Deploy and Manage Hadoop with SUSE® Manager

A Detailed Technical Guide
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## Documentation Conventions

The following typographical conventions are used in this manual:

- **Bold** text represents things you should watch for, buttons you should click, text or options that you should select or text you should enter into a GUI.

- **Option > Option > Option** represents a chain of items selected from a menu.

- **BOLD_UPPERCASE_ITALIC** text represents a “lab variable” that you replace with another value.

- **bold monospace** text represents commands that you type at a command line.

- **Note | Important | Warning** indicates something important to take note of or watch out for.
Executive Summary

Big data technologies are becoming increasingly important in almost all areas of today’s IT world. According to a recent Gartner survey, 64 percent of organizations are investing or planning to invest in big data technology.* As IT architects begin implementing big data initiatives, it is crucial they choose the right components.

One of the most important and most used technologies in big data is Apache Hadoop. Hadoop is an open source big data framework that combines all required technology components to provide a fully functional big data infrastructure called a “Hadoop cluster.”

For enterprises deploying Hadoop, the task of keeping those clusters up-to-date and secure can be challenging, time-consuming and error-prone. SUSE® Manager automates Linux server management, allowing you to provision and maintain your servers faster and more accurately. SUSE Manager monitors the health of each Linux server from a single console so you can identify server performance issues before they impact your business. For the large clusters often required in Hadoop deployments, SUSE Manager allows you to comprehensively manage your Linux servers across physical, virtual and cloud environments while improving data center efficiency. SUSE Manager provides the following benefits in an environment where Hadoop clusters are being deployed:

**Provisioning and Configuring**

- Automate the provisioning of operating system instances on bare-metal hardware using AutoYaST, Kickstart and PXE boot.
- Deploy new servers with the identical characteristics of an existing server or with a predefined configuration.
- Provision RPM-based applications for automatic deployment.
- Centralize management of configuration files for server groups and utilize standardized configuration files.

**Patching**

- Connect to the SUSE Customer Center to easily access updates, security patches and service packs.
- Create and manage multiple organizations from a single remote console.
- Create customized repositories for the delivery of either operating system packages or RPM-based applications and content.
- Maintain the security of enterprise systems and examine systems for signs of compromise.
- Use the Zypp update stack for the deployment of patches and updates.
- Centrally push software by grouping servers.
- Leverage the SUSE Manager API to create custom scripts to manage tasks or integrate third-party applications and management tools.

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* [www.gartner.com/newsroom/id/2593815](http://www.gartner.com/newsroom/id/2593815)
This document will provide detailed instructions on how to deploy Cloudera Distribution for Hadoop (CDH) onto SUSE Linux Enterprise Server using SUSE Manager. The document assumes that SUSE Manager is pre-installed and running; that NTP, firewall ports and DNS/DHCP are already configured; and that you have Novell Customer Center (NCC) credentials. For more information on SUSE Manager or to download an evaluation version, go to:

www.suse.com/products/suse-manager/

Setup

This paper details the deployment of a small-scale Hadoop cluster on SUSE Linux Enterprise Server using SUSE Manager. The Hadoop cluster we will deploy has a NameNode, Job Tracker (ResourceManager) and a configurable and scalable number of DataNodes (customizable by editing the configuration files in Appendix A).

Figure 1. Architecture Overview
NameNode Specification
The NameNode is a virtual machine with 8GB of RAM and with enough disk space to accommodate the HDFS metadata. This is typically at least 40GB, and although a separate disk is not required, it is considered a best practice. An NFS share may also be mounted to keep a remote copy of the metadata. The NFS mount should be added to the “dfs.name.dir” property within hdfs-site.conf.

DataNode Specification
DataNodes are the worker nodes. Hadoop is mostly memory- and IO-hungry in comparison to legacy batch processing workloads, which were CPU-bound. The reference AutoYaST file provided does not format or mount any other available hard disks. Please refer to the document “Deploying Hadoop on SUSE Linux Enterprise Server” for best practices around file system and mount options. This document assumes the processing hard disk of the DataNodes is mounted on /data/1. To balance the blocks and IO, a secondary disk would be mounted on /data/2 and its path added to “dfs.data.dir” property in hdfs-site.conf.

Networking
We recommend you separate the Ethernet network segment from any other network using a router or any other gateway. This ensures that broadcast frames stay within the Hadoop network. More important, the network separation makes it easier to implement your own infrastructure services, like PXE boot with DHCP. This simplifies the cluster deployment. Similarly, you should use exactly one separated IP network for the Hadoop cluster. Always use IPv4, not IPv6, in your setups. This simplifies the setup and ensures compatibility with all Hadoop components.

Figure 2. Logical Network Overview
Hadoop contains a rack-aware replica placement policy which normally needs to be configured. Ideally, the three copies of the blocks are separated, but to maximize communication efficiency, the first and second block can be placed in the same rack with the third copy in a separate rack to avoid downtime should a complete rack fail. Additionally, network traffic increases significantly when DataNodes are started or if a node should fail. Block replication and allocation of the jobs and intermediate data take most of the network bandwidth while jobs execute. Therefore, dedicated fault-tolerant switching is recommended for the Hadoop infrastructure, 1GB minimum required for all communication.

Figure 3. Physical Network Overview
Step 1—Configure SUSE Manager

Special Instructions and Notes
This section assumes SUSE Manager is already installed and NCC credentials, NTP, firewall ports and DNS/DHCP are already configured.

Task I: Subscribe to the SUSE LINUX Enterprise Server Channels
The mgr-ncc-sync tool provides quick subscription to channels.

1. Execute `mgr-ncc-sync -add-product`.
2. Note the number beside “SUSE Linux Enterprise Server 11 SP3 [x86_64]”.
3. Input the channel number at the provided prompt.
4. Allow for all repositories to sync; you may see progress via `tail -f /var/log/rhn/reposync/*`.

Task II: Configure the Hadoop Repository
In this example, we will use the CDH repositories:

1. At the SUSE Manager Web UI, select Channels, Manage Software Channels, Manage Repositories; click “create new repository”:
   - Repository Label: cdhrepo
   - Repository URL: `http://archive.cloudera.com/cdh4/sles/11/x86_64/cdh4

2. Deselect Has Signed Metadata?
3. Click Create Repository.

Task III: Configure the Hadoop Channel
We continue creating the channel for the CDH repositories.

1. At the SUSE Manager Web UI, select Channels, Manage Software Channels, click “create new channel”:
   - Channel Name: cdhsses
   - Channel Label: cdhsses
   - Channel Summary: cdh channel
   - Parent Channel: SLES11-SP3-Pool for x86_64
   - Architecture: x86_64
2. Click Create Channel.
3. Select the Repositories tab, select cdhrepo and click Update Repositories.
4. Select the Sync Tab; click Sync Now.

Task IV: Add Additional Packages
CDH does not provide the Oracle JDK necessary for Hadoop; thus we add it manually:

1. Download jdk-6u31-linux-amd64.rpm from Oracle via “Previous Releases.” Place the jdk RPM at folder /root/customRPM within the SUSE Manager server.
2. Execute `rhnpush -d /root/customRPM -c cdhsses`
   The previous command will add all RPMs within the specified directory to the specified channel.

Task V: Create a System Group
For administrative tasks, we will create a Hadoop Group.

1. Select Systems, System Groups; click create new group:
   - Name: hadoop
   - Description: Hadoop System Group
2. Click Create Group.

Task VI: Create a Configuration Channel
A Configuration channel is needed to push the configuration files to all nodes.

1. Select Configuration, Configuration Channels; click create new config channel:
   - Name: hadoop
   - Label: hadoop
   - Description: Hadoop Config Channel
2. Click Create Config Channel.
3. Click Add Files, Create File:
   - Keep Default Values.
   - Modify Filename/Path as per Appendix A.
   - Add additional files from Appendix A via Configuration, Configuration Channels, hadoop, Add Files.
**Task VII: Set Up an Activation Key**
Registration keys allow us to subscribe systems to software and configuration channels, groups and bootstrap packages.

1. Select Systems, Activation Keys; click create new key:
   - Description: SLES11-SP3-Hadoop
   - Key: 1-hadoop
   - DBase Channels: SLES11-SP3-Pool for x86_64
   - Add-On Entitlements: Monitoring, Provisioning

2. Click Create Activation Key.
3. Select the Child Channels tab, and while holding ctrl, select the cdhsles, SLES11-SP3-Updates for x86_64 and SLES11-SP2-SUSE-Manager-Tools for x86_64.
4. Click Update Key.
5. Select the Packages tab, input:
   - osad
   - rhncfg
   - rhncfg-actions
   - rhncfg-client
   - rhnmd

6. Click Update Key.
7. Select the Configuration tab, Subscribe to Channels; select the hadoop channel; click Continue.
8. Select the Groups tab, Join; select hadoop; click Join Selected Groups.

**Task VIII: Provisioning Setup**
Create a Distribution and Profile. A custom profile may be built via “yast2 autoyast” provided by the autoyast2-installation package:

1. Copy the SUSE Linux Enterprise Server 11 Service Pack 3 iso to the /root folder of the SUSE Manager server.
2. Create the mount point via mkdir -p /mnt/sles-11-sp3
3. Add the following line to /etc/fstab:
   `/root/SLES-11-SP3-DVD-x86_64-GM-DVD1.iso /mnt/sles-11-sp3 iso9660 loop,ro,relatime 0 0`
4. Back into the SUSE Manager Web UI—Select Systems, Autoinstallation, Distributions; click create new distribution:
   - Distribution Label: SLES-11-SP3
   - Tree Path: /mnt/sles-11-sp3
   - Base Channels: SUSE Linux
   - Installer Generation: SUSE Linux

5. Click Create Autoinstallation Distribution.
6. Select the Profiles Autoinstallation sub-option; click upload new kickstart/autoyast file:
   - Label: hadoop
   - Autoinstallation Tree: SLES-11-SP3
   - File Contents: See Appendix B

7. Click Update.
8. Login to SUSE Manager via SSH.
9. Create a copy of the Bootstrap script for the Hadoop nodes:
   - cd /srv/www/htdocs/pub/bootstrap/
   - cp bootstrap.sh bootstrap-hadoop.sh

10. Edit bootstrap-hadoop.sh, to allow its execution, and Activation key by modifying the lines:
    - Line 71 “exit 1” to “#exit 1”
    - Line 75 “ACTIVATION_KEYS=” to “ACTIVATION_KEYS=1-hadoop”

11. Save the file. It should be accessible via: https://ServerHostname/pub/bootstrap


**Task IX: Enabling Monitoring**
Monitoring may help you to understand your cluster utilization.

1. Select the Admin tab, SUSE Manager Configuration and click Monitoring:
   - Enable Monitoring Scout
   - Verify all other values match your environment

2. Click Update Config.
3. Select the General tab; verify that the Enable Monitoring options is selected.
4. Select the top Monitoring tab, Scout Config Push and click the SUSE Manager Monitoring Scout; copy the SSH Key such that it looks like APPENDIX C.
**Step 2—Deploying Hadoop**

**Special Instructions and Notes**
These instructions assume you have completed “Configure SUSE Manager.”

The network has PXE option 60 directing to the SUSE Manager Server, should these be physical systems.

**Task I: Provision the Nodes**
You may now start the physical or virtual nodes that will be part of our cluster. These may be installed via the different methods mentioned in the “SUSE Manager Reference Guide”:

1. For Physical Nodes, you may install via either:
   - 4.4.9.1.4. Integrating AutoYaST with PXE. Boot the systems and select the hadoop profile. This requires the PXE option 60 directing to the SUSE Manager Server IP and option 67 "/pxelinux.0".
   - 4.4.9.1.3. Building Bootable AutoYaST ISOs from which we will make use of the “autoyast=” option, which takes as its value the URL from “Download Autoinstallation File” provided via the Autoinstallation Profile we created and the “install=” value from your distribution “Kernel Options”.
2. SUSE Cloud instances may be associated to a SUSE Manager server while the base image is being designed with SUSE Studio™. See Configuration / Appliance within the Studio Image.

