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Evaluating the Scalability of Hadoop in a Real and Virtual Environment

What is Hadoop?

- Hadoop is a distributed file system written in Java that supports *MapReduce*
 - MapReduce breaks up an input file into many smaller pieces to be computed on individual nodes of a cluster and then reduces all of the results to a single file
- Default installation provides 3 way replication which stores each file in three locations

Installation of Hadoop

- Download package from the Hadoop website
- Extract package
- Set up an ssh key
- Edit the `hadoop-site.xml`, `slaves`, and `masters` files
- Copy the Hadoop files to each nodes in the cluster
- Start the `dfs` and `mapred` services

Managing Hadoop

- Hadoop has two main web GUI's for the cluster

hypertable1 Hadoop Map/Reduce Administration

State: INITIALIZING
Started: Sat Dec 13 21:24:13 EST 2008
Version: 0.19.0, r713890
Compiled: Fri Nov 14 03:12:29 UTC 2008 by ndaley
Identifier: 200812132124

Cluster Summary

Maps	Reduces	Total Submissions	Nodes	Map Task Capacity	Reduce Task Capacity	Avg. Tasks/Node
0	0	0	0	0	0	-

Scheduling Information

Queue Name	Scheduling Information
default	N/A

Filter (Jobid, Priority, User, Name)
Example: 'user.smith 3200' will filter by 'smith' only in the user field and '3200' in all fields

Running Jobs

none

Completed Jobs

none

Failed Jobs

none

Hadoop NameNode hypertable1.54310

Upgrades: There are no upgrades in progress.

Browse the filesystem
Namenode Logs

Cluster Summary

457 files and directories, 525 blocks = 982 total. Heap Size is 7.97 MB / 992.31 MB (0%)

Configured Capacity : 37.22 GB
DFS Used : 741.06 MB
Non DFS Used : 12.29 GB
DFS Remaining : 24.2 GB
DFS Used% : 1.94 %
DFS Remaining% : 65.04 %
Live Nodes : 8
Dead Nodes : 0

Live Datanodes : 8

Node	Last Contact	Admin State	Configured Capacity (GB)	Used (GB)	Non DFS Used (GB)	Remaining (GB)	Used (%)	Used (%)	Remaining (%)	Blocks
hypertable1	2	In Service	4.65	0.29	2.63	1.73	6.34		37.16	487
hypertable2	0	In Service	4.65	0.05	1.42	3.19	0.99		68.47	77
hypertable3	2	In Service	4.65	0.1	1.38	3.17	2.09		68.15	100
hypertable4	1	In Service	4.65	0.03	1.38	3.24	0.73		69.58	58
hypertable5	1	In Service	4.65	0.05	1.39	3.21	1.12		68.93	78
hypertable6	2	In Service	4.65	0.05	1.37	3.23	1.18		69.42	81
hypertable7	1	In Service	4.65	0.06	1.37	3.22	1.24		69.3	77
hypertable8	2	In Service	4.65	0.09	1.34	3.22	1.86		69.28	95

Dead Datanodes : 0

Hadoop, 2008.

•The job tracker webpage shows the status of Jobs that are running on the cluster

•The DFS health webpage shows the status of The file system and provides access to the HDFS

Sending a Job to Hadoop

- The hadoop executable is used to send a job to the cluster
 - *install_dir/bin/hadoop jar program.jar org.myorg.ProgramName /input /output*
- Once a job is sent to the cluster the input is broken up into many small pieces and sent to different nodes in the cluster to process

Cluster Architecture

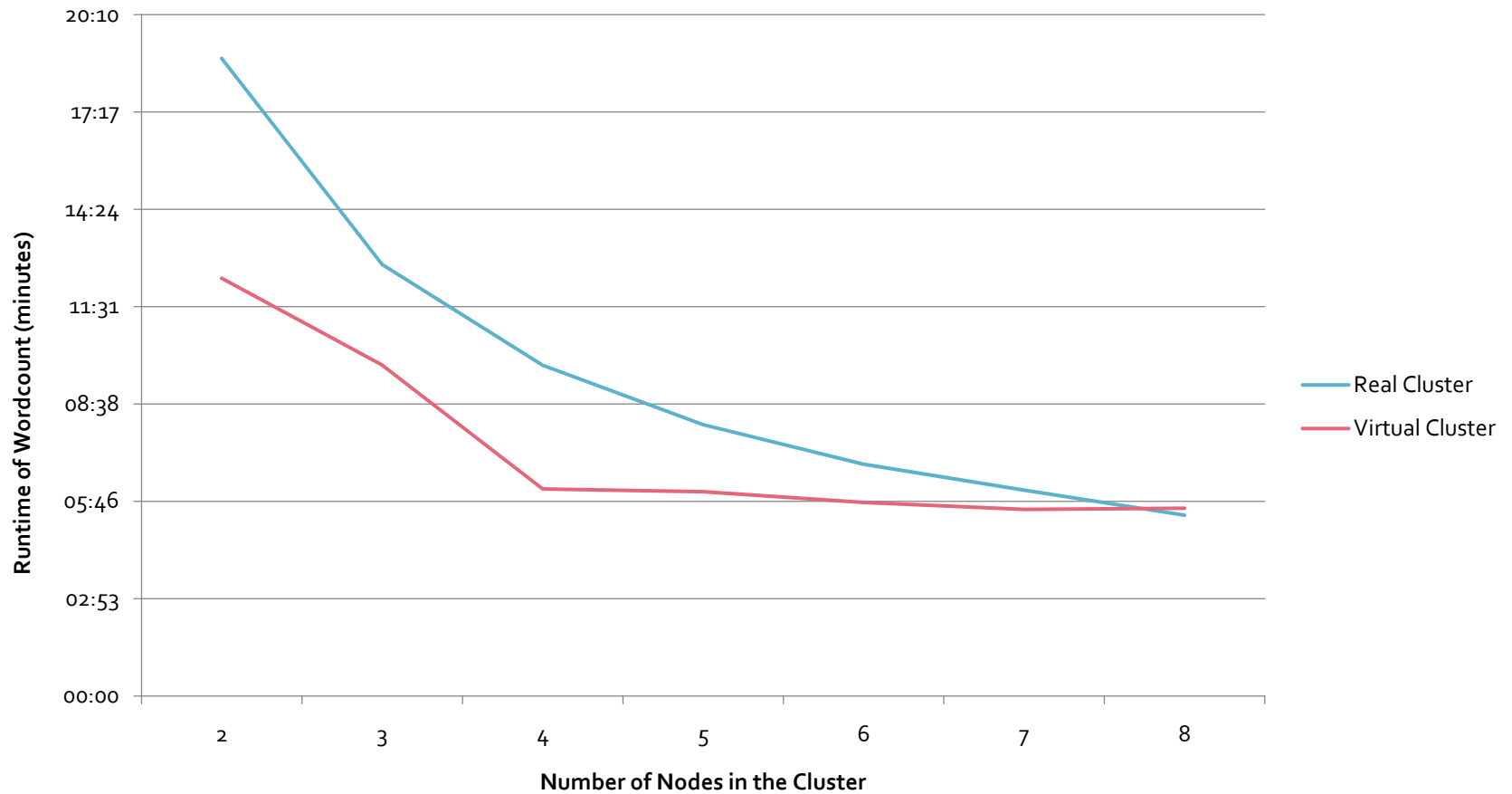
- The real and virtual cluster initially consisted of 8 nodes (the size was automatically decreased during testing)
- One node was specified as the master
 - Ran the NameNode and SecondaryNameNode services along with a DataNode and TaskTracker service
- Each additional node served as a slave
 - Ran the DataNode and TaskTracker services

Testing the Scalability

- Hadoop wordcount example program was used as a benchmark
 - Wordcount counts the occurrences of each word in a set of files
- 438 ebooks totaling 289MB were randomly downloaded from Project Gutenberg to form the test data
- Bash script written to run the experiments
 - Copied books into the dfs
 - Ran the wordcount program 5 times
 - Reduced the cluster size by one node and then ran again (until only 2 nodes left in the cluster)

Results

Runtime of Wordcount With Increasing Cluster Sizes



Results (cont.)

- Increasing the cluster size decreased the time required to run the wordcount program
- The graph begins to show signs of diminishing return
- Surprisingly adding more virtual machines to the virtual environment improved runtime
- In the real cluster there was nearly a 75% decrease in the runtime of wordcount when going from 2 to 8 nodes in the cluster

Future Research

- Experiment more with the customizable parameters of Hadoop
- Conduct a more comprehensive study into the benefits of using Hadoop
- Explore the MapReduce process in much more depth and write programs to utilize it
 - Use MapReduce to try to write solutions for NP-complete problems
- Explore the possibility of creating a permanent Hadoop Cluster in Alden Hall