An Analysis of PDU Transmission Mode Based on AUTOSAR

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Abstract

The AUTOSAR (AUTomotive Open System Architecture) software platform as the international industry standards of automotive electronic software performs PDU Transmission Mode in AUTOSAR COM (Communication) which processes signals in I-PDU for transmission and reception between ECUs. In this paper, we look around operation principles of three methods such as DIRECT/N-Times, PERIODIC, MIXED which are used when I-PDU transmission in COM. Also, we analyze the signal processing function which is executed in AUTOSAR COM and I-PDU transmission method, and present efficient I-PDU transmission methods to guarantee reliability and stability.

Keywords: *AUTOSAR, COM, Signal, I-PDU, Automotive Network*

1. Introduction

AUTOSAR(AUTomotive Open System ARchitecture) is an open software platform in order to solve the complexity of software depend on hardware and ECU(Electronic Control Unit), improve reusability and exhangeability 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.

AUTOSAR standard organization has a three tier structure which consists of core partners, premium members, and associate members, and total 156 members (9 core partners, 48 premium members, 81 associate members, and 18 development members) have joined in AUTOSAR in December 2011.

AUTOSAR constitute mainly three layers such as AUTOSAR SW-C (Software-Component), RTE (Run-Time Environment), and BSW (Basic Software). BSW can commonly apply to various ECU under VFB, separates HW and SW, and consists of is Service Layer, EAL (ECU Abstraction Layer), MCAL (Micro-controller Abstraction Layer), and CDD (Complex Device Driver) [1].

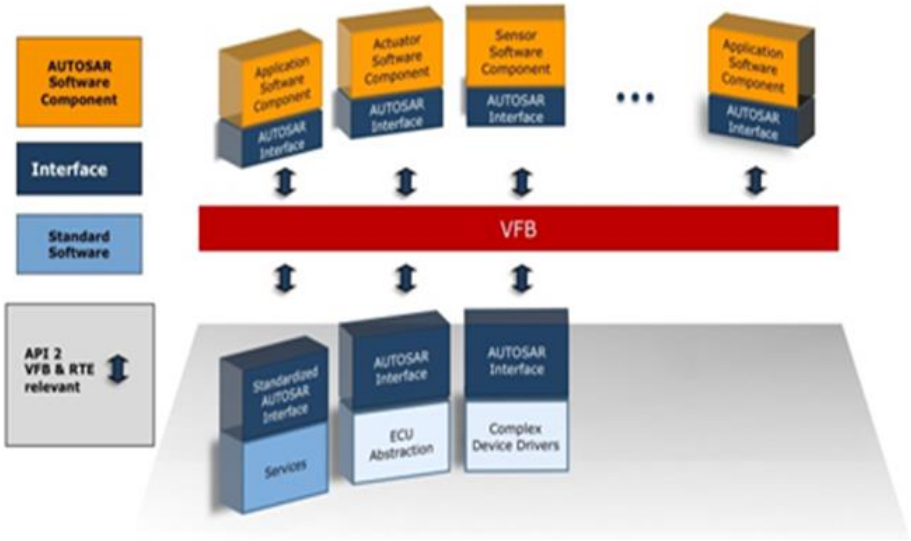

Figure 1. AUTOSAR Layered Architecture [1]

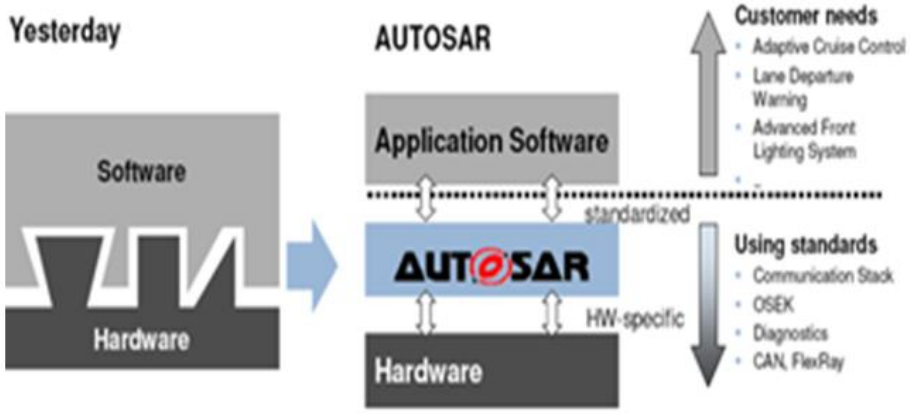

Figure 2. AUTOSAR Vision [1]

