Study on the Application of FMI standard to AUTOSAR Layered Architecture

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AUTOSAR 계층 구조에 대한 FMI 표준 적용에 관한 연구

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Abstract

The complexity of the entire system, including vehicles, is increasing. Several studies are being conducted to test the interaction of the components. This paper presents how to apply the FMI standard that enables Co-simulation to AUTOSAR. As a kind of approach, CAN Interface is set to CAN FMI as the routing table of PDU Router to enable simulation.

Keywords—*AUTOSAR, CAN, FMI, vECU, FMU, PduR*

I. Introduction

CAN(Controller Area Network) is a vehicle communication protocol created by Bosch and Intel[1]. These were made for vehicle communication. CAN is the Message-Oriented Protocol. To improve system control speed and stability, we use a method of prioritizing messages and distinguishing messages using them. In addition, it has the advantage of being able to use it in various environments by enabling high-speed and long-distance communication and supporting Multiple Master, Peer to Peer, and Master/Slave. Early vehicles were connected to each other in a point-to-point manner. As the number of modules entering the vehicle increased, the lines increased, and as a result, maintenance, wiring and cost problems occurred, so CAN communication with several modules connected to one CAN bus network became widely used for the vehicle[2][3]. CAN is a twisted pair wire that operates at different voltages on each wire, so the signal voltage on one wire is inverted and transmitted on the other. This transmission method can be used to cope with electrical noise and is inexpensive.

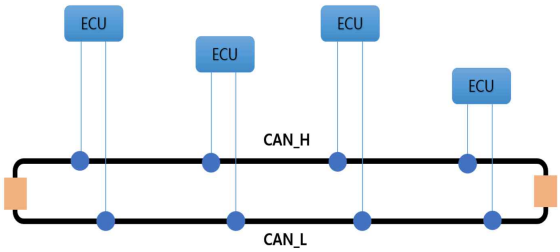

Fig. 1. Can Bus Network Using Can_H, Can_L

In order to test the ECUs containing CAN, it is possible to test them by connecting them with actual hardware, but if they are tested in a virtual environment, more cases can be tested quickly. So in the automotive field, each function is tested through various simulation environments. If development proceeds in such various simulation environments, it is difficult to simulate the entire system, and it is impossible to know what kind of interaction occurs. To do this, a method to correctly simulate the entire system is required, and FMI(Functional Mock-up Interface)[4] is presented as a method. FMI enables simulation of the entire system for each function if only the interface is satisfied, even if the functions tested in different simulation environments are used.

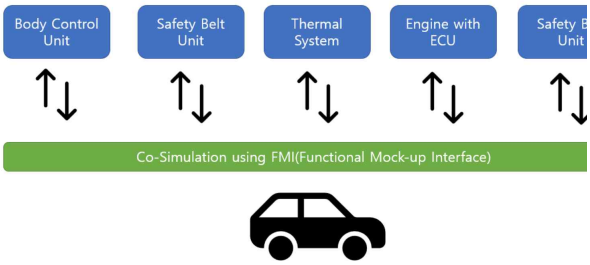

Fig. 2. Vehicles consisting of multiple FMU

Ⅱ. Related Research

A. *Functional Mock-up Interface*

FMI(Functional Mock-up Interface) was developed in a MODELISAR project in Europe to lead to standardization in the development of software for electronic devices inside vehicles[4]. The MODELISAR project is an EU Information Technology for European Advancement(ITEA2) project aimed at improving system design and embedded S/W design. FMI was developed to support the AUTOSAR(AUTomotive Open System Architecture) standard, an open system standard for automotive software. FMI is a standard for connecting several simulation components. Software components that are made in compliance with the FMI standard and have their respective functions in the entire simulation are called FMU(Functional Mockup Unit) [5].

In this research, the AUTOSAR Layer uses CAN FMI instead of CAN Interface to PDU Router to simulate the corresponding Can role. and instead of FMI, we introduce how to make hardware available in a real-world environment when connecting hardware directly.

