Installing Hadoop on a Cluster

This week we will install Hadoop on a cluster of virtual machines. The procedure has many similarities to what you did last week when you installed Hadoop on a single node in the so-called pseudo-distributed mode of operation.

Note: This week the instructions will become a bit more cryptic in the sense that I will not lead you through all the steps.

# Creating your virtual machines

1. Create **four** new virtual machines from the CentOS minimal installation media.
   * Use NAT networking for the four machines.
2. You will need to run all four virtual machines at the same time
   * Consider the memory you assign to each of these machines. It is not recommended that you exceed the physical memory of your host machine. If you have eight gigabytes of memory you might allocate two gigabytes for each machine. If this stretches your memory, then reduce the memory of three of the machines to one gigabyte.
3. Determine the IP address for each of the four machines.
4. Perform OS updates as needed.

# Basic CentOS setup

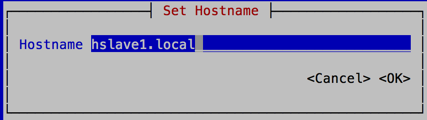
I will use the following names for the four machines.

* + hmaster will be the master node
  + hslave1 will be the first slave node
  + hslave2 will be the second slave node
  + hslave3 will be the third slave node

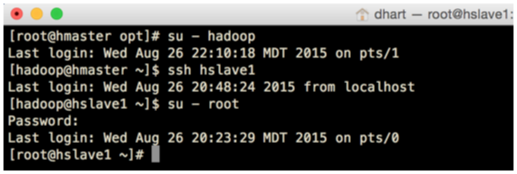
You will need to work on all four nodes as both the root user and the hadoop user. The usual way to move from one machine to another is with the ssh command. To make this more convenient you might want to name your machines rather than using their IP addresses. You can set the hostname of your CentOS system using

# nmtui

The example below sets the name for the slave one node to hslave1.local.



The benefit of doing this is that in your command prompt you will see both the the current user as well as the name of the machine i.e., hostname. In the figure below you will see the hadoop and root user on both the hmaster and hslave1 machines shown in the command line prompts using a notation like root@hmaster. (The third thing you see in the prompt is the final part of the current working directory.)



**On *each node* complete the following steps**

1. Edit /etc/hosts and add the following lines (change the IP addresses to match yours.)

10.0.0.1 hmaster

10.0.0.2 hslave1

10.0.0.3 hslave2

10.0.0.4 hslave3

1. Create the hadoop user

# useradd hadoop

# passwd hadoop

1. Set up passwordless login

# su hadoop

$ ssh-keygen -t rsa

$ ssh-copy-id -i ~/.ssh/id\_rsa.pub hadoop@hmaster

$ ssh-copy-id -i ~/.ssh/id\_rsa.pub hadoop@hslave1

$ ssh-copy-id -i ~/.ssh/id\_rsa.pub hadoop@hslave2

$ ssh-copy-id -i ~/.ssh/id\_rsa.pub hadoop@hslave3

$ chmod 0600 ~/.ssh/authorized\_keys

# Installing Java

On the hmaster node

# cd /opt

# wget --no-cookies --no-check-certificate --header "Cookie: gpw\_e24=http%3A%2F%2Fwww.oracle.com%2F; oraclelicense=accept-securebackup-cookie" http://download.oracle.com/otn-pub/java/jdk/8u60-b27/jdk-8u60-linux-x64.tar.gz

