

Activity Report for 1999 for the project: “Design Guidelines and Visualization Support for Developing Parallel Real-Time Applications” P4-9805

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1. Background

Two Ph.D: students - viz. Daniel Häggander and Magnus Broberg - are currently working in this project. Both of them started somewhat before 1999. Magnus and Daniel took their Licentiate degrees during 1999 from Chalmers and Uppsala respectively. They are, however, now Ph.D. students at Karlskrona/Ronneby.

2. Comparison with plan and other aspects

The expected results, as stated in the project plan, were:

- a set of guidelines on how to design parallel real-time applications with high, predictable and scalable performance. The guidelines will also consider reusability and maintainability aspects.
- a tool for visualizing and predicting the performance of parallel programs. The tool will make it possible to predict the execution time of and identify performance bottlenecks in parallel applications.

The licentiate thesis by Daniel Häggander contained ten design guidelines for migrating server applications to SMPs. This is very close to the goal in the first bullet above. One finding by Daniel was that dynamic memory management can cause severe serialization bottlenecks when using a multiprocessor. Daniel's work will now continue along two parallel paths: first to develop a method that automatically solves the dynamic memory problem in the compilation phase. Second, to validate his guidelines in an industrial project at Ericsson. He is currently working with these two activities. This is somewhat different from the (very rough) outline that we had in the project plan. In the original plan the next step should be to consider other execution environments than Sun Solaris, e.g. Windows NT. We feel that the current line of research is, however, more promising for several reasons, i.e. it would have a large industrial impact if we could solve the dynamic memory problem transparent to the programmer in the compilation phase, and we think that it is important to do a thorough validation of the guidelines in a real industrial environment.

The licentiate thesis by Magnus Broberg was based on a tool for visualizing and predicting the performance of parallel programs. The tool was developed by Magnus as a proof of concept for some of his ideas. Magnus is also following the project plan very closely after his Licentiate degree, i.e. he is currently considering execution environments other than Sun Solaris. The cross-simulation technique for Linux is the first example of this (see reference [M6] below).

In my opinion, this project is progressing nicely, and I expect that Magnus and Daniel will take their Ph.D. degrees during 2001. The only concern that I have is the financing of Magnus and Daniel during 2001. The current funding stops after the year 2000.

3. List of publications

Publications by Magnus:

- M1. M. Broberg, L. Lundberg and H. Grahn, *VPPP - A Visualization and Performance Prediction Tool for Multithreaded Solaris Programs*, in Proceedings of 12th International Parallel Processing Symposium, Orlando, April 1998.
- M2. M. Broberg, L. Lundberg, and H. Grahn, *VPPB - The Second Version: An Approach to Monitor Solaris Kernel Threads*, in DSA-98 Seventh Swedish Workshop on Computer Systems Architecture, Göteborg, Sweden, June 3-5, 1998.

- M3. M. Broberg, L. Lundberg and H. Grahn, *Visualization and Performance Prediction of Multithreaded Solaris Programs by Tracing Kernel Threads*, in Proceedings of 13th International Parallel Processing Symposium, San Juan, Puerto Rico, April 1999, pp. 407-413.
- M4. M. Broberg, L. Lundberg, and H. Grahn, *Performance Optimization Using Extended Critical Path Analysis in Multithreaded Programs on Multiprocessors*, submitted for journal publication.
- M5. M. Broberg, *An Approach for Performance Tuning of Multithreaded Applications on Multiprocessors*, Licentiate Thesis, Chalmers University of Technology, Sweden.
- M6. M. Broberg, *Performance Tuning of Multithreaded Applications for Multiprocessors by Cross-Simulation*, Submitted for conference publication and for presentation at the ARTES student conference in Gothenburg, March 2000.

Publications by Daniel:

- D1. D. Häggander and L. Lundberg, *Optimizing Dynamic Memory Management in a Multithreaded Application Executing on a Multiprocessor*, in Proceedings of International Conference on Parallel Processing, Minneapolis, US, August, 1998.
- D2. D. Häggander and L. Lundberg, *Memory Allocation Prevented Telecommunication Application to be Parallelized for Better Database Utilization*, in Proceedings of the 6th Annual Australasian Conference on Parallel and Real-Time Systems, Melbourne, November 1999 (Springer-Verlag), pp. 258-271.
- D3. L. Lundberg, J. Bosch, D. Häggander, and PO. Bengtsson, *Quality Attributes in Software Architecture Design*, in Proceedings of the 3rd Annual IASTED International Conference on Software Engineering and Applications, Scottsdale, Arizona, October 1999.
- D4. D. Häggander, PO. Bengtsson, J. Bosch, and L. Lundberg, *Maintainability Myth Causes Performance Problems in Parallel Applications*, in Proceedings of the 3rd Annual IASTED International Conference on Software Engineering and Applications, Scottsdale, Arizona, October 1999.
- D5. D. Häggander, PO. Bengtsson, J. Bosch, and L. Lundberg, *Maintainability Myth Causes Performance Problems in SMP Applications*, in Proceedings of the 6th IEEE Asia-Pacific Software Engineering Conference, Takamatsu, Japan, December 1999.
- D6. D. Häggander and L. Lundberg, *Multiprocessor Performance Evaluation of a Telecommunication Fraud Detection Application*, in Proceedings of the ARTES Graduate Student Conference, Västerås, pp. 33-39, May 1999.
- D7. D. Häggander, *Software Design When Migrating to Multiprocessors*, Licentiate Thesis, Department of Computer Systems, Uppsala University, Sweden.
- D8. D. Häggander and L. Lundberg, *Attacking the Dynamic Memory Problem for SMPs*, submitted for publication.
- D9. D. Häggander and L. Lundberg, *A Simple Process for Migrating Server Applications to SMPs*, submitted for journal publication.

4. Statement from Industry

Concerning the work done by Daniel Häggander and Magnus Broberg in the project "Design Guidelines and Visualization Support for Developing Parallel Real-Time Applications"

Magnus and Daniel have actively contributed in the development of two prototype versions of a product called DMO. The purpose of DMO is to detect abnormal situations in the telecommunication network, e.g. that a cell has a very high rate of lost calls. Such situations generally indicate that there is some problem with the cell, e.g. the corresponding base station may need to be repaired. It is important that these indications are done in real-time, since erroneous cells may need to be shut off from the rest of the network. The amount of information that needs to be monitored is enormous even for a medium sized network operator. It is therefore necessary to use computer based applications such as DMO for interpreting the data in real-time.

The DMO prototypes were developed by two groups of software engineering students at the University of Karlskrona/Ronneby. Ericsson handled the requirement specification and part of the project management. One of the groups developed a multithreaded version of DMO, which was intended to scale-up on a symmetric multiprocessor (a Sun SMP). Magnus Broberg's visualization tool played an important role in this development. The other group was working with a commercial DBMS. The design guidelines developed by Daniel Häggander were very valuable for both groups. The DMO project is an example of how Ericsson is cooperating with the University in research and education.

In order to collect information for his design guidelines, Daniel has participated in a number of development projects at Ericsson, e.g. the development of a real-time system for detecting fraud attempts in telecommunication networks. Daniel is currently participating in a project for developing a very performance demanding application for prepaid billing of cellular calls. The advice and expertise that Daniel has shared with us during these projects has been very valuable.

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