

I. IDENTIFICATION DATA

Thesis title:	CAN Bus Latency Test Automation for Continuous Testing and Evaluation
Author's name:	Pavel Hronek
Type of thesis :	bachelor
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Control Engineering - K13135
Thesis reviewer:	Ing. Pavel Píša, Ph.D.
Reviewer's department:	Department of Control Engineering - K13135

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	ordinarily challenging
<i>How demanding was the assigned project?</i>	
The actual task of automation of CAN/CAN FD latency testing and resulting data acquisition and processing into web daily updated presentation is ordinarily demanding, but the student had to step into the project running for a long time and familiarize with previous results, which required understanding how to setup system with own drivers, device-tree and FPGA controller design (CTU CAN FD). The server providing filesystems for targets and controlling the testing was installed, target systems bootstrapped and configured, etc...	

Fulfilment of assignment	fulfilled
<i>How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.</i>	
All negotiated goals have been fulfilled, and the system is running and providing daily results for actual Linux kernel mainline and real-time variant development source trees at https://canbus.pages.fel.cvut.cz/can-latester/ . All software is integrated as modules in CTU FEE CAN/CAN FD project group at https://canbus.pages.fel.cvut.cz/	

Activity and independence when creating final thesis	A - excellent.
<i>Assess whether the student had a positive approach, whether the time limits were met, whether the conception was regularly consulted and whether the student was well prepared for the consultations. Assess the student's ability to work independently.</i>	
The core part of the project, latency profile acquisitions and presentation into web pages, has been designed by the student, and he reacted quickly to usage-oriented remarks. Some help was required for hardware setup, systems installation, network configuration, and FPGA tooling, but it was expected because the project was built on 5 to 10 preceding theses and even the shoulder of Linux CAN bus subsystem creators from VW, Pengutronix, etc.	

Technical level	A - excellent.
<i>Is the thesis technically sound? How well did the student employ expertise in his/her field of study? Does the student explain clearly what he/she has done?</i>	
Python code representing the core of the automation and profiles data processing for the web as well as the JavaScript code for client-side interaction, seems clean written to me. It has been reported as a solid approach even by David Heidelberg, Mesa 3D continuous integration infrastructure maintainer.	

Formal level and language level, scope of thesis	A - excellent.
<i>Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?</i>	

I consider the resulting text as well readable and understandable.

Selection of sources, citation correctness

A - excellent.

Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?

Additional commentary and evaluation (optional)

Comment on the overall quality of the thesis, its novelty and its impact on the field, its strengths and weaknesses, the utility of the solution that is presented, the theoretical/formal level, the student's skillfulness, etc.

The thesis is part of CTU FEE contributing to CAN bus solutions for industrial control and automotive/vehicle applications for more than 30 years. CTU provided CAN cards with CAN open support and firmware for railway automation in the nineties; we have developed drivers for it for VME-based VxWorks and Linux systems and helped to form the unification of Linux subsystem for Linux, NuttX, and RTEMS kernels. We helped SocketCAN to replace others and even our previous attempts and then contributed by CAN FD cores, monitoring and testing systems, QEMU emulation used today by AMD/Xilinx, and many more. The minimization of latency and assurance of the behavior of the system is critical for their durable use in demanding and critical applications.

The student's task was to fill the final gap to provide CAN/CAN FD latency continuous evaluation based on our tooling. The system already caught a problem in the PREEMP_RT Linux kernel release and development process, which has been resolved promptly by its maintainer, Sebastian Andrzej Siewior (Intel/Linutronix). We have already scheduled meetings with experts for real-time quality assurance from OSADL.org, Volkswagen, and more who plan to use our results and duplicate setups.

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

Student started the work early and shown initiative. There was some period of lower intensity of the work when he focused to solve exams from other subjects. But then he got into full pace again.

The grade that I award for the thesis is A - excellent.

Date: 5.6.2023

Signature:

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Thesis reviewer:	Ing. Oliver Hartkopp, PhD
Reviewer's department:	R&D Vehicle Security, Volkswagen AG

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	extraordinarily challenging
<i>How demanding was the assigned project?</i>	
The project required a holistic understanding of technical details about Linux, the CAN Bus and embedded computing hardware as well as requirement and process engineering for latency tests and finally Web presentation and data management. This broad knowledge focusing all ISO-Layers is remarkable.	

Fulfilment of assignment	fulfilled
<i>How well does the thesis fulfil the assigned task? Have the primary goals been achieved? Which assigned tasks have been incompletely covered, and which parts of the thesis are overextended? Justify your answer.</i>	
Creating test setups to perform reproducible testing and measurement tasks that can also be integrated in an existing QA-farm is a challenging task itself. Additionally the author took a deep dive into the Web Presentation to compare and evaluate the generated measurements and built a Linux Kernel driver to configure a project specific crossbar switch via a user friendly device interface.	

Methodology	outstanding
<i>Comment on the correctness of the approach and/or the solution methods.</i>	
Besides creating the test automation setup to perform automated latency tests the author not only implemented a system to bootstrap such system in a reproducible way but the entire idea of how to run precise measurements has been worked out excellently. With the network based file system and log file access the DUT can perform required load scenarios with a minimized impact from house-keeping requirements of that DUT.	

Technical level	A - excellent.
<i>Is the thesis technically sound? How well did the student employ expertise in the field of his/her field of study? Does the student explain clearly what he/she has done?</i>	
The thesis covers the setup of a real-time measurement which has proven its usability and correctness through the measurement results and their representation. The author clearly pointed out the technical requirements and constrains which have been taken into account to build the system and its surrounding artifacts. The reasons that led to technical decisions were made clear.	

Formal and language level, scope of thesis	A - excellent.
<i>Are formalisms and notations used properly? Is the thesis organized in a logical way? Is the thesis sufficiently extensive? Is the thesis well-presented? Is the language clear and understandable? Is the English satisfactory?</i>	
The scope of the thesis and the required preconditions and environments have been presented and documented in a good readable manner. The thesis is quite compact in comparison to the effort and the outcome of the project.	

Selection of sources, citation correctness**B - very good.**

Does the thesis make adequate reference to earlier work on the topic? Was the selection of sources adequate? Is the student's original work clearly distinguished from earlier work in the field? Do the bibliographic citations meet the standards?

The thesis is an academic work based on the valuable test efforts that have been conducted in the CTU/FEL department. The compact description could have been improved by some more figures describing the different CAN frame flows in the referenced test scenarios. Also the reason and need for the IRQ-threading and prioritization setting could have been made more transparent and referenced. But overall the provided information and references are very good and enable the interested reader to either get a comprehensive overview and insights into technical details.

III. OVERALL EVALUATION, QUESTIONS FOR THE PRESENTATION AND DEFENSE OF THE THESIS, SUGGESTED GRADE

"This could have been two bachelor thesis". The author proves his skills on many layers of hardware/software engineering and is looking over the edge when e.g. building up a Linux Kernel driver just to simplify the handling of the special crossbar hardware setup. The entire topic of creating an automation environment to run reproducible latency measurements inside the OSADL QA-farm and a visualization of the created results is completely fulfilled. The work and the resulting artefacts (source code and thesis) are provided in a way that follow-up projects could easily start on this basis.

For the presentation and defense of this thesis I would be happy to see some more figures that depict the measurements CAN frame flows e.g. for the ESP32 idea which is very different to the common measurement concept as well as a picture that shows an overview over the already existing and the new created project components. Although this information can be retrieved from the thesis this would help the reader to understand the context and connections at first sight.

The grade that I award for the thesis is **A - excellent**.

Date: **8.6.2023**

Signature: