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Overview

The SAS High-Performance Analytics Infrastructure: Installation and Configuration Guide explains how to install and initially configure the SAS High-Performance Analytics infrastructure. This infrastructure consists of the following products:

- SAS High-Performance Computing Management Console 2.8
- SAS Plug-ins for Hadoop, version 1.0
- SAS High-Performance Analytics environment 3.5
  (also referred to as the SAS High-Performance Node Installation)

SAS High-Performance Analytics Infrastructure 3.5 includes the following changes and enhancements:

- "SAS High-Performance Deployment for Hadoop Discontinued" on page v
- "SAS Plug-ins for Hadoop" on page vi

SAS High-Performance Deployment for Hadoop Discontinued

SAS has discontinued SAS High-Performance Deployment for Hadoop.

If you want to co-locate the SAS High-Performance Analytics environment with Hadoop, you can select and install a supported commercial version of Hadoop that meets your business requirements. Or you can choose to download and deploy an Apache Hadoop distribution.
Supported Hadoop distributions that you co-locate with the analytics environment must be modified with SAS Plug-ins for Hadoop.

For more information, see “Overview of Modifying Co-located Hadoop” on page 38.

SAS Plug-ins for Hadoop

SAS Plug-ins for Hadoop is a package that provides services to your supported Hadoop distribution. These services enable the SAS High-Performance Analytics environment to write SASHDAT file blocks evenly across the HDFS file system. For more information, see “Overview of Modifying Co-located Hadoop” on page 38.
Accessibility

For information about the accessibility of any of the products mentioned in this document, see the usage documentation for that product.
Introduction to Deploying the SAS High-Performance Analytics Infrastructure

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What Is Covered in This Document?

This document covers tasks that are required after you and your SAS representative have decided what software you need and on what machines you will install the software. At this point, you can begin performing some pre-installation tasks, such as creating a SAS Software Depot if your site already does not have one and setting up the operating system user accounts that you will need.
By the end of this document, you will have deployed the SAS High-Performance Analytics environment, and optionally, SAS High-Performance Computing Management Console, and SAS Plug-ins for Hadoop.

You will then be ready to deploy your SAS solution (such as SAS Visual Analytics, SAS High-Performance Risk, and SAS High-Performance Analytics Server) on top of the SAS High-Performance Analytics infrastructure. For more information, see the documentation for your respective SAS solution.

Which Version Do I Use?

This document is published for each major release of the SAS High-Performance Analytics infrastructure, which consists of the following components:

- SAS High-Performance Computing Management Console, version 2.8
- SAS Plug-ins for Hadoop, version 1.0
- SAS High-Performance Analytics environment, version 3.5
  (also referred to as the SAS High-Performance Node Installation)

Refer to your order summary to determine the specific version of the infrastructure that is included in your SAS order. Your order summary resides in your SAS Software Depot for your respective order under the install_doc directory (for example, C:\SAS Software Depot\install_doc\my-order\ordersummary.html).

What is the Infrastructure?

The SAS High-Performance Analytics infrastructure consists of software that performs analytic tasks in a high-performance environment, which is characterized by massively parallel processing (MPP). The infrastructure is used by SAS products and solutions that typically analyze big data that resides in a distributed data storage appliance or Hadoop cluster.
The following figure depicts the SAS High-Performance Analytics infrastructure in its most basic topology:

**Figure 1.1  SAS High-Performance Analytics Infrastructure Topology (Simplified)**

The SAS High-Performance Analytics infrastructure consists of the following components:

- **SAS High-Performance Analytics environment**
  The SAS High-Performance Analytics environment is the core of the infrastructure. The environment performs analytic computations on an analytics cluster. The analytics cluster is a Hadoop cluster or a data appliance.

- **(Optional) SAS Plug-ins for Hadoop**
  Some solutions, such as SAS Visual Analytics, rely on a SAS data store that is co-located with the SAS High-Performance Analytics environment on the analytics cluster. One option for this co-located data store is SAS Plug-ins for Hadoop.

  If you already have one of the supported Hadoop distributions, you can modify it with files from the SAS Plug-ins for Hadoop package. Hadoop modified with SAS Plug-ins for Hadoop enables the SAS High-Performance Analytics environment to write SASHDAT file blocks evenly across the HDFS file system. This even distribution provides a balanced workload across the machines in the cluster and enables SAS analytic processes to read SASHDAT tables at very impressive rates.

  For more information, see “Overview of Modifying Co-located Hadoop” on page 38.

- **(Optional) SAS High-Performance Computing Management Console**
The SAS High-Performance Computing Management Console is used to ease the administration of distributed, high-performance computing (HPC) environments. Tasks such as configuring passwordless SSH, propagating user accounts and public keys, and managing CPU and memory resources on the analytics cluster are all made easier by the management console.

Other software on the analytics cluster includes the following:

- **SAS/ACCESS Interface and SAS Embedded Process**
  Together the SAS/ACCESS Interface and SAS Embedded Process provide a high-speed parallel connection that delivers data from the co-located SAS data source to the SAS High-Performance Analytics environment on the analytics cluster. These components are contained in a deployment package that is specific for your data source.
  
