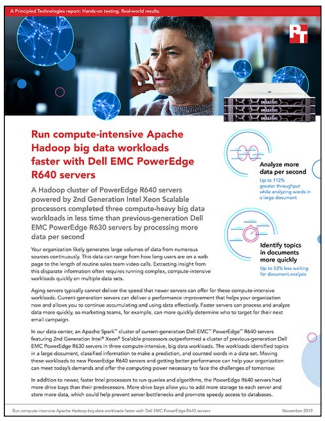

The science behind the report:

Run compute-intensive Apache Hadoop big data workloads faster with Dell EMC PowerEdge R640 servers

This document describes what we tested, how we tested, and what we found. To learn how these facts translate into real-world benefits, read the report Run compute-intensive Apache Hadoop big data workloads faster with Dell EMC PowerEdge R640 servers.

We concluded our hands-on testing on October 27, 2019. During testing, we determined the appropriate hardware and software configurations and applied updates as they became available. The results in this report reflect configurations that we finalized on October 15, 2019 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

The table below presents the throughput each solution delivered when running the HiBench workloads.

	Dell EMC™ PowerEdge™ R640 solution	Dell EMC PowerEdge R630 solution	Percentage more throughput
Latent Dirichlet Allocation (MB/sec)	4.13	1.94	112%
Random Forest (MB/sec)	100.66	94.43	6%
WordCount (GB/sec)	5.10	3.45	47%

The table below presents the minutes each solution needed to complete the HiBench workloads.

	Dell EMC PowerEdge R640 solution	Dell EMC PowerEdge R630 solution	Percentage less time
Latent Dirichlet Allocation	17.11	36.25	52%
Random Forest	5.55	5.92	6%
WordCount	4.95	7.32	32%

System configuration information

The table below presents detailed information on the systems we tested.

Server configuration information	Dell EMC PowerEdge R640	Dell EMC PowerEdge R630
BIOS name and version	2.2.11	2.9.1
Non-default BIOS settings	Performance per watt (OS)	Performance per watt (OS)
Operating system name and version/build number	VMware ESXi™ 6.7.0, 14320388	VMware ESXi 6.7.0, 13981272
Date of last OS updates/patches applied	09/04/2019	09/19/2019
Power management policy	Performance per watt (OS)	Performance per watt (OS)
Processor		
Number of processors	2	2
Vendor and model	Intel® Xeon® Gold 6230	Intel Xeon E5-2690 v3
Core count (per processor)	20	12
Core frequency (GHz)	2.10	2.60
Stepping	6	2
Memory module(s)		
Total memory in system (GB)	256	256
Number of memory modules	24	16
Vendor and model	Hynix® Semiconductor HMA82GR7CJR8N-WM	Samsung® M393A2G40DB0-CPB
Size (GB)	16	16
Type	PC4-2933	PC4-2133
Speed (MHz)	2,933	2,133
Speed running in the server (MHz)	2,933	2,133
Storage controller		
Vendor and model	PERC H740P Mini	PERC H730 Mini
Cache size (GB)	8	1
Firmware version	50.5.1-2818	25.5.5.0005
Driver version	7.708.07.00	7.708.07.00
SATA SSD storage		
Number of drives	8	8
Drive vendor and model	Intel SSDSC2KB019T8R	Intel SSDSC2KB019T8R
Drive size (TB)	1.92	1.92
Drive information (speed, interface, type)	6Gbps SATA SSD	6Gbps SATA SSD

Server configuration information	Dell EMC PowerEdge R640	Dell EMC PowerEdge R630
NVMe™ SSD storage		
Number of drives	2	N/A
Drive vendor and model	Dell EMC Express Flash NVMe P4610	N/A
Drive size (TB)	1.6	N/A
Drive information (speed, interface, type)	PCIe SSD	N/A
Network adapter		
Vendor and model	Intel XXV710	QLogic BCM57800
Number and type of ports	2 x 25Gb	4 x 10Gb
Driver version	1.8.1.9	1.0.77.2
Cooling fans		
Vendor and model	Dell 384-BBQE	Dell TGC4J
Number of cooling fans	8	7
Power supplies		
Vendor and model	Dell 0PJMDN	Dell 0Y9VFC
Number of power supplies	2	2
Wattage of each (W)	750	750

How we tested

Installing the operating system

1. Insert the Red Hat Enterprise Linux 7.7 installation media, and power on the system.
2. Select Install Red Hat Enterprise Linux 7.7, and press Enter.
3. Select English, and click Continue.
4. Click NETWORK & HOST NAME.
5. For the 25Gb Ethernet connection you are using, click ON.
6. Select the 25Gb Ethernet connection you are using, and click Configure.
7. Click IPv4 Settings.
8. Change Method to Manual.
9. Click Add, and enter your IP address, netmask, and gateway.
10. Click Save.
11. Change your host name to something appropriate based on the role of your system, and click Apply.
12. To exit the network configuration, click Done.
13. Click INSTALLATION DESTINATION.
14. Select I will configure partitioning, and click Done.
15. Select Standard Partition, and click Click here to create them automatically.
16. Modify the swap to 4 GB, and click Done.
17. When the summary of changes appears, click Accept Changes.
18. Click Begin Installation.
19. Click ROOT PASSWORD.
20. Enter the root password, confirm it, and click Done.
21. When the installation finishes, click Reboot.
22. For the remaining servers in the test bed, complete steps 1 through 21.

