CTU
CZECH TECHNICAL UNIVERSITY IN PRAGUE

THESIS REVIEWER'S REPORT

I. IDENTIFICATION DATA

Thesis title:	**Energy efficiency of GPU applications in embedded systems**
Author's name:	Lavuš Eduard
Type of thesis :	master
Faculty/Institute:	Faculty of Electrical Engineering (FEE)
Department:	Department of Measurement
Thesis reviewer:	Ing. Peter Mathia
Reviewer's department:	Honeywell International s.r.o

II. EVALUATION OF INDIVIDUAL CRITERIA

Assignment **challenging**

How demanding was the assigned project?

The thesis aims to develop a test framework and evaluate energy efficiency of GPU application in embedded systems. Modern embedded platforms consist of complex system-on-chips and require integration and tweaking of multiple layers of SW libraries, both proprietary and open-source. Therefore, it is quite common to find some inconsistencies, lack of documentation, undocumented HW features, SW or even HW bugs, which all could prevent the fulfillment of an assignment. Therefore, I consider this assignment to be complex.

Fulfilment of assignment **fulfilled with major objections**

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 thesis fulfills primary goals and objectives of the assignment within limits of used HW and SW (some HW and/or SW features are not documented and had to be reverse engineered with partial success). One task has not been fully covered, the evaluation of the proprietary kernel graphics driver, which was required for comparison with open-source version. This area needs more attention, perhaps update of OS, since the version used was not supported.
Although it is probably out of scope of this thesis, it would be interesting to evaluate effects of different cache configurations and cache partitioning (commonly used in aerospace) on overall performance and temperatures, both on CPU as well as on GPU and system memory. This could be a topic for further work.

Methodology **correct**

Comment on the correctness of the approach and/or the solution methods.

The thesis describes architecture of selected HW platform as well as architecture of SW stack. Next, the thesis explains in detail selected drivers and libraries for GPU and CPU benchmarks. Selection of Vulkan API is very valuable, since the Vulkan SC version supersedes legacy OpenGL and OpenCL APIs in safety critical domain. Further, selection of proved and commonly used benchmark framework ADASMark paves the way for the thesis results to be used in the industry and easily reproduced using Yocto.

Technical level **A - excellent.**

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?

The overall technical level is on a very high level. It is obvious the applicant is familiar with embedded systems and used libraries and APIs, such as OpenCL and Vulkan. Throughout the whole thesis, the applicant explains in detail algorithm of each test, it's configuration and effects on results. Results overall are presented in a clear way.

Formal and language level, scope of thesis **B - very good.**

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 overall level of used language is on a very high level, it's obvious that the applicant is familiar with the topic of the thesis and with reading of technical documentation in English. However, I would point out slight grammar mistakes, and sometimes a long sentence could be split into multiple for better reading.

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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?	
Literature used for the master thesis was appropriate. Citations are correct.	

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 shows that modern embedded systems are getting ever more complex and require careful evaluation before being used in a product. Results of the thesis show that designers will have to make a tradeoff between longer computation times, while consuming less energy overall and prolonging battery life, and shorter computation times with less total energy consumed, but at a price of higher temperature peaks. Both present a problem in modern aviation and need to be balanced or addressed differently.

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

Summarize your opinion on the thesis and explain your final grading. Pose questions that should be answered during the presentation and defense of the student's work.

The grade that I award for the thesis is **B - very good.**

Date: **20.1.2023** Signature: