics tool, wherein the relayed data includes vehicle diagnostics data relayed from the vehicle to the vehicle diagnostics tool. A first aspect of the disclosed technology relates to a method of providing a vehicle diagnostics data from a vehicle having a Wi-Fi interface to a diagnostics tool the method comprising at a vehicles communications interface, VCI, having a Wi-Fi access point, Wi-Fi AP, providing a VCI Wi-Fi network configured with a system set identifier, SSID, at least in part recognisable by the vehicle, accepting a connection request generated by the vehicle to use a wireless connection over the VCI Wi-Fi network, establishing a wireless connection between a Wi-Fi interface of the vehicle and the Wi-Fi AP of the VCI adapter over the VCI Wi-Fi network, and relaying data between the vehicle and the vehicle diagnostics tool over the established wireless connection, wherein the relayed data includes vehicle diagnostics data.

[0013] Advantageously the method provides a vehicle with a trusted Wi-Fi AP to connect to without first needing to transfer any workshop Wi-Fi credential or security certificate to the vehicle. The method also allows communication via a wired communication interface in situations where the wireless connection is not available/not secure/does not provide suitable bandwidth or for some other reason the wired connection is preferred in other words, it is supplementary to existing technology and does not replace existing technology. Consequently, the method has the potential to improve the overall performance of a vehicle diagnostics service by supporting higher data transfer speeds in a secure manner over a trusted communications link.

[0014] In some embodiments, the Wi-Fi access point implemented using the VCI adapter is configured either by a remote diagnostics tool or a local the vehicle diagnostics tool.

[0015] In some embodiments, the data is relayed over a wireless connection between the vehicle, the VCI adapter, the vehicle diagnostic tool and the remote system which is at least initially evaluated in terms of the throughput or bandwidth of the data being relayed along the wireless connection.

[0016] In some embodiments, the method further comprises the VCI adapter obtaining an identifier for a vehicle via a wired connection with the vehicle, wherein the system set identifier, SSID, for the wireless access point provided by the VCI adapter includes a unique identifier based on or comprising the identifier for the vehicle.

[0017] In some embodiments, the method further comprises the VCI adapter SSID relaying the obtained identifier for the vehicle to the remote system, and configuring the VCI adapter to include the unique identifier based on the relayed identifier.

[0018] In some embodiments, the SSID for the wireless network access point provided by the VCI adapter is identical for a plurality of VCIs.

[0019] In some embodiments, the SSID for the wireless network access point provided by the VCI adapter is different for each VCI adapter but comprises a vehicle recognisable part.

[0020] In some embodiments, the vehicle recognisable part comprises a VCI identifier and/or a vehicle identifier.

[0021] In some embodiments, the vehicle is a heavy duty vehicle and the vehicle diagnostics tool is a vehicle diagnostics tool for heavy-duty vehicles.

[0022] In some embodiments, the VCI adapter is configured to switch between wired and wireless communication with the vehicle responsive to a bandwidth and/or throughput evaluation over a current wired or wireless connection with the vehicle.

[0023] A second aspect of the disclosed technology relates to a vehicle communication interface, VCI, adapter for communicating with a vehicle, wherein the VCI adapter provides a Wi-Fi access point for a vehicle to provide diagnostics data to a vehicle diagnostics tool, wherein the VCI adapter Wi-Fi access point is configured to relay data between the vehicle and the corresponding vehicle diagnostics tool.

[0024] In some embodiments, the VCI adapter Wi-Fi access point is set up from a remote diagnostics tool.

[0025] In some embodiments, the connection formed between the vehicle and the VCI adapter and the VCI adapter, the vehicle diagnostic and the remote system is initially evaluated in terms of throughput/bandwidth.

[0026] In some embodiments, the VCI adapter is configured to implement a method according to the method aspect or any of the disclosed embodiments of the method.

[0027] A third aspect of the disclosed technology relates to a computer program product comprising computer code, wherein when the computer code is executed by one or more processors or processing circuitry of a vehicle communications interface, VCI, adapter, the VCI adapter is configured to implement a method according to the first aspect of any of the embodiments of the method.

[0028] The disclosed aspects and embodiments may be combined with each other in any suitable manner which would be apparent to someone of ordinary skill in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] Some embodiments of the disclosed technology are described below with reference to the accompanying drawings which are by way of example only and in which:

Figure 1 schematically illustrates a prior art system for obtaining vehicle diagnostics;

Figure 2 schematically illustrates a vehicle diagnostics system for obtaining vehicle diagnostics via a VCI adapter according to some embodiments of the disclosed technology;

Figure 3A schematically illustrates a method of obtaining information to configure a VCI adapter's SSID according to some embodiments of the disclosed technology;

Figure 3B schematically illustrates a method of for providing vehicle diagnostics data according using a VCI Wi-Fi network having a vehicle-recognisable SSID to some embodiments of the disclosed technology;

Figures 4A to 4C illustrates schematically examples of Wi-Fi SSIDS which may be detected by a vehicle; and

Figure 5 illustrates schematically a diagnostics system according to some embodiments of the disclosed technology.

DESCRIPTION OF EXISTING TECHNOLOGY

[0030] An example of a vehicle diagnostics system which uses wired and wireless connections for vehicle diagnostics known in the art is illustrated in Figure 1 of the accompanying drawings.

[0031] Figure 1 shows a scenario where a vehicle 10 is located at a vehicle diagnostics workshop site or similar type of premises. In Figure 1, the vehicle 10 has a telematics system which includes a Wi-Fi interface 11. In the scenario shown, the vehicle 10 may require a repair, or an upgrade, or reconfiguration or installation of some software or hardware which requires diagnostics data to be shared by the vehicle 10 with a local diagnostic tool 18, local meaning located at the workshop so it can be connected to the vehicle 10. The diagnostics data may also be shared with a remote diagnostics tool 20 in some situations.

[0032] The workshop network equipment provides a workshop Wi-Fi access point, shown as Workshop Wi-Fi AP 14 in Figure 1, with which the vehicle 10 can connect to over wireless communications link 24a using its telematics system's Wi-Fi interface 11. To do this, the vehicle must have received certain credentials/certificates. However, if the workshop is privately owned, the SSID may not be recognised as belonging to a trustable network by the vehicle. Even if the vehicle is able to locate the SSID of the workshop, unless it has the corresponding credentials/certificates, it will not request a connection over the Wi-Fi access point 14. This is not a problem if the workshop is a vehicle-manufacturer authorized workshop where such credentials/certificates may be provided by the vehicle manufacturer to the vehicle in advance.

[0033] If a Wi-Fi access point 14 is used, this allows the vehicle to form a data channel over wireless communications link 24a and over wireless communications link 24b with the vehicle diagnostics tool 16. It is also possible to and also, in some embodiments, use a wireless communications link 24c to communicate directly with a cloud-based or remote diagnostics tool 20 via the Internet 23.

[0034] The vehicle 10 also has a diagnostics connector 12 to which a vehicle communications interface, VCI, 16 can be physically connected. The VCI adapter 16 may be plugged directly into the diagnostics connector 12 in some situations or indirectly physically connected using a diagnostic cable 26.

[0035] The VCI adapter 16 may be configured also in some situations use wireless connections 30a, 30b via the workshop Wi-Fi access point 14 (shown a second time in Figure 1 for clarity) to connect with the local diagnostics tool 18 and/or to use a wired connection 28 with the local diagnostics tool 18 in order to transfer diagnostics data from the vehicle 10 to the local diagnostics tool 18.

[0036] The local diagnostics tool 18 is configured to process diagnostics data it receives from a vehicle in order to provide a diagnostics result and/or to provide data to the vehicle, for example, to update software and the like. In some situations, the local diagnostics tool 18 also may be configured to forward some or all of the diagnostics data it receives in some circumstances to the remote diagnostics tool 20 for analysis/further analysis and/or to receive data from the remote diagnostics tool 20. The communication between the local and remote diagnostics tool may use wired connection 32 or wireless connection 33. In reality these may extend into the cloud/internet (not shown for clarity in Figure 1) to reach the remote diagnostics tool 20 in some situations. As shown in Figure 1 the VCI adapter 16 may also communicate with the remote diagnostics tool 20 via connections 30a, 30c in some situations.

[0037] Once a connection is established between the vehicle 10 and the local diagnostics tool 18 (and/or with the remote diagnostics tool 20 if required), the diagnostics data can be shared at a transfer rate which will be limited by the maximum bandwidth available along the connection(s).