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

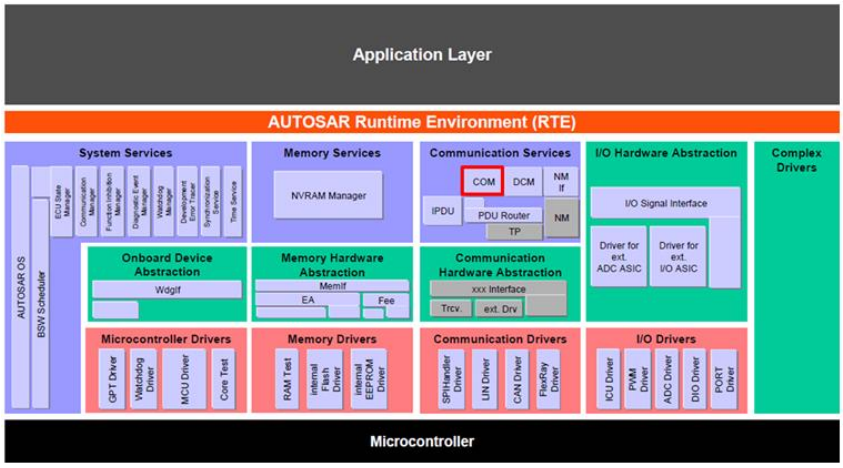

Figure 3. AUTOSAR Software Architecture [2]

Accordingly, in this paper, we analyze the signal processing function which is executed in AUTOSAR COM and I-PDU transmission method, and present efficient I-PDU transmission methods to guarantee reliability and stability.

2. COM Signal

2.1 COM Signal Transmission

When higher module RTE sends signals using Com_SendSignal, COM stores signals received from RTE in I-PDU buffer and it sends stored I-PDU using PduR_ComTransmit function which is provided by lower module PDU Router [3, 4].

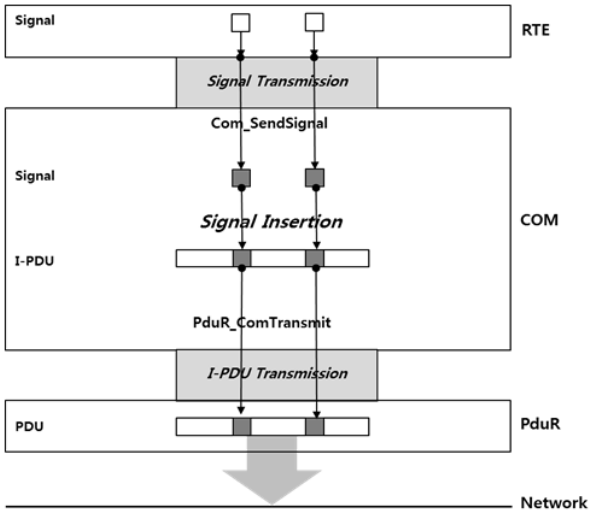

Figure 4. Simplified model for Signal Transmission in COM

2.2 COM Signal Reception

If PDU Router informs COM of reception of PDU using COM_RxIndication function which is provided by COM, COM analyzes information of signals in PDU and tells

RTE reception of signals using RTE callback functions which are assigned respectively to signals. RTE receives signals in COM using Com_ReceiveSignal according to signals [3].

