Internship Report

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I. Introduction

Daimler Trucks North America (DTNA) is a wholly-owned subsidiary of the German Daimler AG. DTNA serves the purpose of engineering and manufacturing trucks with research and development departments. In the Mechatronics Department, the Body Controllers team is responsible for developing and validating Electronic Control Units (ECU) and Power Distribution Modules (PDM). Currently, the Freightliner™ trucks follow P4 and M2 ECU platform while the Western Star™ trucks follow the WST ECU platform. ECU is consisted of Advanced Signal Detect and Actuation Module 12V (ASAM) and Expansion Module 12V (XMC). These electronic units contain numerous software including large application components such as Auxiliary Transmission Control (XTC), Vocational Brake Control (VBC) and Axle Fuel Economy (AFE).

II. Western Star XMC XTC 43N Model Update

Western star truck is a special heavy-duty truck that requires auxiliary transmission control (XTC). By adding the auxiliary transmission control, the truck can switch combinations of gears to change gear ratio and acquire low speed for heavy-duty. At DTNA, the team follows quarterly software releases. Typically, a release candidate is developed and tested for four releases before its final launch to the customer’s end. When I started the project, XTC has been transferred from Matlab 2011b to 2017b. I was responsible to test, update and validate XTC for the second launch of 2019 in western star truck project 43N.

Figure 2: XTC Subsystem Simulink Model

The team uses Matlab, Simulink and Targetlink to do model-based software development (MBSW). With these tools, we implement logic reasoning with signal diagrams, such as the figure above. Then Matlab synthesizes C code. The C code is further compiled to machine language and programmed into the XMC hardware. Testing and validation can be divided into three parts. The engineers begin testing with Matlab model in loop (MIL) simulation and software in loop (SIL) simulation. Then the engineers embed the software into the XMC hardware and test on the XTC (component level) with a graphical interface of debugging tool such as vector CANoe. XTC is a large electronic unit that simulates the real signals inputs and outputs of a truck. CANoe interacts with the CAN network to deliver read and write signals from XTC. After these local tests complete, the XMC will be tested in a real truck.

Figure 3: Expected LUT behavior from Simulink
During local testing, the new XTC for truck model 43N had unexpected resistance-temperature lookup table (LUT) behavior as shown from the figures above. To troubleshoot, I changed the LUT scaling and modified the generated C code. I found that the XMC was not reading the inputs correctly from NVRAM, as shown in the graph below. Further diagnosis proved that the root cause was misconfigured NVRAM block and application layer mapping faults. I added LUT robustness by verifying strictly monotonic increasing on the x-axis and monotonic increasing or decreasing on the y-axis before dynamic LUT configuration.

I was in charge of updating the new XMC DTC HMI. For each DTC label, I collected information from past DTC references, Bosch and Candela Studios to fill the severity, display criteria, message appearance, warning sound and text proposal areas in the specification sheet. The updated XMC DTC fields will better assist customers with their diagnosis.

IV. VBC Work Brake Implementation Specification

Vocational Brake Control (VBC) is a unique attribute of vocational trucks. VBC is applied to disposal trucks that need to frequently stop and proceed. On disposal trucks, there is a component called the work brake. Work brake is set active when the truck velocity is below five miles per hour. In compare with the park brake, work brake consumes less energy and brings less friction.

I was responsible to write the work brake implementation specification given the feature specification. The feature specification is generally written in completed sentences. The variable names are intuitive but undeclared and do not follow the same naming pattern. The if cases are considered separately in multiple grids. Engineers within the Power, Lightening and Control department need to translate the feature specification into the implementation specification. The implementation specification has clear logic statements, if statements and loops. The implementation specification is ready for the engineers to develop model-based software on Matlab and Targetlink.

I tracked the source input names, found the input variables’ address, and renamed output names. By reading the feature specification, I combined lines with the same if condition and reorganized them into one logic box. The Matlab model of VBC will be implemented and launched in the next quarter.

V. CONCLUSION

In my internship, I went through different stages of ECU development: preparing specification sheet; implementing, validating, and troubleshooting software module with Matlab, Targetlink and CANoe; writing DTC HMI guidance for the customer end.

Through this internship experience, I learned more knowledge about model-based software development and embedded system. I was able to integrate previous knowledge from 18-349, 18-240 and 18-290 to ECU module implementation and troubleshooting. I will integrate this experience into my capstone design.

I would like to thank my manager Antoine Delorme, my mentors Walter Hudson, Tayte Nelson and Ryan Lierman for their support and guidance during my internship. It has been a wonderful experience.