  For more information, refer to the *SAS In-Database Products: Administrator’s Guide* and the *SAS/ACCESS for Relational Databases: Reference*.
  
  **Note:** For deployments that use Hadoop for the co-located data provider and access SASHDAT tables exclusively, SAS/ACCESS and SAS Embedded Process is *not* needed.

- **Database client libraries or JAR files**
  Data vendor-supplied client libraries—or in the case of Hadoop, JAR files—are required for the SAS Embedded Process to transfer data to and from the data store and the SAS High-Performance Analytics environment.

- **SAS solutions**
  The SAS High-Performance Analytics infrastructure is used by various SAS High-Performance solutions such as the following:
  - SAS High-Performance Analytics Server
  - SAS Customer Intelligence
  - SAS High-Performance Risk
  - SAS Visual Analytics

---

**Where Do I Locate My Analytics Cluster?**

**Overview of Locating Your Analytics Cluster**

You have two options for where to locate your SAS analytics cluster:

- **Co-locate SAS with your data store.**
- **Separate SAS from your data store.**

  When your SAS analytics cluster is separated (remote) from your data store, you have two basic options for transferring data:
  - Serial data transfer using SAS/ACCESS.
  - Parallel data transfer using SAS/ACCESS in conjunction with the SAS Embedded Process.

The topics in this section contain simple diagrams that describe each option for analytics cluster placement:
Co-Located with your Hadoop cluster
Remote from the data store (serial connection)
Remote from the data store (parallel connection)

**TIP** Where you locate your cluster depends on a number of criteria. Your SAS representative will know the latest supported configurations, and can work with you to help you determine which cluster placement option works best for your site. Also, there might be solution-specific criteria that you should consider when determining your analytics cluster location. For more information, see the installation or administration guide for your specific SAS solution.

### Analytics Cluster Co-Located with Your Hadoop Cluster

**Note:** In a co-located configuration, the SAS High-Performance Analytics environment supports the Apache, Cloudera, Hortonworks, IBM BigInsights, MapR, and Pivotal HD distributions of Hadoop. For more specific version information, see the [SAS 9.4 Supported Hadoop Distributions](#).

The following figure shows the analytics cluster co-located on your Hadoop cluster:

**Figure 1.2 Analytics Cluster Co-Located with the Hadoop Cluster**

Note: For deployments that use Hadoop for the co-located data provider and access SASHDAT tables exclusively, SAS/ACCESS and the SAS Embedded Process are not needed.
Analytics Cluster Remote from Your Data Store (Serial Connection)

The following figure shows the analytics cluster using a serial connection to your remote data store:

*Figure 1.3  Analytics Cluster Remote from Your Data Store (Serial Connection)*

The serial connection between the analytics cluster and your data store is achieved by using the SAS/ACCESS Interface. SAS/ACCESS is orderable in a deployment package that is specific for your data source. For more information, refer to the SAS/ACCESS for Relational Databases: Reference.
Analytics Cluster Remote from Your Data Store (Parallel Connection)

Note: In the third maintenance release of SAS 9.4, SAS Embedded Process supports the Cloudera, Hortonworks, IBM BigInsights, MapR, and Pivotal HD distributions of Hadoop. For more specific version information, see the SAS 9.4 Support for Hadoop.

The following figure shows the analytics cluster using a parallel connection to your remote data store:

Figure 1.4  Analytics Cluster Remote from Your Data Store (Parallel Connection)
Together the SAS/ACCESS Interface and SAS Embedded Process provide a high-speed parallel connection that delivers data from your data source to the SAS High-Performance Analytics environment on the analytics cluster. These components are contained in a deployment package that is specific for your data source. For more information, refer to the SAS In-Database Products: Administrator’s Guide.

Hadoop Deployment Comparison

The following table compares various deployment Hadoop scenarios.

### Table 1.1  Hadoop Deployment Comparison

<table>
<thead>
<tr>
<th></th>
<th>Co-located with Hadoop</th>
<th>Co-located with Hadoop</th>
<th>Remote Data Provider</th>
<th>Remote Data Provider</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SASHDAT: Yes</td>
<td>SASHDAT: No</td>
<td>SASHDAT: Not</td>
<td>SASHDAT: Not</td>
</tr>
<tr>
<td></td>
<td>SAS Embedded Process: No</td>
<td>SAS Embedded Process: Yes</td>
<td>Supported</td>
<td>Supported</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SASHDAT Support</th>
<th>Yes</th>
<th>No</th>
<th>No, SASHDAT is co-located or MapR NFS only.</th>
<th>No. SASHDAT is co-located or MapR NFS only.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Parallel R/W</th>
<th>Yes for SASHDAT and CSV.</th>
<th>Yes. (At least for PROC HDMD.)</th>
<th>No, SAS/ACCESS can perform a serial read through the root node.</th>
<th>Yes. SAS/ACCESS and SAS Embedded Process enable this.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Asymmetric*</th>
<th>No for SASHDAT.</th>
<th>Yes. SAS Embedded Process on all the machines can deliver data to a fewer or greater number of machines.</th>
<th>No. SAS/ACCESS can perform a serial read through the root node.</th>
<th>Yes. SAS Embedded Process on all the machines can deliver data to a fewer or greater number of machines.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Serial Reads for SAS/ACCESS</th>
<th>SAS/ACCESS reads are always serial without SAS Embedded Process.</th>
<th>(If something is misconfigured, SAS/ACCESS performs a serial read.)</th>
<th>SAS/ACCESS reads are always serial without SAS Embedded Process.</th>
<th>(If something is misconfigured, SAS/ACCESS performs a serial read.)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Popularity</th>
<th>This is the SAS Visual Analytics configuration.</th>
<th>Rare.</th>
<th>Rare.</th>
<th>Popular. (Can be combined with a co-located Hadoop configuration.)</th>
</tr>
</thead>
</table>