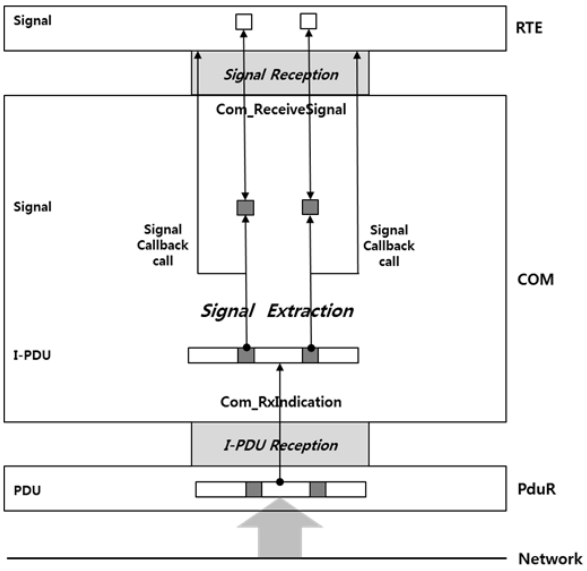

Figure 5. Simplified model for Signal Reception in COM

3. COM I-PDU Transmission Mode

In this section, we look around operation principles of three methods such as DIRECT/N-Times, PERIODIC, MIXED which are used when I-PDU transmission in COM.

Table 1. Transmission mode defined for I-PDU [3]

Transmission Mode	Description
DIRECT/N-Times	Transmission of an I-PDU with Direct transmission mode is caused by the transfer of any signal assigned to the I-PDU with the transfer property. The transfer of the signal to AUTOSAR COM is immediately followed by n transmissions (n = 1 … m, m <= 255) on the underlying layer
PERIODIC	In Periodic transmission mode, AUTOSAR COM issues periodic trans-mission requests for an I-PDU to the underlying layer.
MIXED	Mixed transmission mode is a combination of the “Direct/N-Times” and the Periodic transmission modes.

Table 2. Use case diagram legend [3]

Tc	Periodic Cycle times
Td	Cycle times of Direct N-Times
Tr,min	Minimum SW reaction time of COM-Layer
	Request from upper layers (RTE) to the COM-Layer
	Request from COM-Layer to lower layers
dT	Minimum distance between two requests to lower layers (minimum delay time), dT can be set per I-PDU.

3.1 Direct/N-Times

When signals received from RTE are stored in I-PDU, DIRECT/N-Times method immediately sends signals as many as the number of transmission set to the lower modules. If it is used, it is a merit that upper modules can send current signals in I-PDU at desired time. Following use case is an example that COM sends three I-PDUs at once when signals received from RTE.

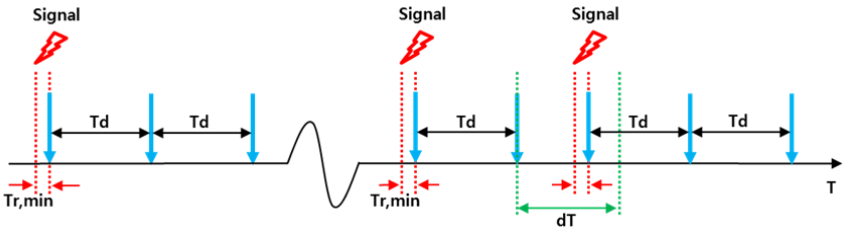

Figure 6. Use case, Direct/N-Times = 3

3.2 PERIODIC

PERIODIC method stores signals received from upper module RTE in I-PDU buffer, and sends them to the lower modules periodically. If it is used, it is possible to send I-PDU periodically. Following use case is an example to send I-PDU in periodic intervals.

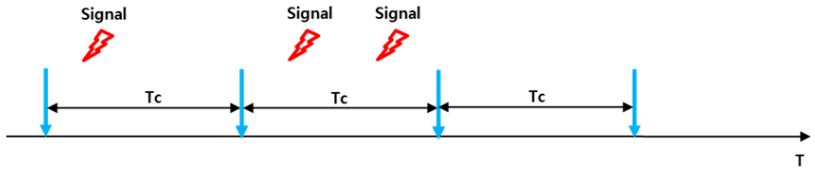

Figure 7. Use case, Periodic

3.3 MIXED

MIXED method is a mixed method which combines DIRECT/N-Times and PERIODIC. It stores signals received from upper module RTE in I-PDU buffer, and send I-PDU as many as the number of transmission set to the lower modules immediately and according to a period set. If it is used, it is possible to send I-PDU of current signal values at desired time and periodically. Following use case is an example to send three I-PDUs at once when receiving signals and periodically.

