

# A Study on Signal Group Processing of AUTOSAR COM Module

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**Abstract.** In vehicle, there are many ECU(Electronic Control Unit)s, and ECUs are connected to networks such as CAN, LIN, FlexRay, and so on. AUTOSAR COM(Communication) which is a software platform of AUTOSAR(AUTomotive Open System ARchitecture) in the international industry standards of automotive electronic software processes signals and signal groups for data communications between ECUs. Real-time and reliability are very important for data communications in the vehicle. Therefore, in this paper, we analyze functions of signals and signal groups used in COM, and represent that functions of signal group are more efficient than signals in real-time data synchronization and network resource usage between the sender and receiver.

## 1. Introduction

AUTOSAR is an open software platform in order to solve the complexity of software depend on hardware and ECU, improve reusability and exchangeability of automotive electronic software between automobile manufacturers and auto parts makers. It is now the industry standard which more than 170 automobile manufacturers and IT companies participate[1].

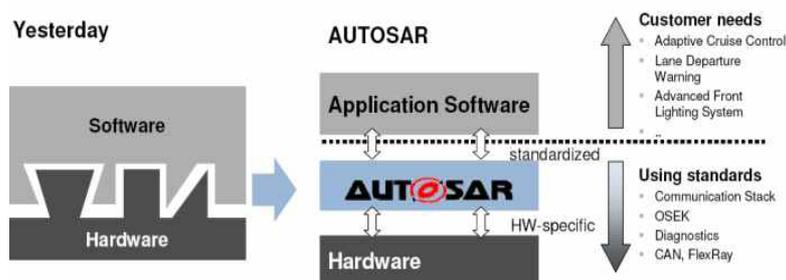


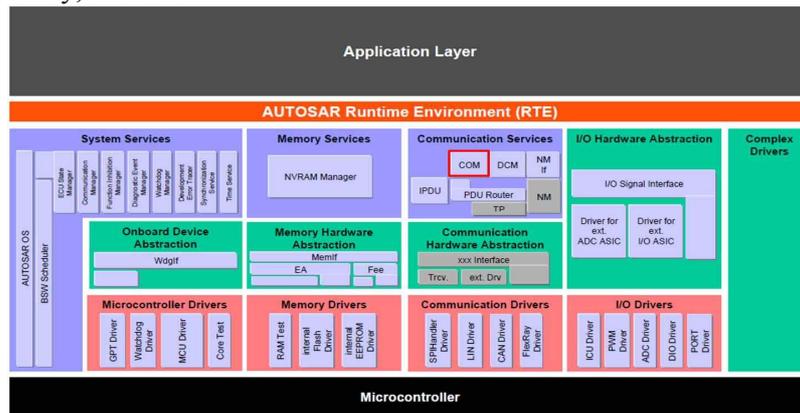
Figure 1. AUTOSAR Vision

AUTOSAR constitute mainly three layers such as AUTOSAR SW-C(Software-Component), RTE(Run-Time Environment), and BSW(Basic Software). BSW composes Service Layer, EAL(ECU

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Abstraction Layer), MCAL(Micro-controller Abstraction Layer), and CDD(Complex Device Driver) as the standard layers[2].

COM belongs to the Service layer in the AUTOSAR software layer, is between PDU Router and RTE, and its main functions are signal processing, signal group processing, I-PDU group communication control, signal gateway, and so on.



**Figure 2.** AUTOSAR Software Architecture

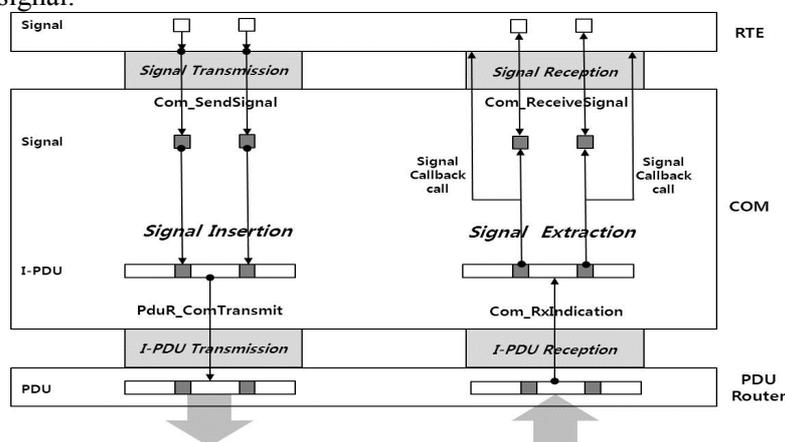
In this paper, we analyze signal and signal group functions which are main functions of COM in AUTOSAR and compare the two functions in real-time data synchronization and network resource usage.