* Asymmetric refers to a deployment where the total number of SAS High-Performance Analytics environment worker nodes is not equal to the total number of Hadoop data nodes. Symmetric refers to an equal number of worker nodes and data nodes.
Overview of Deploying the Infrastructure
The following list summarizes the steps required to install and configure the SAS High-Performance Analytics infrastructure:
1. Create a SAS Software Depot.
2. Check for documentation updates.
3. Prepare your analytics cluster.
4. (Optional) Deploy SAS High-Performance Computing Management Console.
5. (Optional) Modify co-located Hadoop.
6. Deploy the SAS High-Performance Analytics environment.
7. (Optional) Deploy the SAS Embedded Process for Hadoop.
8. (Optional) Configure the analytics environment for a remote parallel connection

The following sections provide a brief description of each of these tasks. Subsequent chapters in the guide provide the step-by-step instructions.

Step 1: Create a SAS Software Depot
Create a SAS Software Depot, which is a special file system used to deploy your SAS software. The depot contains the SAS Deployment Wizard—the program used to install and initially configure most SAS software—one or more deployment plans, a SAS installation data file, order data, and product data.

*Note:* If you have chosen to receive SAS through Electronic Software Delivery, a SAS Software Depot is automatically created for you.

For more information, see “Creating a SAS Software Depot” in *SAS Intelligence Platform: Installation and Configuration Guide.*

Step 2: Check for Documentation Updates
It is very important to check for late-breaking installation information in SAS Notes and also to review the system requirements for your SAS software.

- **SAS Notes**
  
  Go to this web page and click **Outstanding Alert Status Installation Problems**:
  

- **system requirements**
  
  Refer to the system requirements for your SAS solution.
Step 3: Prepare Your Analytics Cluster

Preparing your analytics cluster includes tasks such as creating a list of machine names in your grid hosts file. Setting up passwordless SSH is required, as well as considering system umask settings. You must determine which operating system is required to install, configure, and run the SAS High-Performance Analytics infrastructure. Also, you will need to designate ports for the various SAS components that you are deploying.

For more information, see Chapter 2, “Preparing Your System to Deploy the SAS High-Performance Analytics Infrastructure,” on page 13.

Step 4: (Optional) Deploy SAS High-Performance Computing Management Console

SAS High-Performance Computing Management Console is an optional web application tool that eases the administrative burden on multiple machines in a distributed computing environment.

For example, when you are creating operating system accounts and passwordless SSH on all machines in the cluster or on blades across the appliance, the management console enables you to perform these tasks from one location.

For more information, see Chapter 3, “Deploying SAS High-Performance Computing Management Console,” on page 25.

Step 5: (Optional) Modify Co-located Hadoop

If your site wants to use Hadoop as the co-located data store, then you can modify a supported pre-existing Hadoop distribution.

For more information, see Chapter 4, “Modifying Co-Located Hadoop ,” on page 37.

Step 6: Deploy the SAS High-Performance Analytics Environment

The SAS High-Performance Analytics environment consists of a root node and worker nodes. The product is installed by a self-extracting shell script.

Software for the root node is deployed on the first host. Software for a worker node is installed on each remaining machine in the cluster or database appliance.

For more information, see Chapter 5, “Deploying the SAS High-Performance Analytics Environment,” on page 53.

Step 7: (Optional) Deploy the SAS Embedded Process for Hadoop

Together the SAS/ACCESS Interface and SAS Embedded Process provide a high-speed parallel connection that delivers data from the co-located SAS data source to the SAS High-Performance Analytics environment on the analytics
cluster. These components are contained in a deployment package that is specific for your data source.

For information about installing the SAS Embedded Process, see the SAS In-
Database Products: Administrator's Guide.

Step 8: (Optional) Configure the Analytics Environment for a Remote Parallel Connection

You can optionally configure the SAS High-Performance Analytics Environment for a remote parallel connection.

For more information, see Chapter 6, “Configuring the Analytics Environment for a Remote Parallel Connection,” on page 67.
Preparing your analytics cluster is the third of eight steps required to install and configure the SAS High-Performance Analytics infrastructure.

1. Create a SAS Software Depot.
2. Check for documentation updates.
3. Prepare your analytics cluster.

4. (Optional) Deploy SAS High-Performance Computing Management Console.

5. (Optional) Modify co-located Hadoop.

6. Deploy the SAS High-Performance Analytics environment.

7. (Optional) Deploy the SAS Embedded Process for Hadoop.

8. (Optional) Configure the analytics environment for a remote parallel connection.