FMI defines an application programming interface(API) to exchange models using an XML file that can modify related parameters and a combination of binary and C codes. There are three types of FMI Interface, Co-Simulation with an own solver or scheduler and Model Exchange with support for numerical Integration. Scheduled Execution, which is supported by FMI 3.0 and later, is the importer that triggers the execution of the model partitions

B. *Can Interface*

After checking the PDU ID in the PDU, select the internal channel. When the PDU is delivered to the Hardware Object Handle connected to each channel, the PDU is written to the hardware object of the CAN controller and the CAN frame is delivered to the Transceiver with the object flag value set to 1[6].

C. *PDU Router*

Communication messages are changed to PDUs when communicating information between network layers, which consist of a service data unit(SDU) and protocol control information(PCI). SDU is the data that is actually passed on, and PCI is the part of information such as source, destination, and priority. Moving to the lower layer. The PDU is configured by attaching the SDU and PCI created in the upper layer to the header.

PDUs made in COM are transmitted to PduR, and the PDU Router module performs Interaction layer Protocol Data Unit(I-PDU) routing by referring to the PDU reference in the routing table between various layers. PduR is composed of a routing table and engine. The engine uses the routing table to allow the PDU to reach the desired position[7].

D. *Com*

Signal delivered from application layer is stored in Com's I-PDU buffer and transferred to PduR in I-PDU form by Pdur_ComTransmit function. It provides an interface to read and write PDU data in signal. when an event such as data timeout, data receive or data send occurs for signal, it is delivered to application layer[8].

Ⅲ. How to Use Can FMI

Both FMI and AUTOSAR use XML documents, which generate CAN.FMU files using the FMI standard referring to the existing AUTOSAR Can Interface. The ZIP file will contain a modelDescription.xml file containing a description of the corresponding CAN FMU and a buildDescription.xml file containing a C source for conversion to the AUTOSAR layer. When this is inserted into the AUTOSAR transformation program, an executable file called FMI_CAN_AUTOSAR.jar appears If this is imported and applied to AUTOSAR, CAN FMI can be used. If the simulation environment is configured based on this, I-PDUs that occur between the PduR and Can Interface used in the existing AUTOSAR should be exchanged. This is because when the change between Can Interface and Can FMI occurs using the routing table in PduR, the same behavior should be shown.

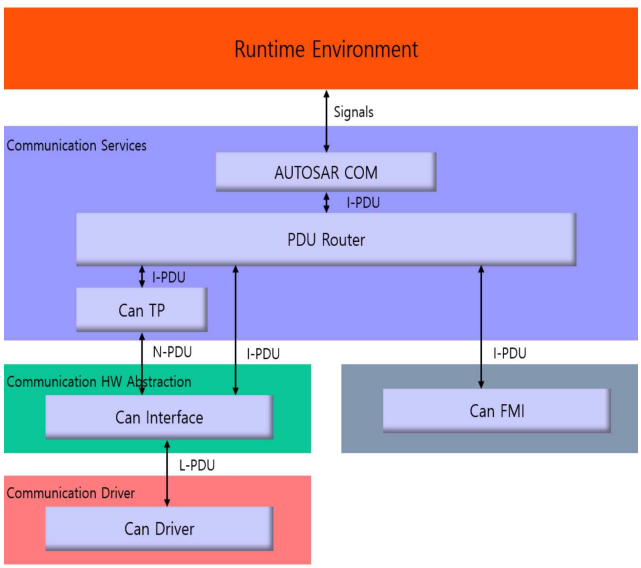

Fig. 3. Autosar Layer PDU Router to Can FMI

Ⅳ. Conclusion

It is accurate to test several systems with complete hardware. However, as one system began to become more complex, several teams developed it by dividing the components. As a result, it takes a lot of time and money to actually test what kind of interaction between components occurs. Therefore, research on vECU has been actively conducted recently. As one of the processes, CAN FMI is proposed to simulate CAN in AUTOSAR. If FMI is further developed in the future, simulation of more diverse communication will be possible, and most of the tests will be possible through FMI.

Acknowledgment

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