Team 8 - Crayowulf

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Overview

Project Crayowulf intends to create a multi-computer cluster (mini-Beowulf cluster) using five Nvidia Jetson TX2 computers. This cluster runs a Linux-based operating system and will utilize parallel computing software for post quantum encryption. A mechanical enclosure will be designed to house the computer cluster. The enclosure will resemble the Cray-1 supercomputer by Cray. This enclosure provides mobility for the cluster and allows for easy maintenance by allowing the case side panels to open outward, revealing all five Nvidia Jetsons, see **Figure 1**. A liquid cooling loop will be designed to expel electrically generated heat from the system.

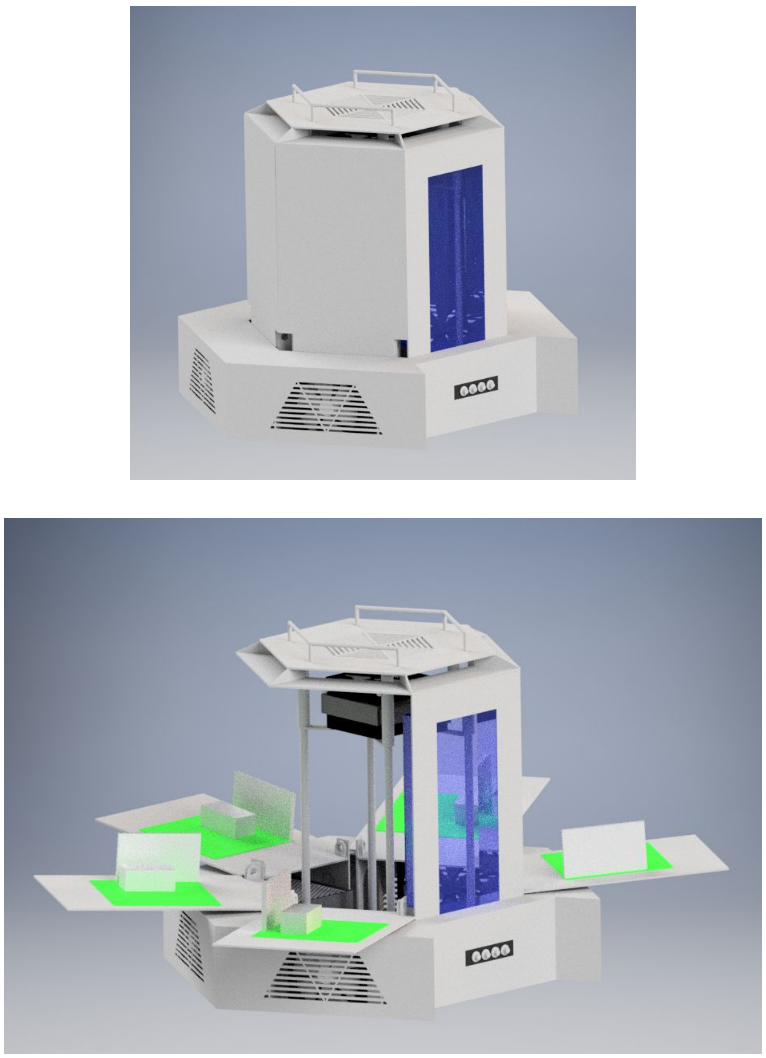

Figure 1. Closed and Opened Case Design

Design and Use

There are several constraints that dictate the approach in designing the computer enclosure. All five units will need to fit into the case, so it cannot be too small. However, it also cannot be too large. The case should fit within a 30” x 30” x 30” cube and the materials the case is made up of must be durable. A prototyping stage will be necessary to determine the best material and design for each function of the case. This prototyping stage will also help determine the optimal size of the inside and outside of the case. The materials chosen must provide the case with structural integrity. The case must be compact while maintaining proper cooling. A portion of the case will be dedicated to housing a single power supply, a network switch, and a storage drive. An I/O panel will be placed within the base of the case; this will provide access to an HDMI output and multiple USB ports. The cooling system will likely consist of a water cooling loop.

An idea for a software application to run is a post quantum secure file server on the system. Supersingular isogeny elliptic curve cryptography will be implemented. This scheme has a relatively small key size at 700 bytes, which helps with using it over the internet. One of the most efficient programs recently made was done by Microsoft; their source code will be used as a jumping off point. Work past Microsoft may include finding a better algorithm, running the current algorithm more efficiently, or parallelizing the problem for use on the GPUs.

