**Modifying Xen: Enabling Parallel Migration and SplitVM Testing**

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**Introduction:**

Data centers form the foundation of cloud computing, an increasingly important computing paradigm. Virtual machines are one of the primary units of computation in cloud computing; in cloud computing data centers, many physical servers—each running hypervisor virtualization software—provide computing resources needed to run the virtual servers. However, failures do occur: whether it’d be by security breach, or a hardware failure, a VM may need to be migrated away from its original host. In such a situation, one available server alone may not have the resources needed to run the VM, while two or more servers may have the resources needed when combined.

Xen is an open-source virtual machine monitor (VMM), or hypervisor, developed by the University of Cambridge, which allows multiple commodity operating systems to share conventional hardware in a safe and resource managed fashion, but without sacrificing either performance or functionality.

**Objectives:**

Currently, Xen operates with a singular migration from Host A to Host B. In this project, I seek to modify Xen to allow a single VM on Host A to be migrated, or cloned in parallel, onto Host B and Host C. Therefore, the Xen migration algorithm must be modified such that the VM on Host A will be migrated to Hosts B and C at the same time. There are certain challenges included in modifying the algorithm; in

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1. [http://caslab.eng.yale.edu/research.html](http://caslab.eng.yale.edu/research.html)
2. Ibid.
3. Ibid.
particular, they include opening up parallel connections to the child hosts and modifying the existing migration algorithm to use multiple threads, one for each connection. Reviewing the code will also take a nontrivial amount of time, due to the number of macros and simply, the sheer lines of code in Xen and as I modify the code, the (possibly many) times rebooting the machines. The ultimate goal is to have the VM running on both Hosts B and C, with no VM left on Host A.

Furthermore, I would like to investigate the Quick Emulator (QEMU) code and analyze how it interfaces with Xen. QEMU is an open-source hosted hypervisor. This is part of an ongoing investigation by Professor Jakub Szefer’s Computer Architecture and Security Lab; I am to be, at the very least, competent in understanding QEMU’s interface with Xen and able to explain it to others working in the lab, and formalize it via the lab’s Wiki and/or in the final project report and/or a presentation to the lab.

Possible stretch goals include modifying Xen domain structs to hold information about the migrated/cloned VM’s other clone; I would have to augment Xen’s existing domain info struct, which stores information about each VM, so that the child Hosts B and C after parallel migration hold information about the other child host. In essence, the hosts will know about each other. Furthermore, partial migration is of immediate interest; I would modify the parallel migration algorithm that I will develop so only part of the VM in Host A is sent to Host B, and the remaining part of the VM to Host C. I also aim to help with team members Faisal Zaghoul and Michael Hoot with performing SPLASH-2 benchmarks (this will possibly be in the final project report if obviously relevant). I hope I will have enough time to accomplish all of these goals during this semester, depending on how my role evolves throughout this semester in lab.

**Significance:**

This is only a part of an ongoing project, Split Virtual Machine Execution for Reliability and Security, at Professor Jakub Szefer’s Computer Architecture and Security Lab. These goals comprise a crucial part of the ongoing project, which has
the promise of increasing the reliability, security, and utilization of cloud computing providers in both public and private sectors.

Furthermore, I have no prior experience with Operating Systems or Distributed Systems. However, they are things I’d like to very much gain experience with before I leave Yale this December, as I am a second-semester senior. More personally, this semester will be a great challenge as I am concurrently trying to complete a late Computer Science B.S. degree, having taken 1 CS credit in my junior year, 4 CS credits in the Spring 2015, 3 CS credits during the summer, and 4 CS credits this semester (including this senior project). I am looking forward to meeting this challenge.

**Deliverables:**

1) Final project report; a side part of the report will hopefully include a more formal analysis of the QEMU interface with Xen, available to the lab and the Yale community at large.

2) Pushed parallel migration algorithm code to the CAS-Lab Github; this will be open to the lab and presumably the Yale community at large.

3) **Possibilities:**
   a. Further modifying Xen open-source code to augment domain info structs to hold info about another host.
   b. Modifying Deliverable 2’s code (or creating a new algorithm) for partial parallel migration.
   c. Formalized benchmarks in the final project report.
   d. Oral presentation to the lab.