DETAILED DESCRIPTION OF THE INVENTION

[0038] Aspects of the present disclosure will be described more fully hereinafter with reference to the accompanying drawings. The apparatus and method disclosed herein can, however, be realized in many different forms and should not be construed as being limited to the aspects set forth herein. Steps, whether explicitly referred to a such or if implicit, may be re-ordered or omitted if not essential to some of the disclosed embodiments. Like numbers in the drawings refer to like elements throughout.

[0039] The terminology used herein is for the purpose of describing particular aspects of the disclosure only, and is not intended to limit the disclosed technology embodiments described herein. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0040] If a vehicle uses a workshop where the Wi-Fi environment is known and the same Wi-Fi SSID is available each time the vehicle visits that workshop, it is possible for the vehicle to establish a degree of trust that it is connecting to the right Wi-Fi AP by configuring the vehicle to store the credentials/certificate to connect with the predefined SSID.

[0041] However, if a vehicle breaks down and needs to use a different workshop, or if the Wi-Fi credentials are not already known to the vehicle for some reason, for example, in privately owned workshops the SSID will normally be different at each workshop (and could also vary within the same workshop between two visits), even if the vehicle detects a valid SSID it won't have the corresponding credential/certificates to connect. These credential/certificate are owned by workshop and are sensitive data.

[0042] A problem exists accordingly when a vehicle is at a workshop where the workshop Wi-Fi access point are untrusted, where untrusted means the network credentials and/or certificates are not yet known and/or not verifiable and/or have not been previously verified either by the vehicle or by a third party such as the vehicle manufacturer. Trusted credentials/certificates can be verified by the vehicle checking against stored information to that effect on the vehicle to match the credentials/certificates to entries/records in a list of trusted credentials/certificates which includes credentials/certificates either previously verified by the vehicle and/or by the vehicles manufacturer.

[0043] Figure 2 of the accompanying drawings shows schematically an example vehicle diagnostics system in which a different type of VCI adapter 22 is provided which may address this problem. The VCI adapter 22 is configured to allow a wireless communications channel 36 to be established by a vehicle 10 with the VCI adapter 22. The VCI adapter 22 can be configured to obtain information from the vehicle 10 in advance using a wired connection 26 via the vehicle diagnostics connector 12, for example, using a method such as that shown in Figure 3A described later below. The information obtained allows the vehicle to recognise the wireless network provided by the VCI adapter 22 is a trusted or trustable network. The VCI adapter 22 can then perform a method such as that shown in Figure 3B.

[0044] Figure 3A shows how the VCI adapter 22 is able to configure its Wi-Fi network to use a trusted SSID which the vehicle 10 will recognise. For example, the VCI adapter 22 may request an identifier for the vehicle, for example, from the ECU of the vehicle using the wired connection 26 with the vehicle's diagnostic connector 12 in 102a.

The obtained vehicle identifier information may then be used to generate a SSID in 104b which the vehicle is able to recognise and so trust originates from the VCI adapter 22. The VCI adapter 22 then configures its Wi-Fi network access point to use the trusted SSID, in others it configures the name of the Wi-Fi network it provides in 102c. Some examples of how the SSID may be generated using the vehicle identifier information to have a vehicle recognisable part which allows the vehicle to trust it can safely connect to that VCI adapter 22 are provided later below. The connection formed over wireless connection 36 is still initiated by the vehicle 10 for security.

[0045] Returning briefly to Figure 2, this also shows some of the other connections which the VCI 22 may form in the vehicle diagnostics system. For example, a wireless connection 31a using the VCI Wi-Fi network may be formed between the VCI adapter 22 and a local diagnostics tool 18, and/or a wireless connection 31b may be established with the remote diagnostics tool 20. In some embodiments, there may also be connections with the workshop Wi-Fi AP 14 and a wired connection 28 with the local diagnostics tool 18.

[0046] Embodiments of a diagnostics system according to the disclosed technology, of which an example embodiment is shown in Figure 2, are accordingly able to provide a network with a SSID a vehicle can trust even if it does not have credential/certificates already provided for that network. This allows vehicle diagnostic data to be relayed between the vehicle 10 and a local or remote vehicle diagnostics tool 18, 20 without the limitations that a wired connection would have if a wired connection were used to connect the vehicle to the VCI adapter 22.

[0047] Figure 3B shows an example of a method 100 which is performed to relay vehicles diagnostics data between the vehicle 10 and a vehicle diagnostics tool 18, 22 via such a VCI adapter 22. The method 100 comprises, having first configured the VCI adapter to have a vehicle trusted SSID in 102, the VCI adapter establishing Wi-Fi data channel between the vehicle 10 and the vehicle diagnostics tool 16 in 108. To do this, a Wi-Fi connection is established between the vehicle, for example, using the telematics system Wi-Fi interface shown in Figure 2 and the VCI adapter 22 in 104. This may involve, for example, the vehicle detecting the trusted SSID network and requesting a connection over it with the VCI adapter 22. The VCI adapter 22 is then able to accept the request and establish a Wi-Fi connection between the vehicle 10 shown as 104 in Figure 3B. The VCI adapter 22 may then be configured, responsive to having established a connection with the vehicle 10, to establish another connection with a vehicle diagnostics tool 18, 20 in 106. A communications link, in other words a data channel, can then be established over the wireless connections between the vehicle 10 and the vehicle diagnostics tool 18 (or 22) in 108.

[0048] This allows diagnostics data to be relayed in 110 between the vehicle 10 and the vehicle diagnostics tool 18, 20. The diagnostics data may comprise data pro-

vided under the control of the vehicle's ECU to the vehicle diagnostics tool 18, 20 for processing and analysis. Data may also be provided responsive to a request sent by the vehicle diagnostics tool 18, 20 to the vehicle which the vehicle's ECU and/or the vehicle's automated driving system, ADS, is used to process. For example, additional types of diagnostics data (for example, additional types of sensor data or data derived from sensor data may be requested or perhaps more detailed, granular data) may be requested in specific circumstances to perform a particular type of diagnostic test.

[0049] Figure 3B also shows how, optionally, in some embodiments, responsive to establishing a wireless communications channel between the vehicle 10, the VCI adapter 22, and the vehicle diagnostic tool 18 or the remote diagnostics tool 20, when diagnostics data is automatically sent over the wireless link between the vehicle and the VCI adapter 22 the wireless communications channel is initially evaluated in terms of throughput or bandwidth of the diagnostics data being relayed along the wireless communications channel in 112. In some embodiments, this allows the VCI adapter 22 to compare in 114 the bandwidth/throughput of data over the wireless communications channel established over the connection 36 between the VCI adapter 22 and the Wi-Fi interface of the vehicle 10 and the data transfer speeds which would be available using the wired diagnostic connection 26 between the VCI adapter and the diagnostics connector 12 of the vehicle. This allows, for example if the Wi-Fi interface of the vehicle is not supporting at a suitably high data transfer rate, the VCI adapter to switch to the wired connection with the vehicle if this would support a higher connection speed in 116. If the wireless connection is sufficiently high, however, the diagnostics data continues to be relayed using the wireless communications link in 110.

[0050] In some embodiments of the disclosed technology, the VCI adapter 22 is configured to switch between wired and wireless communication with the vehicle responsive to a bandwidth and/or throughput evaluation over a current wired or wireless connection with the vehicle.

[0051] Figures 4A to 4C shows schematically examples of network SSIDs. Figure 4A shows an example where a wireless network SSID may be named based on the workshop. As shown in Figure 4A, one SSID 38a is simply labelled "WorkshopToolAP". The other networks shown are merely for illustrative purposes and in some scenarios there may not be any other Wi-Fi networks available for a vehicle to connect to in a workshop. Such a network 38a may be connected to by a vehicle however only if the vehicle knows it can trust the network connection, for example, based on having verified that network's credentials/certificates previously for example.

[0052] Figures 4B and 4C show examples of a vehicle trustable Wi-Fi network SSID which is provided by a vehicle adapter 22 providing a Wi-Fi access point according to the disclosed technology. The Wi-Fi SSIDs 38b and

38c now include information obtained by the VCI adapter 22 using its wired connection with the vehicle. Figure 4b shows an example how the Wi-Fi SSID 38b conforms to a predetermined format which indicates it may contain a vehicle recognisable part using a pre-fix, for example, as shown VCI_SN: followed by a unique identifier for that VCI adapter/vehicle. For example, a vehicle serial number may be used as the unique identifier in some embodiments. The identifier may be unique to the vehicle and also may in some embodiments be a one-time only identifier, for example, it may include data information or other information time-limiting its use. Figure 4C shows another example of a Wi-Fi SSID 38c having a predetermined format which may be used to provide a unique identifier for that VCI adapter/vehicle wireless network in which the SSID takes the form of an VCI identifier followed by the VIN identifier.

[0053] By having an SSID for the wireless network access point provided by the VCI adapter 22 which is different for each VCI adapter, it is easier for vehicles in a workshop with multiple VCI adapters to connect to the correct VCI adapter 22. For example, a VCI adapter may use its VCI serial number as part of the SSID for its Wi-Fi network. The VCI serial number may have been previously provided using the wired connection to the vehicle's ECU so that the ECU will recognise it is to connect to a Wi-Fi network with that SSID. If the vehicle VIN is also used, this increases the likelihood the vehicle 10 can trust its connection with the VCI adapter 22. Whatever form of SSID is used, in order for the vehicle 19 to know it should connect to the network with that SSID to connect with the right VCI adapter 22, the ECU of the vehicle 10 can be suitably configured to check first for a particular structure or format of SSID when it detects a network. It is also possible for the vehicle and VCI to exchange some other form of identifier to allow the vehicle to recognise that VCI's Wi-Fi network SSID should be used to form a wireless connection 26. For example, a shared secret could be exchanged in some embodiments, and this would allow a further degree of security to be provided when updating the vehicle in a workshop as the public key could be used in the SSID and a suitable protocol implemented between the vehicle and the VCI when establishing the wireless connection 26. Accordingly, in some embodiments, the vehicle recognisable part of the SSID may comprise at least in part a VCI identifier and/or a vehicle identifier. Accordingly, in some embodiments, the vehicle recognisable part of the SSID may comprise a pre-determined format.

[0054] By establishing a wireless connection between the vehicle diagnostics tool 18, 20 which uses a wireless connection 36 as shown in Figure 2 between the VCI adapter 22 and the vehicle's Wi-Fi interface, higher connection speeds may be obtained than using a wired connection 26 between the vehicle 10 and the VCI adapter 16 as shown in Figure 1. This may be particularly useful for some embodiments where the vehicle is a heavy-duty vehicle and/or an autonomous, semi-autonomous or oth-

erwise automated, including vehicles which are remote controlled. As the diagnostic data volume to be transferred for diagnostics for such vehicles to occur is much higher than for other types of vehicles which have less complex internal systems.

[0055] Accordingly, in some embodiments, the vehicle is an autonomous, semi-autonomous or automated vehicle with an electronic control unit and an ADS configured to make tactical decisions for a control system in some embodiments. The vehicle may be a heavy-duty vehicle in some embodiments. A heavy-duty vehicle may comprise a wide range of different physical devices, such as combustion engines, electric machines, friction brakes, regenerative brakes, shock absorbers, air bellows, and power steering pumps. These physical devices are commonly known as Motion Support Devices (MSD). The MSDs may be individually controllable, for instance such that friction brakes may be applied at one wheel, i.e., a negative torque, while another wheel on the vehicle, perhaps even on the same wheel axle, is simultaneously used to generate a positive torque by means of an electric machine. The autonomous operation of a heavy-duty vehicle is accordingly more complex than the autonomous operation of a more light-weight vehicle such as a car. For similar reasons performing diagnostics tests on a heavy-duty vehicle, whether autonomous, semi-autonomous, automated or semi-automated, or manually driveable, is more complex and requires the transfer of large amounts of data more data than would be required for conventional vehicles. The vehicle diagnostics tool 18, 20 is a diagnostics tool which is suitably configured to handle diagnostics of such vehicles.

[0056] Although the network connection provided by the VCI adapter 22 disclosed herein is primarily discloses as providing a Wi-Fi network connection, the term "Wi-Fi" may be considered to include other suitable forms of wireless communications protocols which would allow suitable connections to be formed with the vehicle, providing the vehicle is also provided with a suitable interface for such a wireless communications protocol and the connection would support the high-speeds required for diagnostics data transfer to not take too long in the workshop.

[0057] Figure 5 shows diagnostics system in which a method 100 of providing a vehicle diagnostics data from a vehicle 10 having a Wi-Fi interface 11 to a diagnostics tool 18, 20 is performed. The method 100 comprises, at a vehicles communications interface, VCI, adapter 22, having a Wi-Fi access point, Wi-Fi AP, 54, providing a VCI Wi-Fi network configured with a system set identifier, SSID, at least in part recognisable by the vehicle 10, accepting a connection request generated by the vehicle 10 to use a wireless connection over the VCI Wi-Fi network, establishing a wireless connection 36 between a Wi-Fi interface 11 of the vehicle 10 and the Wi-Fi AP 54 of the VCI adapter 22 over the VCI Wi-Fi network, relaying data between the vehicle 10 and the vehicle diagnostics tool 18 over the established wireless connection 36,

wherein the relayed data includes vehicle diagnostics data.

[0058] In the diagnostics system shown in Figure 5, some examples of system components which may be used to implement the disclosed method of providing vehicle diagnostics data are illustrated schematically. Figure 5 shows schematically an embodiment of a vehicle 10 which may be diagnosed by the diagnostic system. The illustrated embodiment of the vehicle 10 includes an advanced or automated driving system, ADS 40, an operating system 42, a memory 44, a diagnostics data reporting module 46, an ECU 48 which is configured to provide vehicle diagnostics data, for example, using a vehicle diagnostics data module 46. The vehicle 10 has a Wi-Fi interface 11, for example, a Wi-Fi interface 11 used by its telematics system (not shown in Figure 5), and also a diagnostics connector 12 which may be connected directly to a VCI adapter 22 or indirectly to the VCI adapter 22 using a wired connection 26.

[0059] As shown schematically in Figure 5, the VCI adapter 22 comprises a suitable memory transmitter/receiver 52 for sending and receiving data communications over its Wi-Fi AP 54, a memory 56 for storing information, for example, the vehicle ID it receives from vehicle 10 may be stored in memory 56. The VCI adapter 22 is also provided with suitable operating system, OS 58, and may include one or more data processor(s) or processing circuitry 60. The memory 56 may also be configured to store computer program code which, when loaded and executed by the one or more data processor(s) or processing circuitry 60 causes the VCI adapter 22 to implement the method aspect 100 or any of the disclosed embodiments of the method 100.

[0060] In some embodiments the VCI adapter 22 is configured communicate with vehicle, 10, using the network provided by its wireless or Wi-Fi access point, AP, 54. By allowing the vehicle 10 to connect to the VCI Wi-Fi network, diagnostics data can be relayed via the VCI adapter 22 between the vehicle and a vehicle diagnostics tool, 18, 20. In some embodiments, the VCI adapter 22 is configured to form a wired connection with the vehicle via a diagnostics connector 12, of the vehicle and obtain and/or share information with the electronic control unit, ECU, 48 of the vehicle which allows the VCI Wi-Fi network provided by the Wi-Fi AP 54 to use a SSID which includes a vehicle-recognisable part.

[0061] In some embodiments, the SSID of the VCI Wi-Fi AP 54 is configured by a local diagnostics tool 18 to have a pre-determined format which uses an identifier for the VCI adapter 22 and/or a vehicle identifier received from the vehicle 10. Alternatively, the VCI Wi-Fi AP 54 may be configured by a remote diagnostics tool 20 in some embodiments.

[0062] In some embodiments, the VCI adapter 22 is further configured to evaluate the wireless connection 36 formed between the vehicle 10 and the VCI adapter 22 at least initially in terms of throughput/bandwidth, compare the data transfer speeds obtained over the Wi-Fi

connection 36 with available wired connection data transfer speeds over a wired diagnostics connection 26 between the VCI adapter 22 and the vehicle 10, and then switches the connection to use the wired diagnostics connection in the event that this has the higher data transfer speeds.

[0063] The computer program code may, in some embodiments of the disclosed technology, be provided by a computer program product comprising the computer code which when executed by the one or more processors or processing circuitry of the VCI adapter 22 enables the VCI adapter 22 to implement the method aspect 100 or any of its disclosed embodiments.

