Research on Application of CAN Bus Technology in Truck

Xuan Dong

Abstract With the development of science and technology and the increase of automotive electrical equipment, the automotive network system becomes increasingly complex to the integrated wiring and information interaction and sharing put forward higher requirements. CAN bus, with its outstanding advantages, has been more and more used in automobile network system. This paper describes the classification of automobile network, the characteristics of CAN bus technology, the network scheme of commercial vehicle bus control system, the design and the application prospect, and the development trend of bus technology in automobile network system.

Keywords CAN bus · Truck

1 Introduction

In recent years on car safety, environmental protection, energy saving, comfortable and so on high demand, the performance of automobile electronic technology rapid development, solve the on-board electrical system increasing and more and more complex control, wiring problem such as space is limited, in today's passenger car, throughout the vehicle communication and control bus system has been basically popularized, technical solution is also very mature. However, for domestic commercial vehicles, the application of bus system is very limited due to the constraints of demand, cost, after-sales service, and other factors. With the increasing requirements for safety, comfort, power, economy, and operation, the electronic equipment of commercial vehicles is becoming more and more complex, such as body controller BCM, anti-lock system ABS, anti-skid control system (ASR), tire pressure monitoring system TPMS, and remote control lock. In the traditional control mode, increasing the corresponding controller, sensors and wiring harness, greatly increasing the number and weight of the vehicle wiring harness, also increased the difficulty

X. Dong (✉)
Key Laboratory of Operation Safety Technology on Transport Vehicles, Ministry of Transport, PRC, No. 8, Xitucheng Road, Haidian District, Beijing 100088, China
e-mail: x.donga@rioh.cn

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of wiring, increased difficulties of assembly and maintenance, and at the same time between each node and need information exchange and data sharing, the traditional cable has far cannot satisfy the demand. The emergence of automobile CAN bus technology provides a new means to solve the above problems. A multiplexed bus system should be adopted to connect all control nodes through a network, so as to realize the network of automobiles and not only achieve the intersection of information exchange, data sharing, reduce the number of wire harness, reduce the cost of the car and failure rate, but also improve the reliability and stability of the system. And the system itself also has excellent scalability, without increasing the system hierarchy structure, does not affect the performance of the system, and, at the same time, can be connected to various modules to achieve more vehicle functions.

2 CAN Bus Technology Characteristics

Compared with general communication bus, CAN bus has outstanding reliability, real-time, and flexibility in data communication. Its main features are as follows:

(1) Has a high-cost performance. Its structure is simple, the device is easy to purchase, the price of each node is low, and the development process can make full use of the current SCM development tools, and development technology is easy to master;
(2) Multiple master control. When the bus is idle, all nodes can start sending messages (multi-master control). The node that accesses the bus first gets the send right. When multiple nodes on the bus start to send messages at the same time, nodes that send high-priority messages can get the right to send;
(3) With the non-destructive bus arbitration technology, when multiple nodes send information to the bus at the same time, the node with the lower priority will take the initiative to exit the transmission, while the node with the highest priority will continue to transmit data unaffected, thus greatly saving the time of bus conflict arbitration. Especially in the case of heavy network load will not appear network paralysis;
(4) Using short frame structure. each frame of the effective number of bytes is 8, the transmission time is short, the probability of interference is low, the retransmission time is short, and each frame of information has cyclic redundancy check code check and error detection measures, has excellent error detection effect, to ensure the low error rate;
(5) In case of serious error, the node has the function of automatically closing the bus and cutting off its connection with the bus so that other operations on the bus are not affected;
(6) CAN node only needs to filter the identifier of the message to realize point-to-point, one-to-many, and global broadcast centralized mode to transmit and receive data, without special "scheduling";

(7) Node information on the network is divided into different priority levels to meet different real-time requirements. High-priority data can be transmitted within 134 μs at most.
(8) Communication medium can be double stranded wire, coaxial cable or optical fiber, flexible choice;
(9) The number of nodes on CAN mainly depends on the bus driver circuit, which can be up to 110 at present. In standard frame, message identifier (CAN 2.0a, 11 bits) can be up to 2032 kinds, while the number of extended frame message identifier (CAN 2.0b, 29 bits) is almost unlimited.
(10) The longest direct communication distance is up to 10 km (below the rate of 5 kb/s), and the highest communication rate is up to 1 Mkb/s (at this time, the longest communication distance is 40 m).

3 Classification of Vehicle Networks

According to the performance from low to high, the current vehicle bus network is divided into three levels, namely A, B, and C [1, 3], as shown in Table 1 [3]. Class A network is a low-speed network, mainly used for the transmission rate real-time, low reliability requirements of the system. Generally, the communication rate is 1–10 kbps, which represents the LIN bus network. Class B network is used for the system with high requirements on data transmission speed, represented by CAN and J1850. The communication rate is generally between 10 and 250 kbps, belonging to the medium-speed bus. The c-level network is used for the system with high-speed, real-time performance and high reliability requirements. It is represented by CAN, FlexRay, MOST, and IBD-1394. The communication rate is generally above 500 kbps, belonging to the high-speed bus.