## 2. AUTOSAR COM Functionality

COM makes PDU using signals or signal group received from the higher module RTE and sends it to lower module PDU Router. On the contrary, COM extracts signals and signal group from PDU received from PDU Router and sends them to RTE[3].

### 2.1. AUTOSAR COM Signal

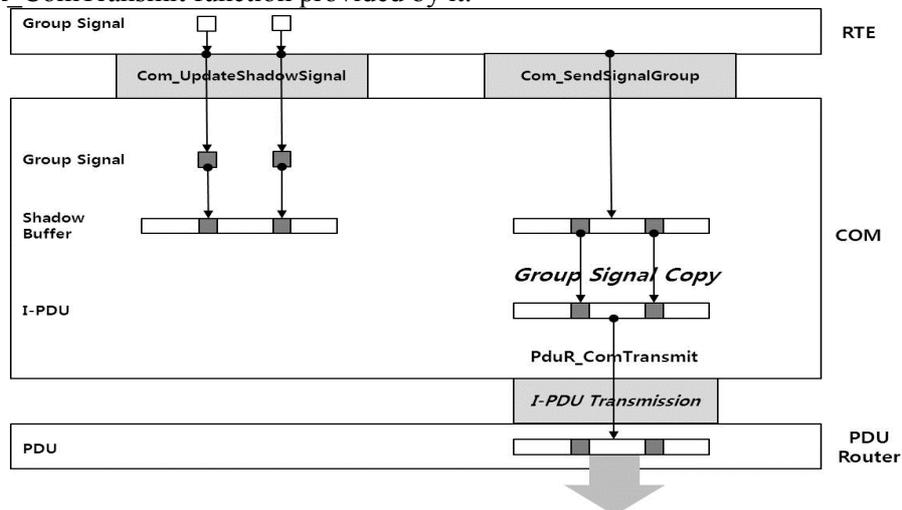
Because COM provides the higher module RTE with Com\_SendSignal function, RTE can send signals to COM. When RTE sends signals calling Com\_SendSignal function, COM stores the received signals from RTE in internal I-PDU buffer and sends I-PDU stored in the buffer to the lower module PDU Router by calling PduR\_ComTransmit function provided by PDU Router[4]. Also, as COM provides the higher module RTE with Com\_ReceiveSignal function, RTE can receive signals from COM. When PDU Router tells to COM that it receives PDU by Com\_RxIndication function, COM analyzes signals in PDU, notifies RTE that signal was received by calling callback functions each of which is assigned to each signal.