Case and Cooling Requirements

- The case needs to be appropriately sized - not too small as to impact air flow and appear cluttered on the inside; not too big as to waste materials and appear bulky
- The cooling system must keep the Nvidia Jetsons at or below 60°C
- The case needs to be designed in a way that makes the Nvidia Jetson boards accessible for easy maintenance (e.g. change liquid)
- The case must incorporate 3D printed parts where appropriate
- The case must have structural integrity and be transportable
- The case must be well organized so that it may be used in a teaching environment
- The cooling system must allow for teaching the impact that CPU/GPU temperature has on processing speed

Cluster and Software Requirements

- The cluster must consist of 5 Nvidia Jetsons connected together

- The system must use a single computer PSU to power the system
- CUDA, MPI, and NFS must be installed
- The nodes must communicate in a master-slave relationship
- The worker (slave) nodes must be able to mount shared storage via NFS
- The nodes must utilize multiple network interfaces efficiently

Major Design Decisions

Issues

Improving the performance of the encryption scheme has proven more difficult than expected. Microsoft has written low level math operations in assembly for x86 and ARMv8 and written them extremely well. So it has been difficult to find any room for improvement in them.

The prototyping phase of the waterblock is taking more time than expected, which has delayed us in ordering components for the water cooling system. This, however, has led us to designing a water block that we are very comfortable to implement.

After speaking to Phil Jaspers, who runs the Calvin machine shop, the case design was adjusted significantly. The idea of having the panels open simultaneously was abandoned due to the fabrication precision needed for this to occur. A design has been drafted which has the panels open up individually. The Changes made can be seen in Figure 2, Below.

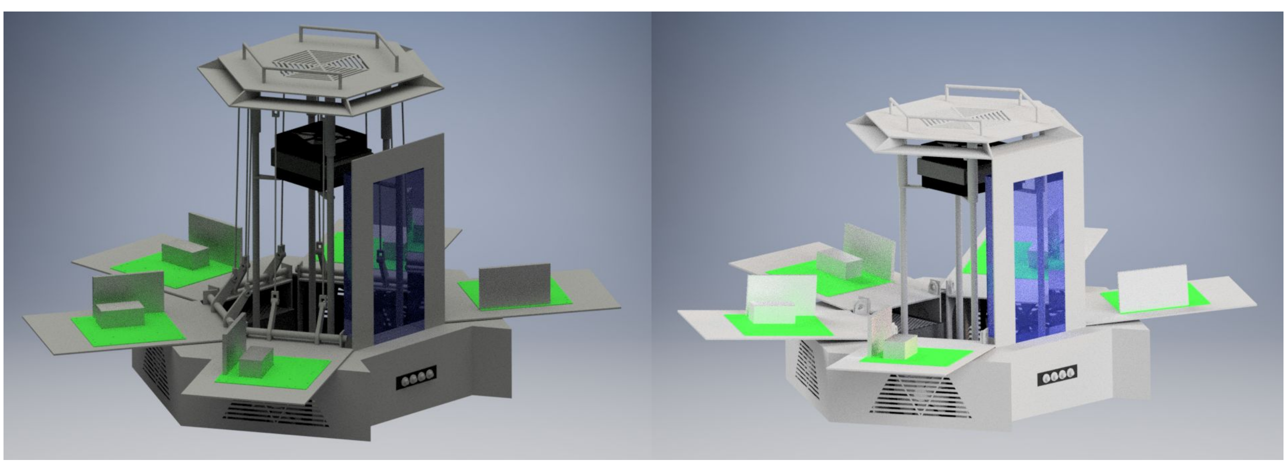

Figure 2. Case Mechanism Design Change - Before (Left) and After (Right).

Status

The Nvidia Jetsons have all arrived. Three out of the five nodes are being set up; the other two are currently used for mechanical and electrical engineering purposes. Many of the configuration settings are set using a tool called Ansible to ease the addition and maintenance of more nodes. The head node is running DHCP, DNS, NIS (user management), and NFS (shared file storage) servers. The next task is to install CUDA, MPI, and the linpack benchmark. RSH access between the nodes is necessary to enable cluster wide computations. After that, work will be done on enabling the proper kernel module for mode 6 channel bonding, enabling each node to utilize multiple ethernet cables. Power adapters have arrived and successfully power the boards.

A simple client server program has been made and allows terminal commands to be run on a remote machine and output to be sent back. Microsoft's encryption API will be added for security.

Progress has been made on the mechanical enclosure for the system in 3D CAD software. The water block design has also been produced with CAD and multiple prototypes have been fabricated using 3D printing. Liquid cooling parts have not been ordered, but components are soon to be reviewed and ordered. Finalized CAD designs have yet to occur due to continual improvement, however, case fabrication is coming underway. Target dates for a variety of tasks (past and present) are shown in **Table 1**. Though some due dates have been missed, the overall project is within its necessary timeframe.

Table 1. Target Dates

General	
Nvidia Jetsons ordered	Wed 11/15/17
Mechanical Enclosure	
CAD Design Draft	Wed 11/15/17
CAD Design Final	Thu 2/15/18
Case Fabrication	Thu 3/15/18
System Assembly	Tue 3/20/18
System Tuning and Benchmaking	Sun 4/1/18
Cooling System	
Settle On Parts	Thu 2/1/18
Cooling parts Ordered	Fri 2/9/18
Software	
Configuring Operation System	Mon 11/20/17
API's	Tue 1/30/18
First Implementation	Wed 2/28/18
Improvements/Parallelize	Tue 5/1/18