DIAGNOSTIC METHOD AND APPARATUS, AND VEHICLE

[0001] This application claims priority to Chinese Patent Application No. 202410343329.1, filed with the China National Intellectual Property Administration on March 22, 2024 and entitled "DIAGNOSTIC METHOD AND APPARATUS, AND VEHICLE", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This application relates to the field of intelligent vehicles, and more specifically, to a diagnostic method and apparatus, and a vehicle.

BACKGROUND

[0003] With development of autonomous driving and high requirements on computational power, an increasing quantity of electronic control units (electronic control units, ECUs) currently have a plurality of systems on chip (systems on chip, SoCs). Each SoC has an independent operating system (operating system, OS). As an independent diagnostic entity, an ECU usually selects one SoC to provide a diagnostic service externally. If the SoC that provides the diagnostic service externally is faulty, the ECU cannot provide the diagnostic service externally, and external test equipment cannot perform subsequent fault detection, problem analysis, and remediation. In this case, when some SoCs in the ECU can still provide a diagnostic service, the entire ECU is unavailable, resulting in poor fault tolerance of the ECU.

SUMMARY

[0004] This application provides a diagnostic method and apparatus, and a vehicle, to help enhance fault tolerance of an ECU in providing diagnostic services.

[0005] According to a first aspect, this application provides a diagnostic method. The method may be applied to a first diagnostic node, where the first diagnostic node and a second diagnostic node are located in an electronic control unit ECU, and the method includes: The first diagnostic node monitors a first broadcast message sent by the second diagnostic node, where the first broadcast message includes an Internet Protocol (internet protocol, IP) address of the second diagnostic node; and the first diagnostic node sends a second broadcast message when the first

broadcast message fails to be detected, where the second broadcast message includes an IP address of the first diagnostic node.

[0006] Based on the foregoing technical solution, the first diagnostic node may send the second broadcast message when the first broadcast message sent by the second diagnostic node fails to be detected by the first diagnostic node, so that an in-vehicle gateway records the IP address of the first diagnostic node. In this case, from the perspective of the in-vehicle gateway and external test equipment, the ECU can still provide a diagnostic service externally. According to the foregoing diagnostic method, when a diagnostic node is faulty, automatic switching of the diagnostic node that provides a diagnostic service externally is implemented, thereby resolving a problem that an entire diagnostic service is unavailable in a scenario in which some diagnostic nodes in the ECU are faulty, and helping improve reliability and availability of the ECU and fault tolerance in providing the diagnostic services.

[0007] In addition, the foregoing diagnostic method is compatible with the DOIP standard protocol and a commonly used diagnostic service procedure in the industry, and the in-vehicle gateway and the external test equipment (or a diagnostic host computer) do not need to perform any adaptation. In addition, automatic switching of the diagnostic node can be implemented without adding additional hardware and software to the vehicle, thereby helping reduce costs of performing the diagnostic service by the vehicle.

[0008] In some possible implementations, the first diagnostic node is a first SoC, and the second diagnostic node may be a second SoC.

[0009] With reference to the first aspect, in some implementations of the first aspect, that the first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected includes: The first diagnostic node sends first indication information to the second diagnostic node when the first broadcast message fails to be detected and the first diagnostic node communicates with the second diagnostic node normally, where the first indication information indicates the second diagnostic node to send the first broadcast message; and the first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected within a first preset duration since sending of the first indication information by the first diagnostic node.

[0010] Based on the foregoing technical solution, when the first broadcast message fails to be detected by the first diagnostic node and the first diagnostic node communicates with the second diagnostic node normally, the first diagnostic node may determine that the second diagnostic node may be faulty, and send the first indication information to the second diagnostic node. If the first broadcast message still fails to be detected by the first diagnostic node within the first preset duration, the first diagnostic node may determine that the second diagnostic node

is faulty, and may send the second broadcast message. In this case, the first indication information is sent to the second diagnostic node, thereby helping improve accuracy of determining a fault status of the second diagnostic node by the first diagnostic node.

[0011] In some possible implementations, that the first diagnostic node sends the first indication information to the second diagnostic node when the first broadcast message fails to be detected and the first diagnostic node communicates with the second diagnostic node normally includes: The first diagnostic node sends the first indication information to the second diagnostic node when the first broadcast message fails to be detected within a third preset duration since starting of the second diagnostic node and the first diagnostic node communicates with the second diagnostic node normally.

[0012] In some possible implementations, that the first diagnostic node sends the first indication information to the second diagnostic node when the first broadcast message fails to be detected within the third preset duration since starting of the second diagnostic node and the first diagnostic node communicates with the second diagnostic node normally includes: The first diagnostic node receives third indication information sent by the second diagnostic node, where the third indication information indicates that the second diagnostic node has been started; and the first diagnostic node sends the first indication information to the second diagnostic node when the first broadcast message fails to be detected within a third preset duration since receiving of the third indication information and the first diagnostic node communicates with the second diagnostic node normally.

[0013] With reference to the first aspect, in some implementations of the first aspect, that the first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected includes: The first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected and a communication fault occurs between the first diagnostic node and the second diagnostic node.

[0014] Based on the foregoing technical solution, when the first broadcast message fails to be detected by the first diagnostic node and the communication fault occurs between the first diagnostic node and the second diagnostic node, the first diagnostic node may directly determine that the second diagnostic node is faulty, and send the second broadcast message. In this case, when the second diagnostic node is faulty, the ECU may further continue to provide a diagnostic service externally via the first diagnostic node, thereby resolving a problem that an entire diagnostic service is unavailable in a scenario in which some diagnostic nodes in the ECU are faulty, and helping improve reliability and availability of the ECU and fault tolerance in providing the diagnostic services.

[0015] With reference to the first aspect, in some implementations of the first aspect, that the

first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected includes: The first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected within a second preset duration since receiving of an ECU discovery request message from the first diagnostic node.

[0016] Based on the foregoing technical solution, when the first broadcast message fails to be detected within a second preset duration since receiving of the ECU discovery request message from the first diagnostic node, the first diagnostic node may determine that the second diagnostic node is faulty, and send the second broadcast message. In this case, when the second diagnostic node is faulty, the ECU may further continue to provide a diagnostic service externally via the first diagnostic node, thereby resolving a problem that an entire diagnostic service is unavailable in a scenario in which some diagnostic nodes in the ECU are faulty, and helping improve reliability and availability of the ECU and fault tolerance in providing the diagnostic services.

[0017] In some possible implementations, that the first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected within the second preset duration since receiving of the ECU discovery request message from the first diagnostic node includes: The first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected within the second preset duration since receiving of the ECU discovery request message from the first diagnostic node and a communication fault occurs between the first diagnostic node and the second diagnostic node.

[0018] In some possible implementations, that the first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected within the second preset duration since receiving of the ECU discovery request message from the first diagnostic node includes: The first diagnostic node sends first indication information to the second diagnostic node when the first broadcast message fails to be detected within the second preset duration since receiving of the ECU discovery request message from the first diagnostic node and the first diagnostic node communicates with the second diagnostic node normally, where the first indication information indicates the second diagnostic node to send the first broadcast message; and the first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected within a first preset duration since sending of the first indication information by the first diagnostic node.

[0019] With reference to the first aspect, in some implementations of the first aspect, the method further includes: The first diagnostic node establishes a connection to an in-vehicle gateway; and the first diagnostic node receives a first diagnostic request sent by external test equipment through the in-vehicle gateway.

[0020] Based on the foregoing technical solution, when receiving the second broadcast message, the in-vehicle gateway may record the IP address of the first diagnostic node, to establish the connection to the first diagnostic node. When receiving the first diagnostic request sent by the external test equipment, the in-vehicle gateway may forward the first diagnostic request to the first diagnostic node, so that the ECU may provide a diagnostic service externally via the first diagnostic node.

[0021] With reference to the first aspect, in some implementations of the first aspect, the method further includes: ignoring the first broadcast message when the first broadcast message is received in a process in which the first diagnostic node performs a first diagnostic service with the external test equipment, where the first diagnostic service is associated with the first diagnostic request; the first diagnostic node receives, through the in-vehicle gateway, a second diagnostic request sent by the external test equipment; and the first diagnostic node sends second indication information to the second diagnostic node in response to receiving the second diagnostic request, where the second indication information indicates the second diagnostic node to send the first broadcast message.

[0022] The first broadcast message may be sent after the second diagnostic node is restored to normal. If the first diagnostic node is currently providing a diagnostic service externally, the first diagnostic node may ignore the first broadcast message. When the first diagnostic node receives a new diagnostic request sent by the in-vehicle gateway, the first diagnostic node may send the second indication information to the second diagnostic node, so that the second diagnostic node can be triggered to send the first broadcast message. When receiving the first broadcast message, the in-vehicle gateway may update the recorded IP address from the IP address of the first diagnostic node to the IP address of the second diagnostic node. In this case, the second diagnostic node may be switched to provide a diagnostic service externally.