# tar xzf jdk-8u60-linux-x64.tar.gz

Now copy Java to all the slave nodes

# scp –r jdk1.8.0\_60 hslave1:/opt

# scp –r jdk1.8.0\_60 hslave2:/opt

# scp –r jdk1.8.0\_60 hslave3:/opt

On each node use the alternatives tool to setup Java

# alternatives --install /usr/bin/java java /opt/jdk1.8.0\_60/bin/java 2  
# alternatives --config java

# alternatives --install /usr/bin/jar jar /opt/jdk1.8.0\_60/bin/jar 2

# alternatives --install /usr/bin/javac javac /opt/jdk1.8.0\_60/bin/javac 2

# alternatives --set jar /opt/jdk1.8.0\_60/bin/jar

# alternatives --set javac /opt/jdk1.8.0\_60/bin/javac

For the hadoop user on the hmaster node, add these environment variables

export JAVA\_HOME=/opt/jdk1.8.0\_60

export JRE\_HOME=/opt/jdk1.8.0\_60/jre

export PATH=$PATH:$JAVA\_HOME/bin

Copy the hadoop user .bashrc file to the slave nodes

scp .bashrc hslave1:/home/hadoop

scp .bashrc hslave2:/home/hadoop

scp .bashrc hslave3:/home/hadoop

# Install Hadoop

Rather than downloading hadoop and unpacking hadoop in the hadoop user directory structure we will add it to the /opt directory.

As the root user and on the hmaster node

# cd /opt

# wget http://mirrors.advancedhosters.com/apache/hadoop/common/hadoop-2.7.1/hadoop-2.7.1.tar.gz

# tar –zxvf hadoop-2.7.1.tar.gz

Copy the hadoop distribution to the three slave nodes

# scp –r hadoop-2.7.1 hslave1:/opt

# scp –r hadoop-2.7.1 hslave2:/opt

# scp –r hadoop-2.7.1 hslave3:/opt

On each node 1) make a directory for the HDFS DataNode, and 2) change the ownership and group of the datanode directory, and the hadoop distribution files to hadoop.

# mkdir /home/hadoop/datanode

# chown hadoop /home/hadoop/datanode/

# chgrp hadoop /home/hadoop/datanode/

# chown –R hadoop /opt/hadoop-2.7.1/

# chgrp –R hadoop /opt/hadoop-2.7.1/

On hmaster create a directory for the HDFS NameNode and change ownerships to the hadoop user

# mkdir /home/hadoop/namenode

# chown hadoop /home/hadoop/namenode

# chgrp hadoop /home/hadoop/namenode

Add the following to the .bashrc file for the hadoop user on each node.

export HADOOP\_PREFIX=/opt/hadoop-2.7.1

export HADOOP\_HOME=$HADOOP\_PREFIX

export HADOOP\_COMMON\_HOME=$HADOOP\_PREFIX

export HADOOP\_CONF\_DIR=$HADOOP\_PREFIX/etc/hadoop

export HADOOP\_HDFS\_HOME=$HADOOP\_PREFIX

export HADOOP\_MAPRED\_HOME=$HADOOP\_PREFIX

export PATH=$PATH:$HADOOP\_PREVIX/sbin:$HADOOP\_PREFIX/bin

You can use the scp command, as used before, to copy the modified .bashrc file to each node.

# Configure Hadoop

Edit /opt/hadoop-2.7.1/etc/hadoop/core-site.xml and set the NameNode URI on each node

<configuration>

<property>

<name>fs.defaultFS</name>

<value>hdfs://hmaster:9000/</value>

</property>

</configuration>

Edit the file /opt/hadoop-2.7.1/etc/hadoop/hdfs-site.xml – set up DataNode on each node

<configuration>

<property>

<name>dfs.replication</name>

<value>3</value>

</property>

<property>

<name>dfs.permissions</name>

<value>false</value>

</property>

<property>

<name>dfs.datanode.data.dir</name>

<value>/home/hadoop/datanode</value>

</property>

</configuration>

Edit /opt/hadoop-2.7.1/etc/hadoop/hdfs-site.xml on hmaster and add the following property to the other properties.

<property>

<name>dfs.namenode.data.dir</name>

<value>/home/hadoop/namenode</value>

</property>

Edit /opt/hadoop/etc/hadoop/mapred-site.xml on hmaster

<configuration>

<property>

<name>mapreduce.framework.name</name>

<value>yarn</value> <!-- and not local (!) -->

</property>

</configuration>

Edit /opt/hadoop-2.7.1/etc/hadoop/yarn-site.xml on hmaster

<configuration>

<property>

<name>yarn.resourcemanager.hostname</name>

<value>hmaster</value>

</property>

<property>

<name>yarn.nodemanager.hostname</name>

<value>hmaster</value> <!-- or hslave1, hslave2, hslave3 -->

</property>

<property>

<name>yarn.nodemanager.aux-services</name>

<value>mapreduce\_shuffle</value>

</property>

</configuration>

Edit /opt/hadoop-2.7.1/etc/hadoop/slaves on hmaster

hmaster

hslave1

hslave2

hslave3

Completely disable the firewall on all four nodes. Note: this command will not survive a reboot of your machines.