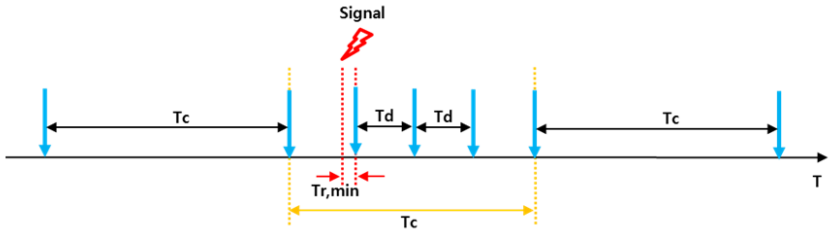

Figure 8. Use case, Periodic + Direct/N-Times = 3

4. Implementation and Test Results

4.1 Test Environment

We use C-language to implement, Altium's Tasking VX-toolset for C166 as complier, 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.

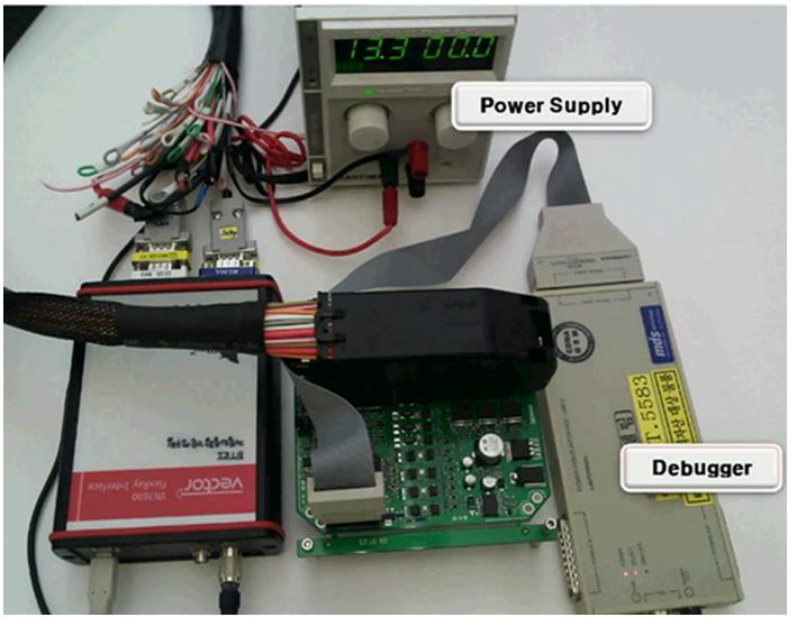

Figure 9. Test Environment screen

4.2 Direct/N-Times

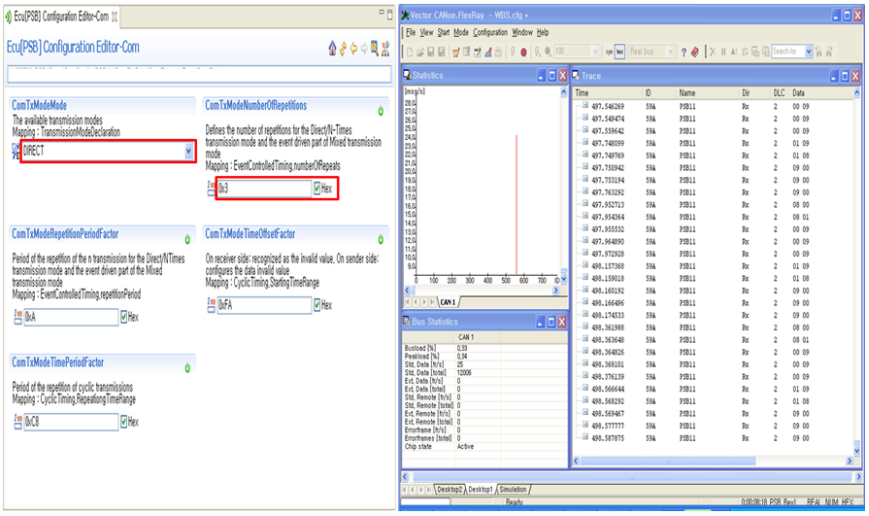

Figure 10. Direct/N-Times Configuration and Test Result screen

We set three transmission number as test environment set like the use case in Figure 5 and tested. The number of I-PDU messages per a second is 25 frames and the bus load on the network is about 0.33%.

4.3 Periodic

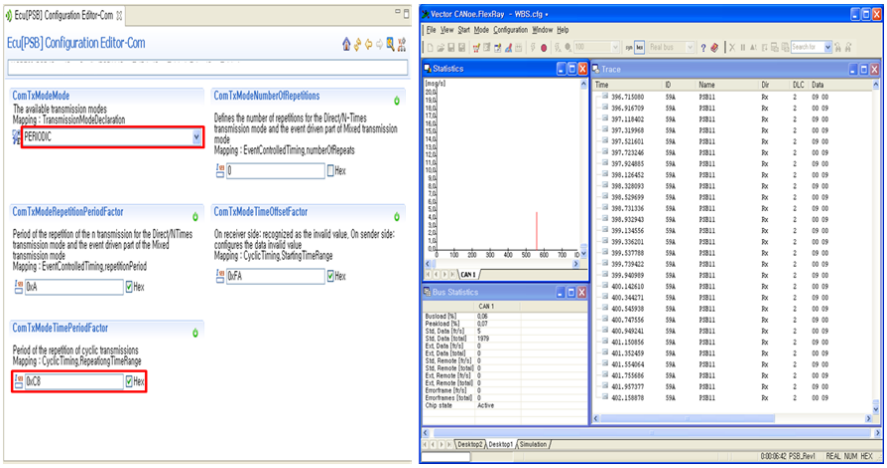

Figure 11. Periodic Configuration and Test Result screen

We set the transmission period of Periodic method as 200ms and tested. The number of I-PDU messages per a second is 5 frames and the bus load on the network is about 0.06%.

4.4 Mixed

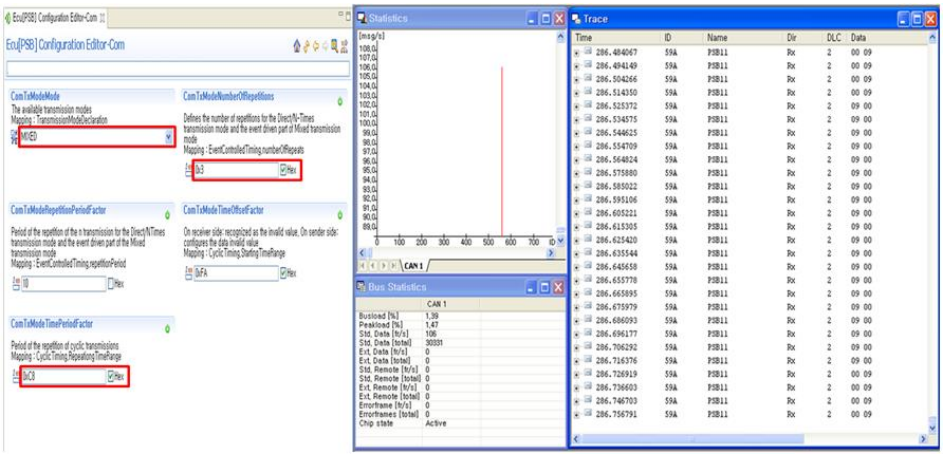

Figure 12. Mixed Configuration and Test Result screen

We set the number of transmission of Mixed method as three like Direct/N-Times and the transmission period of Mixed method as 200ms like Periodic method and tested. The number of I-PDU messages per a second is 106 frames and the bus load on the network is about 1.39%.

5. Conclusion

We analyze the signal processing function which is executed in AUTOSAR COM and I-PDU transmission method, and present efficient I-PDU transmission methods to guarantee reliability and stability. As the test results in this paper, bus loads increases in Periodic, Direct/N-Times, Mixed Transmission Mode order but stability of data, reliability, and real-time increase in Periodic, Direct/N-Times, Mixed order. Hence, transmission method of network should be determined by considering application operations and data size when design of network.

Acknowledgements

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