Table 1 Classification of vehicle networks

Category	Object-oriented	Speed (kbps)	Range of application
A	Sensor and actuator controlled low-speed network	1–10	Air conditioning, lighting, seat adjustment, etc.
B	A medium-speed network for data sharing between independent modules	10–125	Fault diagnosis, instrument display, airbag, etc.
C	Real-time closed-loop control for high-speed networks	125–1000	Transmission, suspension, engine, brake, and other systems

Table 2 Class A network protocol

Designation	The user	Purpose
UART	GM	General and diagnostic
SINEBUS	GM	Audio
LIN	Most car plants	Intelligent sensors and actuators, etc.
CCD	Chrysler	General and diagnostic
SAE J1708	SAE	Control and diagnostic
TTP/A	TT Tech (time triggered technology)	Intelligent sensors

3.1 Class A Bus

Class A network is mainly oriented to the low-speed network of sensors and actuators. This kind of network has low real-time requirements, and the bit rate is generally 1–10 kbps. It is mainly used for the control of air conditioning, luggage, lighting, electric doors, and Windows, seat adjustment, and other systems. Table 2 shows some class A network protocols [3].

3.2 Class B Bus

Class B network is mainly for data sharing among independent modules. It is a medium-speed network. This kind of network is suitable for communication with low real-time requirement to reduce redundant sensors and other electronic components. It is mainly used in vehicle electronic information center, fault diagnosis, instrument display, airbag, and other systems. Currently, there are three types of B bus standards, namely, low-speed CAN, J1850, and vehicle area network (VAN).

3.3 Class C Bus

Class C network is mainly used in places with high requirements on automobile safety and real-time performance, and its transmission rate is relatively high, usually between 125 kbps and 1 mbps. Table 3 shows the use of class C network.

At present, class C network protocols mainly include high-speed CAN, TTP/C, and FlexRay. In the next few years, CAN protocol will still be the main protocol in C network. However, with the introduction of the x-by-wire electronic wire control system to the next generation of vehicles, TTP/C and Flex Ray advantages will be shown.

Table 3 Class C network protocol

Designation	The user	Purpose
ISO 11898	Most car plants	Control and diagnostic
SAE J2284	Foer, Chrysler, etc.	Control and diagnostic
TTP/A	Time triggered technology (TT Tech)	Control

4 Truck Bus Control System Network Scheme

Car CAN bus network nodes are often divided a lot, very fine, car lights have to have more than one node, sunroof, seat and so on are separate nodes. However, for trucks, more nodes are not necessarily good, because each node should have at least one ECU, which is not recommended in practical applications, and trucks have less strong requirements for reducing wiring harness than cars. So on a truck, the bus does not have to have as many nodes as a car.

Truck configuration of a typical control unit has engine control units, electronic control unit (ECU) for automatic transmission, anti-lock braking unit (ABS), drive torque/traction control unit (ASR/TCS), electronic control unit power steering (EPS), electronic control air suspension system (ECAS), driving recorder, the hydraulic retarder, combination instrument, automobile body electronic controller unit, electric Windows, remote central lock, a key if there are tow truck and trailer brake control unit, the trailer chassis and suspension unit, the trailer body electronic control unit, etc. We define each control unit as a node, and each node corresponds to an ECU.

According to the above principles, the following network schemes of truck CAN bus control system are designed:

(1) In the absence of a trailer, all nodes CAN be hung on the same CAN bus if the network load allows. All network nodes transmit data over a single bus. As shown in Fig. 1, the heavy vehicle bus control system network scheme 1 without trailer system is presented.

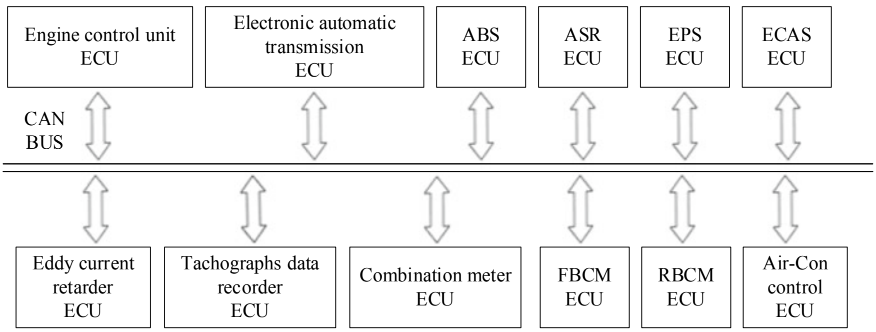

Fig. 1 Network scheme 1 of truck bus control system without trailer

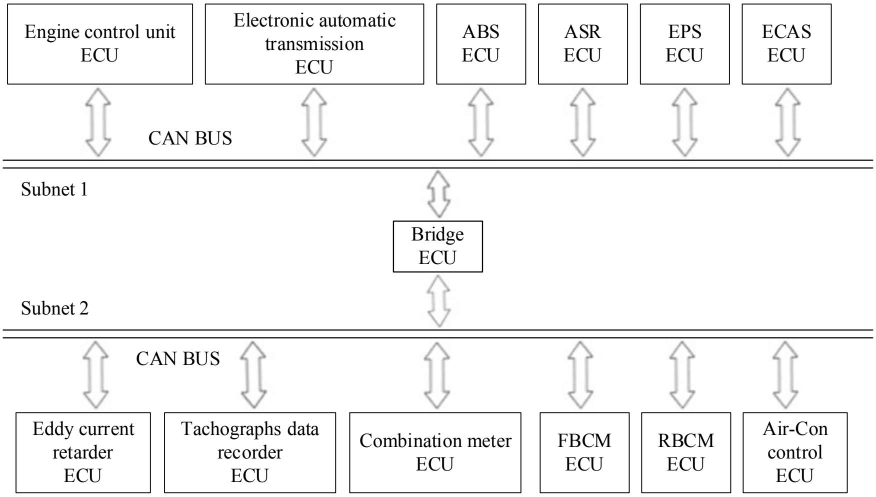

Fig. 2 Network scheme 2 of truck bus control system without trailer

(2) According to the load of the bus, each control unit of the tractor can be divided into two or more network segments, as shown in Fig. 2. The network can be divided into two or more subnets and connected through the bridge, so as to reduce the data information flow on each subnet and improve the efficiency of the whole network. Due to the long distance between the front and rear electric appliances of heavy vehicles, the vehicle electronic control unit can be divided into several nodes according to the distribution position to save wiring harness, and the vehicle electronic control unit can be divided into two nodes or several nodes of front body control and rear body control, or be integrated into one node.

(3) If there is a trailer system, it is recommended to connect the trailer system as a network segment with the tractor bridge, so as to reduce the data flow on each network and improve the efficiency of the whole network. Figure 3 is a heavy vehicle bus control system network scheme constructed in this way. Two subnets are connected by a bridge, and the information of each subnet is transmitted and filtered through the bridge. If the load on subnet 1 is too heavy, it can be subdivided into two or more subnets to reduce the data traffic of each subnet, as in the case of the no-trailer heavy vehicle bus control system network scheme 2.

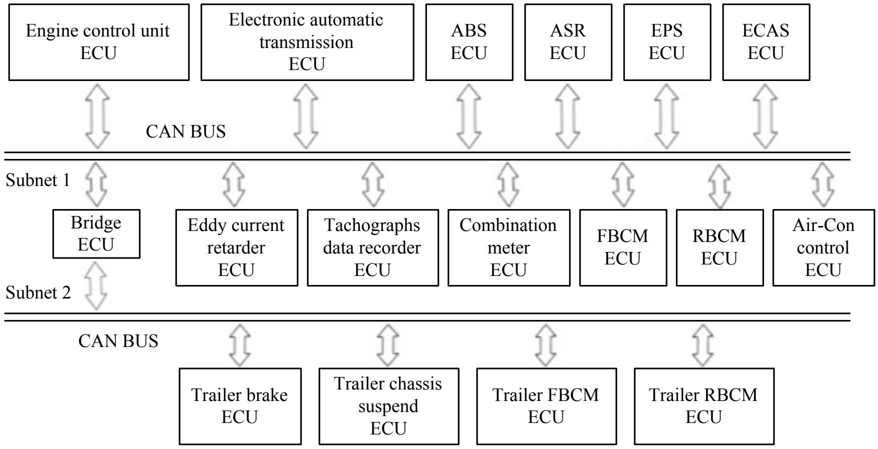

Fig. 3 Bus control system network for heavy duty vehicles with trailers

5 Node Design

The design of each node includes hardware design and software design, and software design is the key step. The design process requires the use of embedded program development software such as MPLAB, emulator, and C language. When using modular program design, in order to enhance the reliability and understandability of control unit, the whole program can be divided into four parts: the main program composed of system initialization program and monitoring program; CAN communication driver consists of message sending and receiving program and CAN error management program. Including the peripheral interface chip driver, switch signal recognition program, such as the peripheral interface program; Interrupt service routine. In the design process, the initialization program of CAN interface is a focus that needs special attention. If the design is unreasonable, the system may not work properly.

6 The Foreground and Developing Trend of Bus Technology in Automobile Network System Application

The general trend of automotive network application is networking [2]. With many master nodes, open architecture and the ability to detect errors and self-recovery, CAN bus has become the focus of automotive network applications. CAN bus is a three-layer network composed of physical layer, data link layer, and application layer. In the early 1990s, the specification of the physical layer and data link layer of CAN bus began to be gradually standardized. In the current CAN application layer, according to the different application occasions, there are some famous agreements such as J 1939 proposed for the application of truck.

In foreign countries, the application of bus technology in automobile has been rapidly popularized, and the number of companies supporting CAN bus standard is increasing gradually, making it an inevitable trend of the development of automobile network. At present, China is also studying and formulating the application layer standard of CAN network in the aspect of communication protocol coding, which plays a certain role in promoting the application of CAN network technology in China.

X-by-wire, or wire control operation, is the future development direction of automobile [3]. In the next 5–10 years, X-by-wire technology will turn traditional automotive mechanical systems into electrical systems connected to high-performance cpus through high-speed fault-tolerant communication buses.

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