Configuring the operating system

1. Log into the Red Hat console.
2. To disable selinux, type the following commands:

```
setenforce 0
sed -i 's/SELINUX=.*/SELINUX=disabled/' /etc/selinux/config
```

3. To disable the firewall, type the following commands:

```
systemctl stop firewalld
systemctl disable firewalld
```

4. To configure the default file permissions, type the following command:

```
echo umask 0022 >> /etc/profile
```

5. Either register your system with Red Hat or configure your yum patch repositories to operate off of a locally accessible repository.
6. To remove chrony from your system, type the following command:

```
yum remove -y chrony
```

7. To update the system, type the following command:

```
yum update -y
```

8. Reboot the system.
9. To install the prerequisites for Ambari and HDP, type the following command:

```
yum install -y ntp time xfsprogs tuned wget vim nfs-utils openssh-clients man zip unzip numactl
sysstat bc lzop xz libhugetlbfs python numpy blas64 lapack64 gtk2 atk cairo gcc-gfortran tcsh lsof
tcl tk java-1.8.0-openjdk-devel perl-Data-Dumper.x86_64
```

10. To enable NTP, type the following commands:

```
systemctl enable ntpd
systemctl start ntpd
```

11. Reboot the system.
12. To clear the SSH settings, type the following commands:

```
mkdir -p /root/.ssh
chmod 700 /root/.ssh
cd /root/.ssh
mv * *.orig
```

13. To create an SSH private key for all hosts, type the following commands:

```
ssh-keygen -t rsa -q
cp id_rsa.pub authorized_keys
echo "StrictHostKeyChecking=no" > config
```

14. Copy the key to the other hosts.
15. Create a hosts file containing a FQDN, nickname, and IP address of every host you plan to use in the cluster, and copy the file to all hosts.
16. To format and prepare the drives you are using for HDFS on the hosts that will be data nodes, run the following script, making sure to modify the SKIP_LETTER variable for the drive your operating system is running on:

```
#!/bin/bash
FS=xfs
COUNT=0
SKIP_LETTER="w"
umount /grid/*
rmdir /grid/*
rmdir /grid
mkdir -p /grid
for i in {a..h};
do
  if [ "$SKIP_LETTER" = "$i" ]; then
    continue
  fi
  DEV=/dev/sd$i
  GRID=/grid/$COUNT
  echo $DEV $COUNT
  mkdir -p $GRID
  #dd if=/dev/zero of=$DEV bs=1M count=10 oflag=direct
  sync
  mkfs.${FS} $DEV
  echo -e "`blkid -p $DEV | awk '{print $2}'`\t${GRID} \t${FS}\tdefaults,noatime,nodiratime,nofail,x-
systemd.device-timeout=60\t0 0" >> /etc/fstab
  ((COUNT++))
done
```

Installing Ambari

1. Log into your Ambari host.
2. To add the Ambari repository to your yum repos, type the following command:

```
wget -nv http://public-repo-1.hortonworks.com/ambari/centos7/2.x/updates/2.7.4.0/ambari.repo -O /etc/
yum.repos.d/ambari.repo
```

3. To start the Ambari server setup, type the following command:

```
ambari-server setup
```

4. To accept the default of not customizing a user account for the ambari-server daemon, press Enter.
5. To accept the default Java engine, press Enter.
6. To accept the default of not entering advanced database configuration, press Enter.
7. To start up the Ambari host, type the following command:

```
ambari-server start
```

Installing Hortonworks Data Platform on the cluster

1. Open a web browser, and navigate to the Ambari host website.
2. Log into the Ambari host website.
3. In Welcome to Apache Ambari, click Launch Install Wizard.
4. In the Get Started page, name your cluster, and click Next.
5. In Select Version, select the latest version, make sure Use Public Repository is checked, and click Next.
6. In Install Options, enter the hosts you plan to use. For example:

```
namenode[1-2].hdp.local
datanode[1-3].hdp.local
client1.hdp.local
```

7. Copy the contents of the SSH private key you created previously into the host registration information, and type `root` as the User Account and `22` as the port number.
8. Click Register and Confirm.
9. When the Host name pattern expressions window appears, verify that all hosts are there, and click OK.
10. In the Confirm Hosts window, verify that all hosts you intend to install on are there, and click Next.
11. In Choose Services, uncheck the following services:

