Professional Forum

CAN Programming Creates Cooperation between Students in Automotive Technology and Information Technology

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Viewpoint

In the past, most of the car manufacturers applied *Engine Control Unit* (ECU) in controlling their produced vehicles. But now, pure knowledge in mechanics is no longer enough for automotive technicians, as they need to use complex software to operate in cars instead of using basic high/low electrical voltage. In this *Professional Forum*, the author would like to give a broad picture of the CAN protocol that can merge mechanics and IT into one world. The author also suggests essential knowledge for students in mechanics and information technology to develop IT applications with CAN related protocols. Both mechanics and IT practitioners can learn more to start up their prototype project.

Overview

As known at the time of invention, parts of the cars were typically mechanics with some electric wiring. All electronic parts were to communicate with one another by using wires. Later, electronic devices were introduced as parts of the vehicles. Since the electronic systems were complicated, complex wiring required copper wiring which was costly and not easy to maintain and scrutinize (Leen & Heffernan, 2002). Bosch proposed an alternative by using just one cable to control electronic parts in a car. This bus style protocol is called CAN Bus. CAN stands for Controller Area Network. CAN can help reduce the number of required wires as shown in Figure 1. CAN provides a fundamental standard that covers physical and data link layers in *Open Systems Interconnection* (OSI) layers as seen in Figure 2. It is a digital messaging protocol. After launching CAN, a field of controlling machines, vehicles are related to programming which is one of main fields of *Information Technology* (IT). A software related to vehicle operations works both inside and outside ECU. Computer equipment can be used to diagnose a vehicle system. It is important that a design program must contain an appropriate data structure to maintain the car performance as expected.

Figure 1: CAN Bus to Help Reduce the Number of Wires

Source : (https://qph.fs.quoracdn.net/main-qimg-f373e33c8abbdb051a342fc15d29d8aa)
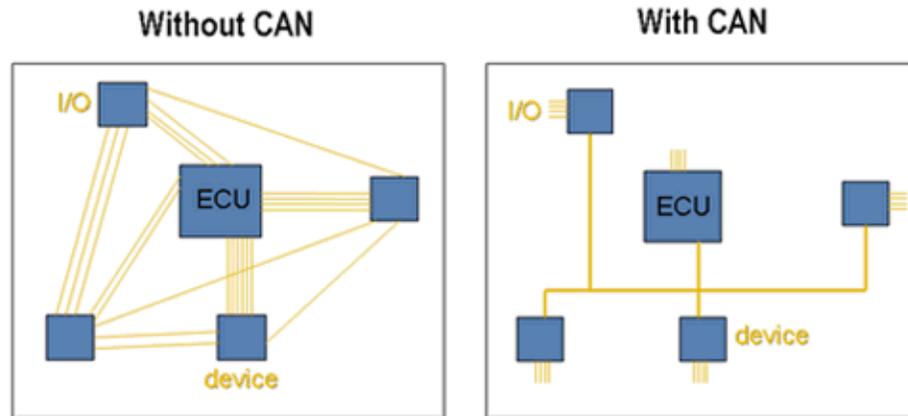
Figure 2: CAN Standard Covers More Than One OSI Layers
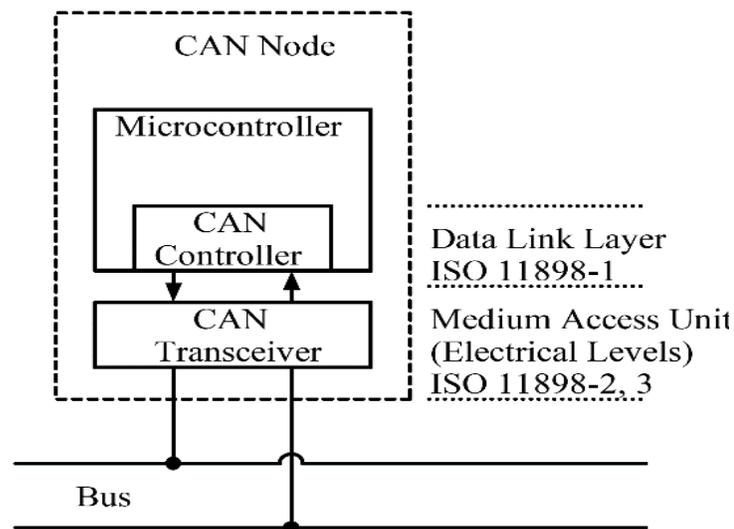
Source : (https://upload.wikimedia.org/wikipedia/commons/c/c0/CAN_Node.png)

CAN bus and Protocol

CAN bus and CAN protocol (Lawrenz, 2013) have been adopted for use in the automotive industry since 1986 from the proposal of Bosch in SAE Congress. CAN 2.0, which has 2 sub versions, CAN 2.0a (11 bit) and CAN 2.0b (29 bit), was released in 1996. It was adopted as world standard, ISO11898, in 1993.   The advanced version of CAN, CAN FD, which allowed flexible data length has been introduced since 2012. CAN was much used in the automotive industry, especially in Europe. It has been applied to other fields as well, such as,

trucks, buses, ships, submarines, drones, radar devices and industrial automation. With the emergence of Internet of Things (IoT) and Internet Cloud Service, CAN and its derived protocol tend to gain more popularity among technical groups other than mechanical engineers, as their provided data can be applied in various application platforms by IT developers.

Various CAN Versions

Currently, there are many CAN versions used in the industry, CAN 2.0A, CAN 2.0B and CAN FD (Flexible Data Rate or Fast Data). Their structure is shown in Figure 3.

Figure 3: Frame Structure of Various Versions of CAN Protocol

CAN 2.0A (Standard Frame)									
SOF	Identifier	RTR	IDE	r0	DLC	Data	CRC	ACK	EOF
1	11	1	1	1	4	0..8bytes	15+1*	1+1*	7

CAN 2.0B (Extended Frame)											
SOF	Identifier	SRR	IDE	RTR	r1	r0	DLC	Data	CRC	ACK	EOF
1	18	1	1	1	1	1	4	0..8bytes	15+1*	1+1*	7

CAN FD (Standard Frame)												
SOF	Identifier	RTR	IDE	EDL	r0	BRS	ESI	DLC	Data	CRC	ACK	EOF
1	11	1	1	1	1	1	1	4	0..64bytes	17or21#+1*	1+1*	7

CAN FD (Extended Frame)														
SOF	Identifier	SRR	IDE	Identifier Extension	RTR	EDL	r0	BRS	ESI	DLC	Data	CRC	ACK	EOF
1	11	1	1	18	1	1	1	1	1	4	0..64bytes	17or21#+1*	1+1*	7

Note: If not specified as others, unit of values above are bit.
* +1 is delimiter
# If data is more than 16 bytes, CRC 21 is used or else CRC 17 is applied.

As shown in Figure 3, data can be sent or received throughout the car by using any version of the standard CAN protocol. Automotive Technology students can learn about what data being sent or received from the systems in the vehicle. IT students can help in this case as

they have already learnt Data Structure in the topic of Byte Array to apply encoding or decoding data. With this kind of cooperation, IT students can improve their skills in protocol programming which is related to Data Structure, while Automotive Technology students can learn more about modern vehicle controlling techniques. The application that connects encoding and decoding data can be in either web, windows or mobile application. Automotive Technology students can track data from their computer screen or mobile phone. They can improve skills in both fields, as listed in Table 1, which shows a lower cost of self-developing software than that of buying regular technical equipment.

CAN uses the concept of Messaging bus for IT students to get a sample code in C# as shown by Ahmed (2018). For more advanced development, data security needs to be one of the prime concerns for developers.

Table 1: Skills to Be Gained by Students in Automotive Technology and Information Technology

Automotive Technology Students	CAN supported vehicle	IT Students
Easier to understand and apply skills in topics of • Learning kinds of data communicated among various systems in the car. • Learning how CAN data can communicate in the car.		Easier to understand and apply skills in field of • Data Structure (Byte Array), such as, BitArray Class in C# (option) • Multiplatform Structural and Object Oriented Software Development • Database Management (option) • Data Security (option)

Final Note

CAN bus can significantly reduce the number of wires used in the car. Various versions of CAN bus and protocol are of standard data communication among various systems in modern cars and other vehicles. Since digital data are easily handled by a regular computer, IT students who are familiar with computer programming can help Automotive Technology students to understand data communication in the systems of modern cars, whereas IT students can in turn improve their protocol-leveled programming skills.

The Author

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Feedback: The author would appreciate your feedback and comments or questions you may have about this topic. Please email Kayun Chantarasathaporn at <dr.kayun@gmail.com> or <kayunc@siamtechno.ac.th>.

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