Doctoral Thesis Report

Author of the thesis: Stanislav Böhm
Title of the thesis: Unifying Framework for Development of Message-Passing Applications

The thesis presents results of the research of S. Böhm in the area of development of distributed applications based on the MPI technology. The high-level goal is to ease the development of such applications, which is much more demanding than development of classical sequential programs. Due to the constantly increasing use of concurrent and distributed computing environments, the subject area of the thesis is highly up-to-date and interesting both for academia as well as industry.

In the thesis, S. Böhm in particular presents his proposal of the Kaira framework that is centered around a visual language for developing distributed applications which combines high-level Petri nets and C++. Here, C++ is used to describe sequential computation whereas high-level Petri nets are used for describing parallel aspects of the developed programs. Kaira uses an original dialect of high-level Petri nets which is a nice compromise between being general enough to allow for describing common MPI applications, being simple enough to use, allowing for efficient execution, as well as for various ways of analyzing the developed application. Indeed, apart from means for designing MPI applications using a combination of visual and textual programming, Kaira provides tools for generation of executable applications, debugging them, tracing them, predicting their performance, formally verifying some of their important features, as well as for generating libraries out of them.

The particular building blocks of the Kaira framework mentioned above are evaluated on several concrete examples in the thesis. Although these examples are not really very complex, they are at the same time non-trivial and provide a sufficient evidence that all the described building blocks of Kaira do indeed provide promising results – both individually as well as from the point of view of providing a uniform environment for all the tasks.

The results obtained in the thesis were published in the proceedings of 7 international conferences and workshops, some of which were published by Springer Verlag or ACM. Apart from that, the results were also published in one article in a journal indexed by Scopus. Moreover, recently, a tool paper about Kaira has been accepted for publication in the proceedings of the 35rd International Conference on Application and Theory of Petri Nets and Concurrency, which is the most prestigious conference in the area of Petri nets. Hence, the results were clearly published in a sufficient way.

The thesis is written in English of a quite reasonable level although some language errors do appear from time to time. The thesis is well structured and all parts of the Kaira framework are presented in a clear way. Here, I would especially like to highlight Chapter 5 which provides a rigorous definition of the semantics of the Kaira language.
Overall, the thesis made a positive impression on me. However, I do have one concern about the design of the Kaira language. Kaira uses high-level Petri nets which are flat, this is, they are not structured in any way. In my opinion, this can be a problem when developing larger applications in the framework. I would like to ask the author to explain during the defense of his thesis whether or not he considered some structuring of the Kaira nets.

Further, I also have a few minor critical remarks about the thesis. According to my opinion, the description of MPI in Section 2.1 could be somewhat extended to make the text more self-contained. I would also expect the author to mention some more dialects of high-level Petri nets and to make a more detailed comparison with them, explaining why they are not suitable for use within Kaira. Next, the comparison of performance of Kaira applications and manually created applications in Section 6.1.1 is based on a single, not very complex application (where the performance of the considered Kaira application and its manually created counterpart are almost identical). It would be better to provide comparisons on more case studies, including some more complex ones. A similar criticism applies to the experiments with performance prediction.

To sum up, despite the criticism presented above, I think that the quality of the PhD thesis of Stanislav Böhm, the original contribution of the student presented in it, and the ability of Stanislav Böhm to conduct independent scientific work fulfill the requirements commonly put on PhD theses and PhD candidates in the area of computer science. Moreover, it should be stressed that Stanislav Böhm is also a co-author of multiple results from the area of computational complexity, which are not part of his thesis but which were published at prestigious conferences, including the STOC conference. In view of all these facts, I recommend the thesis of Stanislav Böhm to be accepted for defense and upon its successful completion, Stanislav Böhm to be assigned a PhD degree.

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