

Dell™ PowerEdge™ C5220 delivered excellent performance



with Hadoop TeraSort

Every year, the amount of data that businesses must sort through grows enormously. The ability to sort, filter, and analyze this data is becoming more and more vital to many businesses in analyzing their customers and their market segment. Additionally, businesses need an infrastructure that is powerful and flexible, but also compact and scale-friendly. The Dell PowerEdge C5220 server is an ideal solution to pair with Apache Hadoop, a powerful multi-node data analysis application. With the PowerEdge C5220, organizations can scale out to their data processing requirements and successfully handle these ever-increasing data volumes, finding new value in their big data.

To test the Hadoop performance capabilities of the Dell PowerEdge C5220, we configured eight Dell PowerEdge C5220 servers into a Hadoop cluster and ran the TeraSort benchmark on the platform. We found that eight Dell PowerEdge C5220 servers, all contained within the single shared infrastructure design of the Dell PowerEdge C5000 chassis, could sort a 10GB dataset in just 155 seconds.



DELL POWEREDGE C5220 AND HADOOP – BETTER TOGETHER

Today's marketplace has moved beyond the structural confines of relational data and up to the category of "big data." Companies with hyperscale data centers are dealing with tremendous amounts of existing data, with massive data growth on the horizon. They require reliable and powerful hardware and software platforms on which to process this big data. Dell PowerEdge C series servers provide this solid infrastructure for companies to offer their data processing capabilities. Integrating many PowerEdge C servers together in a Hadoop cluster allows companies to process large datasets quickly and efficiently.

In our lab tests, we configured eight Dell PowerEdge C5220 microservers into a Hadoop cluster and ran the TeraSort benchmark on the cluster to demonstrate the performance capabilities of the Dell PowerEdge C platform. Below, we discuss the PowerEdge C5220 microserver, our test topology, and our results in more detail.

Figure 1: The Dell PowerEdge C5220 microserver provides power and reliability in a tight and dense form factor, within the C5000 shared infrastructure.



Dell PowerEdge C5220

The Dell PowerEdge C5220 microserver is a highly dense small-form-factor server mounted on a sled, which is housed in a Dell PowerEdge C5000 shared infrastructure enclosure, offering up to 12 microservers in a 3U rack density. These high physical server densities offer massive scale-out configurations, and are ideal for service providers and large data centers that need to optimize their space, power, and cooling infrastructure. Each server, all cold-aisle accessible for maintenance, features processing power from the Intel® Xeon® E3-1200 series, up to 32GB RAM capacity, and up to four drives per server. The high

Highlights of the Dell PowerEdge C5220

- Up to 12 PowerEdge C5220 microservers in a single 3U C5000 chassis
- Cold aisle serviceability
- Shared infrastructure uses less floor space, power, and cooling
- Dense form factor ideal for service providers, hosting platforms, and hyperscale environments
- Up to 6TB raw storage in a single microserver
- Embedded chassis management control

performance levels it delivers, coupled with a simple, modular, and easy-to-maintain design, make the Dell PowerEdge C5220 microserver an optimal choice to deploy for extremely dense compute fabrics handling big data, large software as a service (SaaS) environments, and cloud deployments. Figure 2 presents a view of the Dell PowerEdge C5220.



Figure 2: The PowerEdge C5220 microserver.

The Dell PowerEdge C5220 can deliver many benefits to your large cloud deployment, and lets you:

- Maintain your environment easily with cold-aisle accessible, swappable microserver modules and connections
- Make better use of expensive data center space by increasing the rack density with up to 12 server nodes fitting into a standard 3U rack slot
- Utilize up to 6 TB of raw disk storage per microserver with SAS drives or 4 TB of raw disk storage per microserver with SATA drives – up to 72 TB and 48

TB respectively across the entire C5000 shared infrastructure in just a 3U form factor

- Reuse or repurpose servers easily when workloads change with hot-swap server nodes – you no longer need to experience downtime by replacing the entire server chassis.

Designed with power efficiency and maintainability in mind, the Dell PowerEdge C5220 maximizes operating efficiency with a shared-infrastructure design. To learn more about the Dell PowerEdge C5220 and the entire Dell PowerEdge C Series, visit <http://www.dell.com/us/enterprise/p/poweredge-cloud-servers>.

WHAT WE TESTED

To test the ability of the PowerEdge C5220 microserver to handle large data processing tasks, we used Hadoop, specifically Cloudera Distribution Including Apache Hadoop (CDH). Below we briefly discuss Hadoop and the benchmark tool we used, TeraSort.

Hadoop

Hadoop, developed by Apache Software Foundation, is an open-source distributed application that enables the analysis of large volumes of data for specific purposes. Using Hadoop's framework, IT organizations and researchers can build applications that tailor the data analysis to specific needs for each company, even using unstructured data. Many different markets—among them finance, IT, and retail—use Hadoop due to its ability to handle heterogeneous data, both structured and unstructured.

Hadoop can run across any number of machines using varied hardware, spreading data across all available hardware resources using a distributed file system, Hadoop Distributed File System (HDFS), and replicating data to minimize loss if a hardware malfunction occurs. The software is able to detect hardware failures, and to work around said failures to allow uninterrupted access to data. Because of its ability to run on different hardware, a Hadoop cluster is scalable and flexible – it can be expanded to encompass growing databases and companies. It is also cost-effective, as it allows companies to utilize commodity hardware effectively.

TeraSort

The process of sifting and sorting through large amounts of data is a critical one for many businesses, and they need the most efficient set of hardware and software tools to do the job. The TeraSort benchmark on Hadoop tests the sorting speed and efficiency of a Hadoop cluster. It measures how quickly a set of systems, in our case eight PowerEdge C5220 servers, can sort a set amount of data. The main output of a

TeraSort benchmark run is the time it takes to sort that amount of data. We report those times, and the specifics of our test scenario, in the sections below.

TEST RESULTS IN MORE DETAIL

We used the TeraSort benchmark program from the Cloudera Hadoop distribution to generate 10GB of test data and to sort it using an eight-node Hadoop cluster consisting of Dell PowerEdge C5220 servers. We set up an auxiliary server for the Cloudera Manager and used the Dell PowerEdge C5220 servers to perform the sort. For more details on the setup of the Hadoop cluster, see [Appendix B](#).

There are three main portions of the TeraSort benchmark: TeraGen, TeraSort and TeraValidate. TeraGen generates the data with which to populate your Hadoop cluster. TeraSort measures the data sort time. When the test run is finished, TeraValidate validates the sorted output, and reports the time it took to sort the data. Comparing these times to those of other Hadoop clusters indicates how your hardware's sort capability measures up. Figure 3 presents the time, in seconds, it took for the Dell PowerEdge C5220 cluster to complete each TeraSort task.

TeraSort phase	Time to complete (seconds)
Generating the data	82
Sorting the data	155
Validating the data	59

Figure 3: The time spent in each phase of the Hadoop TeraSort benchmark.

CONCLUSION

Companies that wish to process big data in scale-out environments require powerful and dense hardware that complete large data processing tasks, such as Hadoop analysis, quickly and efficiently. Selecting the right server for your underlying hardware infrastructure is critical at hyperscale.

In our tests, an eight-node Dell PowerEdge C5220 Hadoop cluster was able to sort the 10 GB of data in just 155 seconds. While each scenario and each environment vary, our eight-node Hadoop TeraSort test shows that even a small number of Dell PowerEdge C5220 microservers can sort large amounts of data; as with most Hadoop operations, we expect adding server nodes would result in an even faster sort time.

APPENDIX A – SERVER CONFIGURATION INFORMATION

Figure 4 provides detailed configuration information for the microserver we tested.

System	Dell PowerEdge C5220
General	
Number of processor packages	1
Number of cores per processor	4
Number of hardware threads per core	1
System power management policy	Balanced
CPU	
Vendor	Intel
Name	Xeon
Model number	E3-1220
Stepping	D2
Socket type	LGA1155
Core frequency (GHz)	3.20
Bus frequency	5 GT/s
L1 cache	32 KB + 32 KB (per core)
L2 cache	256 KB (per core)
L3 cache (MB)	8
Platform	
Vendor and model number	Dell PowerEdge C5220
Motherboard model number	1KTH4B0
BIOS name and version	Dell 1.0.11
BIOS settings	Defaults
Memory module(s)	
Total RAM in system (GB)	32
Vendor and model number	Samsung M391B1G73AH0-YH9
Type	PC3L-10600E
Speed (MHz)	1,333
Speed running in the system (MHz)	1,333
Timing/Latency (tCL-tRCD-tRP-tRASmin)	9-9-9-36
Size (GB)	8
Number of RAM module(s)	4
Chip organization	Double-sided
Rank	Dual
Operating system	
Name	CentOS 6.2, x86_64
File system	ext4
Kernel	2.6.32-220.13.1.el6.x86_64
Language	English
Updates	All as of 4/12/2012
Graphics	
Vendor and model number	AST2050