[0023] Based on the foregoing technical solution, after the second diagnostic node is recovered, the first diagnostic node may be switched to a standby state after the current diagnostic service is processed, so that the second diagnostic node is switched to provide a diagnostic service externally.

[0024] With reference to the first aspect, in some implementations of the first aspect, the first diagnostic node is a secondary diagnostic node, and the second diagnostic node is a primary diagnostic node; or the first diagnostic node and the second diagnostic node are secondary diagnostic nodes, and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

[0025] Based on the foregoing technical solution, when the ECU includes one primary diagnostic node and a plurality of secondary diagnostic nodes, priorities of the plurality of

secondary diagnostic nodes may be set. In this case, when the primary diagnostic node is faulty, the secondary diagnostic node with a higher priority may provide a diagnostic service externally.

[0026] In some possible implementations, the primary diagnostic node may also be referred to as a primary node, and the secondary diagnostic node may also be referred to as a standby node.

[0027] According to a second aspect, a diagnostic method is provided. The method is applied to an ECU, the ECU includes a first diagnostic node and a second diagnostic node, and the method includes: The ECU sends a first broadcast message, where the first broadcast message includes an Internet Protocol IP address of the second diagnostic node; and the ECU sends a second broadcast message when the second diagnostic node is faulty, where the second broadcast message includes an IP address of the first diagnostic node.

[0028] Based on the foregoing technical solution, when the second diagnostic node in the ECU is faulty, the ECU may send the broadcast message carrying the IP address of the first diagnostic node, so that an in-vehicle gateway records the IP address of the first diagnostic node. In this case, when the second diagnostic node in the ECU is faulty, the ECU may further provide a diagnostic service externally via the first diagnostic node. According to the foregoing diagnostic service procedure, when a diagnostic node in the ECU is faulty, automatic switching of the diagnostic node that provides a diagnostic service externally is implemented, thereby helping improve reliability and availability of the ECU, and fault tolerance in providing the diagnostic services.

[0029] With reference to the second aspect, in some implementations of the second aspect, before the ECU sends the second broadcast message, the method further includes: determining that the second diagnostic node is faulty when the first broadcast message sent by the second diagnostic node fails to be detected by the first diagnostic node.

[0030] Based on the foregoing technical solution, when the first broadcast message fails to be detected by the first diagnostic node, the ECU may determine that the second diagnostic node is faulty, and send the second broadcast message, so that the in-vehicle gateway records the IP address of the first diagnostic node, and the ECU may further provide a diagnostic service externally via the first diagnostic node. According to the foregoing diagnostic service procedure, when the diagnostic node in the ECU is faulty, automatic switching of the diagnostic node that provides a diagnostic service externally is implemented, thereby resolving a problem that an entire diagnostic service is unavailable in a scenario in which some diagnostic nodes in the ECU are faulty, and helping improve reliability and availability of the ECU and fault tolerance in providing the diagnostic services.

[0031] With reference to the second aspect, in some implementations of the second aspect,

determining that the first diagnostic node is faulty when the first broadcast message sent by the second diagnostic node fails to be detected by the first diagnostic node includes: determining that the second diagnostic node is faulty when the first broadcast message fails to be detected by the first diagnostic node within a second preset duration since receiving of an ECU discovery request message from the ECU.

[0032] Based on the foregoing technical solution, when the first broadcast message fails to be detected by the first diagnostic node within the second preset duration since receiving of the ECU discovery request message from the ECU, the ECU may determine that the second diagnostic node is faulty, and may send the second broadcast message via the first diagnostic node. In this case, when the second diagnostic node is faulty, the ECU may further continue to provide a diagnostic service externally via the first diagnostic node, thereby resolving a problem that an entire diagnostic service is unavailable in a scenario in which some diagnostic nodes in the ECU are faulty, and helping improve reliability and availability of the ECU and fault tolerance in providing the diagnostic services.

[0033] With reference to the second aspect, in some implementations of the second aspect, the first diagnostic node is a secondary diagnostic node, and the second diagnostic node is a primary diagnostic node; or the first diagnostic node and the second diagnostic node are secondary diagnostic nodes, and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

[0034] Based on the foregoing technical solution, when the ECU includes one primary diagnostic node and a plurality of secondary diagnostic nodes, priorities of the plurality of secondary diagnostic nodes may be set. In this case, when the primary diagnostic node is faulty, the secondary diagnostic node with a higher priority may provide a diagnostic service externally.

[0035] According to a third aspect, this application provides a diagnostic method. The diagnostic method includes: receiving a first broadcast message sent by an ECU, where the first broadcast message includes an IP address of a second diagnostic node; recording the IP address of the second diagnostic node; receiving a second broadcast message sent by the ECU, where the second broadcast message includes an IP address of a first diagnostic node; and updating the recorded IP address from the IP address of the second diagnostic node to the IP address of the first diagnostic node.

[0036] According to a fourth aspect, this application provides a diagnostic apparatus. The apparatus is used in a first diagnostic node, the first diagnostic node and a second diagnostic node are located in an electronic control unit ECU, and the apparatus includes: a monitoring unit, configured to monitor a first broadcast message sent by the second diagnostic node, where the first broadcast message includes an IP address of the second diagnostic node; and a sending unit,

configured to send a second broadcast message when the first broadcast message fails to be detected by the monitoring unit, where the second broadcast message includes an IP address of the first diagnostic node.

[0037] With reference to the fourth aspect, in some implementations of the fourth aspect, the sending unit is specifically configured to: send first indication information to the second diagnostic node when the first broadcast message fails to be detected by the monitoring unit and the first diagnostic node communicates with the second diagnostic node normally, where the first indication information indicates the second diagnostic node to send the first broadcast message; and send the second broadcast message when the first broadcast message fails to be detected by the monitoring unit within a first preset duration since sending of the first indication information.

[0038] With reference to the fourth aspect, in some implementations of the fourth aspect, the sending unit is specifically configured to send the second broadcast message when the first broadcast message fails to be detected by the monitoring unit and a communication fault occurs between the first diagnostic node and the second diagnostic node.

[0039] With reference to the fourth aspect, in some implementations of the fourth aspect, the apparatus further includes a receiving unit, and the sending unit is specifically configured to send the second broadcast message when the first broadcast message fails to be detected by the monitoring unit within a second preset duration since receiving of an ECU discovery request message from the receiving unit.

[0040] With reference to the fourth aspect, in some implementations of the fourth aspect, the apparatus further includes a connection establishment unit, configured to establish a connection to an in-vehicle gateway. The receiving unit is configured to receive a first diagnostic request sent by external test equipment through the in-vehicle gateway.

[0041] With reference to the fourth aspect, in some implementations of the fourth aspect, the receiving unit is further configured to: ignore the first broadcast message when the first broadcast message is received in a process in which the first diagnostic node performs a first diagnostic service with the external test equipment, where the first diagnostic service is associated with the first diagnostic request; the receiving unit is further configured to receive, through the in-vehicle gateway, a second diagnostic request sent by the external test equipment; and the sending unit is further configured to send second indication information to the second diagnostic node, where the second indication information indicates the second diagnostic node to send the first broadcast message.

[0042] With reference to the fourth aspect, in some implementations of the fourth aspect, the first diagnostic node is a secondary diagnostic node, and the second diagnostic node is a primary diagnostic node; or the first diagnostic node and the second diagnostic node are secondary

diagnostic nodes, and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

[0043] According to a fifth aspect, this application provides a diagnostic apparatus. The apparatus is used in an electronic control unit ECU, the ECU includes a first diagnostic node and a second diagnostic node, the apparatus includes a sending unit and a fault detection unit. The sending unit is configured to send a first broadcast message, where the first broadcast message includes an IP address of the second diagnostic node. The sending unit is further configured to send a second broadcast message when the fault detection unit detects that the second diagnostic node is faulty, where the second broadcast message includes an IP address of the first diagnostic node.

[0044] With reference to the fifth aspect, in some implementations of the fifth aspect, the fault detection unit is specifically configured to determine that the second diagnostic node is faulty when the first broadcast message sent by the second diagnostic node fails to be detected by the first diagnostic node.

[0045] With reference to the fifth aspect, in some implementations of the fifth aspect, the apparatus further includes a receiving unit, and the fault detection unit is specifically configured to determine that the second diagnostic node is faulty when the first broadcast message fails to be detected by the first diagnostic node within a second preset duration since receiving of an ECU discovery request message from the receiving unit.

[0046] With reference to the fifth aspect, in some implementations of the fifth aspect, the first diagnostic node is a secondary diagnostic node, and the second diagnostic node is a primary diagnostic node; or the first diagnostic node and the second diagnostic node are secondary diagnostic nodes, and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

[0047] According to a sixth aspect, this application provides a diagnostic apparatus. The apparatus includes: a receiving unit, configured to receive a first broadcast message sent by an ECU, where the first broadcast message includes an IP address of a second diagnostic node; and an IP address recording unit, configured to record the IP address of the second diagnostic node. The receiving unit is further configured to receive a second broadcast message sent by the ECU, where the second broadcast message includes an IP address of a first diagnostic node; and the IP address recording unit is further configured to update the recorded IP address from the IP address of the second diagnostic node to the IP address of the first diagnostic node.

