Revamp of High Energy Physics Laboratory's Computer Systems

Joseph Bostik, Eric Pereira, Ryan Wojtyla

Faculty Advisor: Dr. Marcus Hohlmann, Dept. of Aerospace, Physics and Space Sciences, Florida Institute of Technology

ABSTRACT

Dr. Hohlmann's High Energy Physics (HEP) research group at Florida Tech contributes to micropattern gas detector research with the CMS experiment at CERN and R&D for a future Electron-Ion Collider to be built in the United States. In order to conduct this research, the group makes extensive use of several computer systems. These systems can be split into three main sections: the high throughput computing cluster, the muon tomography station (MTS), and general use machines.

BACKGROUND

The high throughput computing cluster is primarily used to store data and run calculations. It is also affiliated with the Open Science Grid (OSG), where researchers from across the globe can submit jobs to be run. The MTS is an experimental device that makes use of micropattern gas detectors to track the paths of muons in order to image an object placed within it. Our project focuses on the computer system used to interface with the device. The research group uses general purpose Linux machines to interface with miscellaneous detectors and electronics, process and store data, and run simulations. The researchers using these machines often run into technical trouble and benefit from technical assistance provided both within and without the group.

INITIAL SITUATION

At the outset of the project, the situation was quite dire. The computing cluster had been under severe maintenance for a good deal of time, and its software would soon be outdated. After attempting to help solve its many issues, the OSG support staff finally recommended a full rebuild of the entire system. The computer system for the MTS was running grossly outdated software, had grown unreliable, and had an inefficient and convoluted data-taking workflow. The lab's general purpose machines, while largely usable, had much room for optimization in terms of resource allocation and workflow automation.

ACKNOWLEDGEMENTS

Daniel Campos helped us overcome obstacles encountered with the computing cluster. **Samantha Wohlstadter** assisted us a great deal with the computing cluster, saving us much valuable time. The **ROCKS User's Guide** (http://central-7-0-x86-64.rocksclusters.org/roll-documentation/base/7.0/) provided us much needed guidance during the ROCKS installation process.

GOALS

- Rebuild the computing cluster in its entirety.
- Construct a new, up-to-date computer system for the MTS and an interface for conveniently interacting with the MTS.
- Optimize the use of the lab's computing resources.
- Generate detailed documentation for each of the lab's major computer systems.

KEY ISSUES

- Installing the new OS onto the individual cluster components and incorporating them into the cluster.
- Difficulties building and integrating the various pieces of software for the MTS computer system.
- Miscellaneous hardware failures and software hiccups with all the systems in the lab.

CURRENT SITUATION

Although the issues we encountered prevented us from attaining all our goals, we have made significant progress towards them and created extensive documentation detailing our journey. All but one of the cluster components have been incorporated together. All but one of the software packages have been installed and built on the new MTS computer system. The lab's computing resources have been optimally reallocated and the researchers' computational efficiency has been significantly enhanced.

FUTURE WORK

There still remains a considerable amount of work to be done in order to bring the lab's systems to full working order. For the computing cluster, the final component, a network accessible storage unit, needs to be incorporated, the job submission software needs to be configured, and it must be reintegrated with OSG. AMORE still needs to be built on the MTS's new computer system, and the interfacing software must be completed alongside. Additionally, the lab's researchers can continue to benefit from technical support.

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LINUX COMPUTING CLUSTER

BACKGROUND & INITIAL SITUATION

The high throughput computing cluster is primarily used to store data and run calculations. It is also affiliated with the Open Science Grid (OSG), where researchers from across the globe can submit jobs to be run. At the beginning of the project, the cluster had been under severe maintenance for a good deal of time, and its software would soon be outdated. After attempting to help solve its many issues, the OSG support staff finally recommended a full rebuild of the entire system.

GOALS

- Rebuild the cluster with the latest version of ROCKS.
- Integrate the cluster with the Open Science Grid.
- Create documentation detailing the construction and operation of the cluster.

KEY ISSUES

- Installing ROCKS 7 onto the CE.
- Integrating the cluster components.
- Configuring OSG software.

CURRENT SITUATION & FUTURE WORK

As of now, all but one of the cluster components have been incorporated together, and we are in the midst of configuring the OSG software. However, the final component, a network accessible storage unit, needs to be incorporated, the job submission software needs to be configured, and the cluster must be reintegrated with OSG.

GENERAL PURPOSE MACHINES

BACKGROUND & INITIAL SITUATION

The research group uses general purpose Linux machines to interface with miscellaneous detectors and electronics, process and store data, and run simulations. The researchers using these machines often run into technical trouble and benefit from technical assistance provided both within and without the group. The lab's general purpose machines, while largely usable, had much room for optimization in terms of resource allocation and workflow automation.