[0064] Also shown schematically in in Figure 5 is an example embodiment of a vehicle diagnostics tool 18. The diagnostics tool 18 comprises suitable memory 62, processors 64, an operating system 66 and suitable transmitter/receiver component(s) 68 configured to use wired connections, for example, wired connection 28 or wireless connections, for example, wireless connection 31a, with the VCI adapter 22. The VCI diagnostics tool 18 is configured in some embodiments of the diagnostics system to configure the Wi-Fi AP 54 implemented using the VCI adapter 22. Alternatively, the VCI diagnostics tool 18 may provide vehicle identifying information and VCI identifying information to a remote system, in other words, to a remote diagnostics tool 20, which processes the received information to determine a suitable SSID for the VCI adapter 22 to use.

[0065] Accordingly, in some embodiments of the VCI adapter 22, the VCI adapter 22 obtains an identifier for the vehicle 10 via a wired connection 26 with the vehicle, provides the identifier to the vehicle diagnostics tool 18, 20, receives back a system set identifier, SSID, from the vehicle diagnostics tool 18, 20, and then configuring its VCI Wi-Fi AP 54 to provide a network with the received SSID. The SSID may include a unique identifier based on or comprising the identifier for the vehicle 10 and/or an identifier for the VCI adapter 22.

[0066] In some embodiments, the SSID has a predetermined vehicle recognisable format, wherein the ECU 48 of the vehicle 10, responsive to the vehicle 10 detecting an Wi-Fi network SSID with the predetermined format, is able to recognise the SSID as belonging to a Wi-Fi network AP 54 of VCI adapter 22 with which it has or had a wired connection.

[0067] In some embodiments, the vehicle recognisable part of the SSID comprises a VCI identifier and/or a vehicle identifier, for example, the SSID may include at least in part a vehicle VIN and a serial number for the VCI adapter 22. In some embodiments, the VCI adapter 22 may be configured to connect with a vehicle 10 which is an autonomous, semi-autonomous or automated vehicle. In such embodiments, the vehicle diagnostics tool 18, 20 is a vehicle diagnostics tool for autonomous, semi-autonomous or automated vehicles. In some embodiments, the vehicle may be heavy duty vehicle and the vehicle diagnostics tool is a vehicle diagnostics tool for

heavy-duty vehicles, and the VCI adapter 22 is configured to connect with heavy-duty vehicles.

[0068] The VCI adapter 22 may also be configured to monitor and/or evaluate from time to time, or at least initially after the connection 36 with the vehicle 10 is first established, the data speeds of the data relayed over the wireless connection 36 between the vehicle 10 and the VCI adapter 22. For example, the data speeds of the data relayed over the wireless connection 36 between the vehicle 10 and the VCI adapter 22 may be monitored and evaluated in terms of the throughput or bandwidth of the data being relayed along the wireless Wi-Fi connection 36. In some embodiments, this allows the VCI adapter 22 is configured to switch between the wireless Wi-Fi connection 36 and the wired connection 26 and vice versa comparing the available bandwidth and/or throughput over a currently used Wi-Fi connection 36 or wired connection 26 with the vehicle 10.

[0069] The software used to configure the VCI adapter 22 to have the vehicle recognisable SSID may be provided by the local diagnostics tool using a suitable user interface. For example, the local diagnostics tool may be implemented on a computer such as a PC or Android device, mobile communications device or tablet having a HMI, Human Machine Interface, also referred to herein as a user interface. The user interface allows data to be input to the local diagnostics tool software application. In some embodiments of the vehicle diagnostics tool 18, 20, this allows a user to configure one or more characteristics of the VCI AP 54 such as, for example, its SSID name, channel, authentication method.

[0070] Alternatively, in some embodiments, the VCI AP 54 is provided with a hidden configuration which may be implemented on the diagnostics tool without requiring an HMI or UI, for example, by the vehicle manufacturer. This hidden configuration enables the SSID to be recreated on the VCI adapter 22 so that the vehicle manufacturer controls what types of SSID formats are used. In both cases, to avoid interferences between different VCIs in the same workshop, the frequency/ channel should be able to be configured and/or reconfigured at the workshop, i.e. in situ, and this may also need to be configured dynamically each time a vehicle wired connection is first formed with the vehicle.

[0071] Based on the received Wi-Fi AP configuration data, the VCI adapter 22 can configure a Wi-Fi AP with the appropriate SSID as soon as it is provided with sufficient power. The VCI adapter 22 doesn't need to be plugged to the vehicle 10 to be powered at this point, as it may receive power from the diagnostics tool 18 to which it has a wired connection or even be provided with a battery power source. If the VCI adapter 22 does not have any wired connection with the vehicle, then it is not possible to use the wired interface as a back-up connection if the wireless link fails, in other words, it won't be possible for the VCI adapter 22 to automatically transfer the diagnostics data channel to use the wired connection 26 if the data speeds drop to a lower transfer rate than could

be achieved using that connection 26 instead of the Wi-Fi connection 36.

[0072] As mentioned above, a vehicle is able to have more confidence it is forming a connection with a trusted wireless communications network provide by the correct VCI adapter because the network SSID for the network provided by that VCI adapter will follow a predetermined structure/format/naming convention.

[0073] The SSID format which the vehicle 10 may be configured to recognise can differ in different embodiments. For example, in some embodiments, the SSID provided by a VCI adaptor 22 may be always the same for all the VCIs at a particular workshop or location. In some embodiments, the SSID provided by each VCI adapter 22 at a location with multiple VCI adapters 22 is different for each VCI adapter but retains in its format a part or sub-label that a vehicle 10 can recognize so that it knows which VCI it should connect with.

[0074] For example, in some embodiments, as mentioned above the SSID may include an identifier for the VCI adapter 22 such as its serial number and also an identifier for the vehicle. The vehicle identifier may be fetched by the VCI adapter 22 using its wired connection or interface with the vehicle's ECU 48. For example, the SSID of the VCI network may use part or all of a vehicle VIN number as the vehicle identifier and/or part or all of a VCI serial number as the VCI adapter identifier in some embodiments. For example, the SSID may be set to something like:

VCI_SN123456_VIN0123456789012345 in some embodiments. Alternatively, the SSID may use the vehicle identifier in some embodiments, e.g. just use VCI_SN123456 or just use a vehicle identifier, for example, just use VIN0123456789012345 in some other embodiments. It is also possible to use another user configured SSID provided via the vehicle diagnostics tool 18, 20 in some embodiments, providing the format is one which the vehicle 10 can recognise as originating from the correct VCI adapter 22 via which it is to share data with that vehicle diagnostics tool 18, 20.

[0075] In some embodiments, although the VCI adapter 22 establishes, 106, a Wi-Fi connection with the vehicle diagnostics tool using its Wi-Fi AP 54, the connection between the VCI adapter 22 and the diagnostic tool 18, 20 may use an existing workshop's Wi-Fi connection, such as connection 30a and 30b shown in Figure 2

[0076] Whilst in some embodiments the same access point provided by the VCI-AP 54 is used by both the diagnostic tool 18 and the vehicle 10, alternatively, in some embodiments, the VCI adapter 22 will provide two different Wi-Fi networks which have different SSIDs (i.e. different network names are used for each of the two different networks), and the vehicle diagnostics tool will be connected to a network using a different SSID to the SSID of the network that the vehicle uses. In either of these embodiments, the serial number of the VCI adapter 22 may be represented in full or in part in the SSID to simplify matching between the diagnostic tool 18 and the VCI

adapter 22.

[0077] In some embodiments, the vehicle 10 which forms a connection to the VCI adapter Wi-Fi AP provided network is able to recognize the VCI Wi-Fi network it should connect to using a list of Wi-Fi network SSIDs it is allowed to connect to. This list is configured in the vehicle software and can be regularly and remotely updated by the vehicle's telematics system using a trusted Wi-Fi connection or using a 4G/5G data connection.

[0078] The vehicle connects to the SSID provided by the VCI adapter only if it matches one in its own list or if there are some rules which indicate a predetermined format for acceptable connections. For example, SSIDs may include a predetermined type of prefix such as "VCI_SN" in their SSID. The vehicle 10 can use an appropriate authentication method such as, for example, EAP-TLS with certification, to avoid any requirements to provide an ID and password when seeking to connect with the VCI Wi-Fi network.

[0079] In some embodiments, the SSID of the VCI Wi-Fi network doesn't include a vehicle identifier for that vehicle. In some embodiments of the system shown in Figure 5, for example, several VCI adapters, each connected to different vehicle diagnostic systems 18 may be configured to provide Wi-Fi networks with the same SSID.