# systemctl stop firewalld

Disable IPv6 by adding these lines to /etc/sysctl.conf

net.ipv6.conf.all.disable\_ipv6 = 1

net.ipv6.conf.default.disable\_ipv6 = 1

On the hmaster node change to the hadoop user

# su – hadoop

Format the namenode

# hdfs namenode –format

Start HDFS

# start-dfs.sh

At this point I see the NameNode, DataNode, and SecondaryNameNode running on hmsater – using jps. On the slaves I see NameNode and DataNode running.

Start YARN

# start-yarn.sh

Here I see the NodeManager running on all nodes.

You should now be able to run the shakespeare.txt word count problem on hmaster. Note, there is a lot of startup time, so be patient.

# Here Are My Commands for Starting HDFS and YARN and running the Hadoop word count problem. (I did not start the History Server.)

[hadoop@hmaster ~]$ start-dfs.sh

Starting namenodes on [hmaster]

hmaster: starting namenode, logging to /opt/hadoop-2.7.1/logs/hadoop-hadoop-namenode-hmaster.local.out

hmaster: starting datanode, logging to /opt/hadoop-2.7.1/logs/hadoop-hadoop-datanode-hmaster.local.out

hslave1: starting datanode, logging to /opt/hadoop-2.7.1/logs/hadoop-hadoop-datanode-hslave1.local.out

hslave3: starting datanode, logging to /opt/hadoop-2.7.1/logs/hadoop-hadoop-datanode-hslave3.local.out

hslave2: starting datanode, logging to /opt/hadoop-2.7.1/logs/hadoop-hadoop-datanode-hslave2.local.out

Starting secondary namenodes [0.0.0.0]

0.0.0.0: starting secondarynamenode, logging to /opt/hadoop-2.7.1/logs/hadoop-hadoop-secondarynamenode-hmaster.local.out

[hadoop@hmaster ~]$ ls -la

total 4456

drwx------. 4 hadoop hadoop 4096 Sep 4 11:02 .

drwxr-xr-x. 4 root root 31 Aug 26 20:22 ..

-rw-------. 1 hadoop hadoop 3480 Sep 4 11:01 .bash\_history

-rw-r--r--. 1 hadoop hadoop 18 Mar 5 2015 .bash\_logout

-rw-r--r--. 1 hadoop hadoop 193 Mar 5 2015 .bash\_profile

-rw-r--r--. 1 hadoop hadoop 637 Aug 27 19:34 .bashrc

drwxrwxr-x. 2 hadoop hadoop 39 Aug 27 09:33 .oracle\_jre\_usage

-rw-rw-r--. 1 hadoop hadoop 4538523 Aug 16 2011 shakespeare.txt

drwx------. 2 hadoop hadoop 76 Aug 26 20:33 .ssh

[hadoop@hmaster ~]$ start-yarn.sh

starting yarn daemons

starting resourcemanager, logging to /opt/hadoop-2.7.1/logs/yarn-hadoop-resourcemanager-hmaster.local.out

hslave1: starting nodemanager, logging to /opt/hadoop-2.7.1/logs/yarn-hadoop-nodemanager-hslave1.local.out

hslave3: starting nodemanager, logging to /opt/hadoop-2.7.1/logs/yarn-hadoop-nodemanager-hslave3.local.out

hslave2: starting nodemanager, logging to /opt/hadoop-2.7.1/logs/yarn-hadoop-nodemanager-hslave2.local.out

hmaster: starting nodemanager, logging to /opt/hadoop-2.7.1/logs/yarn-hadoop-nodemanager-hmaster.local.out

[hadoop@hmaster ~]$ ls -la

total 4456

drwx------. 5 hadoop hadoop 4096 Sep 4 11:05 .

drwxr-xr-x. 4 root root 31 Aug 26 20:22 ..

-rw-------. 1 hadoop hadoop 3480 Sep 4 11:01 .bash\_history

-rw-r--r--. 1 hadoop hadoop 18 Mar 5 2015 .bash\_logout

-rw-r--r--. 1 hadoop hadoop 193 Mar 5 2015 .bash\_profile

-rw-r--r--. 1 hadoop hadoop 637 Aug 27 19:34 .bashrc

drwx------. 3 hadoop hadoop 38 Sep 4 11:06 datanode

drwxrwxr-x. 2 hadoop hadoop 39 Aug 27 09:33 .oracle\_jre\_usage

-rw-rw-r--. 1 hadoop hadoop 4538523 Aug 16 2011 shakespeare.txt

drwx------. 2 hadoop hadoop 76 Aug 26 20:33 .ssh

[hadoop@hmaster ~]$ hadoop fs -ls

ls: `.': No such file or directory

[hadoop@hmaster ~]$ hadoop fs -mkdir -p /user/hadoop

[hadoop@hmaster ~]$ hadoop fs -ls

[hadoop@hmaster ~]$ hadoop fs -mkdir shakespeare

[hadoop@hmaster ~]$ hadoop fs -mkdir shakespeare/input

[hadoop@hmaster ~]$ hadoop fs -copyFromLocal ~/shakespeare.txt shakespeare/input

[hadoop@hmaster ~]$ hadoop fs -ls shakespeare/input

Found 1 items

-rw-r--r-- 3 hadoop supergroup 4538523 2015-09-04 11:10 shakespeare/input/shakespeare.txt

[hadoop@hmaster ~]$

hadoop jar /opt/hadoop-2.7.1/share/hadoop/mapreduce/hadoop-mapreduce-examples-2.7.1.jar wordcount shakespeare/input shakespeare/output

[hadoop@hmaster ~]$ hadoop fs -ls shakespeare/output

Found 2 items

-rw-r--r-- 3 hadoop supergroup 0 2015-09-04 11:18 shakespeare/output/\_SUCCESS

-rw-r--r-- 3 hadoop supergroup 356409 2015-09-04 11:18 shakespeare/output/part-r-00000

[hadoop@hmaster ~]$ hadoop fs -copyToLocal shakespeare/output/part-r-00000 ~/shakespeareoutput.txt

15/09/04 11:20:01 WARN hdfs.DFSClient: DFSInputStream has been closed already

[hadoop@hmaster ~]$ ls -la

total 4808

drwx------. 5 hadoop hadoop 4096 Sep 4 11:20 .

drwxr-xr-x. 4 root root 31 Aug 26 20:22 ..

-rw-------. 1 hadoop hadoop 3480 Sep 4 11:01 .bash\_history

-rw-r--r--. 1 hadoop hadoop 18 Mar 5 2015 .bash\_logout

-rw-r--r--. 1 hadoop hadoop 193 Mar 5 2015 .bash\_profile

-rw-r--r--. 1 hadoop hadoop 637 Aug 27 19:34 .bashrc

drwx------. 3 hadoop hadoop 38 Sep 4 11:06 datanode

drwxrwxr-x. 2 hadoop hadoop 39 Aug 27 09:33 .oracle\_jre\_usage

-rw-r--r--. 1 hadoop hadoop 356409 Sep 4 11:20 shakespeareoutput.txt

-rw-rw-r--. 1 hadoop hadoop 4538523 Aug 16 2011 shakespeare.txt

drwx------. 2 hadoop hadoop 76 Aug 26 20:33 .ssh

[hadoop@hmaster ~]$ more shakespeareoutput.txt

! 10526

!' 183

!'By 1

!'t 1

!'twas 1

!, 1

!About 1

!All 1

!As 1

!Ay 1

!Burn 1

!Come 1