System Settings for the Infrastructure

Understand the system requirements for a successful SAS High-Performance Analytics infrastructure deployment before you begin. The lists that follow offer recommended settings for the analytics infrastructure on every machine in the cluster or blade in the data appliance:

- Edit the /etc/sudoers file to disable the requirement for a terminal:
  
  `Defaults !requiretty`

  Also, when issuing a sudo command with the simultaneous commands (simcp, simsh) be sure to place sudo first. For example:

  `sudo /opt/TKGrid/bin/simsh ls -dl /root`

  These steps address a known bug in Red Hat Linux:

  https://bugzilla.redhat.com/show_bug.cgi?id=1020147

- Modify /etc/ssh/sshd_config with the following setting:

  `MaxStartups 1000`

- Modify /etc/security/limits.conf with the following settings:

  - soft nproc 65536
  - hard nproc 65536
  - soft nofile 350000
  - hard nofile 350000

- Modify /etc/security/limits.d/90-nproc.conf with the following setting:

  - soft nproc 65536

- Modify /etc/sysconfig/cpuspeed with the following setting:

  `GOVERNOR=performance`

- The SAS High-Performance Analytics components require approximately 1.1 GB of disk space. This estimate does not include the disk space that is needed for storing data that is added to Hadoop Distributed File System (HDFS) for use by the SAS High-Performance Analytics environment.

  For more information, refer to the system requirements for your SAS solution.
List the Machines in the Cluster or Appliance

Before the SAS High-Performance Analytics infrastructure can be installed on the machines in the cluster, you must create a file that lists all of the host names of the machines in the cluster.

On blade 0 (known as the Master Server on Greenplum), create an `/etc/gridhosts` file for use by SAS High-Performance Computing Management Console, SAS Plug-ins for Hadoop, and the SAS High-Performance Analytics environment. (The grid hosts file is copied to the other machines in the cluster during the installation process.) For more information, see Chapter 3, “Deploying SAS High-Performance Computing Management Console,” on page 25 before you start the installation.

**CAUTION!** The gridhosts file must contain only those machines that are members of your analytics cluster or data appliance. These machines are the NameNode (or Root Node) and its DataNodes (or Worker Nodes). If the management console is located on a machine that is not a member of the analytics cluster, then this machine must also contain a copy of `/etc/gridhosts` with its host name added to the list of machines.

You can use short names or fully qualified domain names so long as the host names in the file resolve to IP addresses. The long and short host names for each node must be resolvable from each node in the environment. The host names listed in the file must be in the same DNS domain and sub-domain. These host names are used for Message Passing Interface (MPI) communication.

The root node is listed first. This is also the machine that is configured as the following, depending on your data provider:

- **Supported Hadoop distributions:** NameNode (blade 0)
- **Greenplum Data Computing Appliance:** Master Server

The following lines are an example of the file contents:

```
grid001
grid002
grid003
grid004
...
```

**Note:** Care must be taken with your gridhosts file. The gridhosts file can appear to be readable, but the SAS High-Performance Analytics environment can skip entries when whitespace characters (such as tabs) have been inadvertently inserted.

**TIP** You can use SAS High-Performance Computing Management Console to create and manage your grid hosts file. For more information, see the **SAS High-Performance Computing Management Console: User's Guide**.
TIP If you are not familiar with passwordless Secure Shell (SSH) please see Appendix 5, “Setting Up Passwordless Secure Shell (SSH),” on page 93.

Secure Shell (SSH) has the following requirements:

- To support Kerberos, enable GSSAPI authentication methods in your implementation of Secure Shell (SSH).
  
  Note: If you are using Kerberos, see “Configure Passwordless SSH to Use Kerberos” on page 18.

- Passwordless Secure Shell (SSH) is required on all machines in the cluster or on the data appliance.
  
  Note the following items:
  
  - If your SAS compute server is on a separate system from the SAS High-Performance Analytics environment name node, then you need to copy the ~/.ssh directory on the compute server machine as well.
  - Passwordless SSH must be bi-directional between all of the analytics environment worker nodes.

- The following user accounts require passwordless SSH:

  - root user account
    
    The root account must run SAS High-Performance Computing Management Console and the simultaneous commands (for example, simsh and simcp). For more information about management console user accounts, see “Preparing to Install SAS High-Performance Computing Management Console” on page 20.

  - Hadoop user account
    
    For more information about Hadoop user accounts, see “Requirements for Co-located Hadoop” on page 21.

  - SAS High-Performance Analytics environment user account
    
    Passwordless SSH must be configured for every user that runs a SAS High-Performance procedure or interacts with SAS LASR Analytic Server or SAS data (sashdat format).

    For more information about the environment’s user accounts, see “Preparing to Deploy the SAS High-Performance Analytics Environment” on page 21.

TIP Users’ home directories must be located in the same directory on each machine in the analytics cluster. For example, you will experience problems if user foo has a home directory at /home/foo on blade one and blade two, and a home directory at /mnt/user/foo on blade three.
Preparing for Kerberos

Kerberos Prerequisites

The SAS High-Performance Analytics infrastructure supports the Kerberos computer network authentication protocol. Throughout this document, we indicate the particular settings that you need to perform in order to make parts of the infrastructure configurable for Kerberos. However, you must understand and be able to verify your security setup. If you are using Kerberos, you need the ability to get a Kerberos ticket.