**Figure 3.** Simplified model for Signal Transmission and Reception in COM

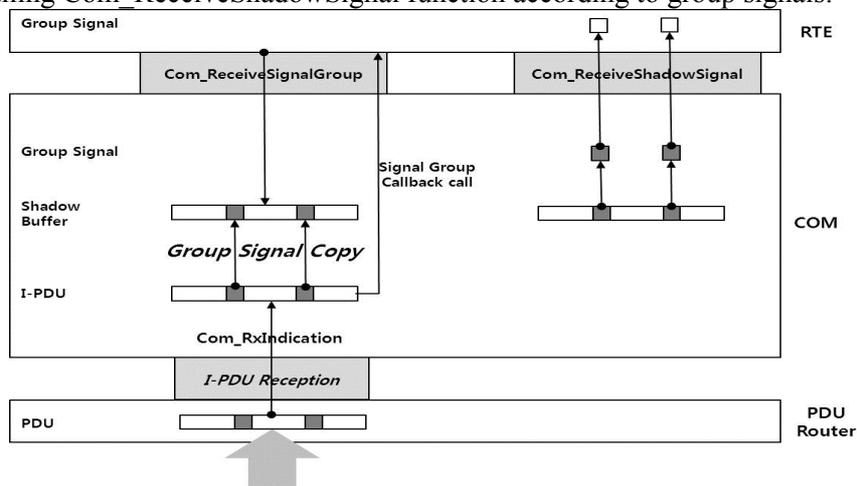
### 2.2. AUTOSAR COM Signal Group

In AUTOSAR, COM provides the signal group function to support the notion of complex data type. Signals in the signal group are named group signal and they consist of one more group signals. Also, COM synchronizes group signal sent from higher module RTE and PDU transmission by using shadow buffer mechanism. As COM provides higher module RTE with `Com_UpdateShadowSignal` and `Com_SendSignalGroup` functions, RTE can send signal group to COM. RTE send group signal in signal group to COM by calling `Com_UpdateShadowSignal` and COM stores received group signals from RTE in shadow buffer. After RTE sends all group signal to COM, it will call `Com_SendSignalGroup` function to transmit. At this time, COM reads group signal stored in shadow buffer and writes it in I-PDU buffer. And then COM send I-PDU to lower module PDU Router by calling `PduR_ComTransmit` function provided by it.



**Figure 4.** Simplified model for Signal Group Transmission in COM

Also, since COM provides higher module RTE with `Com_ReceiveShadowSignal` and `Com_ReceiveSignalGroup` functions, RTE can receive group signals sent from COM. When PDU Router notifies PDU reception by calling `Com_RxIndication` provided by COM, COM analyzes signal groups in PDU and tells reception of signal groups to RTE by calling callback functions each of which is assigned to each signal group. COM copies group signals stored in I-PDU to shadow buffer by calling `Com_ReceiveSignalGroup` function, and RTE receives group signals stored in shadow buffer of COM by calling `Com_ReceiveShadowSignal` function according to group signals.

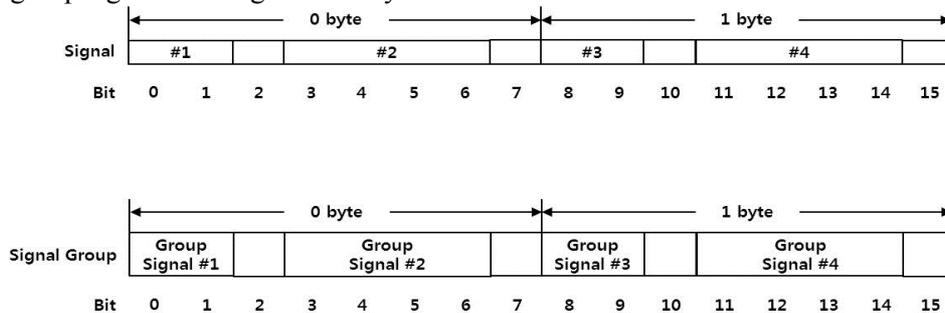


**Figure 5.** Simplified model for Signal Group Reception in COM

### 3. Implementation

#### 3.1. Test Design

We designed four signals and one signal group to contain four group signals for comparison and analysis of COM signal and signal group in aspect to real-time data synchronization and network resource, and implemented it. To make the same test environment, we use unsigned char data type for four signals which consist of two 2-bit signals and two 4-bit signals. And group signal also has the same composition as signal and is sent at 10ms periods. In addition, the size of PDU in order to send signals and group signals is designed as 2 bytes.