**Task II: Install Hadoop**
In this section, the NameNode, Job Tracker and DataNodes/Task Tracker roles are installed.

1. Click the hostname of your Primary node from the available Systems under the “Systems” tab.
2. Select Software and then Install.
3. Filter by Package Name and select:
   - jdk
   - sudo
   - hadoop-hdfs-namenode
4. Click Install Selected Packages.
   5. Ensure Schedule action as soon as possible is selected and click confirm.
   6. Select the Systems tab and click the hostname of your Job Tracker node. This role may also be installed at the NameNode node for small deployments.
   7. Select Software and then Install.
   8. Filter by Package Name and select:
      - jdk
      - sudo
      - hadoop-0.20-mapreduce-jobtracker
   9. Click Install Selected Packages.
   10. Ensure Schedule action as soon as possible is selected and click confirm.
   11. Select the Systems tab and select all the systems that will be part of the DataNodes Cluster.
   12. Click Manage.
   13. Click Packages, then Install.
   14. Select the cdhstes channel and install the packages:
      - jdk
      - hadoop-hdfs-datanode
   15. If your images do not provide sudo, you may need to install it from the SLES11-SP3-Pool channel.

**Task III: Create the Folder Structure**
Hadoop requires certain folders to operate, which match the configuration files values. As a good practice, we will use the System Group we previously created.

1. Select the Systems tab, then System Groups; click the group name Hadoop.
2. Click work with group, located at the top right.
3. Select Provisioning then Remote Command.
   - Paste the content of the temporary notepad we created which includes the Monitoring Scount Config Push similar to APPENDIX C.
   - Paste APPENDIX D.
4. Click Schedule Remote Command.
5. Click Schedule commands.
6. Optional: You may automate these steps by adding them to the Bootstrap script we created previously. New nodes would have the SSH key pushed and directory structure.
Task IV: Push the Configuration
The systems are ready for the configuration files. This can be achieved using our System Group or via the Configuration Channel.

1. Select the Systems tab, then System Groups; click the group name Hadoop.
2. Click work with group, located at the top right.
3. Click the Configuration option.
4. Under Deploy Files, click Select All and Schedule File Deploy.

Task V: Hands on Hadoop
The NameNode will need to be initialized.

1. SSH to your NameNode host.
2. Execute the following command to format HDFS:
   ```bash
   sudo -u hdfs hdfs namenode -format
   ```
3. Identify a confirmation line for success such as
   ```bash
   Storage directory /var/lib/hadoop-hdfs/cache/hdfs/dfs/name has been successfully formatted.
   ```
4. The above step can also be done via SUSE Manager Remote Commands. Note: If executed from within SUSE Manager, the output can be seen within each system or scheduled job under Events / History.

Task VI: Start the Services
Try executing remote commands on the different systems with their roles. Use the bash shell as expected by Hadoop, i.e., #!/bin/bash:

1. For the NameNode server, execute:
   ```bash
   - for x in `cd /etc/init.d ; ls hadoop-hdfs-*` ; do sudo service $x start ; done
   - for x in `cd /etc/init.d ; ls hadoop-hdfs-*` ; do sudo service $x status ; done
   - sudo hdfs hadoop fs -mkdir /tmp
   - sudo hdfs hadoop fs -mkdir /user/hdfs
   ```
2. The MapReduce HDFS Systems Directories need to get created; you may also execute this within the NameNode:
   ```bash
   - sudo -u hdfs hadoop fs -mkdir -p /var/lib/hadoop-hdfs/cache/mapred/mapred/staging
   - sudo -u hdfs hadoop fs -chmod 777 /var/lib/hadoop-hdfs/cache/mapred/mapred/staging
   - sudo -u hdfs hadoop fs -chown -R mapred /var/lib/hadoop-hdfs/cache/mapred
   ```
3. For the Job Tracker and DataNodes, simply execute:
   ```bash
   - for x in `cd /etc/init.d ; ls hadoop-hdfs-*` ; do sudo service $x start ; done
   - for x in `cd /etc/init.d ; ls hadoop-hdfs-*` ; do sudo service $x status ; done
   - for x in `cd /etc/init.d ; ls hadoop-0.20-mapreduce-*` ; do sudo service $x start ; done
   - for x in `cd /etc/init.d ; ls hadoop-0.20-mapreduce-*` ; do sudo service $x status ; done
   ```

Task VII: Verify Hadoop Is Properly Running
Hadoop Jobs should be executed within SUSE Manager to keep an event History/Audit. For this example we will use the command line to familiarize you with Hadoop.

1. SSH into the Hadoop NameNode; execute the following commands and read through their output.
   ```bash
   - sudo -u hdfs hdfs dfsadmin -report
   - sudo -u hdfs hadoop fs -ls -R /
   - sudo -u hdfs hdfs balancer
   ```
2. To “upload” a file into HDFS:
   ```bash
   - sudo -u hdfs hadoop fs -put /root/MyBigLog input
   ```
3. To delete a file, skipping the Trash bin:
   ```bash
   - sudo -u hdfs hadoop fs -rm -r -skipTrash /user/hdfs/input
   ```
Appendix A—Hadoop Configuration Files

/etc/hadoop/conf/mapred-site.xml

```xml
<?xml version="1.0"?>
<!--
   Licensed to the Apache Software Foundation (ASF)...
-->?
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>

<configuration>
  <property>
    <name>mapred.job.tracker</name>
    <value>JobTrackerHost_Name.Domain.com:8021</value>
  </property>
  <property>
    <name>mapred.local.dir</name>
    <value>/data/1/mapred/local</value>
  </property>
</configuration>
```

/etc/hadoop/conf/hdfs-site.xml

```xml
<?xml version="1.0"?>
<!--
   Licensed to the Apache Software Foundation (ASF)...
-->?
<?xml-stylesheet type="text/xsl" href="configuration.xsl"?>

<configuration>
  <property>
    <name>dfs.name.dir</name>
    <value>/data/1/dfs/nn</value>
  </property>
  <property>
    <name>dfs.permissions.superusergroup</name>
    <value>hadoop</value>
  </property>
  <property>
    <name>dfs.data.dir</name>
    <value>/data/1/dfs/dn</value>
  </property>
</configuration>
```

/etc/hadoop/conf/core-site.xml
Appendix B—Minimal AutoYaST Profile for Automated Installations

The following AutoYaST profile will install a SUSE Linux Enterprise Server system with all default installation options including a default network configuration with DHCP. After the installation is completed, a bootstrap script located on the SUSE Manager server will be executed in order to register the freshly installed system with SUSE Manager. You will need to adjust the IP address of the SUSE Manager server, the name of the bootstrap script and the root password according to your needs in the following lines.

```xml
<user>
  ...
  <username>root</username>
  <user_password>linux</user_password>
</user>
<location>http://192.168.1.1/pub/bootstrap/my_bootstrap.sh</location>
```

The complete AutoYaST file:

```xml
<configuration>
  <property>
    <name>fs.defaultFS</name>
    <value>hdfs://NameNodeHostname.Domain.com/</value>
  </property>
</configuration>
```

```xml
<?xml version="1.0"?>
<!DOCTYPE profile>
<profile xmlns="http://www.suse.com/1.0/yast2ns" xmlns:config="http://www.suse.com/1.0/configns">
  <general>
    <mode>
      <confirm config:type="boolean">false</confirm>
    </mode>
  </general>
  <networking>
    <keep_install_network config:type="boolean">true</keep_install_network>
  </networking>
  <software>
    <install_recommended config:type="boolean">true</install_recommended>
    <patterns config:type="list">
      <pattern>base</pattern>
    </patterns>
</profile>
```
Appendix C—SUSE Manager Monitoring Key

nocpulse monitoring key

#!/bin/sh
cat <<EOF > .nocpulse/.ssh/authorized_keys
ssh-dss AABBAB3NzaC3k3MABCCCAJ4cmyf5jt/IhdfETbN6IYHsT0np0SYJz7xkJh0cUUNm2m0Uq7eXctbGbC2iZLpp0Zg2Aepw1vUHXfAY/L9X1XvsV8K5Qmcu70h0JgchBIder/11jgbHMCgDVFPtFvVseada4AAAACa99dHbWhk/dMPIwXgHxd10vT2Snuoz1ox2klmfbTe04Ajn/Rcrxqgs5diat/NIaeoItuGUYepX0vVv8DVL3wpp45E02hjmp4j2MYNpc6FCn3nPOVntu6YBv+whB0VrsVzegX89u23FFjTLQbfYrmMQtINi
j8yyGRePIMPhI= root@example.com
EOF
Appendix D—Other Required Commands

mkdir -p /data/1/dfs/nn
mkdir -p /data/1/dfs/dn
mkdir -p /data/1/mapred/local
chown -R hdfs:hdfs /data/1/dfs/nn
chown -R hdfs:hdfs /data/1/dfs/dn
chown -R mapred:hadoop /data/1/mapred/local