CTU
CZECH TECHNICAL UNIVERSITY IN PRAGUE

# THESIS SUPERVISOR'S REPORT

## I. IDENTIFICATION DATA

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| **Thesis title:** | **Open Rapid Control Prototyping and Real-Time Systems** |
| **Author's name:** | **Micha Lenc** |
| **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** **challenging**

*How demanding was the assigned project?*

The project submitted and covered by the thesis is a smaller side branch of the building of new open-platform for control control systems for generic use in multiple companies. The NuttX operating system has been selected during PiKRON company consultations as the perspective base for Electroline.cz embedded systems used to control tram depots and traffic worldwide. Michal Lenc has been responsible for NuttX system porting to chosen microcontrollers and over the two years contributed over sixty changes-sets accepted by mainline (more new BSPs, CAN FD, SPI, DMA, UART drivers).
As the topic of the theses has been selected porting of the still young and minimal rapid control prototyping system pysimCoder to the NuttX and combine it with open source Elektroline's silicon/heaven protocol to allow runtime introspection and tuning of the models compiled for NuttX and GNU/Linux systems. The experiment has been initially motivated by wish to provide accessible rapid control platform alternative for enthusiasts with cheap MCU and Linux based boards who cannot afford overpriced and too heavy solutions which are not flexible and often require overpriced and not flexible hardware (which internally use often same community developed operating systems). The project has been successful and silicon-heaven rewrite to bare C language and port to NuttX has even influenced Elektroline that they want to start to use this solution in combination with NuttX for their "IoT" smaller systems – it has not been initial plan of the experiment. The base C silicon-heaven routines has been used for remote knobs control in remote B35APO subject laboratory access system even before thesis submission.
Thesis covered subproject was demanding, required to to understand complete silicon-heaven system which documentation is emerging still. This allowed him to re-implement important portions in C language. Some latest enhancements of the NuttX system by the student to provide peripherals support for demo plants control prove his deep understanding of operating systems and processor hardware and software. Understanding and changes and extensions in core pysimCoder implementation has been required as well.

**Fulfilment of assignment** **fulfilled**

*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.*

The project provided expected outputs and provided background for Elektroline company strategic decision to use not oly NuttX and ports build on their order but even new bare C version silicon-heaven implementation. The project has been used to support Computer Architectures education. The previous contributions to BSPs are used in experimental and future production version of tram circuits. Changes documented in the thesis are core contributions for new version of the Elektroline developed system.

**Activity and independence when creating final thesis** **A - excellent.**

*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.*

Student fully cooperated, studied suggested fields and complex systems, coordinated his development with company, more experts and mentors. He has proved high working standard even before when he successfully solved related Google Summer of Code project. Even that he has been guided, he studied huge manuals components and sources and work on

many complex tasks independently to the level to provide fully working prototype and the communicated with multiple projects communities to tune solution into shape acceptable for mainlines. The tuning has been mostly some style details etc. never indication of misunderstanding or bad programmer practice.

**Technical level** **A - excellent.**

*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?*

The resulting code has been smoothly integrated into mainline project, some with large community and many reviewers from professional chip-maker companies, drone controllers produces, customer equipment producers, etc... This is really different level than if the project is accepted in single corporate to solve their itch with forbidden access to the sources for others.

**Formal level and language level, scope of thesis** **A - excellent.**

*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?*

Student has participated in written and oral knowledge exchange not only with Czech companies but with worldwide community. He presented on NuttX workshop in 2021. There has been never problem with his language skills. I am not expert, but I consider his thesis well written.

**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?*

References points cleanly to the main information sources. For sure, not each e-mail and advice is cited. The own work is available in repositories, student contributed to NuttX and pysimCoder official documentation.

**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.*

Great thesis with functional results. I have fear that it is one of the last theses of the students of CTU Cybernetic and Robotics study program in the filed of professional contribution in the core parts of processors and microcontrollers based controlled system. For students from new accreditation, it would require months of individual investments to transfer missing fundamental knowledge of computer architectures to them.

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

I have described excellence of the work in the assignment and task related field already. I would highlight again local and international cooperation with more companies, large communities, universities and direct use of the results in education tools and professional control units.

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

Date: **31.5.2022** Signature: