A Flexible HPC-Environment for Spin-Glass Calculations based on Tycho

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1 Project Background

Spin glass science is a relatively mature field of research in physics and much work has been invested to experimentally investigate as well as to theoretically model and understand the intriguing properties of this magnetically (dis)ordered phase at low temperatures. However, up to now, many fundamental questions, e.g. what are the critical dimensions and what happens in finite-dimensional spin glasses, remain unanswered.

Already at the beginning of the theoretical investigation of spin glasses it turned out that even the classical mean-field theory of a range-free spin glass is technically and conceptually highly nontrivial, and its correct treatment requires a powerful tool, known as replica symmetry breaking (RSB). [2]

The objective of this HPC-EUROPA2 visit to EPCC and the University of Reading was to develop and test a distributed framework for the calculation of different RSB models with Tycho [1] as middleware. Tycho is an implementation of a wide-area asynchronous messaging framework with an integrated distributed registry. Tycho is currently being developed at the University of Reading / Centre for Advanced Computing and Emerging Technologies (ACET). The Spin-Glass algorithms depend on different numerical solvers for differentiation, integration, linear algebra and similar problems. Thus, the aim of this project was to develop some of these solvers and execute them depending on availability and demand on different HPC systems.

In cooperation with one of the developers of Tycho, Dr Hugo Mills, a first prototype was written within two weeks. However, several needed Tycho features where not yet implemented. Two of the needed features were P2P bootstrapping and secure communication.

2 P2P Mediator Bootstrapping

Tycho consists of three concepts:

1. Producers gather and publish information for Consumers
2. Consumers connect to Producers and receive information
3. Mediators register Producers and Consumers in a Virtual Registry (VR) and mediate connections between them

If Producers and Consumers know each others address, they can establish connections between themselves. However, if this is not possible due to firewalls or other restrictions, the Mediators can provide wide-area connectivity to other Mediators which relay traffic to its destination. To be able to find each other, the Mediators registered themselves at one world wide unique - web server running at University of Reading / ACET. Thus,
if this web server is not reachable because of restrictions or fails because of an error, all newly started Tycho Mediators would not be able to find other Mediators in their working domain and provide wide-area connectivity.

The projected HPC environment should be able to transfer data between restricted networks especially if one or more of this networks don’t have access to the Internet and thus to the server in Reading. A solution for this problem is P2P bootstrapping. In the case of Tycho the Mediator communication protocol was extended to spread address information of other Mediators to newly connected ones. Thus, if one knows the address of one other Mediator in the working domain, the new Mediator can join the network of Mediators without contacting the central server in Reading.

3 Secure Communication

While Tycho 1.0 supported secure communication over SSL-Sockets and HTTPS, newer versions did not because of internal communication protocol changes. However, since the Producers are supposed to run on HPC systems with access restriction and execute code on this machines, one cannot risk loosing control of them to crackers. Thus, the changes of the protocol from version 1.0 to 1.3 were analyzed and changes where made to support encrypted communication. However, this work is not yet finished and the code needs to be tested.

4 Future Work

After finishing the secure communication implementation, the experiences made while writing the prototype will help in developing Spin-Glass solvers. With the help of this solvers general ones will be developed to ease the calculation of numerical problems.

4.1 Acknowledgment

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References