[0080] In this case, where multiple networks use the same SSID, the vehicle will recognise multiple networks that it could connect to but must select one. The selection made by the vehicle may be based in some embodiments on the strongest detected Wi-Fi network signal. This is likely to be associated with the closest VCI adapter to the vehicle, which is likely to be the VCI adapter 22 connected to the vehicle 10. In this embodiment, the signal strength is used as a metric and the highest the signal strength usually means the closest the network source is, although this is not 100% guaranteed. To reduce or avoid the issue of the vehicle 10 connecting to the wrong network in such situations, it is accordingly preferable to have a vehicle specific identifier included in the SSID, such as the vehicle's VIN.

[0081] Once connected to the correct VCI's Wi-Fi network the vehicle 10 beings an IP assignment procedure, for example, it may request (for example, using the Dynamic Host Configuration Protocol, DHCP) to establish an IP link between the vehicle 10 and the vehicle diagnostics tool (see 108 in Figure 3B). Vehicle diagnostics data can now be relayed between the vehicle 10 and the vehicle diagnostics tool 18 via the Wi-Fi access point provided by the VCI adapter 22 (shown in Figure 3B as 110).

[0082] The wired connection used by the VCI adapter 22 to connect to the vehicle 10 may comprise a Controller Area Network, Can, bus and/or an Ethernet connection in some embodiments. A CAN bus however is relatively quite a slow connection often limited to data transfer speeds below 500kbps/2Mbps. An Ethernet offers higher speeds but these are still relatively low and 100Mbps, whereas a Wi-Fi connection can offer far faster speeds,

for example, in the region of 500 Mbps or higher speeds at 1Gbps, 10Gbps in some situations. However, the actual wireless data transfer speeds may be affected by environmental issues and/or by the Wi-Fi interface 11 provided at the vehicle 10.

[0083] In some embodiments of the method, the VCI adapter 22 is configured to monitor and/or measure the Wi-Fi emission/reception connection speeds to assess if the wireless connection 36 has a data transfer speed greater than the wired data transfer speeds it could use instead over wired connection 26 with the vehicle 10.

[0084] For the actual bandwidth assessment, the VCI adapter can apply a factor (e.g.: 2) to the theoretical connection speed or run a specific speed test implemented on the vehicle side. In some embodiments, diagnostics data traffic is switched between wired and wireless connections depending on the available wireless bandwidth/throughput. The switch may be triggered in either direction by the vehicle 10 or the VCI and traffic re-routed from/to the wireless connection 36 to the wired connection 26 depending on which offers the faster data transfer speed. The change from the wired to the wireless connection may be controlled by the vehicle diagnostics tool 18 receiving the data in some embodiments. In some embodiments however it may be automatically implemented by the VCI adapter 22. It can be automatic in the VCI adapter especially if it is the traffic is based on the IP (Internet Protocol). Pure IP based vehicle diagnostics protocols, for example, Diagnostics over Internet Protocol, DoIP, and Service Oriented Vehicle Diagnostics, SOVD, can be routed either on the wireless connection 36 or the wired connection 26. The VCI 22 can act as a router independently from the diagnostic tool 28.

[0085] The disclosed technology seeks to improve the way that vehicle diagnostics data is provided to local and remote diagnostics tools 18, 20 in a way that still allows for wired connections to be used between the vehicle and VCI adapter 22 for the diagnostics tool 18, 20. A benefit of providing the Wi-Fi access point using the VCI adapter 22 rather than, for example, using a Wi-Fi access point provided by a vehicle diagnostics tool directly is that available bandwidth is less likely to be affected by movement. As, the vehicle 10 is serviced, the vehicle diagnostics tool may be moved around which may affect the bandwidth and other characteristics of any Wi-Fi network it provided, also, the diagnostics tool 18 would need to be configured with a dedicated Wi-Fi interface for that purpose. Another drawback to providing a wireless access tool using a diagnostic tool is that the diagnostic tool may be moved around the vehicle more during the diagnostic procedure which in turn could influence the wireless bandwidth available to transfer data between the vehicle and the diagnostic tool.

[0086] Some, if not all, of the above embodiments may be implemented using computer program code which may be provided as software or hardcoded, for example, as a computer program product configured to be implemented using a VCI adapter.

[0087] Those skilled in the art will also appreciate that the processor(s) and processing circuitry and the memory providing computer readable storage described herein above may refer to a combination of analog and digital circuits and/or one or more processors configured with software and/or firmware, for example, software and/or firmware stored in a memory. One or more of these processors, as well as the other digital hardware, may be included in a single application-specific integrated circuit (ASIC), or several processors and various digital hardware may be distributed among several separate components, whether individually packaged or assembled into a system-on-a-chip (SoC).

[0088] The vehicle's electronic control unit, ECU, comprises or is capable of controlling how signals are sent wirelessly via suitable antenna(s) in order for the vehicle 10 to communicate via one or more communications channels with remote entities, for example, the vehicle diagnostics tool.

[0089] The communication channels may be point-to-point, or use networks, for example, as shown in the Figures, a Wi-Fi network provided by a Wi-Fi AP 54 located at a VCI adapter 22 can be used. The vehicle's ECU may also be configured to use, for example, cellular or satellite networks which support wireless communications. The wireless communications may conform to one or more public or proprietary communications standards, protocols and/or technologies, including but not limited to Global System for Mobile Communications (GSM), Enhanced Data GSM Environment (EDGE), high-speed downlink packet access (HSDPA), wideband code division multiple access (W-CDMA), code division multiple access (CDMA), time division multiple access (TDMA), Bluetooth, Wireless Fidelity (Wi-Fi) (e.g., IEEE 802.11a, IEEE 802.11b, IEEE 802.11g and/or IEEE 802.11n), voice over Internet Protocol (VoIP), Wi-MAX, a protocol for email (e.g., Internet message access protocol (IMAP) and/or post office protocol (POP)), instant messaging (e.g., extensible messaging and presence protocol (XMPP), Session Initiation Protocol for Instant Messaging and Presence Leveraging Extensions (SIMPLE), and/or Instant Messaging and Presence Service (IMPS)), and/or Short Message Service (SMS)), or any other suitable communication protocol, including communication protocols not yet developed as of the filing date of this document.

[0090] The operating system of the vehicle may further various software components and/or drivers for controlling and managing general system tasks (e.g., memory management, storage device control, power management, etc.) which facilitate communication between various hardware and software components of the vehicle, these may not be shown in the Figures for the sake of clarity where such components would be apparent to one of ordinary skill in the art. For example, all of the components shown in Figure 5 require electrical power to operate, and the source of such electrical power is not indicated in the drawings for the same of clarity.

[0091] Where the disclosed technology is described with reference to drawings in the form of block diagrams and/or flowcharts, it is understood that several entities in the drawings, e.g., blocks of the block diagrams, and also combinations of entities in the drawings, can be implemented by computer program instructions, which instructions can be stored in a computer-readable memory, and also loaded onto a computer or other programmable data processing apparatus. Such computer program instructions can be provided to a processor of a general purpose computer, a special purpose computer and/or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer and/or other programmable data processing apparatus, create means for implementing the functions/acts specified in the block diagrams and/or flowchart block or blocks.

[0092] In some implementations and according to some aspects of the disclosure, the functions or steps noted in the blocks can occur out of the order noted in the operational illustrations. For example, two blocks shown in succession can in fact be executed substantially concurrently or the blocks can sometimes be executed in the reverse order, depending upon the functionality/acts involved. Also, the functions or steps noted in the blocks can according to some aspects of the disclosure be executed continuously in a loop.

[0093] The description of the example embodiments provided herein have been presented for the purposes of illustration. The description is not intended to be exhaustive or to limit example embodiments to the precise form disclosed, and modifications and variations are possible in light of the above teachings or may be acquired from practice of various alternatives to the provided embodiments. The examples discussed herein were chosen and described in order to explain the principles and the nature of various example embodiments and its practical application to enable one skilled in the art to utilize the example embodiments in various manners and with various modifications as are suited to the particular use contemplated. The features of the embodiments described herein may be combined in all possible combinations of methods, apparatus, modules, systems, and computer program products. It should be appreciated that the example embodiments presented herein may be practiced in any combination with each other.

[0094] It should be noted that the word "comprising" does not necessarily exclude the presence of other elements, features, functions, or steps than those listed and the words "a" or "an" preceding an element do not exclude the presence of a plurality of such elements, features, functions, or steps. It should further be noted that any reference signs do not limit the scope of the claims, that the example embodiments may be implemented at least in part by means of both hardware and software, and that several "means", "units" or "devices" may be represented by the same item of hardware.

[0095] The various example embodiments described

herein are described in the general context of methods, and may refer to elements, functions, steps or processes, one or more or all of which may be implemented in one aspect by a computer program product, embodied in a computer-readable medium, including computer-executable instructions, such as program code, executed by computers in networked environments.

[0096] A computer-readable medium may include removable and non-removable storage devices including, but not limited to, Read Only Memory (ROM), Random Access Memory, (RAM), which may be static RAM, SRAM, or dynamic RAM, DRAM. ROM may be programmable ROM, PROM, or EPROM, erasable programmable ROM, or electrically erasable programmable ROM, EEPROM. Suitable storage components for memory may be integrated as chips into a printed circuit board or other substrate connected with one or more processors or processing modules, or provided as removable components, for example, by flash memory (also known as USB sticks), compact discs (CDs), digital versatile discs (DVD), and any other suitable forms of memory. Unless not suitable for the application at hand, memory may also be distributed over a various forms of memory and storage components, and may be provided remotely on a server or servers, such as may be provided by a cloud-based storage solution. Generally, program modules may include routines, programs, objects, components, data structures, etc. that perform particular tasks or implement particular abstract data types. Computer-executable instructions, associated data structures, and program modules represent examples of program code for executing steps of the methods disclosed herein. The particular sequence of such executable instructions or associated data structures represents examples of corresponding acts for implementing the functions described in such steps or processes.

[0097] The memory used by any apparatus whatever its form of electronic apparatus described herein accordingly comprise any suitable device readable and/or writable medium, examples of which include, but are not limited to: any form of volatile or non-volatile computer readable memory including, without limitation, persistent storage, solid-state memory, remotely mounted memory, magnetic media, optical media, random access memory (RAM), read-only memory (ROM), mass storage media (for example, a hard disk), removable storage media (for example, a flash drive, a Compact Disk (CD) or a Digital Video Disk (DVD)), and/or any other volatile or non-volatile, non-transitory device readable and/or computer-executable memory devices that store information, data, and/or instructions that may be used by processing circuitry. Memory may store any suitable instructions, data or information, including a computer program, software, an application including one or more of logic, rules, code, tables, etc. and/or other instructions capable of being executed by processing circuitry and, utilized by the apparatus in whatever form of electronic apparatus. Memory may be used to store any calculations made by process-

ing circuitry and/or any data received via a user or communications or other type of data interface. In some embodiments, processing circuitry and memory are integrated. Memory may be also dispersed amongst one or more system or apparatus components. For example, memory may comprise a plurality of different memory modules, including modules located on other network nodes in some embodiments.

[0098] In the drawings and specification, there have been disclosed exemplary aspects of the disclosure. However, many variations and modifications can be made to these aspects which fall within the scope of the accompanying claims. Thus, the disclosure should be regarded as illustrative rather than restrictive in terms of supporting the claim scope which is not to be limited to the particular examples of the aspects and embodiments described above. The invention which is exemplified herein by the various aspects and embodiments described above has a scope which is defined by the following claims.

Claims

1. A method of providing a vehicle diagnostics data from a vehicle (10) having a Wi-Fi interface (11) to a diagnostics tool (18, 20) the method comprising:
 - at a vehicles communications interface, VCI (22) having a Wi-Fi access point, Wi-Fi AP, (54) providing a VCI Wi-Fi network configured with a system set identifier, SSID, at least in part recognisable by the vehicle (10);
 - accepting a connection request generated by the vehicle (10) to use a wireless connection over the VCI Wi-Fi network;
 - establishing a wireless connection (36) between a Wi-Fi interface (11) of the vehicle (10) and the Wi-Fi AP (54) of the VCI adapter (22) over the VCI Wi-Fi network; and
 - relaying data between the vehicle (10) and the vehicle diagnostics tool 18 over the established wireless connection (36), wherein the relayed data includes vehicle diagnostics data.
2. The method of claim 1, wherein the Wi-Fi communications access point implemented using the VCI adapter is configured either by a remote diagnostics tool or a local vehicle diagnostics tool.
3. The method of any one of the preceding claims, wherein the method further comprises the VCI adapter (22):
 - obtaining an identifier for the vehicle (10) via a wired connection (26) with the vehicle;
 - providing the identifier to the vehicle diagnostics tool (18, 20);
4. The method of claim 3, wherein the SSID has a predetermined vehicle recognisable format, wherein the ECU 48 of the vehicle (10), responsive to the vehicle (10) detecting an Wi-Fi network SSID with the predetermined format, is able to recognise the SSID as belonging to a Wi-Fi network AP (54) of VCI adapter (22) with which it has or had a wired connection.
5. The method of any previous claim, wherein the vehicle recognisable part of the SSID comprises a VCI identifier and/or a vehicle identifier.
6. The method of any one of the previous claims, wherein the SSID includes at least in part a vehicle VIN and a serial number for the VCI adapter (22).
7. The method of any one of the preceding claims, wherein the vehicle is an autonomous, semi-autonomous or automated vehicle and the vehicle diagnostics tool is a vehicle diagnostics tool for autonomous, semi-autonomous or automated vehicles.
8. The method of any one of the preceding claims, wherein the vehicle is a heavy duty vehicle and the vehicle diagnostics tool is a vehicle diagnostics tool for heavy-duty vehicles.
9. The method of claim 1 or 2, wherein the data speeds of the data relayed over the wireless communications channel (36) between the vehicle (10), the VCI adapter (22) are monitored and evaluated in terms of the throughput or bandwidth of the data being relayed along the wireless Wi-Fi connection (36).
10. The method of claim 9, wherein the VCI adapter (22) is configured to switch between the wireless Wi-Fi connection (36) and the wired connection 26 and vice versa comparing the available bandwidth and/or throughput over a currently used Wi-Fi connection (36) or wired connection (26) with the vehicle (10).
11. A vehicle communication interface, VCI, adapter (22) for communicating with a vehicle, (10), wherein the VIC adapter (22) includes a wireless or Wi-Fi access point, AP, (54) for the vehicle (10) to connect to so that diagnostics data can be relayed via the VCI adapter (22) to a vehicle diagnostics tool (18, 20) and wherein the VCI adapter (22) is configured to:
 - receiving a system set identifier, SSID, from the vehicle diagnostics tool; and
 - configuring the VCI Wi-Fi network with the SSID, wherein the SSID includes a unique identifier based on or comprising the identifier for the vehicle (10) and/or an identifier for the VCI adapter (22).

form a wired connection with the vehicle via a diagnostics connector (12) of the vehicle;
 obtain and/or share information with an electronic control unit, ECU, 48 of the vehicle which allows the VCI Wi-Fi network provided by the Wi-Fi AP (54) to use a SSID which includes a vehicle-recognisable part.

12. The VCI adapter (22) of claim 11, wherein the SSID of the VCI Wi-Fi AP (54) is configured by a local diagnostics tool 18 or a remote diagnostics tool 20 to have a predetermined format which uses an identifier for the VCI adapter (22) and/or a vehicle identifier received from the vehicle (10).

13. The VCI adapter (22) of claim (10) or 11, wherein the VCI adapter (22) is further configured to:

evaluate the wireless connection (36) formed between the vehicle (10) and the VCI adapter (22) at least initially in terms of throughput/bandwidth;
 compare the data transfer speeds obtained over the Wi-Fi connection (36) with available wired connection data transfer speeds over a wired diagnostics connection 26 between the VCI adapter (22) and the vehicle (10), and
 switches the connection to use the wired diagnostics connection in the event that this has the higher data transfer speeds.

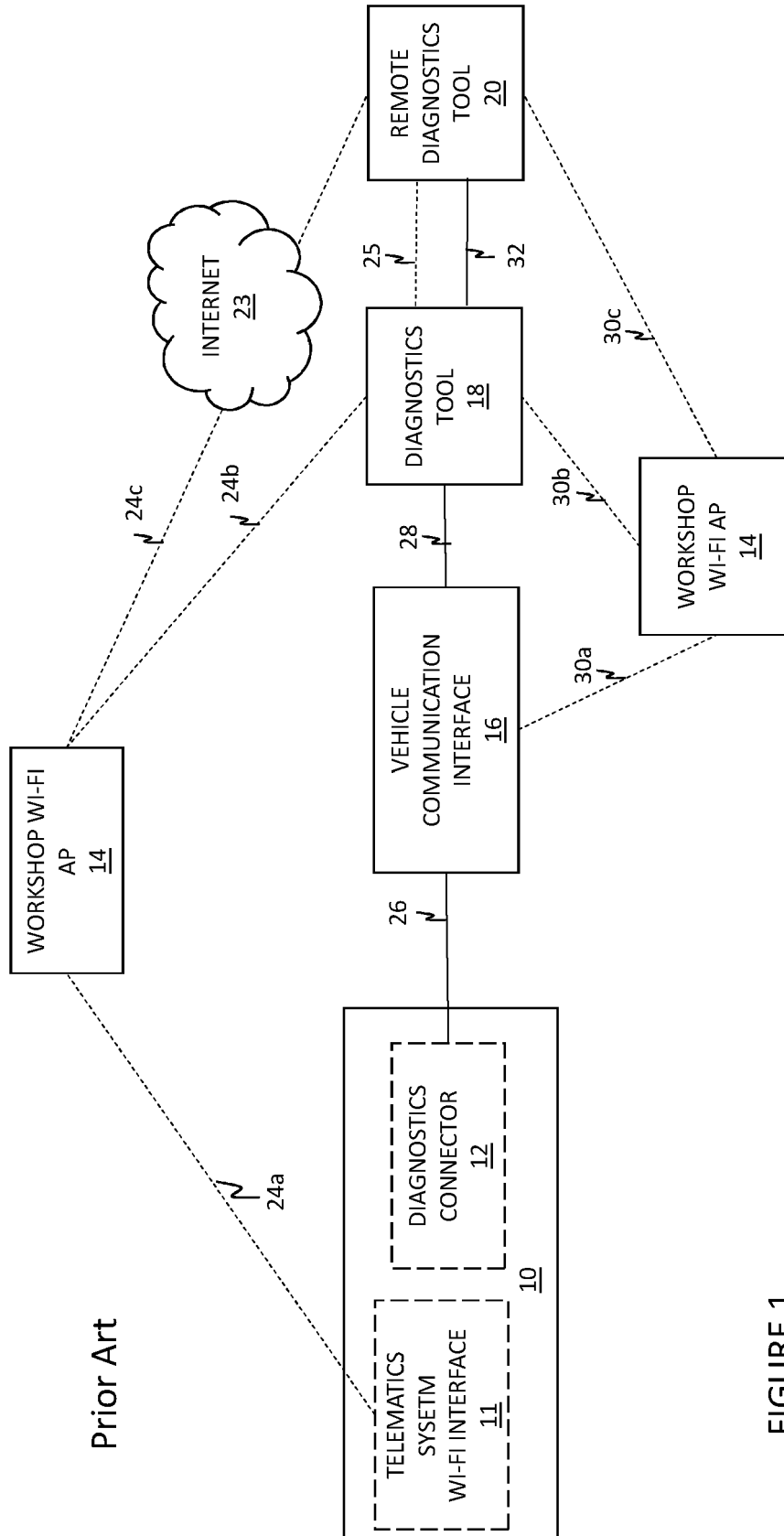
14. The VCI adapter (22) of any one of claims 10 to 13, wherein the VCI adapter is configured to implement a method according to any one of claims 1 to 9.

15. A computer program product comprising computer code which when executed by one or more processors or processing circuitry of a vehicle communications interface, VCI, adapter (22) enables the VCI adapter (22) to implement a method according to any one of claims 1 to 9.

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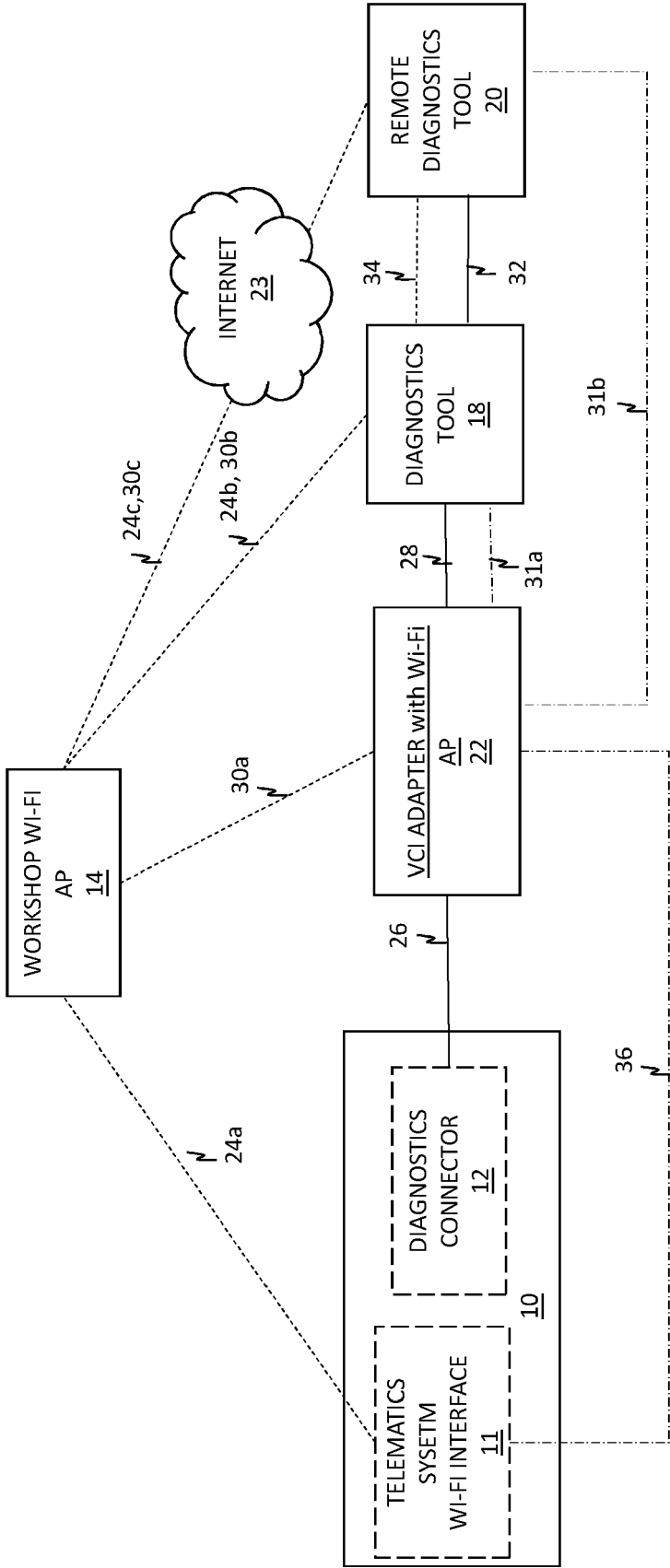


FIGURE 2

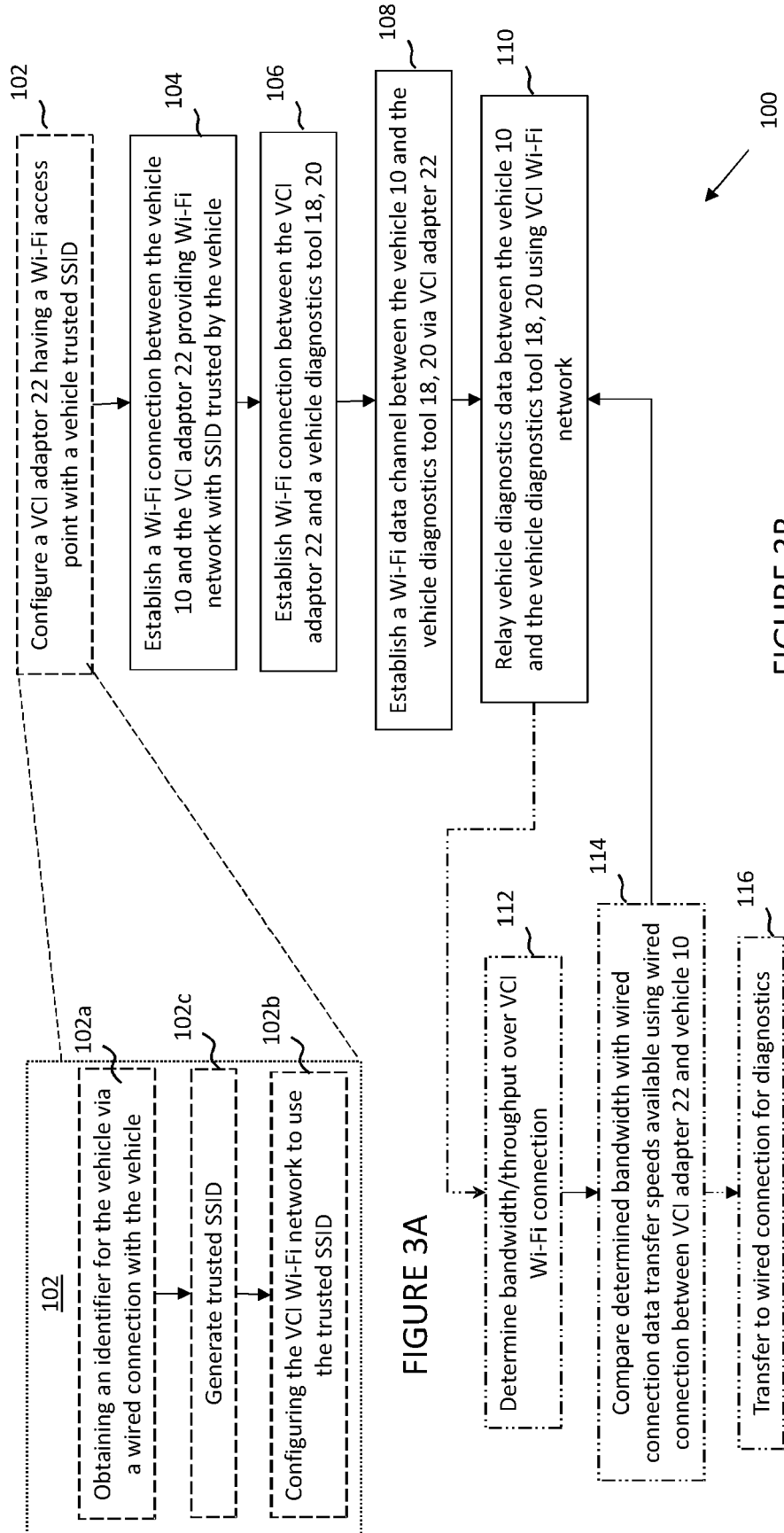


FIGURE 3B

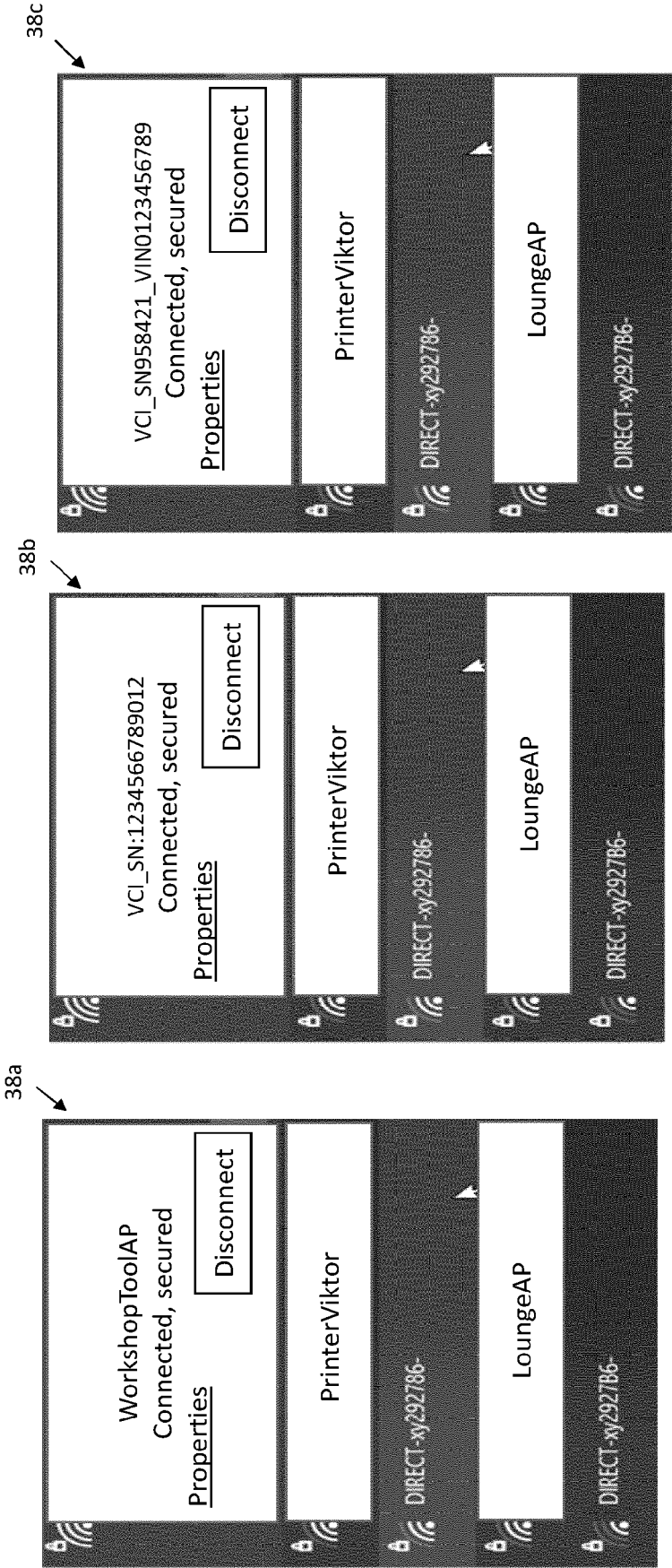


FIGURE 4A

FIGURE 4B

FIGURE 4C

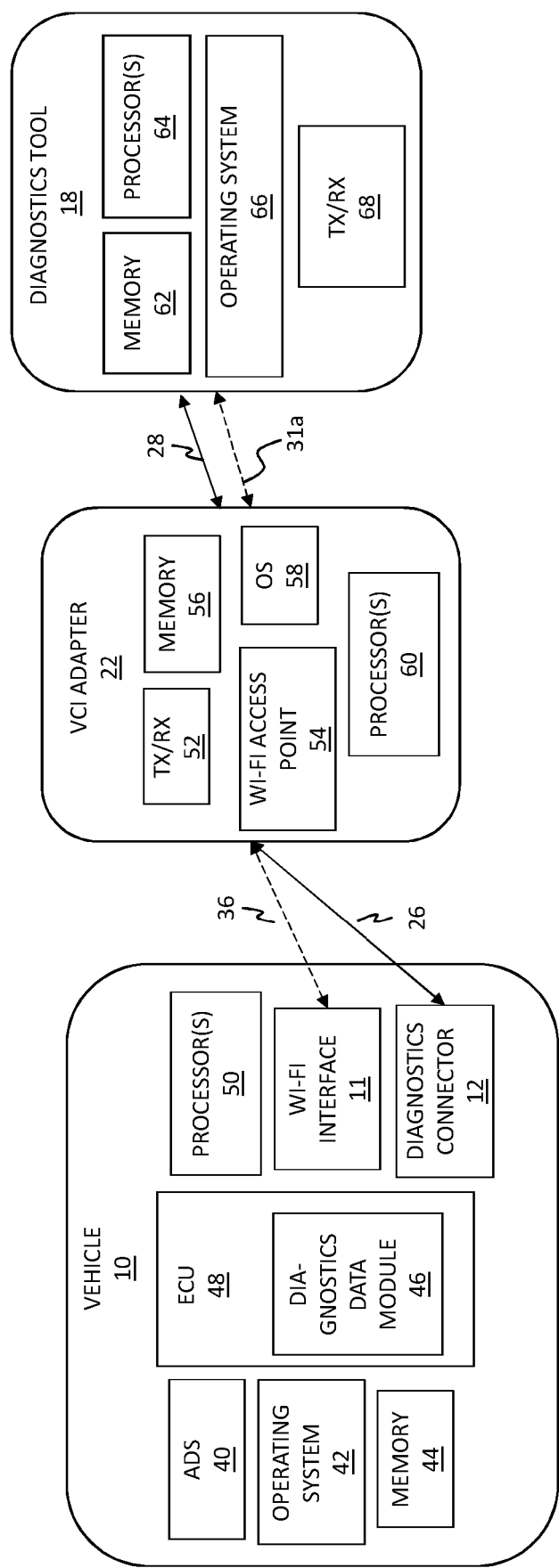


FIGURE 5



EUROPEAN SEARCH REPORT

Application Number

EP 22 16 5262

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Place of search		Date of completion of the search	Examiner
The Hague		31 August 2022	Harder, Sebastian
CATEGORY OF CITED DOCUMENTS		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			

**ANNEX TO THE EUROPEAN SEARCH REPORT
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