**Figure 6.** Signal and Signal Group Architecture

#### 3.2. Test Environment

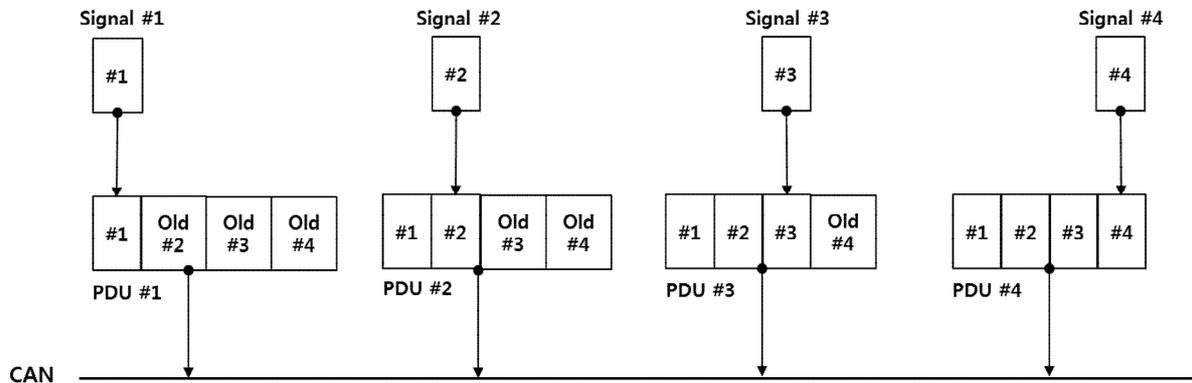
We use C-language to implement, Altium's Tasking VX-toolset for C166 as compiler, Vector's CANoe as simulator, and Lauterbach' TRACE-32 as debugging device, and program image results are loaded the target board built in Infineon XC2365A MCU.



**Figure 7.** Test Environment Picture

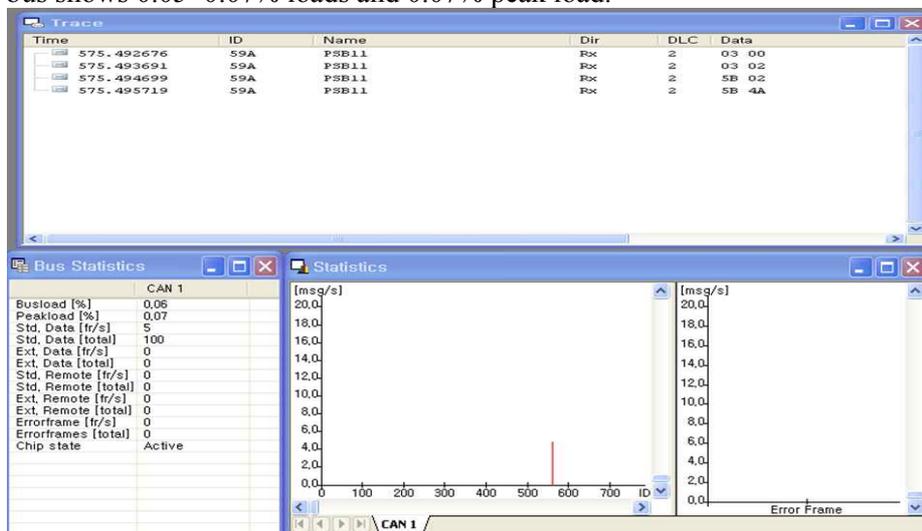
#### 3.3. Test Results

Higher RTE module calls Com\_SendSignal function four times to send four signals, and COM also calls PduR\_ComTransmit function four times to send them to PduR. Therefore, 4 PDUs are sent via CAN network for four signals and when 4th PDU is sent, for the first time, all up-to-date signals are transmitted via CAN network.



