Parallel Systems Theory Exam
January 29th 2013

Prepare your answers on paper carefully. Make sure you have complete answers which are to the point. I cannot give the maximum for answers only given during the oral defense.

1. Consider a Discrete Optimization problem solved by exploring a search tree of size *W*. Perform a scalability analysis for distributed memory systems. Explain how the performance evolves with *W* and *p* for a *basic parallel version* and for an *improved version* (minimizing the overhead). Consider depth-first tree search. Explain the choices you make for the improved version to arrive at a scalable parallel solution.

2. To enable shared-memory multi-threaded programs on a multicore, the hardware has to solve several problems and provide several functionalities. Explain them and how they are implemented nowadays.

   Consider the question as follows: we put several CPUs together and connect them to the same RAM memory. Now: what should be provided additionally on the hardware level to be able to run shared-memory multi-threaded programs efficiently?

   b. What is the role of the Operating System?

   c. Considering the programming primitives for writing multi-threaded programs, explain the role of hardware and operating system in all three of them.

3. Consider implementing quicksort and mergesort for distributed-memory systems (message-passing solutions) and shared-memory systems (multi-threaded solutions). Analyze the 4 possible combinations: when do they give an efficient implementation?

   a. Sketch the parallel implementations. Follow the principles of quicksort and mergesort.

   b. Analyze their efficiency (consider the overheads). Are they efficient? Can we eliminate the overheads? Compare the overheads for the 4 combinations.

   c. Lastly, try to implement quicksort and mergesort in hardware, to create a hardwired sorting network.