[0048] According to a seventh aspect, this application provides a diagnostic apparatus, where the apparatus includes a processor and a memory, the memory is configured to store instructions, and the processor executes the instructions stored in the memory, to enable the apparatus to

perform any possible method according to the first aspect.

[0049] In some possible implementations, the diagnostic apparatus may be an SoC.

[0050] According to an eighth aspect, this application provides a diagnostic apparatus, where the apparatus includes a processor and a memory, the memory is configured to store instructions, and the processor executes the instructions stored in the memory, to enable the apparatus to perform any possible method according to the second aspect.

[0051] In some possible implementations, the diagnostic apparatus may be an ECU, and the ECU may include a plurality of SoCs.

[0052] According to a ninth aspect, this application provides a diagnostic system, where the diagnostic system includes an ECU and an in-vehicle gateway, and the ECU includes any possible apparatus according to the fourth aspect, the fifth aspect, the seventh aspect, or the eighth aspect.

[0053] According to a tenth aspect, an intelligent driving device is provided. The intelligent driving device includes any possible diagnostic apparatus according to the fourth aspect to the eighth aspect, or includes any possible diagnostic system according to the ninth aspect.

[0054] In some possible implementations, the intelligent driving device is a vehicle.

[0055] According to an eleventh aspect, this application provides a computer program product. The computer program product includes computer program code, and when the computer program code is run on a computer, the computer is enabled to perform any possible method according to the first aspect to the third aspect.

[0056] It should be noted that all or a part of the computer program code may be stored in a first storage medium. The first storage medium may be packaged together with a processor, or may be packaged separately from a processor. This is not specifically limited in embodiments of this application.

[0057] According to a twelfth aspect, this application provides a computer-readable storage medium. The computer-readable storage medium stores program code, and when the computer program code is run on a computer, the computer is enabled to perform any possible method according to the first aspect to the third aspect.

[0058] According to a thirteenth aspect, this application provides a chip. The chip system includes a circuit, and the circuit is configured to perform any possible method according to the first aspect to the third aspect.

BRIEF DESCRIPTION OF DRAWINGS

[0059] FIG. 1 is a schematic flowchart of discovering an ECU by external test equipment;

[0060] FIG. 2 is a diagram in which an OS 1 in an ECU 2 provides a diagnostic service externally;

[0061] FIG. 3 is a block diagram of an ECU according to an embodiment of this application;

[0062] FIG. 4A and FIG. 4B are a schematic flowchart of a diagnostic method according to an embodiment of this application;

[0063] FIG. 5 is another schematic flowchart of a diagnostic method according to an embodiment of this application;

[0064] FIG. 6 is another schematic flowchart of a diagnostic method according to an embodiment of this application;

[0065] FIG. 7 is another schematic flowchart of a diagnostic method according to an embodiment of this application;

[0066] FIG. 8 is another schematic flowchart of a diagnostic method according to an embodiment of this application;

[0067] FIG. 9 is a block diagram of a diagnostic apparatus according to an embodiment of this application;

[0068] FIG. 10 is another block diagram of a diagnostic apparatus according to an embodiment of this application; and

[0069] FIG. 11 is a block diagram of a diagnostic system according to an embodiment of this application.

DESCRIPTION OF EMBODIMENTS

[0070] The following describes technical solutions in embodiments of this application with reference to accompanying drawings in embodiments of this application. In descriptions of embodiments of this application, "/" means "or" unless otherwise specified. For example, A/B may represent A or B. In this specification, "and/or" describes only an association relationship for describing associated objects and represents that three relationships may exist. For example, A and/or B may represent the following three cases: Only A exists, both A and B exist, and only B exists. "At least one item" means one or more items. For example, "at least one of A and B", similar to "A and/or B", describes an association relationship between associated objects and indicates that three relationships may exist. For example, at least one of A and B may indicate the following three cases: Only A exists, both A and B exist, and only B exists.

[0071] In embodiments of this application, prefix words such as "first" and "second" are used only to distinguish between different described objects, and do not limit a location, a sequence, a priority, a quantity, content, or the like of the described objects. Use of prefix words such as

ordinal numbers used to distinguish between the described objects in embodiments of this application does not constitute a limitation on the described objects. For descriptions of the described objects, refer to the context descriptions in the claims or embodiments. The use of such prefix words should not constitute a redundant limitation. In addition, in the descriptions of embodiments of this application, unless otherwise specified, "a plurality of" means two or more.

[0072] FIG. 1 is a schematic flowchart of discovering an ECU by external test equipment. As shown in FIG. 1, a process in which the external test equipment discovers the ECU includes S101 to S106.

[0073] S101: External test equipment (external test equipment) sends a first dynamic host configuration protocol (dynamic host configuration protocol, DHCP) request to an in-vehicle gateway, where the first DHCP request is used to request an address of the in-vehicle gateway.

[0074] The external test equipment may also be referred to as a diagnostic instrument or a diagnostic host computer.

[0075] S102: The in-vehicle gateway sends a first DHCP response to the external test equipment, where the first DHCP response includes the address of the in-vehicle gateway.

[0076] S103: After a diagnostic communication over internet protocol (diagnostic communication over internet protocol, DOIP) entity is started, send a broadcast message through a diagnostic network, where the broadcast message includes a vehicle identification number (vehicle identification number, VIN), a logical address (logical address), an entity identifier (entity identification, EID), and an IP address of the DOIP entity.

[0077] For example, after the DOIP entity is started, the DOIP entity may send the broadcast message to the diagnostic network three times.

[0078] For example, the DOIP entity may be an ECU.

[0079] S104: After receiving the broadcast message, the in-vehicle gateway and the external test equipment separately record information about the DOIP entity.

[0080] For example, the external test equipment may record the VIN, the logical address, and the EID that correspond to the DOIP entity.

[0081] For example, the DOIP entity is an ECU. The in-vehicle gateway may record a VIN, a logical address, and an EID that correspond to the ECU, and an IP address of the ECU.

[0082] For example, Table 1 shows information about the ECU recorded by the in-vehicle gateway.

Table 1

DOIP entity name	VIN	Logical address	EID	IP

DOIP entity name	VIN	Logical address	EID	IP
ECU 1	...	4000	...	192.168.1.X
ECU 2	...	4001	...	192.168.1.Y
...	...	...	...	...

[0083] S105: The external test equipment sends a diagnostic request to a target DOIP entity through the recorded logical address of the DOIP entity.

[0084] S106: The in-vehicle gateway finds an IP address of the target DOIP entity through the logical address in the recorded information, to perform connection and related message forwarding.

[0085] For example, the DOIP entity is an ECU. As an independent diagnostic entity, the ECU usually selects a SoC (or OS) in the ECU to provide a diagnostic service externally. For example, FIG. 2 is a diagram in which an OS 1 in an ECU 2 provides a diagnostic service externally. When there are a plurality of SoCs (such as SoC 1 and SoC 2) in the ECU 2, a diagnostic agent module (diagAgent) may be deployed in an OS of each SoC, and a diagnostic service module (diagServer) may be deployed in the OS 1, so that the diagnostic service is provided externally through the OS 1. After receiving a diagnostic request, the diagnostic service module may distribute the diagnostic request to a diagnostic agent module of each OS according to a rule for operation.

[0086] As shown in FIG. 2, the OS 1 in the ECU 2 provides a diagnostic service externally. In this case, the IP address of the ECU 2 recorded in the in-vehicle gateway is an IP address of the OS 1. When the SoC 1 or the OS 1 is faulty and cannot provide a diagnostic service, and the OS 2 is still operating normally and can provide some diagnostic services, because the in-vehicle gateway only records the IP address of the OS 1, the in-vehicle gateway cannot connect to the original diagnostic service module. From the outside, it seems that the entire ECU 2 cannot provide a diagnostic service externally, and the ECU 2 cannot determine a fault and cannot remediate the fault. In this case, when some SoCs in the ECU 2 are available, the entire ECU 2 is unavailable, resulting in poor fault tolerance of the ECU.

[0087] Embodiments of this application provide a diagnostic method and apparatus, to resolve a problem that an entire diagnostic service is unavailable in a scenario in which some SoCs or OSs of an ECU are faulty. Embodiments of this application may be a set of services and processing procedures defined based on a DOIP standard protocol (for example, ISO134000 or ISO14229), to implement a diagnostic service in a normal case and automatic switching of a diagnostic node after a SoC (or an OS) is faulty.

[0088] FIG. 3 is a block diagram of an ECU according to an embodiment of this application.

For example, a DOIP entity is an ECU. The ECU may include a SoC 1 and a SoC 2. The SoC 1 includes an OS 1, and the SoC 2 includes an OS 2. Each OS includes a diagnostic service module. The ECU may select one of the diagnostic service modules as a primary node to provide a diagnostic service externally, and the remaining diagnostic service modules are used as standby nodes. For example, a diagnostic service module 1 in the OS 1 is used as a primary node to provide a diagnostic service externally, and a diagnostic service module 2 in the OS 2 is used as a standby node. When the SoC 1 or the OS 1 is faulty, the ECU may switch to the diagnostic service module 2 to provide a diagnostic service externally.

[0089] An example in which the ECU shown in FIG. 3 includes two SoCs (or two OSs) is used for description. A quantity of SoCs or OSs included in the ECU is not specifically limited in embodiments of this application. For example, the ECU may further include three or more SoCs.

[0090] For example, the ECU includes two SoCs. FIG. 4A and FIG. 4B are a schematic flowchart of a diagnostic method 400 according to an embodiment of this application. The diagnostic method 400 shown in FIG. 4A and FIG. 4B is an operating procedure in which an ECU normally provides a diagnostic service externally. The method includes S401 to S412.

[0091] S401: After being started, a diagnostic service module 1 loads configuration information 1.

[0092] For example, the configuration information 1 indicates that the diagnostic service module 1 is set as a primary node and provides a diagnostic service externally.

[0093] S402: After being started, a diagnostic service module 2 loads configuration information 2, and monitors a broadcast message 1 sent by the diagnostic service module 1 (or the primary node).

[0094] For example, the configuration information 2 indicates that the diagnostic service module 2 is set as a standby node.

[0095] The diagnostic service module 2 may determine, based on whether the broadcast message 1 is detected, whether the primary node normally provides the diagnostic service externally.

[0096] For example, the broadcast message 1 may be a 0x0004 message in the ISO13400 protocol, or the broadcast message 1 may also be referred to as an ECU announcement message.

[0097] S403: A bidirectional heartbeat is established between the diagnostic service module 1 and the diagnostic service module 2 to perform status detection.

[0098] For example, that the bidirectional heartbeat is established between the diagnostic service module 1 and the diagnostic service module 2 to perform status detection includes: The diagnostic service module 1 sends a heartbeat request to the diagnostic service module 2. In response to receiving the heartbeat request, the diagnostic service module 2 sends a heartbeat

response to the diagnostic service module 1. In this case, the diagnostic service module 1 may determine that the diagnostic service module 1 normally communicates with the diagnostic service module 2.

[0099] S404: The diagnostic service module 1 sends the broadcast message 1.

[00100] For example, the broadcast message 1 may include a VIN, a logical address, information about an EID, and an IP address of an SoC 1.

[00101] S405: When receiving the broadcast message 1, an in-vehicle gateway may record information about the ECU.

[00102] For example, the in-vehicle gateway may record the logical address of the ECU and the IP address of the SoC 1.

[00103] S406: When receiving the broadcast message 1, the diagnostic service module 2 determines that a primary node can normally provide a diagnostic service externally.

[00104] S407: After accessing the in-vehicle gateway, external test equipment sends an ECU discovery request message to the in-vehicle gateway.

[00105] For example, the ECU discovery request may be a 0x0001 message in the ISO13400 protocol.

[00106] S408: When receiving the ECU discovery request message, the in-vehicle gateway may broadcast the ECU discovery request message through a diagnostic network.

[00107] S409: When receiving the ECU discovery request message, the diagnostic service module 1 may send an ECU discovery response message to the in-vehicle gateway.

[00108] S410: When receiving the ECU discovery request message, the diagnostic service module 2 performs no processing.

[00109] S411: When receiving the ECU discovery request message, the diagnostic service module 1 may further send the broadcast message 1 through the diagnostic network.

[00110] That the diagnostic service module 1 sends the broadcast message 1 in S404 may be understood as that the SoC 1 actively broadcasts a notification after being started, and that the diagnostic service module 1 sends the broadcast message 1 in S411 may be understood as that the ECU passively broadcasts a response after receiving an inquiry from the external test equipment.

[00111] For example, after receiving the broadcast message 1, the in-vehicle gateway may record the information about the ECU.

[00112] In the foregoing method 400, an example in which the SoC 1 normally provides a diagnostic service externally is used for description. In this case, when receiving the ECU discovery request message, the SoC 1 may send the broadcast message 1 through the diagnostic network, and the in-vehicle gateway may record the information about the ECU in the broadcast

message 1, or the in-vehicle gateway may overwrite the information about the ECU recorded in S405 with the information about the ECU carried in the broadcast message 1 in S411.

[00113] S412: After receiving the broadcast message 1, the diagnostic service module 2 determines that the primary node can normally provide a diagnostic service externally.

[00114] In this embodiment of this application, the diagnostic service module 2 serving as the standby node may monitor the broadcast message sent by the diagnostic service module 1. If the diagnostic service module 2 can monitor the broadcast message sent by the diagnostic service module 1, the diagnostic service module 2 may determine that the diagnostic service module 1 can normally provide a diagnostic service externally and can maintain a standby node state.

[00115] FIG. 5 is a schematic flowchart of a diagnostic method 500 according to an embodiment of this application. The diagnostic method 500 shown in FIG. 5 is a process of switching between a primary node and a standby node when an SoC 1 or an OS 1 is faulty.

[00116] S501: A diagnostic service module 2 determines whether a broadcast message 1 sent by a diagnostic service module 1 is detected.

[00117] For example, when the diagnostic service module 2 receives an ECU discovery request message, the diagnostic service module 2 may start a timer. The diagnostic service module 2 may monitor the broadcast message 1 during running of the timer. If the broadcast message 1 fails to be detected during running of the timer, S502 may be performed; otherwise, the diagnostic service module 2 may determine that the diagnostic service module 1 can normally provide a diagnostic service externally and can maintain a standby node state.

[00118] S502: Set a host exception flag when the broadcast message 1 sent by the diagnostic service module 1 fails to be detected by the diagnostic service module 2 during running of the timer.

[00119] For example, during running of the timer, if the diagnostic service module 2 fails to receive the broadcast message 1 sent by the diagnostic service module 1, the diagnostic service module 2 may determine that the diagnostic service module 1 may be faulty.

[00120] S503: The diagnostic service module 2 determines whether the diagnostic service module 2 can normally communicate with the diagnostic service module 1.

[00121] If the diagnostic service module 2 can normally communicate with the diagnostic service module 1, S504 is performed; otherwise, S506 is performed.

[00122] S504: The diagnostic service module 2 resets the timer and sends indication information 1 to the diagnostic service module 1, where the indication information 1 indicates the diagnostic service module 1 to send a broadcast message or perform diagnostic service processing.

[00123] For example, the diagnostic service module 2 continues to monitor, during running of

the timer, the broadcast message 1 sent by the diagnostic service module 1.

[00124] S505: The diagnostic service module 2 determines whether the broadcast message 1 is detected during running of the timer.

[00125] If the broadcast message 1 sent by the diagnostic service module 1 still fails to be detected by the diagnostic service module 2 during running of the timer, the diagnostic service module 2 may determine that the diagnostic service module 1 is faulty and perform S506; otherwise, the diagnostic service module 2 cancels the host exception flag and determines that the diagnostic service module 1 can normally provide a diagnostic service externally.

[00126] S506: The diagnostic service module 2 sends a broadcast message 2 through a diagnostic network.

[00127] For example, the broadcast message 2 may include a VIN, a logical address, an EID, and an IP address of an SoC 2.

[00128] When receiving the broadcast message 2, an in-vehicle gateway may replace information about an ECU in the previously recorded broadcast message 1 with information about an ECU in the broadcast message 2. After the information about the ECU is replaced, an IP address of the ECU recorded in the in-vehicle gateway is updated to an IP address of the SoC 2. In this case, after receiving a diagnostic request sent by external test equipment, the in-vehicle gateway may further forward the diagnostic request to the ECU. After receiving the diagnostic request, the ECU may provide a diagnostic service externally via the SoC 2. In this case, although the SoC 1 is faulty, from the perspective of the outside (for example, the in-vehicle gateway), the entire ECU can still provide a diagnostic service externally.

[00129] According to the foregoing diagnostic method, when a diagnostic node (for example, the SoC 1) is faulty, automatic switching of the diagnostic node that provides a diagnostic service externally is implemented (for example, the node that provides the diagnostic service externally is switched from the SoC 1 to the SoC 2), thereby resolving a problem that an entire diagnostic service is unavailable in a scenario in which some diagnostic nodes in the ECU are faulty, and helping improve reliability and availability of the ECU and fault tolerance in providing the diagnostic services.

[00130] FIG. 6 is a schematic flowchart of a diagnostic method 600 according to an embodiment of this application. The diagnostic method 600 shown in FIG. 6 is a process in which an SoC 1 is switched back to a primary node after being restored to normal.