    Accumulo
    Atlas
    Falcon
    Flume
    HBase
    Sqoop
    Oozie

12. Leave the rest of the services at their defaults, and click Next.
13. In Assign Masters, assign services to the following master servers:

    namenode1
        NameNode
        ZooKeeper Server
        DRPC Server
        Storm UI Server
        Nimbus
        Infra Solr Instance
        Metrics Collector
        Grafana
        Kafka Broker
        Knox Gateway
        HST Server
        Activity Explorer
        Activity Analyzer
        Spark History Server
        Spark2 History Server

    namenode2
        SNameNode
        App Timeline Server
        ResourceManager
        History Server
        WebHCat Server
        Hive Metastore
        HiveServer2
        ZooKeeper Server

14. In Assign Slaves and Clients, apply the slave and client components to the following hosts:

    datanode1-3

        DataNode
        NodeManager
        Supervisor

    vclient1

        Client

15. In Customize Services, perform the following actions:
    a. For the Hive Metastore, enter a database password.
    b. For the Grafana Admin, enter a password.
    c. For the Knox Master Secret, enter a password.
    d. For the admin in SmartSense, enter a password.
    e. In the HDFS section, add the following line to the DataNode directories textbox:

    ```
    /grid/0,/grid/1,/grid/2,/grid/3,/grid/4,/grid/5,/grid/6
    ```

16. When a warning appears in the Configurations window, Click Proceed Anyway.
17. In Review, verify your settings, and click Deploy.
18. After the deployment completes, in Install, Start and Test, click Next.
19. In Summary, click Complete.

Installing HiBench

1. Log into your client host.
2. To install the prerequisite packages to the client, type the following commands:

```
yum install -y maven git vim numpy blas64 lapack64
echo "/usr/hdp/current/hadoop-client/lib/native" > /etc/ld.so.conf.d/hadoop-client-native.conf
```

3. To change to the HDFS user, create the HiBench directory in the dfs, and set permissions, type the following commands:

```
su - hdfs
hdfs dfs -mkdir /HiBench
hdfs dfs -chown -R root:hadoop /HiBench
hdfs dfs -mkdir /user/root
hdfs dfs -chown root /user/root
exit
```

4. To edit the bash profile to automatically include the HiBench prerequisites, type the following commands:

```
vim ~/.bash_profile
export JAVA_HOME=/usr/lib/jvm/java-1.8.0-openjdk
export HADOOP_HOME=/usr/hdp/current/hadoop-client
export SPARK_HOME=/usr/hdp/current/spark2-client
export KAFKA_HOME=/usr/hdp/current/kafka-broker
export LD_LIBRARY_PATH=/usr/hdp/current/hadoop-client/lib/native
```

5. To download the HiBench benchmark from Github, type the following commands:

```
cd /root
git clone https://github.com/intel-hadoop/HiBench.git
```

6. Change to the newly downloaded HiBench directory, and type the following command:

```
mvn -Dspark=2.1 -Dscala=2.11 clean package | tee hibench_build.log
```

7. To modify the 99-user_defined_properties.conf file, change the following lines:

```
hibench.hadoop.home                                 /usr/hdp/current/hadoop-client
hibench.spark.home                                 /usr/hdp/current/spark2-client
hibench.hadoop.mapreduce.home        /usr/hdp/current/hadoop-mapreduce-client
```

Configuring Hortonworks Data Platform

We made the following changes to the settings of the services via the Ambari console:

HDFS

NameNode

NameNode Java heap size - 5.25 GB
NameNode Server threads - 1800

DataNode

DataNode directories - each of the drives on the server
DataNode failed disk tolerance - 2

Advanced

NameNode new generation size - 672 MB
NameNode maximum new generation size - 672 MB

YARN

Memory

R630s:
Memory allocated for all YARN containers on a node - 240 GB
Maximum Container Size (Memory) - 245760 MB
R640s:
Memory allocated for all YARN containers on a node - 360 GB
Maximum Container Size (Memory) - 368640 MB

CPU

Percentage of physical CPU allocated for all containers on a node - 100%
(R630s) Number of virtual cores - 96
(R640s) Number of virtual cores - 160
Maximum Container Size (VCores) - 16

Configuring HiBench

We used the following settings for the tests we ran:

	Dell EMC PowerEdge R630 servers	Dell EMC PowerEdge R640 servers
hibench.conf configuration changes		
hibench.scale.profile	bigdata	bigdata
hibench.default.map.parallelism	132	912
hibench.default.shuffle.parallelism	132	912
spark.conf configuration changes		
hibench.yarn.executor.num	33	57
hibench.yarn.executor.cores	4	4
spark.executor.memory	20g	18g
spark.driver.memory	4g	4g

Running HiBench

1. Log into the first data node.
2. To clear the PageCache, dentries, and inodes, type the following command:

```
echo 3 > /proc/sys/vm/drop_caches
```

3. For the remaining data nodes, complete steps 1 and 2.
4. Log into the client host.
5. In the HiBench directory, navigate to the bin/workload/[benchmark] directory.
6. To initialize the data, type the following command:

```
./prepare/prepare.sh
```

7. After the data initializes, wait five minutes.
8. To run the benchmark, type the following command:

```
./spark/run.sh
```

9. After the test completes, record the results.

Read the report at http://facts.pt/jqj8hg1 ▶

This project was commissioned by Dell EMC.

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