The list of Kerberos prerequisites is:

- A Kerberos key distribution center (KDC)
- All machines configured as Kerberos clients
- Permissions to copy and secure Kerberos keytab files on all machines
- A user principal for the Hadoop user
  (This is used for setting up the cluster and performing administrative functions.)
- Encryption types supported on the Kerberos domain controller should be aes256-cts:normal and aes128-cts:normal

Generate and Test Host Principals: Example

This topic provides an example of setting up hosts using MIT Kerberos. There are other implementations of Kerberos, such as Microsoft Active Directory, that the SAS High-Performance Analytics infrastructure supports.

Every machine in the analytics cluster must have a host principal and a Kerberos keytab in order to operate as Kerberos clients.

To generate and test host principals, follow these steps:

1. Execute kadmin.local on the KDC.

2. Run the following command for each machine in the cluster:
   ```
   addprinc -randkey +ok_to_delegate host/$machine-name
   ```
   where `machine-name` is the host name of the particular machine.

3. Generate host keytab files in kadmin.local for each machine, by running the following command:
   ```
   ktadd -norandkey -k $machine-name.keytab host/$machine-name
   ```
   where `machine-name` is the name of the particular machine.

   **TIP** When generating keytab files, it is a best practice to create files by machine. In the event a keytab file is compromised, the keytab will contain only the host principal associated with machine it resides on, instead of a single file that contains every machine in the environment.
4 Copy each generated keytab file to its respective machine under /etc, rename the file to krb5.keytab, and secure it with mode 600 and owned by root.

For example:

```
cp keytab /etc/krb5.keytab
chown root:root /etc/krb5.keytab
chmod 600 /etc/krb5.keytab
```

5 Validate your configuration in a temporary credential cache (ccache) to avoid overwriting any ccache in your user session with the host’s credentials:

```
kinit -kt /etc/krb5.keytab -c ~/testccache host/REALM.NAME
```

6 Because kinit obtains only a krbtgt ticket for a given principal, also validate that Kerberos is able to issue service tickets for the host principal:

```
kvno -c ~/testccache machine.name@REALM.NAME
```

7 Run the klist command to check the status of your Kerberos ticket:

```
klist -efac ~/testccache
```

Your klist output should resemble the following:

```
Ticket cache: FILE:/home/myacct/testccache
Default principal: host/myserver.example.com@NA.EXAMPLE.COM

Valid starting   Expires           Service principal
07/07/15 15:33:32 07/08/15 15:33:32  krbtgt/NA.EXAMPLE.COM@NA.EXAMPLE.COM
   renew until 07/14/15 15:33:32, Flags: FRIA
   Addresses: (none)
07/07/15 15:34:09 07/08/15 15:33:32  host/myserver.example.com@NA.EXAMPLE.COM
   renew until 07/14/15 15:33:32, Flags: FRAO
   Addresses: (none)
```

Note: If you intend to deploy the SAS Embedded Process on the cluster for use with SAS/ACCESS Interface to Hadoop, then a user keytab file for the user ID that runs HDFS is required.

8 Delete your ccache:

```
kdestroy -c ~/testccache
```

---

### Configure Passwordless SSH to Use Kerberos

**TIP** If you are not familiar with passwordless Secure Shell (SSH), please see Appendix 5, “Setting Up Passwordless Secure Shell (SSH),” on page 93.

Passwordless access of some form is a requirement of the SAS High-Performance Analytics environment through its use of the Message Passing Interface (MPI). Traditionally, public key authentication in Secure Shell (SSH) is used to meet the passwordless access requirement. For Secure Mode Hadoop, GSSAPI with Kerberos is used as the passwordless SSH mechanism. GSSAPI
with Kerberos not only meets the passwordless SSH requirements, but also supplies Hadoop with the credentials required for users to perform operations in HDFS with SAS LASR Analytic Server and SASHDAT files. Certain options must be set in the SSH daemon and SSH client configuration files. Those options are as follows and assume a default configuration of sshd.

To configure passwordless SSH to use Kerberos, follow these steps:

1. In the `sshd_config` file, set:

   `GSSAPIAuthentication yes`

2. In the `ssh_config` file, set:

   `Host *.domain.net
   GSSAPIAuthentication yes
   GSSAPIDelegateCredentials yes`

   where `domain.net` is the domain name used by the machine in the cluster.

   **TIP** Although you can specify `host *`, this is not recommended because it would allow GSSAPI Authentication with any host name.

---

**Preparing the Analytics Environment for Kerberos**

During start-up, the Message Passing Interface (MPI) sends a user’s Kerberos credentials cache (KRB5CCNAME) that can cause an issue when Hadoop attempts to use Kerberos credentials to perform operations in HDFS.

Under Secure Shell (SSH), a random set of characters are appended to the credentials cache file, so the value of the KRB5CCNAME environment variable is different for each machine. To set the correct value for KRB5CCNAME on each machine, you must use the option below when asked for additional options to MPIRUN during the analytics environment installation:

```
-genvlist `env | sed -e s/=.*/,/ | sed /KRB5CCNAME/d | tr -d '\n'`TKPATH,LD_LIBRARY_PATH
```

**Note:** Enter the above option on one line. Do not add any carriage returns or other whitespace characters.

For more information, see Table 5.2 on page 59.

You must use a launcher that supports GSSAPI authentication because the implementation of SSH that is included with SAS does not support it. Add the following to your SAS programs on the client:

```
option set=GRIDRSHCOMMAND="/path-to-file/ssh";
```

**TIP** Adding GRIDRSHCOMMAND to your sasv9_usermods.cfg preserves the setting during SAS upgrades and avoids having to manually set that environment variable on the client before starting SAS.
Preparing to Install SAS High-Performance Computing Management Console

User Account Considerations for the Management Console

SAS High-Performance Computing Management Console is installed from either an RPM or a tarball package and must be installed and configured with the root user ID. The root user account must have passwordless secure shell (SSH) access between all the machines in the cluster. The console includes a web server. The web server is started with the root user ID, and it runs as the root user ID.

The reason that the web server for the console must run as the root user ID is that the console can be used to add, modify, and delete operating system user accounts from the local passwords database (/etc/passwd and /etc/shadow). Only the root user ID has Read and Write access to these files.

Be aware that you do not need to log on to the console with the root user ID. In fact, the console is typically configured to use console user accounts. Administrators can log on to the console with a console user account that is managed by the console itself and does not have any representation in the local passwords database or whatever security provider the operating system is configured to use.

Management Console Requirements

Before you install SAS High-Performance Computing Management Console, make sure that you have performed the following tasks:

- Make sure that the Perl extension perl-Net-SSLeay is installed.
- For PAM authentication, make sure that the Authen::PAM PERL module is installed.
  
  Note: The management console can manage operating system user accounts if the machines are configured to use the /etc/passwd local database only.
- Create the list of all the cluster machines in the /etc/gridhosts file. You can use short names or fully qualified domain names so long as the host names in the file resolve to IP addresses. These host names are used for Message Passing Interface (MPI) communication and Hadoop network communication. For more information, see “List the Machines in the Cluster or Appliance” on page 15.
- Locate the software.
  
  Make sure that your SAS Software Depot has been created. (For more information, see Creating a SAS Software Depot in the SAS Intelligence Platform: Installation and Configuration Guide.)
Requirements for Co-located Hadoop

If you already have one of the supported Hadoop distributions, you can modify it with files from the SAS Plug-ins for Hadoop package. Hadoop modified with SAS Plug-ins for Hadoop enables the SAS High-Performance Analytics environment to write SASHDAT file blocks evenly across the HDFS file system.

The following is required for existing Hadoop clusters with which the SAS High-Performance Analytics environment can be co-located:

- **Your Hadoop distribution must be supported.**
- Each machine in the cluster must be able to resolve the host name of all the other machines.
- The NameNode host does not also have a DataNode configured on it.
- These Hadoop directories must reside on local storage:
  - the directory on the file system where the Hadoop NameNode stores the namespace and transactions logs persistently
  - the directory on the file system where temporary MapReduce data is written
  - the directory on the file system where the MapReduce framework writes system files

  **Note:** The exception is the `hadoop-data` directory, which can be on a storage area network (SAN). Network attached storage (NAS) devices are not supported.
- Time must be synchronized across all machines in the cluster.
- (Cloudera 5 only) Make sure that all machines configured for the SAS High-Performance Analytics environment are in the same role group.
- For Kerberos, in the SAS High-Performance Analytics environment, `/etc/hosts` must contain the machine names in the cluster in this order: short name, fully qualified domain name.

Preparing to Deploy the SAS High-Performance Analytics Environment

If you are using Kerberos, see also “Preparing for Kerberos” on page 17.

User Accounts for the SAS High-Performance Analytics Environment

This topic describes the user account requirements for deploying and running the SAS High-Performance Analytics environment:

- Installation and configuration must be run with the same user account.
The installer account must have passwordless secure shell (SSH) access between all the machines in the cluster.

**TIP** We recommend that you install SAS High-Performance Computing Management Console before setting up the user accounts that you will need for the rest of the SAS High-Performance Analytics infrastructure. The console enables you to easily manage user accounts across the machines of a cluster. For more information, see "User Account Considerations for the Management Console" on page 20.

The SAS High-Performance Analytics environment uses a shell script installer. You can use a SAS installer account to install this software if the user account meets the following requirements:

- The SAS installer account has Write access to the directory that you want to use and Write permission to the same directory path on every machine in the cluster.
- The SAS installer account is configured for passwordless SSH on all the machines in the cluster.

The root user ID can be used to install the SAS High-Performance Analytics environment, but it is not a requirement. When users start a process on the machines in the cluster with SAS software, the process runs under the user ID that starts the process. Any user accounts running analytics environment processes must also be configured with passwordless SSH.

**Consider Umask Settings**

The SAS High-Performance Analytics environment installation script (described in a later section) prompts you for a umask setting. Its default is no setting.

If you do not enter any umask setting, then jobs, servers, and so on, that use the analytics environment create files with the user’s pre-existing umask set on the operating system. If you set a value for umask, then that umask is used and overrides each user’s system umask setting.

Entering a value of 027 ensures that only users in the same operating system group can read these files.

**Note:** Remember that the account used to run the LASRMonitor process (by default, sas) must be able to read the table and server files in `/opt/VADP/var` and any other related subdirectories.

**Note:** Remember that the LASRMonitor process that is part of SAS Visual Analytics must be run with an account (by default, sas) that can read the server signature file. (This signature file is created when you start a SAS LASR Analytic Server and the file is specified in SAS metadata. For more information, see Establishing Connectivity to a SAS LASR Analytic Server in the SAS Intelligence Platform: Data Administration Guide.

You can also add umask settings to the resource settings file for the SAS Analytics environment. For more information, see “Resource Management for the Analytics Environment” on page 64.

For more information about using umask, refer to your Linux documentation.
Additional Prerequisite for Greenplum Deployments

For deployments that rely on Greenplum data appliances, the SAS High-Performance Analytics environment requires that you also deploy the appropriate SAS/ACCESS interface and SAS Embedded Process that SAS supplies with SAS In-Database products. For more information, see the SAS In-Database Products: Administrator's Guide.

Recommended Database Names

SAS solutions, such as SAS Visual Analytics, that rely on a co-located data provider can make use of two database instances. The first instance often already exists and is expected to have your operational or transactional data that you want to explore and analyze.

A second database instance is used to support the self-service data access features of SAS Visual Analytics. This database is commonly named "vapublic," but you can specify a different name if you prefer. Keep these names handy, as the SAS Deployment Wizard prompts you for them when deploying your SAS solution.

Pre-installation Ports Checklist for SAS

While you are creating operating system user accounts and groups, you need to review the set of ports that SAS will use by default. If any of these ports is unavailable, select an alternate port, and record the new port on the ports pre-installation checklist that follows.

The following checklist indicates what ports are used for SAS by default and gives you a place to enter the port numbers that you will actually use.

We recommend that you document each SAS port you reserve in the following standard location on each machine: /etc/services. This practice will help avoid port conflicts on the affected machines.

Note: These checklists are superseded by more complete and up-to-date checklists that can be found at http://support.sas.com/installcenter/plans. This website also contains a corresponding deployment plan and an architectural diagram. If you are a SAS solutions customer, consult the pre-installation checklist provided by your SAS representative for a complete list of ports that you must designate.

Table 2.1 Pre-installation Checklist for SAS Ports

<table>
<thead>
<tr>
<th>SAS Component</th>
<th>Default Port</th>
<th>Data Direction</th>
<th>Actual Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAS High-Performance Computing Management Console server</td>
<td>10020</td>
<td>Inbound</td>
<td></td>
</tr>
<tr>
<td>SAS Component</td>
<td>Default Port</td>
<td>Data Direction</td>
<td>Actual Port</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------</td>
<td>----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>SAS Plug-in on the NameNode</td>
<td>15452</td>
<td>Inbound</td>
<td></td>
</tr>
<tr>
<td>SAS Plug-in on the DataNode</td>
<td>15453</td>
<td>Inbound</td>
<td></td>
</tr>
</tbody>
</table>
Deploying SAS High-Performance Computing Management Console

Infrastructure Deployment Process Overview

Benefits of the Management Console

Overview of Deploying the Management Console

Installing the Management Console

Install SAS High-Performance Computing Management Console Using RPM

Install the Management Console Using tar

Configure the Management Console

Create the Installer Account and Propagate the SSH Key

Create the First User Account and Propagate the SSH Key

Infrastructure Deployment Process Overview

Installing and configuring SAS High-Performance Computing Management Console is an optional fourth of eight steps required to install and configure the SAS High-Performance Analytics infrastructure.

1. Create a SAS Software Depot.
2. Check for documentation updates.
3. Prepare your analytics cluster.
4. (Optional) Deploy SAS High-Performance Computing Management Console.
5. (Optional) Modify co-located Hadoop.
6. Deploy the SAS High-Performance Analytics environment.
7. (Optional) Deploy the SAS Embedded Process for Hadoop.
8. (Optional) Configure the analytics environment for a remote parallel connection.
Benefits of the Management Console

Passwordless SSH is required to start and stop SAS LASR Analytic Servers and to load tables. For some SAS solutions, such as SAS High-Performance Risk and SAS High-Performance Analytics Server, passwordless SSH is required to run jobs on the machines in the cluster.

Also, users of some SAS solutions must have an operating system (external) account on all the machines in the cluster and must have the key distributed across the cluster. For more information, see “Create the First User Account and Propagate the SSH Key” on page 32.

SAS High-Performance Computing Management Console enables you to perform these tasks from one location. When you create new user accounts using SAS High-Performance Computing Management Console, the console propagates the public key across all the machines in the cluster in a single operation. For more information, see the SAS High-Performance Computing Management Console: User’s Guide.

Overview of Deploying the Management Console

The SAS High-Performance Computing Management Console is deployed on the machine where the SAS High-Performance Analytics environment is deployed. In this document, that machine is blade 0.

Figure 3.1 Management Console Deployed with a Hadoop Cluster
Installing the Management Console

There are two ways to install SAS High-Performance Computing Management Console.