System	Dell PowerEdge C5220
Graphics memory (MB)	128
RAID controller	
Vendor and model number	Intel C204 SATA Raid Controller
Driver version	N/A
Cache size (GB)	None
Hard drive	
Vendor and model number	Dell ST9500620NS
Number of disks in system	4
Size (GB)	500
Buffer size (MB)	64
RPM	7.2K
Type	SATA
Ethernet adapters	
Vendor and model number	Intel 82580DB Gigabit Network Connection
Type	Integrated
Driver	Intel(R) Gigabit Ethernet Network Driver; igb, 3.0.6-k
USB ports	
Number	1 internal
Type	2.0

Figure 4: Configuration details for the microserver we tested.

APPENDIX B – HOW WE TESTED

We installed and configured CentOS on an auxiliary server, which provided both basic services and Hadoop management for the C5220 nodes in the Hadoop cluster. We installed and configured CentOS on the C5220 nodes, using the C5000's baseboard management controller (BMC) virtual console feature. We installed the Cloudera Hadoop Manager on the auxiliary manager server and used it to install Hadoop on the C5220 nodes.

Configuring the auxiliary server

Below, we review the steps necessary to configure the management server, which runs the necessary auxiliary services and the Cloudera Manager.

1. Install the base-installation of CentOS 6.2 x86_64 following the steps in the section CentOS base installation.
2. Log onto the server as root.
3. Configure one network interface, e.g. eth0, to access a network connected to the Internet with, for example, IP address 10.1.1.10.
4. Configure one network interface, e.g., eth1, to access the network of C5220 nodes with, for example, IP address 192.168.1.10 and CIDR prefix of 24.
5. Install CentOS updates:
`yum update`
6. Reboot the server:
`shutdown -r now`
7. After the system reboots, log onto the server as root.
8. Install Squid as a HTTP proxy for the C5220 nodes:
`yum install squid`
9. Apply the following patch file, squid.conf.diff, to modify /etc/squid/squid.conf with the patch program:

```
acl ftp proto FTP
http_access allow ftp
## cluster network
acl intranet src 192.168.1.0/21
http_access allow intranet
```
10. Install dnsmasq to supply hostname resolution for the nodes:
`yum install dnsmasq`
11. Edit the configuration /etc/dnsmasq.conf and modify these lines as shown:

```
interface=eth1
no-dhcp-interface=eth1
```
12. Add the IP addresses and hostnames of the auxiliary server and C5220 nodes to /etc/hosts on the auxiliary server. For example:

```
192.168.1.10    had01-ctrl01
192.168.1.31    cl01n01
192.168.1.32    cl01n02
192.168.1.33    cl01n03
192.168.1.34    cl01n04
192.168.1.35    cl01n05
192.168.1.36    cl01n06
192.168.1.37    cl01n07
192.168.1.38    cl01n08
```
13. Start the DNS server:
`chkconfig dnsmasq on`
`service dnsmasq start`

14. Install the ntpd time server to provide a common time source for the nodes:

```
yum install ntpd
```

15. Modify the configuration file /etc/ntp.conf to use Internet time sources, and to be a time service on the nodes network. For example:

```
# Hosts on local network are less restricted.
restrict 192.168.1.0 mask 255.255.255.0
# Use public servers from the pool.ntp.org project.
# Please consider joining the pool (http://www.pool.ntp.org/join.html).
server 0.pool.ntp.org
```

16. Start the NTP server:

```
chkconfig ntpd on
service ntpd start
```

17. Generate an SSH public-key pair with, for example, no password:

```
ssh-keygen -t dsa -N ""
```

18. Reboot the server.

Configuring the C5220 Hadoop nodes

1. Install the base-installation of CentOS 6.2 x86_64 following the steps in the section CentOS base installation.
2. Configure one network interface, e.g. em1, to access the Hadoop network of C5220 nodes with, for example, IP address 192.168.1.31 and CIDR prefix of 24.

3. Configure the system to synchronize its time with the NTP service on the auxiliary server. Replace the server lines in /etc/ntp.conf with references to the IP address of the auxiliary server:

```
server 192.168.1.10
```

4. Configure the yum updater to use the cluster's HTTP proxy:

```
echo "proxy=http://192.168.1.10:3128/" >> /etc/yum.conf
```

5. Copy the auxiliary server's public SSH key to the node to allow easy remote management:

```
mkdir /root/.ssh
chmod 700 /root/.ssh
scp 192.168.1.10:/root/.ssh/id_dsa.pub /root/.ssh/authorized_keys
```

6. Install CentOS updates:

```
yum update
```

7. Reboot the server:

```
shutdown -r now
```

8. Repeat steps 1 through 7 for the remaining nodes.

Cloudera Hadoop (CDH3u3) installation using Cloudera manager (3.7.5)

1. Log onto the auxiliary server as root.
2. Download and transfer the free edition of the Cloudera Manager installer, version 3.7.5, for CentOS from Cloudera.com to the auxiliary server.

3. Run the Cloudera Manager installer:

```
./cloudera-manager-installer.bin
```

4. On the Cloudera Manager README screen, read the installation overview, and select Next.

5. On the Cloudera Manager (Free Edition) License screen, review the license, and select Next.

6. On the next screen, select Yes to accept this license.

7. On the Oracle Binary Code License Agreement screen, review the license, and select Next.

8. On the next screen, select Yes to accept this license.

9. The auxiliary server now has a Web interface for managing Hadoop. Select OK on the Next Step screen.
10. On the installer's Finish screen, select OK to exit the installer.
11. Using a Web browser, open the page <http://<clouderamanager>:7180/>, where <clouderamanager> is the IP address of the auxiliary manager server.
12. Copy the SSH keys, previously generated in the Configuring the auxiliary server section, from the auxiliary server to the local desktop running the Web browser.
13. Log onto the Cloudera manager with username `admin` and password `admin`.
14. On the Thank you for choosing Cloudera Manager and Cloudera's Distribution including Apache Hadoop (CDH) screen, click Continue.
15. On the register your CDH3 installation, click Skip Registration.
16. On the Specify hosts for your CDH3 cluster installation screen, enter a list of hostnames or IP addresses in the text box at the bottom, such as `192.168.1.3[1-8]`. Click Find Hosts.
17. The upper text box will contain a list of potential Hadoop hosts. Select the applicable nodes, and click Continue.
18. On the provide SSH login credentials screen, select All hosts use the same public key, click Choose file for the Public Key File, and browse to and select the SSH public-key file for the auxiliary server's public key (see step 12).
19. Repeat step 18 to select the auxiliary server's Private Key File.
20. Click Start Installation.
21. After the Hadoop installation on the nodes has finished, switch to a console session on the auxiliary server.
22. Format two of the remaining four disks on each node as part of the Hadoop file system.

```
# Note: in the following example, the contents of disks /dev/sdc and /dev/sdd
#       will be destroyed
# partition /dev/sdc and /dev/sdd and create EXT4 file systems

for i in $(seq 31 38); do
    ssh 192.168.1.$i parted -s /dev/sdc mklabel gpt \; parted -s /dev/sdd mklabel gpt
    ssh 192.168.1.$i parted /dev/sdc mkpart primary "1 -1" \; \
        parted /dev/sdd mkpart primary "1 -1"
    ssh 192.168.1.$i mkfs.ext4 /dev/sdc1 \; mkfs.ext4 /dev/sdd1
done

# Modify fstab so that these file systems are mounted at boot time

for i in $(seq 31 38); do
    ssh 192.168.1.$i '(echo "/dev/sdc1 /dfs/d1 ext4 defaults,noatime 1 2";\
        echo "/dev/sdd1 /dfs/d2 ext4 defaults,noatime 1 2") \
        >> /etc/fstab'
done

# Create the default Hadoop HDFS directories

for i in $(seq 31 38); do
    ssh 192.168.1.$i mkdir -p '/dfs/{d1,d2,n1,n2,s1,s2}' '/mapred/{local,jt}'
    ssh 192.168.1.$i mount '/dfs/d{1,2}'
done

for i in $(seq 31 38); do
    ssh 192.168.1.$i chmod 700 '/dfs/{d1,d2,n1,n2,s1,s2}' \;
        chmod 755 '/mapred/{local,jt}'
    ssh 192.168.1.$i chown hdfs:hadoop '/dfs/{d1,d2,n1,n2,s1,s2}' \;
```

```
chown mapred:hadoop '/mapred/{local,jt}'
```

