Daemon Deacons

Mitch Eisenstat, Zachary Green, Paul Kefer, Mudit Singhania, Matteo Spighi, and Vera Zhang

Department of Computer Science, Wake Forest University, Winston-Salem, NC, 27109, USA

Primary Advisor: Samuel S. Cho (Depts. Computer Science and Physics)

Secondary Advisors: Adam Carlson (Information Systems) and Cody Stevens (Information Systems)

About our Team

(Left to right: Matteo, Mudit, Zach, Paul, Mitch, Vera, and Kewen)

Our undergraduate student team consists of Freshman, Sophomore, and Junior students with majors in Computer Science, Math, and Economics (several are double-majors) along with minors in Statistics, Chemistry and Entrepreneurship. Moreover, our team has a very diverse background that includes American and international students coming from China, India, Austria, and Italy. Our students have taken a wide range of relevant prerequisite classes including Data Structures I and II, Databases, Parallel Computing, GPU Programming, Cloud Computing, and Machine Learning to name a few. Moreover, students have exposure to coding languages such as C/C++, Java, Python, CUDA, Swift, HTML, CSS, and Javascript. This gives us a diverse background and diverse set of skills which will enable us to perform better at the SC18 Student Cluster Competition.

Our team name is the “Daemon Deacons”, a play on our university’s mascot, the “Demon Deacons”. Our university mascot’s origin dates back to a football game vs. Trinity (later named Duke University) when we defeated them. The newspaper editor recognized the team “devilish" play and fighting spirit, and the name stuck. In computing, a daemon is a process that works in the background and carries out critical processes. The origin of that name came from a Maxwell’s Demon in a physical chemistry thought experiment where an imaginary supernatural being works in the background sorting molecules to defy entropy.

This is our time at the Student Cluster Competition, and we feel like underdogs against more well-established teams. While we may not get the same level of attention as the other teams, we have a strong “devilish” fighting spirit, which we believe will end up defying expectations and surprise everyone by defeating them.

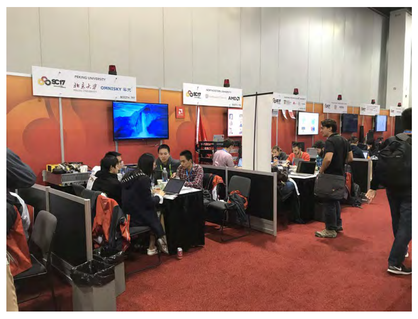
Wake Forest University is a liberal arts university with a predominantly undergraduate population that is currently listed on US World News Reports with a National Rank of #27. Located in North Carolina, Wake Forest University has about 5,000 undergraduate and 3,000 graduate students and prides itself on its low faculty student ratio (1:10). To date, there has been no school from North Carolina that has ever participated in the SC Student Cluster Competition, and we will to be the first. Also, we will be the first to win (see below, right).

Team Preparation

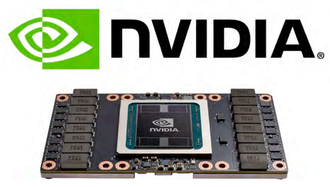
To prepare for the competition, the Computer Science Dept. created a brand new High Performance Computing class, which is taught by Prof. Samuel Cho (Associate Prof., Depts. Computer Science & Physics), who is the primary advisor for this team. Prof. Cho has extensive experience performing research and teaching classes in GPU Programming, Parallel Algorithms, and Computational Biophysics. In addition, Adam Carlson (Senior System Architect) and Cody Stevens (System Architect) who comprise the High Performance Computing Team at our university’s DEAC Supercomputing Facilities (3.5k+ x86_64 compute and 12k+ GPU cores) served as secondary advisors for this team. They provided practical experience of compiling, running, and benchmarking applications in a high performance computing facility, as well as maintaining it.

The inaugural class in the Fall 2017 semester consisted of 6 undergraduate students who learned about High Performance Computing, as well as compile, run, and benchmark applications on the DEAC Supercomputer. In November, Prof. Cho, Mr. Carlson, and all 6 undergraduate students attended SC17 to directly see the competition in person and gather information about the competition. We were fortunate that the Dept. Computer Science funded their travel through a generous donation from a former alumni. The Spring 2018 and Fall 2018 semester consisted of 9 and 7 undergraduate students, respectively, including all the members competing in SC18.

To obtain the hardware that we will use in the competition, we also leveraged our existing relationships with Cisco Systems, Inc., which is the main vendor for our campus DEAC Supercomputing Facilities. Also, Prof. Cho has had a strong relationship with NVIDIA due to his research with GPU computing. We also opened up a new relationship with Mellanox Technologies through our new vendor partners at Cisco Systems, Inc.



Hardware



For the competition, our team has recruited three vendors (Cisco Systems, Inc., NVIDIA Corp., and Mellanox Technologies) to lend us equipment.

Cisco provided four (4) C240 M5 servers, each with 192GB DDR4 RAM, 980GB SATA SSD, and 770 W AC Power Supply. In addition, Mellanox provided a SB7800 Infiniband Switch, ConnectX-5 HCAs, and cables for EDR 100Gb/s InfiniBand. Finally, NVIDIA provided 8 V100 GPUs; our servers are designed to hold a maximum of 8.

The main motivation for this configuration is that the servers should be capable of performing serial and parallel computations with the fastest communication, depending on the types of applications provided. As such, the servers will use latest Intel Xeon Skylake processors that are capable of great single-core and multi-core performance with a lower power consumption than its Broadwell predecessor.

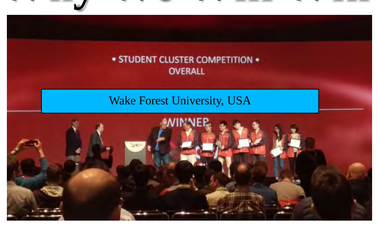
However, for parallel computations, the applications will need to communicate between each of the servers to complete their execution. Therefore, we chose to use Mellanox Infiniband, which is the fastest interconnect on the market. For highly parallelized applications, we will use NVIDIA V100 GPUs, which is currently the state of the art for server models. By building a cluster consisting of multiple GPUs, we have thousands of cores that can perform parallel single- and double-precision computations for applications that are written in CUDA and can therefore take advantage of the GPU architecture.

For applications that are particularly inefficient in our servers, perhaps the mystery application, we will transfer the workload to Azure Cyclecloud.

Software

We installed the CentOS operating system and the SLURM scheduler for the servers. Cisco Intersight provided hardware-level power consumption monitoring. The SLURM scheduler is an open source software with power usage monitoring capabilities and is GPU aware for optimal applications. All parallel applications are compiled using the OpenMPI when appropriate. We can also throttle or turn off high power consuming hardware such as GPUs or use Ethernet connections instead of Infiniband. We will also implement checkpointing in all applications to avoid losing more than 30 minutes of work.

Why We Will Win



One of our secret sauces is **preparation**. Even though this is our first time at the event, we have invested a lot of time and resources to make sure that we have the strongest possible team. We attended SC17 to observe the Student Cluster Competition and interview the participants as they were competing.

We are not only planning to win this year, we are also taking careful notes of the things that work and do not work so that we can learn to optimize ourselves too. We will overcome every failure and **persevere**. Why? We are already planning on winning next year too.

Acknowledgements

In addition to our team advisors and the Wake Forest University Computer Science Dept., we would like to thank Christine Harvey (Mitre Corp., Student Programs @ SC) who first introduced the Student Cluster Competition (SCC) to us. Also, we are grateful to Damian Valles for early support for our application to the SCC. We are especially grateful for the generous anonymous alumni who funded our travel to the SCC.