[00131] S601: After being restored to normal, the diagnostic service module 1 may send a broadcast message 1 through a diagnostic network.

[00132] S602: When a diagnostic service module 2 receives the broadcast message 1 and the diagnostic service module 2 is providing a diagnostic service externally, the diagnostic service

module 2 may ignore the broadcast message 1 and continue to provide a diagnostic service to external test equipment.

[00133] S603: After receiving the broadcast message 1 and determining that the external test equipment is performing diagnostic service processing with an ECU, an in-vehicle gateway may ignore the broadcast message 1.

[00134] When the external test equipment needs to diagnose an ECU, the external test equipment and the ECU do not directly communicate with each other, but information related to the diagnostic service is forwarded through the in-vehicle gateway. Therefore, when forwarding information related to a diagnostic service between the external test equipment and the ECU, the in-vehicle gateway may determine that the external test equipment is performing diagnostic service processing with the ECU.

[00135] S604: The in-vehicle gateway initiates a new diagnostic request to the diagnostic service module 2.

[00136] For example, after receiving the new diagnostic request, the in-vehicle gateway may forward the new diagnostic request to the ECU.

[00137] S605: The diagnostic service module 2 does not respond and sends indication information 2 to the diagnostic service module 1, where the indication information 2 indicates the diagnostic service module 1 to send a broadcast message.

[00138] For example, because an IP address recorded in the in-vehicle gateway is an IP address of an SoC 2, the in-vehicle gateway may forward the new diagnostic request to the SoC 2 in the ECU. After receiving the diagnostic request, the SoC 2 may not respond and send the indication information 2 to the diagnostic server module 1.

[00139] S606: In response to receiving the indication information 2, the diagnostic service module 1 sends the broadcast message 1.

[00140] S607: When receiving the broadcast message 1, the in-vehicle gateway forwards the new diagnostic request to the diagnostic service module 1 again, and subsequently restores the service to the diagnostic service module 1.

[00141] When receiving the broadcast message 1, the in-vehicle gateway may update information about the ECU stored in the in-vehicle gateway. For example, the IP address in the information about the ECU is updated from the IP address of the SoC 2 to an IP address of the SoC 1. In this case, after receiving the diagnostic request sent by the external test equipment, the in-vehicle gateway may forward the diagnostic request to the diagnostic service module 1 in the ECU.

[00142] S608: When receiving the broadcast message 1, the diagnostic service module 2 may determine that the diagnostic service module 1 can normally provide a diagnostic service

externally.

[00143] In an embodiment, if the diagnostic service module 2 in S602 is providing a diagnostic service externally when receiving the broadcast message 1, the diagnostic service module 2 may also stop processing the diagnostic service, and the in-vehicle gateway may update the stored information about the ECU when receiving the broadcast message 1, to re-establish a connection to the SoC 1. In this case, the diagnostic service may be switched to the SoC 1 for execution.

[00144] FIG. 7 is a schematic flowchart of a diagnostic method 700 according to an embodiment of this application. The method is applied to a first diagnostic node, where the first diagnostic node and a second diagnostic node are located in an electronic control unit ECU. The method 700 includes the following steps.

[00145] S710: The first diagnostic node monitors a first broadcast message sent by the second diagnostic node, where the first broadcast message includes an Internet Protocol IP address of the second diagnostic node.

[00146] For example, the first diagnostic node may be the SoC 2, and the second diagnostic node may be the SoC 1.

[00147] For example, the first diagnostic node may be a standby node, and the second diagnostic node may be a primary node. After the standby node and the primary node are powered on, the primary node may provide a diagnostic service externally, and the standby node does not provide a diagnostic service externally and monitors a broadcast message sent by the primary node.

[00148] For example, the first broadcast message may be the broadcast message 1.

[00149] Optionally, the first broadcast message may include a VIN of a vehicle, a logical address of the ECU, an EID of the ECU, and the IP address of the second diagnostic node.

[00150] S720: The first diagnostic node sends a second broadcast message when the first broadcast message fails to be detected, where the second broadcast message includes an IP address of the first diagnostic node.

[00151] For example, the second broadcast message may be the broadcast message 2.

[00152] Optionally, the second broadcast message may include a VIN of the vehicle, a logical address of the ECU, an EID of the ECU, and the IP address of the first diagnostic node.

[00153] Optionally, that the first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected includes: The first diagnostic node sends first indication information to the second diagnostic node when the first broadcast message fails to be detected and the first diagnostic node communicates with the second diagnostic node normally, where the first indication information indicates the second diagnostic node to send the first

broadcast message; and the first diagnostic node sends the second broadcast message when the first broadcast message fails to be received within a first preset duration since sending of the first indication information by the first diagnostic node.

[00154] For example, the first indication information may be the indication information 1.

[00155] For example, when the SoC 2 is started, the SoC 2 may start a timer 1 and monitor, during running of the timer 1, the broadcast message 1 sent by the SoC 1. When the broadcast message 1 sent by the SoC 1 fails to be detected during running of the timer 1 and the SoC 1 can communicate with the SoC 2 normally, the SoC 2 may send the indication information 1 to the SoC 1 and start a timer 2. When the broadcast message 1 sent by the SoC 1 fails to be detected during running of the timer 2, the SoC 2 may determine that the SoC 1 is faulty, and send the broadcast message 2. In this case, the SoC 2 is switched from a standby node to a primary node (or the SoC 2 provides a diagnostic service externally). When receiving the broadcast message 2, an in-vehicle gateway may record an IP address of the SoC 2.

[00156] Optionally, that the first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected includes: The first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected and a communication fault occurs between the first diagnostic node and the second diagnostic node.

[00157] For example, when the SoC 2 is started, the SoC 2 may start the timer 1 and monitor, during running of the timer 1, the broadcast message 1 sent by the SoC 1. When the broadcast message 1 sent by the SoC 1 fails to be detected during running of the timer 1 and a communication fault occurs between the SoC 1 and the SoC 2, the SoC 2 may determine that the SoC 1 is faulty, and send the broadcast message 2. In this case, the SoC 2 is switched from a standby node to a primary node (or the SoC 2 provides a diagnostic service externally).

[00158] Optionally, that the first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected includes: The first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected within a second preset duration since receiving of an ECU discovery request message from the first diagnostic node.

[00159] For example, when the SoC 2 is started, the SoC 2 may start the timer 1 and monitor, during running of the timer 1, the broadcast message 1 sent by the SoC 1. When the broadcast message 1 sent by the SoC 1 is detected during running of the timer 1, the SoC 2 may determine that the SoC 1 can normally provide a diagnostic service externally. When receiving the broadcast message 1 sent by the SoC 1, the in-vehicle gateway may record an IP address of the SoC 1.

[00160] When receiving the ECU discovery request message sent by external test equipment,

the in-vehicle gateway may send the ECU discovery request message in a broadcast manner through a diagnostic network. When receiving the ECU discovery request message sent by the in-vehicle gateway, the SoC 2 may start the timer 2 and monitor, during running of the timer 2, the broadcast message 1 sent by the SoC 1. If the broadcast message 1 sent by the SoC 1 fails to be detected during running of the timer 2, the SoC 2 may determine that the SoC 1 is faulty and the SoC 2 may send the broadcast message 2.

[00161] Optionally, that the first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected within the second preset duration since receiving of the ECU discovery request message from the first diagnostic node includes: The first diagnostic node sends first indication information to the second diagnostic node when the first broadcast message fails to be detected within the second preset duration since receiving of the ECU discovery request message from the first diagnostic node and the first diagnostic node communicates with the second diagnostic node normally, where the first indication information indicates the second diagnostic node to send the first broadcast message; and the first diagnostic node sends the second broadcast message when the first broadcast message fails to be received within a first preset duration since sending of the first indication information by the first diagnostic node.

[00162] Optionally, that the first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected within the second preset duration since receiving of the ECU discovery request message from the first diagnostic node includes: The first diagnostic node sends the second broadcast message when the first broadcast message fails to be detected within the second preset duration since receiving of the ECU discovery request message from the first diagnostic node and a communication fault occurs between the first diagnostic node and the second diagnostic node.

[00163] Optionally, the method 700 further includes: The first diagnostic node establishes a connection to an in-vehicle gateway; and the first diagnostic node receives a first diagnostic request sent by external test equipment through the in-vehicle gateway.

[00164] For example, the in-vehicle gateway may establish a connection to the SoC 2 and receive the first diagnostic request sent by the external test equipment, and the in-vehicle gateway may send the first diagnostic request to the SoC 2 based on the IP address of the SoC 2. In this case, the SoC 2 may provide a diagnostic service externally.

[00165] Optionally, the method 700 further includes: ignoring the first broadcast message when the first broadcast message is received in a process in which the first diagnostic node performs a first diagnostic service with the external test equipment, where the first diagnostic service is associated with the first diagnostic request; the first diagnostic node receives, through

the in-vehicle gateway, a second diagnostic request sent by the external test equipment; and the first diagnostic node sends second indication information to the second diagnostic node in response to receiving the second diagnostic request, where the second indication information indicates the second diagnostic node to send the first broadcast message.