done

23. Return to the Cloudera Manager in the browser.
24. On the Services screen, click Add a Service.
25. On the Select the type of service you want screen, select HDFS and click Continue.
26. Accept the default host assignments for HDFS (eight DataNodes and one each of NameNode, Secondary NameNode and Balancer nodes), and click Continue.
27. Review the configuration changes, and click Continue.
28. On the Services screen, click Add a Service.
29. On the Select the type of service you want screen, select MapReduce and click Continue.
30. On the Select the set of dependencies for your new service screen, select HDFS and click Continue.
31. Accept the default host assignments for HDFS (eight TaskTrackers and one JobTracker nodes), and click Continue.
32. Review the configuration changes, and click Continue.

Running the TeraSort benchmark

1. Log onto one of the Hadoop nodes as root.
2. Switch the login shell to the mapred user:

```
su - mapred
```
3. Generate 10GB of data (or 100,000,000 100-byte rows of data) for sorting by the cluster by starting a Hadoop job. The data will be stored on the HDFS file system under the directory `/user/mapred/ts-in`.

```
hadoop jar ~/hadoop-examples.jar teragen 100000000 /user/mapred/ts-in
```
4. When that job completes, start the TeraSort job. The sorted data will be found under directory `/user/mapred/ts-out/`

```
hadoop jar ~/hadoop-examples.jar terasort \  
    /user/mapred/ts-in /user/mapred/ts-out
```
5. Finally, verify that the data is properly sorted by running the validation jobs:

```
hadoop jar ~/hadoop-examples.jar teravalidate  
    /user/mapred/ts-in /user/mapred/ts-out
```

CentOS 6.2 base installation

1. Insert and boot from the CentOS-6.2-x86_64-bin-DVD1 installation DVD.
2. At the welcome screen, select Install or upgrade an existing system, and press Enter.
3. At the Media test screen, select Skip, and press Enter.
4. At the CentOS 6 title screen, click Next.
5. At the Choose an Installation Language screen, select English, and click Next.
6. At the Keyboard Type screen, select U.S. English, and click Next.
7. At the Storage Devices screen, select Basic Storage Devices, and click Next.
8. If a warning for device initialization appears, select Yes, discard any data.
9. At the Name the Computer screen, type the host name, and click Configure Network.
10. At the Network Connections screen, select the server's main or management network interface, and click Edit.
11. At the Editing network interface screen, check Connect Automatically.

12. On the same screen, Select the IPv4 Settings tab, change the Method to Manual, and click Add.
13. On the same screen, enter the IP address, Netmask, Gateway, and DNS server. Click Apply.
14. Click Close on the Network Connections screen, and click Next on the Name the Computer screen.
15. At the Time zone selection screen, select the appropriate time zone, and click Next.
16. Enter the root password in the Root Password and Confirm fields, and click Next.
17. At the Partition selection screen, select Replace Existing Linux System(s), and click Next.
18. If a warning appears, click Write changes to disk.
19. At the default installation screen, click Next to begin the installation.
20. At the Congratulations screen, click Reboot.
21. After the system reboots, log in as root.
22. Disable SELinux by editing the file `/etc/selinux/config`, and change the line `SELINUX=enforcing` to `SELINUX=disabled`. These changes take effect after rebooting.
23. Disable these unused services by running the following command-line script:

```
CHK_OFFS="auditd autofs cups ip6tables iptables nfslock netfs portreserve postfix\  
        qpid rhnsd rhsmcertd rpcgssd rpcidmapd rpcbind"  
for i in ${CHK_OFFS}; do  
    chkconfig $i off  
    service $i stop  
done
```

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