

I. IDENTIFICATION DATA

Thesis title:	Memory Safety Analysis in Rust GCC
Author's name:	Bc. Jakub Dupák
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Measurement – K13138
Thesis reviewer:	Ing. Pavel Píša Ph.D.
Reviewer's department:	Department of Control Engineering – K13135

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment	extraordinarily challenging
<i>How demanding was the assigned project?</i>	
<p>Jakub Dupák joined the professional developers' team working on Rust language frontend implementation for the GNU Compiler Collection project. The Rust language is modern but quite complex and introduces new concepts, which have to join the GCC source base with 40 years of history. GCC is the cornerstone of all open-source development projects, including Linux kernel, and a base that allowed Cygnus, later RedHat, to work for the US Army and enabled Objective-C for NextSTEP, the base of modern Apple operating systems. The demand for the code quality to be acceptable in such a project mainline is very high. In particular, the chosen work area of the borrow checker is one of the most complex, and a combination of the C++-written Rust frontend, GCC internals, and calling into the Rust code base of Polonius requires familiarization with a broad range of technologies and APIs. Much of the code has already been accepted for the GCC-14 release, and previous preparatory works are already part of the previous releases.</p>	

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>	
<p>The work planned for the thesis period has reached a state where the borrow-checker is able to analyze code in specially designed BIR representation, and errors are reported. Support for complete Rust language and descriptive reporting are the next phases, which would require a lot of work, which is planned for further phases. The project represents man-years of ongoing effort, and it is a big achievement that the proof of concept designed by the student in the thesis preparatory phase has already evolved into an accepted solution and base of the complete community project.</p>	

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>	
<p>The student has been attracted by the area of compilers and safety-related languages solutions during his previous work on the RISC-V architecture educational simulator (used already by universities worldwide). He has met teams working in this area during his presentation and visit to the Embedded World Conference 2022. He has joined GCC core developers teams and chosen his topic according to community needs. He has chosen and studied multiple compilers-related classes at other faculties and even Charles University because there are no experts with deep enough knowledge in this area at our faculty.</p>	

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>	
<p>The project topic is demanding, and it has been solved with the use of state-of-the-art techniques. A lot of the concepts</p>	

required architectural and innovative work. The student prepared preliminary report Contribution to the Rust front-end for the GCC compiler to summarize his knowledge and provide a basis for discussion with the core team a year ago. The thesis text has the potential to transform into the project's core documentation.

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?

The text is well structured into the goal statement, part describing existing solutions and reusable components, analysis of internal representations, and actual description of the work done and future potential and required steps.

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?

The sources of language documentation, GCC, LLVM-based implementations, and related intermediate representations are listed, as well as the references to relevant conference articles.

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 second, independent Rust language implementation is critical for its development and standardization, and the number of new additional architectures and code flow analysers gained by the reuse of GCC infrastructure and backends is enormous. The project has sound potential to be used by broad developers community.

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

The project is demanding, and Jakub Dupák has proven his ability to participate in professional core software development, propose the development direction, and present his plan to the core steering members and companies. His plan has been accepted, and the project is advancing in the chosen direction. The demand for knowledge in the area of computer language compilers led him to study courses at Charles University, Faculty of Mathematics and Physics. Their graduates and teachers participate and are steering members of the GCC and Linux kernel development worldwide and Jakub Dupák is on the way to join this group of excellence.

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

Date: 29.1.2024

Signature: