Accurate and Efficient Emulation of Network Topologies in Wrekavoc

Master Internship

Research team name: AlGorille (NUM theme ; leader: Jens Gustedt)
Research Unit: Nancy – Grand Est
Intern tutors: Lucas Nussbaum <lucas.nussbaum@loria.fr>
Intern level: Master student (or PhD student)
Internship duration: 4 to 6 months
Possibility of a follow-up Ph-D: yes

This internship will be supervised in collaboration with the MADYNES INRIA research team to provide more expertise in networking.

1. Context

Distributed computing and distributed systems is a branch of computer science that has recently gained a lot of attention. Grids, clusters, peer-to-peer systems, high-performance supercomputers, cloud computing infrastructures, desktop computing environments like BOINC, are all examples of successful environments on which distributed applications (scientific computing, data management, ...) are executed routinely.

However such environments and applications are very complex, and very hard to study, test, and evaluate. Experimental evaluation is generally used in that context. One can distinguish three different methodologies for performing experiments [GJQ09]: real-scale, simulation and emulation. Real-scale (or in situ) consists in executing the real application under study on an experimental platform like Grid’5000 or PlanetLab. On the opposite, with Simulation, both the application and the environments are replaced by models, and the interactions between both models are computed by a simulator. Emulation, which is at the core of the internship proposal, can be seen as an intermediate approach, since the real application is executed within a synthetic environment: typically, one will use a cluster of fast identical machines as an execution environment, and use an emulation later to reproduce conditions found on the real Internet (slower links with latency and limited bandwidth, heterogeneous machines).

Wrekavoc [CJ06, DGJ08] is an emulator developed by the AlGorille team. It allows to execute distributed applications on a cluster of machines, emulating different features of the environment (CPU speed, memory size, network characteristics – bandwidth, latency, topology) by using system-level tools, like the network emulator included in the Linux kernel.

2. Description

Wrekavoc already provides support for the emulation of network topologies, but this support has a large margin for improvements. The work to be done during this internship is:

• Evaluate the topology models provided by various network topology emulators: Modelnet, Emulab, Wrekavoc, eWan, P2PLab, ...

• Implement one or more of those models (or design new models) in Wrekavoc by relying on the Linux Traffic Control subsystem (similar to Dummynet and NISTNet, see [NR09]). The implementation will be done with a mix of C (for the low-level parts) and scripting language (for the high-level parts).
• Evaluate the resulting implementation by doing large scale experiments on the Grid’5000 platform (a unique 1600-machines platform dedicated to research on distributed systems). Typically, the intern will run applications (peer-to-peer systems, for example) and verify that the results under emulation meet the expected ones.

The efficiency and the scalability of the implementations are crucial, and solutions to improve efficiency and scalability will be explored. In particular, the feasibility of using High Performance networking (Infiniband and Myrinet technologies) in the context of network emulation will be studied.

3. Skills required
In addition to the skills that can reasonably be expected from Master-level students, the applicant should have: strong knowledge of networking, and of the implementation of networking in Linux; good system programming skills on Linux.

4. Links
• Wrekavoc: http://wrekavoc.gforge.inria.fr/
• Research team (ALGORILLE): http://www.loria.fr/equipes/algorille/
• Grid’5000 Experimental platform: https://www.grid5000.fr/
• Tutor (Lucas Nussbaum): http://www.loria.fr/~lnussbau/

References

