



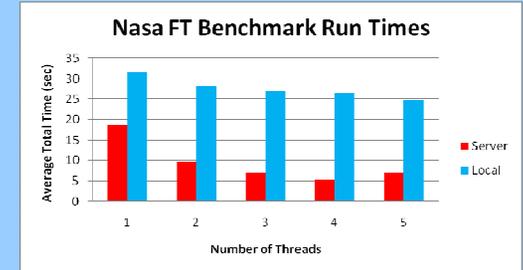
# 2009 REU in Telematics and Cyber Physical Systems

## Offloading CPU Intensive Applications to the Cloud Using Java RMI

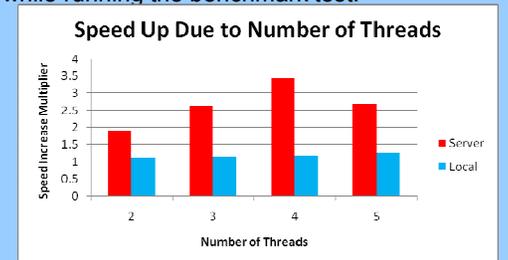
Faculty Mentor: Dr. Cheng-Zhong Xu  
Grad Student Mentor: Kun Wang

Elizabeth Halash, Wayne State University, Detroit, Michigan

### Results and Discussion:



As you can see from the chart, the tests run on the server are significantly faster than the tests run on a local machine. Using one thread, the run time on the server is 58% of the time it took to run the same test on the local machine. This percentage continues to decrease to 20% as more threads are utilized while running the benchmark test.



Moreover, since the server has more powerful resources, it takes greater advantage of the program when it is run on multiple threads. Thus, run times on the server are 3.5 times faster when run on four threads compared to the initial value when run using one thread. However, utilizing more threads on the local machine does not considerably decrease the run time.

### Conclusion:

These results prove that cloud computing is very possible and that offloading computations to a server is a viable, time-saving option. As long as network speeds are decent, it is advantageous to offload computationally intensive applications to a more powerful server.

### References:

- [1] Jianbin Wei, Xiaobo Zhou, Cheng-Zhong Xu. **Robust Processing Rate Allocation for Proportional Slowdown Differentiation on Internet Server**. IEEE Computer Society, 2005
- [2] Armsbrust, Michael, Fox, Armando, etc. UC Berkeley. **Above the Clouds: A Berkeley View of Cloud Computing**. Technical Report No. UCB/ECS-2009-28. February 10, 2009.
- [3] Chun Byung-Gon, Maniatis Petros. Intel Berkeley Research. **Augmented Smartphone Applications Through Cloud Execution**. HotOS 2009.
- [4] Rakesh Agrawal, etc. **The Claremont Report on Database Research**. SIGMOD Record, September 2008 (Vol. 37, No. 3). Retrieved on May 12, 2009 from: <http://delivery.acm.org>
- [5] Cassimir Medford. **Computing in a Mobile Cloud**. 08 September 2008. Retrieved on May 12, 2009 from: <http://www.redherring.com/Home/24836>
- [6] java.sun.com
- [7] www.nas.nasa.gov

### Benchmark Tests:

To take advantage of the server's multi-threading capabilities, I needed to use java programs that contain algorithms for splitting the code into multiple threads. The NAS Parallel Benchmarks proved a good choice for this work. These benchmarks have been developed at NASA Ames Research Center to compare the performance of parallel computers and are recognized as a standard indicator of computer performance. The implementation is available as the NPB3.0-JAV package from [www.nas.nasa.gov](http://www.nas.nasa.gov). [7]

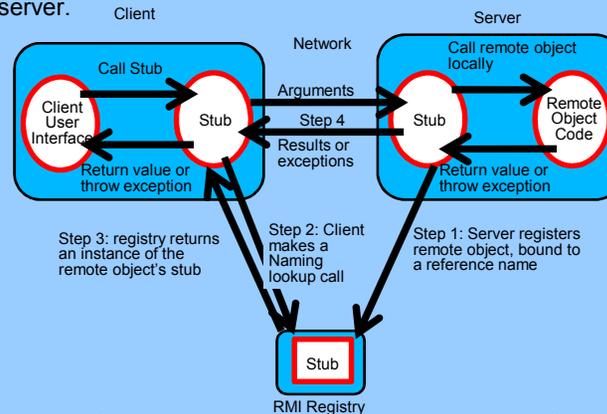


### My Work:

#### Java Remote Method Invocation:

Java RMI performs the object-oriented equivalent of remote procedure calls. Particularly, I implemented the Java Remote Method Invocation (RMI) in order to control applications on a server from a client machine. RMI functionality comes in the package `java.rmi`.

In order to run the Java RMI system, certain java script files are installed on the server as well as the host. Obviously, the class files as well as the imported java packages of the Nasa Benchmark test need to be installed on the server. There is a certain file, called the stub file, that is generated through compilation that needs to be saved on both the client and the server.



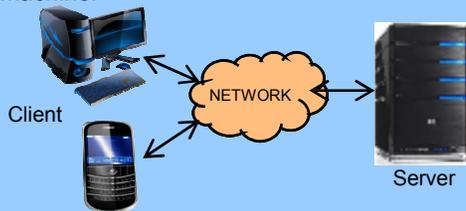
The stub file links the client to the server and allows for communication. After all Java files are compiled without errors, the RMI registry is run on the server side. Next, the class file on the server that links to the client is started. Finally, the class file on the client side that interacts with the user is run on the command line. Any user input arguments are sent to the server and the results are sent back to the user. As you can see from this example, the user should be oblivious that the program was run remotely.

### Abstract:

The term "cloud computing" is becoming more and more popular in the mass media, but what does the term really mean and what are its implications? The current consensus of the definition of the "cloud" is the combination of hardware and software provided remotely as a service. [5]

My research focused on analyzing the potential of cloud computing. More specifically, I am researching whether it is beneficial in terms of speed to offload CPU intensive applications to a powerful server in the cloud. While I have currently only run tests using a desktop computer as the client, the ultimate goal is to offload applications from a mobile device.

My current research has shown that offloading a computationally intensive application to a remote server can be significantly faster than running the same application on a local machine. In fact, it can take 80% less time to run an application on the server compared to running it on the local client machine.



### Introduction:

Mobile devices, such as smart phones, PDAs and netbooks, continue to grow in popularity as they incorporate more functions, such as music players or games. However, a shortcoming of mobile devices is their limited computing capabilities due to portability and cost issues. Bridging the gap between high-end servers and mobile devices could solve the computing problem and is an important research focus of distributed computing.

In this cloud computing model, mobile devices are thin-clients that only provide the interfaces or consoles to the complex applications. [4] The computational-heavy processing like 3D image rendering in games or mathematical optimization in scientific simulations is actually processed in the cloud. Thus, mobile applications could become more complex while the actual devices could become smaller.[1]



At this stage of my research project, I did not use a mobile device as the test bed. Since a mobile device was not readily available for testing, a desktop computer was used in place of a mobile device.