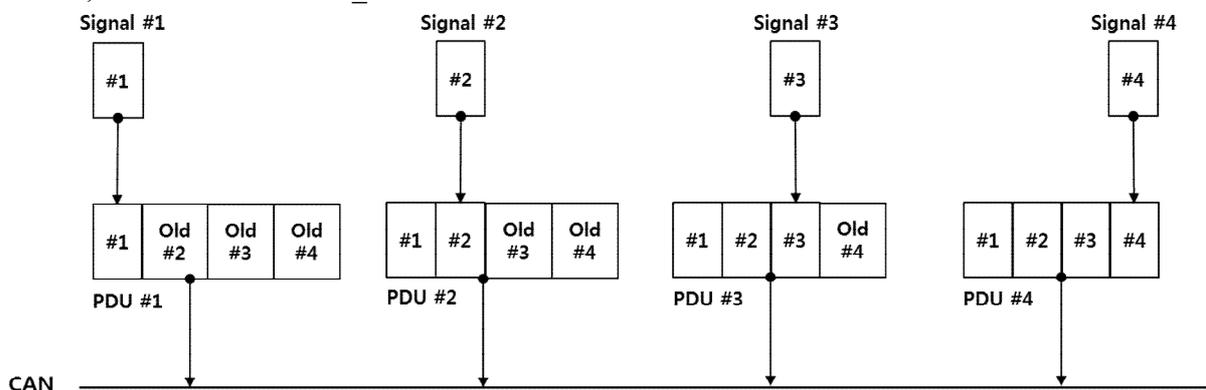
**Figure 8.** Signal Transmission Procedure

Consequently, as you can see Figure 9, when the last signal is being sent, PDU in which all signals are updated as new signals will be sent via CAN network, and transmission of other PDU except the last PDU results in waste of network resource which is unnecessary. Also, when we transmit 2-byte PDU, CAN bus shows 0.05~0.07% loads and 0.07% peak load.



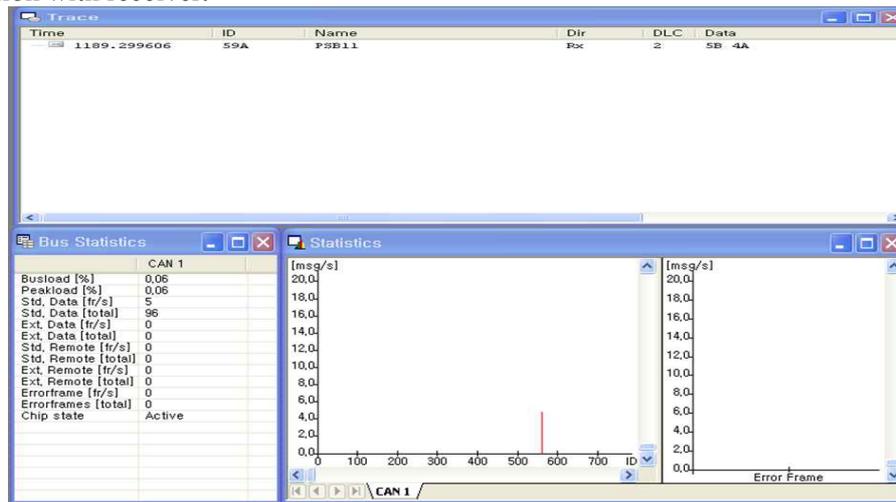
**Figure 9.** Signal Transmission Result Screen

Unlike transmitting signal, in transmission of signal group, higher RTE module calls Com\_UpdateShadowSignal function four times to transmit four group signal in signal group to COM module. But, Com\_SendSignalGroup function is called for transmission of signal groups via CAN network, and COM calls PduR\_ComTransmit function to send them to PduR.



**Figure 10.** Signal Group Transmission Procedure

Accordingly, As you can see Figure 11, for transmission of four group signals to CAN, all new group signals are sent by transmitting PDU once. The CAN bus shows 0.04~0.06% loads, and 0.07% peak loads. In transmission of 2-byte PDU, it shows difference of at least 0.01% bus loads compared to transmission of signals. As the number and size of PDU increase, it shows remarkable difference of bus loads. Transmission of signal groups doesn't result in waste of network because it doesn't make unnecessary transmission and since transmits new group signals in real-time, it has benefit of synchronization with receiver.



**Figure 11.** Signal Group Transmission Result Screen

#### 4. Conclusion

In the results of this paper, at transmission of 2-byte PDU, the method of signal groups has at least 0.01% less loads than one of signals. This means that as the number and size of PDU increase, it shows remarkable difference of bus loads. Hence, it is turned out that in automobiles for real-time data reliability and synchronization, and efficient usage of network resource, application of the method of signal group which is provided by AUTOSAR COM is effective.

#### 5. Acknowledgments

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#### 6. References

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