شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

HOSSAM MAGHRABY

شبكة المعلومات الجامعية

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

HOSSAM MAGHRABY

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

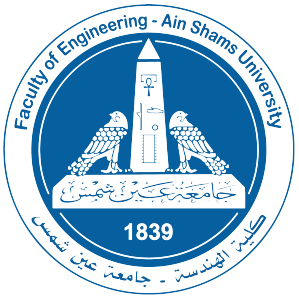
نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها

علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

HOSSAM MAGHRABY



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Computer and Systems Engineering

Accelerating AUTOSAR-based Data Transformation

A Thesis submitted in partial fulfillment of the requirements of
Master of Science in Electrical Engineering
(Computer and Systems Engineering)

by
Abdelrahman Hamada Ahmed Elbahnihy
Bachelor of Science in Electrical Engineering
(Computer and Systems Engineering)
Faculty of Engineering, Ain Shams University, 2015

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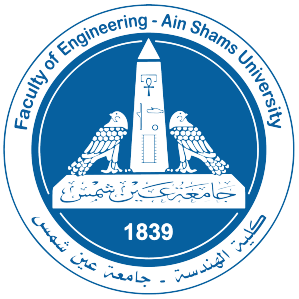
Cairo, 2021



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Date: 01/02/2021

Statement

This thesis is submitted as a partial fulfillment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain shams University. The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Date: 01 02 2021

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Abstract

In traditional protocols (i.e., CAN/FlexRay), the exchanged data between ECUs are of basic types (e.g., integer/float types for engine-speed/temperature values). In addition, static frame layout is sufficient for typical use cases, where no need to dynamically change the sent/received data. However, lately after the emergence of autonomous driving and with the availability of Ethernet communication with its large bandwidth capabilities in automotive ECUs, the need for a new communication strategy is raised. One of the new communication strategies that have taken place is the Service Oriented Communication.

In this thesis, we explore an approach to accelerate one of the AUTOSAR functions that is part of any Ethernet-connected AUTOSAR-based Electronic Control Units. Based on the AUTOSAR standard, a so-called SOME/IP (Scalable Service-Oriented MiddlewarE over IP) transformer is used to serialize application data before they are communicated between ECUs over an Ethernet interface. With future autonomously driven, fully connected vehicles, the need for communication will significantly increase either between different sensors distributed across the vehicle or even between the vehicles themselves. In our approach, we used a Hardware Co-Processor instead of the conventional Software implementation used by all AUTOSAR stack suppliers for data serialization. Having a dedicated hardware for serialization makes the architecture more reliable. Our approach achieves up to 50x speedup over the Software implementation, which in turn helps to cope with the increased demand for data communication required in modern vehicles. This approach also gives more CPU room for other real-time applications to utilize the CPU.

Summary

This thesis presents a Hardware solution for data serialization in automotive Software. The proposed solution reserves the flexibility provided by current Software solution that is standardized by the AUTOSAR. The proposed solution fits with the current workflow used in the Software solution.

We designed a co-processor as an on-chip unit to offload from the main CPU. We verified the functionality with an open source simulator and synthesized the design with Xilinx ISE Design Suite.

We measured the current overhead of SOME/IP serialization in typical AUTOSAR stacks to highlight the need for performance enhancement. We created a sfotware version to implement the latest SOME/IP specification to measure the speedup of our proposed Hardware solution. We automated the complete workflow with Python scripts and evaluated the proposed solution with different examples.

The thesis is divided into six chapters as listed below:

Chapter 1: This chapter is an introduction chapter that introduces the problem, provides a background, and the roadmap of this thesis.

Chapter 2: This chapter describes the AUTOSAR standard workflow that is used by many automotive OEMs and discusses SOME/IP protocol specifications.

Chapter 3: This chapter presents our proposed Hardware-based solution. Starting by the architecture and going through the internal design and supported instructions.

Chapter 4: This chapter explains the complete workflow with our proposed Hardware implementation. Starting from the AUTOSAR model, that is common with the traditional Software implementation. Moving through internal model transformation, generation of configuration files and memory image, and finally validating the functionality with detailed insights.

Chapter 5: This chapter presents different measurements to realize the overhead for Ethernet transmitted signals, evaluates the proposed architecture, and assesses the complexity of the proposed co-processor.

Chapter 6: In this chapter, we summarize our efforts, document our contributions, and list some potential directions for future work for the implemented Hardware solution.

Keywords: Automotive Electronic Control Unit (ECU), AUTOSAR, Co-Processor, Serialization, SOME/IP