GOALS

- Reallocate hardware resources in a way to best benefit all PC's
- Maintain machines with long term support in mind

KEY ISSUES

- Miscellaneous hardware failures and software hiccups with all the systems in the lab.
- Inefficient scripts reduce the productivity of lab members

CURRENT SITUATION & FUTURE WORK

The lab's computing resources have been optimally reallocated and the researchers' computational efficiency has been significantly enhanced. Additionally, the lab's researchers can continue to benefit from technical support.

MUON TOMOGRAPHY STATION INTERFACE

BACKGROUND & INITIAL SITUATION

The MTS is an experimental device that makes use of micropattern gas detectors to track the paths of muons in order to image an object placed within it. The computer system for the MTS was running outdated software, had grown unreliable, and had an inefficient and convoluted data-taking workflow.

GOALS

- Construct a new, up-to-date computer system for the MTS
- Create an interface for conveniently interacting with the MTS.
- Create documentation detailing the construction and operation of the MTS.

KEY ISSUES

- Difficulties building and integrating the various pieces of software for the MTS computer system.

CURRENT SITUATION & FUTURE WORK

All but one of the software packages have been installed and built on the new MTS computer system. The updated system will need to be integrated with the MTS hardware.

ACKNOWLEDGEMENTS

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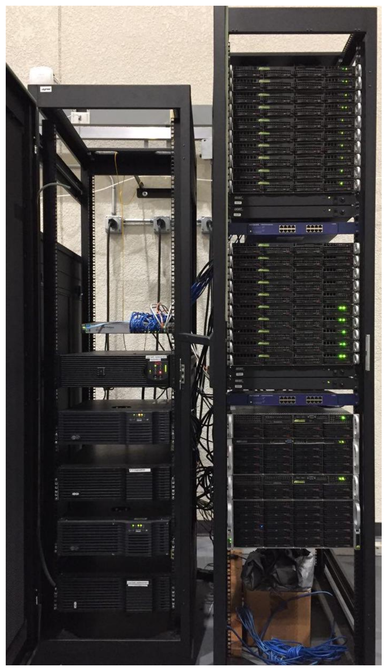

Figure 1: *The group's linux computing computer split up into its two racks. The right cabinet houses the computing hardware, while the left one houses the UPSs.*

Install ROCKS 7 onto the CE.	
Install ROCKS 7 onto the other cluster components.	
Configure HTCondor.	
Integrate cluster with OSG.	
Create a cluster rebuild manual.	

GENERAL PURPOSE MACHINES

BACKGROUND & INITIAL SITUATION

The research group uses general purpose Linux machines to interface with miscellaneous detectors and electronics, process and store data, and run simulations. The researchers using these machines often run into technical trouble and benefit from technical assistance provided both within and without the group. The lab's general purpose machines, while largely usable, had much room for optimization in terms of resource allocation and workflow automation.

LEGEND

Fully Completed	
Partially Completed	
Not Yet Completed	

Reallocate hardware.	
Optimize workflows.	
Develop solutions for long-term maintenance.	
Provide miscellaneous technical support.	

MUON TOMOGRAPHY STATION INTERFACE

BACKGROUND & INITIAL SITUATION

The MTS is an experimental device that makes use of micropattern gas detectors to track the paths of muons in order to image an object placed within it. The computer system for the MTS was running outdated software, had grown unreliable, and had an inefficient and convoluted data-taking workflow.

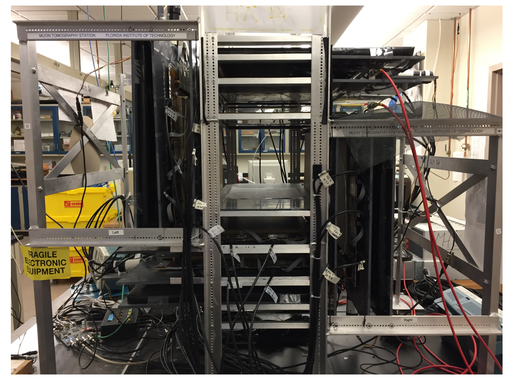

Figure 2: *The group's Muon Tomography Station. The cavity into which objects to be imaged are placed is beset on four sides by three layers of micro pattern gas detectors.*

Install software onto new machine.	
Configure the software to work together.	
Create a user interface for operating the software.	
Integrate the new machine with the MTS.	
Create a manual describing the construction and operation of a new MTS machine.	

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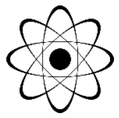
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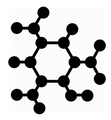
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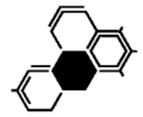
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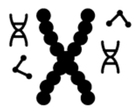
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