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DOCTORAL DISSERTATION REVIEW

Title of the PhD dissertation on which the candidate is applying in the current procedure for the award of PhD degree

Review of the PhD dissertation “Data plane programmability for software datapaths in a virtualized network infrastructure” written by the candidate Tomasz Piotr Osinski.

Assessment of the layout of the dissertation, including information on its various components

The dissertation is well written and well structured. Chapter 2 discusses the state of the art, Chapter 3 discusses a number of relevant use cases and the related work. Chapter 4 describes and evaluates the first original proposal of the dissertation, i.e. the P4rt-OVS software switch. Chapter 5 describes and evaluates the second original proposal of the dissertation, i.e. the NIKSS software switch. Chapter 6 reviews the contribution of the work. Finally, two appendices review more in detail the methodology to measure CPU cycles in NIKSS and how to perform DDOS mitigation with P4rt-OVS.

Chapters 2 and 3 comprise an extensive review of the relevant literature. The dissertation covers literature from the most important scientific venues on the topic of network programmability and also covers recent open-source projects. Chapters 4 and 5 are well balanced, covering the motivation, the design choices and the evaluation of the performance of the prototype. The results show that the proposed solution can achieve high data rates.

Evaluation of the literature used within the dissertation

The literature is extensive and up to date. About two thirds of the references are recent papers from the most significant venues in the fields of network programmability and of system design. The other references comprise open-source project repositories and technical documents from open-source projects.

Indication and assessment of the purpose of the candidate's work

The motivation of the work is mostly discussed in Chapter 3 and consists in proving that it is feasible to apply data plane programmability concepts to software switches. In particular, the candidate wants

to provide evidence that the P4 abstraction for data-plane programmability, which was developed for hardware switches, can be successfully used also for software switches with good performance.

The motivation of the work is valid. While programmable software switches are not novel, no uniform abstraction layer has been successfully deployed so far. The P4 layer has gained significant traction in recent years also in the context of software switches and the candidate's work was a precursor to other, more recent, industry-supported project leveraging the same ideas.

Indication and evaluation of the testing methods used

The evaluation of performance is carried out according to industry-standard methodology using a professional traffic generator. The work provides extensive benchmarks comparing the proposed design to alternative solutions.

Evaluation of the part of the dissertation concerning the discussion of research results

Research results are discussed for each individual contribution at the end of Chapters 4 and 5 and for the whole work in Chapter 6. The discussion is well structured. The work identifies three clear research questions to which the dissertation answers by providing the evidence collected in Chapters 4 and 5. The answer to the first question (p. 127) is quantitative and based on the evidence collected in the previous chapters. The answer to the second and third questions are qualitative and based on the lessons learned during the implementation of the prototypes.

Information concerning the practical application of the research results obtained

The research results have immediate practical applications. The prototypes are available to other researchers to develop new ideas. The dissertation results are general enough to be applicable also to new and ongoing projects developing alternative solutions to the problem of software switch programmability.

Information on possible irregularities which appeared in the evaluated dissertation

No irregularities appear in the dissertation.

Assessing whether the dissertation provides an original solution to a scientific problem

The dissertation addresses a significant research question that attracted several researchers in recent years, namely what performance can be expected by software switches and what is the best abstraction that can be used to dynamical program software switches. The dissertation addresses these research questions by providing original implementations and showing that the P4 abstraction results in a small performance gap. This is evidence enough to prove that the P4 abstraction is good, within the limits discussed in the conclusion.

A critique that can be moved to this approach is that the limitations of P4 was designed as a hardware abstraction and some of its limitations can be lifted in a different abstraction layer designed for software switches.

Assessing whether the PhD thesis demonstrates the candidate's overall theoretical knowledge of the discipline or disciplines and his or her ability to carry out scientific or artistic work independently

The thesis demonstrates extensive knowledge of the field of network programmability and of networking in general. The candidate shows ability to carry out independent research.

In the case when the Contractor states that the dissertation deserves to be distinguished, the justification for this conclusion should be indicated.

This reviewer thinks that the dissertation deserves to be distinguished for the following reasons:

- (1) The research questions are clearly formulated and the dissertation presents a methodology to derive the answers in a logical and formal way from the evidence collected from the prototypes.
- (2) The two prototypes are well designed showing an in-depth knowledge of the internal mechanisms of software switches, their limitations and the mechanisms to overcome them.
- (3) The design of the research leverages an in-depth analysis of the most recent and relevant literature, positioning the work in a fruitful research field.

Milano, May 4th, 2023