[00166] For example, the second indication information may be the indication information 2.

[00167] For example, in a process in which the SoC 2 performs the first diagnostic service associated with the first diagnostic request with the external test equipment, if the broadcast message 1 sent by the SoC 1 is received, the SoC 2 may determine that the SoC 1 is restored to normal, and ignore the broadcast message 1. When the SoC 2 receives, through the in-vehicle gateway, the second diagnostic request sent by the external test equipment, the SoC 2 may send the indication information 1 to the SoC 1. After receiving the indication information 1, the SoC 1 may send the broadcast message 1. When receiving the broadcast message 1, the in-vehicle gateway may update the IP address stored in the in-vehicle gateway from the IP address of the SoC 2 to the IP address of the SoC 1. Then, the in-vehicle gateway may send the second diagnostic request to the SoC 1. In this case, after the SoC 1 is restored to normal, the SoC 1 may provide a diagnostic service externally.

[00168] Optionally, the first diagnostic node and the second diagnostic node are secondary diagnostic nodes, and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

[00169] For example, the ECU may further include an SoC 3. After the SoC 3 is started, a diagnostic service module 3 in the SoC 3 may load configuration information 3. The configuration information 1 indicates that the SoC 1 is a primary node, configuration information 2 indicates that the SoC 2 is a standby node and the SoC 2 has a high priority, and the configuration information 3 indicates that the SoC 3 is a standby node and the SoC 3 has a low priority.

[00170] For example, when the SoC 1, the SoC 2, and the SoC 3 are started, the SoC 2 may start the timer 1, and the SoC 3 may also start the timer 1. The SoC 2 and the SoC 3 may separately monitor, during running of the timer 1, the broadcast message 1 sent by the SoC 1. When the broadcast message 1 sent by the SoC 1 fails to be detected during running of the timer 1, the SoC 2 may send the broadcast message 2, and the SoC 3 may start a timer 3. When the broadcast message 2 sent by the SoC 2 is detected during running of the timer 3, the SoC 3 may determine that the SoC 2 can normally provide a diagnostic service externally. Alternatively, when the broadcast message 2 sent by the SoC 2 fails to be detected during running of the timer 3, the SoC 3 may determine that the SoC 2 is faulty, and the SoC 3 sends a broadcast message 3, where the broadcast message 3 may include an IP address of the SoC 3.

[00171] FIG. 8 is a schematic flowchart of a diagnostic method 800 according to an embodiment of this application. The method is applied to an electronic control unit ECU, where the ECU includes a first diagnostic node and a second diagnostic node, and the method 800 includes the following steps.

[00172] S810: The ECU sends a first broadcast message, where the first broadcast message includes an Internet Protocol IP address of the second diagnostic node.

[00173] For example, the first diagnostic node may be the SoC 2, and the second diagnostic node may be the SoC 1.

[00174] For example, the first diagnostic node may be a standby node, and the second diagnostic node may be a primary node. After the standby node and the primary node are powered on, the primary node may provide a diagnostic service externally, and the standby node does not provide a diagnostic service externally and monitors a broadcast message sent by the primary node.

[00175] For example, the first broadcast message may be the broadcast message 1.

[00176] Optionally, after receiving the first broadcast message, an in-vehicle gateway may record the IP address of the second diagnostic node. In this case, after receiving a diagnostic request sent by external test equipment, the in-vehicle gateway may send the diagnostic request to the ECU based on the IP address of the second diagnostic node.

[00177] S820: The ECU sends a second broadcast message when the second diagnostic node is faulty, where the second broadcast message includes an IP address of the first diagnostic node.

[00178] For example, the second broadcast message may be the broadcast message 2.

[00179] Optionally, the ECU may send the second broadcast message when the second diagnostic node is faulty. After receiving the second broadcast message, the in-vehicle gateway may update the stored IP address from the IP address of the second diagnostic node to the IP address of the first diagnostic node. After receiving the diagnostic request sent by the external test equipment, the in-vehicle gateway may send the diagnostic request to the ECU based on the IP address of the first diagnostic node.

[00180] In this case, the ECU may send the IP address of the first diagnostic node when the second diagnostic node in the ECU is faulty and the first diagnostic node can normally provide a diagnostic service externally, so that the in-vehicle gateway records the IP address of the first diagnostic node, and the ECU may further continue to provide the diagnostic service externally via the first diagnostic node. According to the foregoing diagnostic service procedure, when a diagnostic node is faulty, automatic switching of a diagnostic service is implemented, thereby improving reliability and availability of the ECU and fault tolerance in providing the diagnostic services.

[00181] Optionally, before the ECU sends the second broadcast message, the method 800 further includes: determining that the second diagnostic node is faulty when the first broadcast message sent by the second diagnostic node fails to be detected by the first diagnostic node.

[00182] For example, the first diagnostic node is a standby node, and the second diagnostic node is a primary node. After the ECU receives an ECU discovery request message sent by the in-vehicle gateway, the ECU may send the first broadcast message via the second diagnostic node and monitor the first broadcast message via the first diagnostic node. If the first broadcast message fails to be detected by the first diagnostic node, the ECU may determine that the second diagnostic node is faulty, and send the second broadcast message via the first diagnostic node.

[00183] Optionally, determining that the first diagnostic node is faulty when the first broadcast message sent by the second diagnostic node fails to be detected by the first diagnostic node includes: determining that the second diagnostic node is faulty when the first broadcast message fails to be detected by the first diagnostic node within a second preset duration since receiving of an ECU discovery request message from the ECU.

[00184] For example, after the ECU receives the ECU discovery request message sent by the in-vehicle gateway, the first diagnostic node may start a timer and monitor, during running of the timer, the first broadcast message. If the first broadcast message fails to be detected by the first diagnostic node during running of the timer, the ECU may determine that the second diagnostic node is faulty, and send the second broadcast message via the first diagnostic node.

[00185] Optionally, the first diagnostic node is a secondary diagnostic node, and the second diagnostic node is a primary diagnostic node; or the first diagnostic node and the second diagnostic node are secondary diagnostic nodes, and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

[00186] Optionally, the ECU further includes a third diagnostic node, and the method further includes: The ECU sends a third broadcast message when the first diagnostic node is faulty, where the third broadcast message includes an IP address of the third diagnostic node, and the priority of the first diagnostic node is higher than a priority of the third diagnostic node.

[00187] Correspondingly, after receiving the third broadcast message, the in-vehicle gateway may update the stored IP address from the IP address of the first diagnostic node to the IP address of the third diagnostic node.

[00188] FIG. 9 is a block diagram of a diagnostic apparatus 900 according to an embodiment of this application. The apparatus 900 is used in a first diagnostic node, the first diagnostic node and a second diagnostic node are located in an electronic control unit ECU, and the apparatus 900 includes: a monitoring unit 910, configured to monitor a first broadcast message sent by the second diagnostic node, where the first broadcast message includes an IP address of the second

diagnostic node; and a sending unit 920, configured to send a second broadcast message when the first broadcast message fails to be detected by the monitoring unit 910, where the second broadcast message includes an IP address of the first diagnostic node.

[00189] Optionally, the sending unit 920 is specifically configured to: send first indication information to the second diagnostic node when the first broadcast message fails to be detected by the monitoring unit 910 and the first diagnostic node communicates with the second diagnostic node normally, where the first indication information indicates the second diagnostic node to send the first broadcast message; and send the second broadcast message when the first broadcast message fails to be detected by the monitoring unit 910 within a first preset duration since sending of the first indication information by the sending unit 920.

[00190] Optionally, the sending unit 920 is specifically configured to send the second broadcast message when the first broadcast message fails to be detected by the monitoring unit 910 and a communication fault occurs between the first diagnostic node and the second diagnostic node.

[00191] Optionally, the apparatus 900 further includes a receiving unit 930, and the sending unit 920 is specifically configured to send the second broadcast message when the first broadcast message fails to be detected by the monitoring unit 910 within a second preset duration since receiving of an ECU discovery request message from the receiving unit 930.

[00192] The monitoring unit 910 is configured to monitor a broadcast message (for example, the broadcast message 1) inside the ECU, and the receiving unit 930 may be configured to receive a message (for example, the ECU discovery request message) outside the ECU (or a diagnostic network).

[00193] Optionally, the apparatus 900 further includes a connection establishment unit, configured to establish a connection to an in-vehicle gateway. The receiving unit 930 is configured to receive a first diagnostic request sent by external test equipment through the in-vehicle gateway.

[00194] Optionally, the receiving unit 930 is further configured to: ignore the first broadcast message when the first broadcast message is received in a process in which the first diagnostic node performs a first diagnostic service with the external test equipment, where the first diagnostic service is associated with the first diagnostic request; the receiving unit 930 is further configured to receive, through the in-vehicle gateway, a second diagnostic request sent by the external test equipment; and the sending unit 920 is further configured to send second indication information to the second diagnostic node, where the second indication information indicates the second diagnostic node to send the first broadcast message.

[00195] Optionally, the first diagnostic node is a secondary diagnostic node, and the second

diagnostic node is a primary diagnostic node; or the first diagnostic node and the second diagnostic node are secondary diagnostic nodes, and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

[00196] FIG. 10 is a block diagram of a diagnostic apparatus 1000 according to an embodiment of this application. The apparatus 1000 is used in an electronic control unit ECU, the ECU includes a first diagnostic node and a second diagnostic node, the apparatus 1000 includes a sending unit 1010 and a fault detection unit 1020. The sending unit 1010 is configured to send a first broadcast message, where the first broadcast message includes an IP address of the second diagnostic node. The sending unit 1010 is further configured to send a second broadcast message when the fault detection unit 1020 detects that the second diagnostic node is faulty, where the second broadcast message includes an IP address of the first diagnostic node.

[00197] Optionally, the fault detection unit 1020 is specifically configured to determine that the second diagnostic node is faulty when the first broadcast message sent by the second diagnostic node fails to be detected by the first diagnostic node.

[00198] Optionally, the apparatus 1000 further includes a receiving unit 1030, and the fault detection unit 1020 is specifically configured to determine that the second diagnostic node is faulty when the first broadcast message fails to be detected by the first diagnostic node within a second preset duration since receiving of an ECU discovery request message from the receiving unit 1130.

[00199] Optionally, the first diagnostic node is a secondary diagnostic node, and the second diagnostic node is a primary diagnostic node; or the first diagnostic node and the second diagnostic node are secondary diagnostic nodes, and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

[00200] It should be understood that division into units in the apparatus is merely logical function division. During actual implementation, all or some of the units may be integrated into one physical entity or may be physically separated. In addition, the units in the apparatus may be implemented in a form of software invoked by a processor. For example, the apparatus includes a processor, the processor is connected to a memory, the memory stores instructions, and the processor invokes the instructions stored in the memory, to implement any one of the foregoing methods or functions of the units in the apparatus. The processor is, for example, a general-purpose processor like a CPU or a microprocessor, and the memory is a memory inside the apparatus or a memory outside the apparatus. Alternatively, the units of the apparatus may be implemented in a form of a hardware circuit, and functions of some or all of the units may be implemented by designing the hardware circuit. The hardware circuit may be understood as one or more processors. For example, in an implementation, the hardware circuit is an ASIC, and

functions of some or all of the foregoing units are implemented by designing a logical relationship between elements in the circuit. For another example, in another implementation, the hardware circuit may be implemented by using a PLD. An FPGA is used as an example. The hardware circuit may include a large quantity of logic gate circuits, and a connection relationship between the logic gate circuits is configured by using a configuration file, to implement functions of some or all of the foregoing units. All units of the foregoing apparatuses may be implemented in a form of software invoked by the processor, or all units may be implemented in a form of the hardware circuit, or some units may be implemented in a form of software invoked by the processor, and a remaining part may be implemented in a form of the hardware circuit.

[00201] In embodiments of this application, the processor is a circuit having a signal processing capability. In an implementation, the processor may be a circuit having an instruction reading and running capability, for example, a CPU, a microprocessor, a GPU, or a DSP. In another implementation, the processor may implement a specific function based on a logical relationship of a hardware circuit, and the logical relationship of the hardware circuit is fixed or reconfigurable. For example, the processor is a hardware circuit implemented by an ASIC or a PLD, for example, an FPGA. In the reconfigurable hardware circuit, a process in which the processor loads a configuration document to implement hardware circuit configuration may be understood as a process in which the processor loads instructions to implement functions of some or all of the foregoing units. In addition, the processor may be alternatively a hardware circuit designed for artificial intelligence, and may be understood as an ASIC, for example, an NPU, a TPU, or a DPU.

[00202] It can be learned that the units in the foregoing apparatus may be configured as one or more processors (or processing circuits) for implementing the foregoing methods, for example, a CPU, a GPU, an NPU, a TPU, a DPU, a microprocessor, a DSP, an ASIC, an FPGA, or a combination of at least two of these processor forms.

[00203] In addition, all or some of the units of the apparatus may be integrated, or may be implemented independently. In an implementation, these units are integrated and implemented in a form of SoC. The SoC may include at least one processor, configured to implement any one of the methods or implement the functions of the units of the apparatus. Types of the at least one processor may be different, for example, include a CPU and an FPGA, a CPU and an artificial intelligence processor, or a CPU and a GPU.

[00204] An embodiment of this application further provides a diagnostic apparatus. The apparatus includes a processing unit and a storage unit. The storage unit is configured to store instructions. The processing unit executes the instructions stored in the storage unit, to enable the apparatus to perform the methods or the steps performed in the foregoing embodiments.

[00205] FIG. 11 is a block diagram of a diagnostic system 1100 according to an embodiment of this application. The diagnostic system 1100 may include an ECU 1110 and an in-vehicle gateway 1120. The ECU 1110 may be the ECU shown in FIG. 3, or the ECU 1110 may include the apparatus 900 or the apparatus 1000.

[00206] An embodiment of this application further provides a vehicle. The vehicle may include the diagnostic apparatus 900, the diagnostic apparatus 1000, or the diagnostic system 1100.

[00207] An embodiment of this application further provides a computer program product. The computer program product includes computer program code. When the computer program code is run on a computer, the computer is enabled to perform the methods in the foregoing embodiments.

[00208] An embodiment of this application further provides a computer-readable medium. The computer-readable medium stores program code. When the computer program code is run on a computer, the computer is enabled to perform the methods in the foregoing embodiments.

[00209] An embodiment of this application further provides a chip. The chip includes a circuit, and the circuit is configured to perform the methods in the foregoing embodiments.

[00210] In an implementation process, steps in the foregoing methods can be implemented by using a hardware integrated logical circuit in the processor, or by using instructions in a form of software. The method of the communication disclosed with reference to embodiments of this application may be directly performed by a hardware processor, or may be performed by using a combination of hardware in the processor and a software module. The software module may be located in a mature storage medium in the art, like a random access memory, a flash memory, a read-only memory, a programmable read-only memory, an electrically erasable programmable memory, or a register. The storage medium is located in the memory, and a processor reads information in the memory and completes the steps in the foregoing methods in combination with hardware of the processor. To avoid repetition, details are not described herein again.

[00211] It should be understood that in embodiments of this application, the memory may include a read-only memory and a random access memory, and provide instructions and data to the processor.

[00212] It should be understood that sequence numbers of the foregoing processes do not mean execution sequences in various embodiments of this application. The execution sequences of the processes should be determined according to functions and internal logic of the processes, and should not be construed as any limitation on the implementation processes of embodiments of this application.

[00213] A person of ordinary skill in the art may be aware that, in combination with the

examples described in embodiments disclosed in this specification, units and algorithm steps may be implemented by electronic hardware or a combination of computer software and electronic hardware. Whether the functions are performed by hardware or software depends on particular applications and design constraint conditions of the technical solutions. A person skilled in the art may use different methods to implement the described functions for each particular application, but it should not be considered that the implementation goes beyond the scope of this application.

[00214] It may be clearly understood by a person skilled in the art that, for the purpose of convenient and brief description, for a detailed working process of the foregoing system, apparatus, and unit, refer to a corresponding process in the foregoing method embodiments. Details are not described herein again.

[00215] In the several embodiments provided in this application, it should be understood that the disclosed system, apparatus, and method may be implemented in other manners. For example, the described apparatus embodiments are merely examples. For example, division into the units is merely logical function division, and may be other division in an actual implementation. For example, a plurality of units or components may be combined or integrated into another system, or some features may be ignored or not performed. In addition, the displayed or discussed mutual couplings or direct couplings or communication connections may be implemented through some interfaces. The indirect couplings or communication connections between the apparatuses or units may be implemented in electronic, mechanical, or another form.

[00216] The units described as separate components may or may not be physically separate, and components shown as units may or may not be physical units, to be specific, may be located in one place, or may be distributed on a plurality of network units. Some or all of the units may be selected based on actual requirements to achieve the objectives of the solutions of embodiments.

[00217] In addition, functional units in embodiments of this application may be integrated into one processing unit, or each unit may exist physically alone, or two or more units may be integrated into one unit.

[00218] When the functions are implemented in the form of a software functional unit and sold or used as an independent product, the functions may be stored in a computer-readable storage medium. Based on such an understanding, the technical solutions of this application essentially, or the part contributing to the conventional technology, or some of the technical solutions may be implemented in a form of a software product. The computer software product is stored in a storage medium, and includes several instructions for instructing a computer device (which may be a personal computer, a server, a network device, or the like) to perform all or

some of the steps of the methods described in embodiments of this application. The foregoing storage medium includes any medium that can store program code, such as a USB flash drive, a removable hard disk, a read-only memory (read-only memory, ROM), a random access memory (random access memory, RAM), a magnetic disk, or an optical disc.

[00219] The foregoing descriptions are merely specific implementations of this application, but are not intended to limit the protection scope of this application. Any variation or replacement readily figured out by a person skilled in the art within the technical scope disclosed in this application shall fall within the protection scope of this application. Therefore, the protection scope of this application shall be subject to the protection scope of the claims.

CLAIMS

1. A diagnostic method, wherein the method is applied to a first diagnostic node, the first diagnostic node and a second diagnostic node are located in an electronic control unit ECU, and the method comprises:

monitoring, by the first diagnostic node, a first broadcast message sent by the second diagnostic node, wherein the first broadcast message comprises an Internet Protocol IP address of the second diagnostic node; and

sending, by the first diagnostic node, a second broadcast message when the first broadcast message fails to be detected, wherein the second broadcast message comprises an IP address of the first diagnostic node.

2. The method according to claim 1, wherein sending, by the first diagnostic node, the second broadcast message when the first broadcast message fails to be detected comprises:

sending, by the first diagnostic node, first indication information to the second diagnostic node when the first broadcast message fails to be detected and the first diagnostic node communicates with the second diagnostic node normally, wherein the first indication information indicates the second diagnostic node to send the first broadcast message; and

sending, by the first diagnostic node, the second broadcast message when the first broadcast message fails to be detected within a first preset duration since sending of the first indication information by the first diagnostic node.

3. The method according to claim 1, wherein sending, by the first diagnostic node, the second broadcast message when the first broadcast message fails to be detected comprises:

sending, by the first diagnostic node, the second broadcast message when the first broadcast message fails to be detected and a communication fault occurs between the first diagnostic node and the second diagnostic node.

4. The method according to claim 1, wherein sending, by the first diagnostic node, the second broadcast message when the first broadcast message fails to be detected comprises:

sending, by the first diagnostic node, the second broadcast message when the first broadcast message fails to be detected within a second preset duration since receiving of an ECU discovery request message from the first diagnostic node.

5. The method according to any one of claims 1 to 4, wherein the method further comprises:

establishing, by the first diagnostic node, a connection to an in-vehicle gateway; and

receiving, by the first diagnostic node, a first diagnostic request sent by external test equipment through the in-vehicle gateway.

6. The method according to claim 5, wherein the method further comprises:

ignoring the first broadcast message when the first broadcast message is received in a process in which the first diagnostic node performs a first diagnostic service with the external test equipment, wherein the first diagnostic service is associated with the first diagnostic request;

receiving, by the first diagnostic node through the in-vehicle gateway, a second diagnostic request sent by the external test equipment; and

sending, by the first diagnostic node, second indication information to the second diagnostic node in response to receiving the second diagnostic request, wherein the second indication information indicates the second diagnostic node to send the first broadcast message.

7. The method according to any one of claims 1 to 6, wherein

the first diagnostic node is a secondary diagnostic node, and the second diagnostic node is a primary diagnostic node; or

the first diagnostic node and the second diagnostic node are secondary diagnostic nodes, and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

8. A diagnostic method, wherein the method is applied to an electronic control unit ECU, the ECU comprises a first diagnostic node and a second diagnostic node, and the method comprises:

sending, by the ECU, a first broadcast message, wherein the first broadcast message comprises an Internet Protocol IP address of the second diagnostic node; and

sending, by the ECU, a second broadcast message when the second diagnostic node is faulty, wherein the second broadcast message comprises an IP address of the first diagnostic node.

9. The method according to claim 8, wherein before sending, by the ECU, the second broadcast message, the method further comprises:

determining that the second diagnostic node is faulty when the first broadcast message sent by the second diagnostic node fails to be detected by the first diagnostic node.

10. The method according to claim 9, wherein determining that the first diagnostic node is faulty when the first broadcast message sent by the second diagnostic node fails to be detected by the first diagnostic node comprises:

determining that the second diagnostic node is faulty when the first broadcast message fails to be detected by the first diagnostic node within a second preset duration since receiving of an ECU discovery request message from the ECU.

11. The method according to any one of claims 8 to 10, wherein

the first diagnostic node is a secondary diagnostic node, and the second diagnostic node is a primary diagnostic node; or

the first diagnostic node and the second diagnostic node are secondary diagnostic nodes,

and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

12. A diagnostic apparatus, wherein the apparatus is used in a first diagnostic node, the first diagnostic node and a second diagnostic node are located in an electronic control unit ECU, and the apparatus comprises:

a monitoring unit, configured to monitor a first broadcast message sent by the second diagnostic node, wherein the first broadcast message comprises an IP address of the second diagnostic node; and

a sending unit, configured to send a second broadcast message when the first broadcast message fails to be detected by the monitoring unit, wherein the second broadcast message comprises an IP address of the first diagnostic node.

13. The apparatus according to claim 12, wherein the sending unit is specifically configured to:

send first indication information to the second diagnostic node when the first broadcast message fails to be detected by the monitoring unit and the first diagnostic node communicates with the second diagnostic node normally, wherein the first indication information indicates the second diagnostic node to send the first broadcast message; and

send the second broadcast message when the first broadcast message fails to be detected by the monitoring unit within a first preset duration since sending of the first indication information.

14. The apparatus according to claim 12, wherein the sending unit is specifically configured to:

send the second broadcast message when the first broadcast message fails to be detected by the monitoring unit and a communication fault occurs between the first diagnostic node and the second diagnostic node.

15. The apparatus according to claim 12, wherein the apparatus further comprises a receiving unit, and the sending unit is specifically configured to:

send the second broadcast message when the first broadcast message fails to be detected by the monitoring unit within a second preset duration since receiving of an ECU discovery request message from the receiving unit.

16. The apparatus according to any one of claims 12 to 15, wherein the apparatus further comprises:

a connection establishment unit, configured to establish a connection to an in-vehicle gateway, wherein

the receiving unit is configured to receive a first diagnostic request sent by external test equipment through the in-vehicle gateway.

17. The apparatus according to claim 16, wherein

the receiving unit is further configured to: ignore the first broadcast message when the first broadcast message is received in a process in which the first diagnostic node performs a first diagnostic service with the external test equipment, wherein the first diagnostic service is associated with the first diagnostic request;

the receiving unit is further configured to receive, through the in-vehicle gateway, a second diagnostic request sent by the external test equipment; and

the sending unit is further configured to send second indication information to the second diagnostic node, wherein the second indication information indicates the second diagnostic node to send the first broadcast message.

18. The apparatus according to any one of claims 12 to 17, wherein

the first diagnostic node is a secondary diagnostic node, and the second diagnostic node is a primary diagnostic node; or

the first diagnostic node and the second diagnostic node are secondary diagnostic nodes, and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

19. A diagnostic apparatus, wherein the apparatus is used in an electronic control unit ECU, the ECU comprises a first diagnostic node and a second diagnostic node, and the apparatus comprises a sending unit and a fault detection unit, wherein

the sending unit is configured to send a first broadcast message, wherein the first broadcast message comprises an IP address of the second diagnostic node; and

the sending unit is further configured to send a second broadcast message when the fault detection unit detects that the second diagnostic node is faulty, wherein the second broadcast message comprises an IP address of the first diagnostic node.

20. The apparatus according to claim 19, wherein the fault detection unit is specifically configured to:

determine that the second diagnostic node is faulty when the first broadcast message sent by the second diagnostic node fails to be detected by the first diagnostic node.

21. The apparatus according to claim 20, wherein the apparatus further comprises a receiving unit, and the fault detection unit is specifically configured to:

determine that the second diagnostic node is faulty when the first broadcast message fails to be detected by the first diagnostic node within a second preset duration since receiving of an ECU discovery request message from the receiving unit.

22. The apparatus according to any one of claims 19 to 21, wherein

the first diagnostic node is a secondary diagnostic node, and the second diagnostic node is a primary diagnostic node; or

the first diagnostic node and the second diagnostic node are secondary diagnostic nodes,

and a priority of the second diagnostic node is higher than a priority of the first diagnostic node.

23. A diagnostic apparatus, comprising:

a memory, configured to store a computer program; and

a processor, configured to execute the computer program stored in the memory, so that the apparatus performs the method according to any one of claims 1 to 11.

24. A diagnostic system, wherein the diagnostic system comprises an ECU and an in-vehicle gateway, and the ECU comprises the apparatus according to any one of claims 12 to 23.

25. A vehicle, comprising the apparatus according to any one of claims 12 to 23, or the system according to claim 24.

26. A computer-readable storage medium, wherein the computer-readable storage medium stores instructions, and when the instructions are executed by a processor, the processor is enabled to implement the method according to any one of claims 1 to 11.

27. A computer program product, wherein the computer program product comprises computer program code, and when the computer program code is run on a computer, the computer is enabled to perform the method according to any one of claims 1 to 11.