Report

On

Cluster Administration

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Table of Contents

Abstract

This report allows learning about basic cluster administration. Cluster administration includes different areas such as maintaining cluster, running and analyzing diagnostics tests, updating software on a cluster and also maintaining the hardware of the cluster.

This report mainly focuses on maintaining and monitoring the cluster. Maintenance of the cluster involves setup of the software that is required for monitoring activities. This report will also address the issues faced during the installation of CodeBlocks software. Monitoring the cluster involves the activities like regularly checking the SAM Tests and resolving issues if any test is failed. Sometimes hardware crashes or the software malfunctions. Such issues are resolved and tracked for future reference. This report also includes some of these issues occurred during the monitoring of the cluster.

The report explains the current hardware and software installations used in the University. The data processing and analysis done is also considered for the discussion and findings.

Introduction

Cluster Administration plays very crucial role in data processing and analyzing. The administrator has to monitor both hardware and software used for the cluster. The key role is to resolve issues related to the tests that are running on the cluster and update the cluster wiki for future reference.

Cluster and Grid Computing

A computer cluster is group of computers that are linked together in order to improve the computing performance.

As per Mark Baker and Rajkumar Buyya, *"A cluster is a type of parallel or distributed processing system, which consists of a collection of interconnected stand-alone computers working together as a single, integrated computing resource."[1]*

The single stand-alone processing system cannot handle heavy traffic as it leads to degraded performance. When multiple processing systems are linked together, they are effective in handling enormous data and computation traffic. Load balancing is the main advantage achieved leading to the performance enhancement. This also ensures the availability for the processing and computing, useful for mission critical applications.

The clusters are developed for the Local Area Networks and the size of data stored for the computation can be managed within the physically accessible area. With the advancements of the technologies and awareness about the researches and experiments in the world, researchers could use data from the other similar experiments for their computations. The grid is developed by connecting the supercomputers from different geographical locations enabling the availability of the data to the universities or researchers sharing common intent of research.

Cluster and Grid Computing in High Energy Physics

Grid computing can easily be adopted in High Energy Physics (HEP) for analyzing the data gathered from various experiments and tests. Data from the CMS experiments can be analyzed using grid computing and the required computations can be carried out at the high performance rate.

The data collected from these experiments is huge in capacity and cannot be stored at one place and made on-line for computations. This can be resolved by forming grids for sharing the data from various nodes. This ensures the availability of such huge data at all times for computation and further research purpose.

Florida Institute of Technology has a tier 3 cluster: uscms1.fltech-grid3.fit.edu. This cluster is used for processing and analyzing data for Compact Muon Solenoid (CMS) experiments as well as for Muon Tomography.

Hardware used in cluster

Basic hardware used in building cluster includes NAS, Compute element (CE), Storage element (SE) and computing nodes. The brief description of these parts is as follows:

Network Attached Storage (NAS): Network Attached Storage is file level computer data storage connected to computer network and it allows to access the data to different clients. NAS not only operates as a file server, but is specialized for this task either by its hardware, software, or configuration of those elements.[2] Potential benefits of network-attached storage, compared to file servers, includes faster data access, easier administration, and simple configuration.[3]

Compute Element (CE): Compute element provides the capability of sharing local resources with grid computing user.[4]

Storage element (SE): Storage element provides the capability of high performance data transfers over the grid.[4]

Computing nodes: Computing Nodes are the physical disks that store the data for the computation purpose.

Software used in cluster

Linux operating system is used in cluster building. Various software are used in monitoring and processing data on the cluster. Some of the software are as follows:

Rocks: It is an open-source toolkit for real and virtual cluster.

Kernel: It is the most important component in the operating system. It connects the application software to the hardware of the system. The kernel's primary function is to manage the computer's resources and allow other programs to run and use these resources.[5] The resources consist of Central Processing Unit (CPU), computer's memory and any input/output.

Condor: Condor is a specialized workload management system for computing intensive jobs. Condor performs following functions: a job queuing mechanism, scheduling policy, priority scheme, resource monitoring, and resource management. User submit their serial or parallel jobs to Condor and then it will place them in a queue. It also decides when and where to run jobs based upon a priory policy, monitor the process and informs the user after completing them.[6]

Ganglia: This is used for checking cluster performance. It shows how much load is carried by the cluster. Also it shows load on the individual node.

SAM tests: SAM (Service Availability Monitoring) is a framework for the monitoring of production and pre-production grid sites. It provides a set of probes which are submitted at regular intervals, and a database that stores test results. In effect, SAM provides monitoring of grid services from a user perspective.[7]

GUMS: Grid User Management System, a site tool for resource authorization that addresses the function of mapping grid.

PhEDEx: Physics Experiment Data Exports (PhEDex) allows CMS grid users to ask for data transfers to/from particular sites and it controls the data flow.

BeStMan: Berkeley Storage Manager (BeStMan) manages globus file transfers in and out of the cluster.

Findings

Maintaining and monitoring cluster

1. Administration Certificate

The administration certificate is a permission to a user to access the cluster. Therefore, it is very important for the user to apply for the certificate in order to use the cluster. The role of a cluster administrator is to get admin certificate for a new user. This can be done by registering on the OIM at http://oim.grid.iu.edu/oim/home. After the registration, one can import grid certificate to become a user of the cluster. It is very important to check the certificate status. If any of the user certificates is expired, then it is the duty of the administrator to renew it.

2. Web page for monitoring the activities on the cluster

The web page is created in order to monitor the activities on the cluster. http://uscms1.fltech-grid3.fit.edu/diagnostics.php this diagnostic page allows us to monitor SAM Tests. These tests inform that whether all the parts of cluster are functioning properly. These tests rerun in every 30 minutes. Also these tests show if CRAB is running or not and whether PHEDEX will have any issues. Terminology used in SAM Tests is as follows:

squid = Squid server	ana = Analysis
Front = frontier	Bas = basic
Jsub = job submission	swint = related to cms
mc = monte carlo	getPFN = check pfn and Ifn mapping
Put = put a file on the srm server	Del = delete a file
Get = download a file from server	

When all tests function properly, they are indicated by green color. Whenever there is any problem with these tests, their color changes from **GREEN** to **RED.** This is the first sign to know that test is not working. By clicking on the test that has turned RED, it redirects to the page having details about the errors. By analyzing the cause, necessary action should be taken in order to resolve the problem.

The above web page also shows status of the computing nodes. There are 20 computing nodes that work on the different projects at the same time. The computing nodes change their color according to the amount of load at that moment. Dark pink shade represents the high load, while light shade of blue shows low load. Using this web page one can see the yearly, monthly, weekly, and hourly data. Continuous monitoring of this web page is the very essential in maintaining the cluster as it is the first source to get to know about the errors that are responsible to down the cluster.

3. Regular checks

There are some commands that are used regularly to check the proper functioning of the cluster.
> condor q | less : This command is use to check the jobs condition. It checks who submitted the jobs, how many jobs are in the queue, jobs are running properly or they are held. Are there any idle jobs?

> df –h : This command checks the memory status.

4. Installation of new software

One of the tasks in maintaining cluster is installing new software as per the requirement of the user. The basic pattern follow to install new software is as follows:

a. Go to the official site of software and find the latest version.

b. Check basic requirements of tools for the software. If needed, update the tools.

c. Download the software configuration file.

d. Upload the file on the cluster.

e. Extract this uploaded file, which automatically creates directory in user home directory.

f. Check the README file.

g. Use ./configure --prefix=home/vbhopatkar to install actual program in user home directory.

h. Check "makefile" file.

i. Set environment variables and run the setup as per the makefile.

j. Export environment variables in order to change the paths.

I understood this basic pattern of software installation while installing the CodeBlocks software. Unfortunately, this project was unsuccessful as there were configuration errors. It was unable to create the makefile as well as to run the GTK+. To resolve this problem, GTK+ is reinstalled. When actual installation process started, we prepared SRPM package from svn. We gave following commands.

```
>cd trunk
>./bootstrap
```

ERROR followed with these commands is **configure.in:80: error: possible undefined macro: AM_PATH_WXCONFIG.** We worked on this issue for long time.

Though it was an unsuccessful attempt, I learnt many things. Now I'm aware of basic pattern that is used to install any new software on the cluster. Also I understood the process of

uploading any file on the cluster and learnt how to untar the tar files. Furthermore, I increased my knowledge regarding the approach that is necessary for troubleshooting. This project is a software installation learning experience for me.

5. Upgrading the existing software

GTK: To find existing version, use command $ find / -name "gtk*" and to upgrade it, command used is $ yum info GTK.

ROOT Upgrade: The cluster required new ROOT version to run smoothly. Therefore, we upgrade the ROOT version from v5. 19. 00 to v5. 30. 02. I learnt this upgrading process by assisting Xenia. We followed the following steps:

```
Download tar file from http://root.cern.ch
Copy it into the directory where the earlier version is saved i.e. /user/local
# tar -xvf root_v30.02.tar // this command untars the copied file
# cd root
# ./configure --prefix=/user/local
# make ( to create makefile)
# make install
ldconfig
# root
```

After upgrading the ROOT version, we were trying to open it. It showed error that it was unable to find "libCore.so" while it is library for root. According to the Xenia's analysis, if we redirect the path for the file, cluster will able to locate the file. This logic worked when we edited the file: # vi /etc/ld.so.conf and there we added /user/local/root/lib. After editing, to update the file, we gave command as # ldconfig. Now Root is working fine. In this way we upgrade the ROOT version.

6. Updating wiki

Cluster wiki has all important information about the cluster which focuses on building cluster, installation of parts of the cluster as well as the software. All this information is presented in the form of official documents, logs by students and their research report. To update these, we add files on wiki as follows:

First Copy the file on the cluster with no space in the file name.

Use sudo su privilege

copy to

> cp Fall2011.pdf /var/www/html

> cd /var/www/html

Check the file privileges i.e. check whether it is readable by others.

Then open wiki page

Edit : use account

then again edit

copy the file in format

[http://uscms1.fltech-grid3.fit.edu /var/www/html Fall2011.pdf Fall2011.pdf.log]

In this manner I have copied my log on the wiki for this fall 2011 semester

Solution to the problems

Problem 1: Multiple incorrect log-in blocks the user.

Solution: To retrieve log-in, on terminal type the following command

> /etc/host.deny

It will show the number of IP addresses block by the cluster, due to incorrect log in. Check the IP address of your system and delete the same from the given list.

Problem 2: One of the hard drives of Nas01 was indicating red light and Nas01 was beeping loudly.

Solution: The cause of this problem was one of the hard drives had failed. We replaced the hard drive with spare one and rebooted it. During the rebooting, press C to redirect to the RAID configuration screen. On that screen there was a Volume icon and by clicking on that icon we were able to turn off the beeping sound. Automatically red light also got turned off. Next step involved in rebooting the new drive is to configure it. For that, click on the icon saying import configuration. By doing this, data will be copied to the new drive from the other drives. This entire process took one day. On the next day we again rebooted the machine and everything was fine.

Problem 3: The APC and power strips are not working

Solution: When power strips stopped working, our first impression was that they might have got damaged due to the over current passed through it. But to cross check our thoughts, we tried to connect these strips to other switch and we observed that when we press the reset button, they started working properly. We concluded that the problem was with the switch which is mounted on the wall and not with power strips. On the same line, we checked the APC

and we realized that it was working fine. The switch which was connected to APC got tripped. The solutions to the switch problem was to change the fuse of the first switch and called facilities of the university to flip the switch of the second one.

Problem 4: Re-plugging the nodes.

Solution: For re-plugging the nodes we first turn off all the 20 nodes, storage element, and Nas01. We used the following commands:

Become root user

```
# cluster-fork /sbin/init 0 // to turn of the nodes
# ssh dev-0-0  // ssh to storage element
# /sbin/init 0
# ssh nas-0-1
# / sbin/int 0
```

After following commands, we just unplugged the nodes from their earlier position. Upper 10 nodes were connected to the front end(CE) and to the Nas-0-0. Lower 10 notes we connected to the switch which was mounted on the wall. Initially we turn on only 3-3 nodes which are on CE and nas-0-0. It indicated power was overloaded, so rest of the 2-2 nodes were kept off. When we switched on the lower nodes connected to the switch, we observed that they were not working. The reason we found was that the wall switch was not functioning and so we used the other two power strips and connected them separately on two switches. By doing this we were able to start 16 nodes. By this time we were considering that our APC was dead. But after solving the problem 3, we got to know that we could use APC to manage the nodes. Therefore, using APC and three power strips we were able to re-plug all the twenty nodes.

From Xenia's work, I learnt to fix the errors related to SAM test such as mc, ana, squid and frontier failed.

Future Work

By observing the diagnostic web page, we realized that node 2.4 is missing. Further analysis can be done to fix the problem with node 2.4. The process can be tracked in the cluster wiki.

References

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[7] https://twiki.cern.ch/twiki/bin/view/LCG/SAMOverview