Install SAS High-Performance Computing Console Using RPM

To install SAS High-Performance Computing Management Console using RPM, follow these steps:

Note: For information about updating the console, see Appendix 1, “Updating the SAS High-Performance Analytics Infrastructure,” on page 79.

1 Make sure that you have reviewed all of the information contained in the section “Preparing to Install SAS High-Performance Computing Management Console” on page 20.

2 Log on to the target machine as root.

3 In your SAS Software Depot, locate the standalone_installs/SAS_High-Performance_Computing_Management_Console/2_8/Linux_for_x64 directory.

4 Enter one of the following commands:
   - To install in the default location of /opt:
     ```
     rpm -ivh sashpcmc*.rpm
     ```
   - To install in a location of your choice:
     ```
     rpm -ivh --prefix=directory sashpcmc*.rpm
     ```
     where `directory` is an absolute path where you want to install the console.

5 Proceed to the topic “Configure the Management Console” on page 28.

Install the Management Console Using tar

Some versions of Linux use different RPM libraries and require and alternative means to Install SAS High-Performance Computing Management Console. Follow these steps to install the management console using tar:

1 Make sure that you have reviewed all of the information contained in the section “Preparing to Install SAS High-Performance Computing Management Console” on page 20.

2 Log on to the target machine as root.

3 In your SAS Software Depot, locate the standalone_installs/SAS_High-Performance_Computing_Management_Console/2_8/Linux_for_x64 directory.

4 Copy sashpcmc-2.8.tar.gz to the location where you want to install the management console.
5 Change to the directory where you copied the tar file, and run the following command:

```bash
tar -xzvf sashpcmc-2.8.tar.gz
```

Tar extracts the contents into a directory called `sashpcmc`.

6 Proceed to the topic “Configure the Management Console” on page 28.

---

**Configure the Management Console**

After installing SAS High-Performance Computing Management Console, you must configure it. This is done with the setup script.

1 Log on to the SAS Visual Analytics server and middle tier machine (blade 0) as root.

2 Run the setup script by entering the following command:

```bash
management-console-installation-directory/opt/webmin/utilbin/setup
```

Answer the prompts that follow.

Enter the username for initial login to SAS HPC MC below. This user will have rights to everything in the SAS HPC MC and can either be an OS account or new console user. If an OS account exists for the user, then system authentication will be used. If an OS account does not exist, you will be prompted for a password.

3 Enter the user name for the initial login.

Creating using system authentication
Use SSL\HTTPS (yes|no)

4 If you want to use Secure Sockets Layer (SSL) when running the console, enter yes. Otherwise, enter no.

5 If you chose not to use SSL, then skip to Step 7 on page 28. Otherwise, the script prompts you to use a pre-existing certificate and key file or to create a new one.

Use existing combined certificate and key file or create a new one (file|create)?

6 Make one of two choices:

- Enter create for the script to generate the combined private key and SSL certificate file for you.
  The script displays output of the `openssl` command that it uses to create the private key pair for you.
- Enter file to supply the path to a valid private key pair.
  When prompted, enter the absolute path for the combined certificate and key file.

7 To start the SAS High-Performance Computing Management Console server, enter the following command from any directory:

```bash
service sashpcmc start
```
8 Open a web browser and, in the address field, enter the fully qualified domain name for the blade 0 host followed by port 10020.

For example: https://myserver.example.com:10020

The Login page appears.

9 Log on to SAS High-Performance Computing Management Console using the credentials that you specified in Step 2.

The Console Management page appears.

---

**Create the Installer Account and Propagate the SSH Key**

The user account needed to start and stop server instances and to load and unload tables to those servers must be configured with passwordless secure shell (SSH).

To reduce the number of operating system (external) accounts, it can be convenient to use the SAS Installer account for both of these purposes.

Implementing passwordless SSH requires that the public key be added to the authorized_keys file across all machines in the cluster. When you create user accounts using SAS High-Performance Computing Management Console, the console propagates the public key across all the machines in the cluster in a single operation.

To create an operating system account and propagate the public key, follow these steps:

1 Make sure that the SAS High-Performance Computing Management Console server is running. While logged on as the root user, enter the following command from any directory:
service sashpcmc status

(If you are logged on as a user other than the root user, the script returns the message *sashpcmc is stopped*.) For more information, see To start the SAS High-Performance Computing Management Console server on page 28.

2 Open a web browser and, in the address field, enter the fully qualified domain name for the blade 0 host followed by port 10020.

For example: http://myserver.example.com:10020

The Login page appears.

3 Log on to SAS High-Performance Computing Management Console.

The Console Management page appears.

4 Click **HPC Management**.

The HPC Management page appears.

5 Click **Users and Groups**.

The Users and Groups page appears.
6 Click **Create a new user**.

The Create User page appears.

7 Enter information for the new user, using the security policies in place at your site.

Be sure to choose **Yes** for the following:
Create the First User Account and Propagate the SSH Key

Depending on their configuration, some SAS solution users must have an operating system (external) account on all the machines in the cluster. Furthermore, the public key might be distributed on each cluster machine in order for their secure shell (SSH) access to operate properly. SAS High-Performance Computing Management Console enables you to perform these two tasks from one location.

To create an operating system account and propagate the public key for SSH, follow these steps:

1. Make sure that the SAS High-Performance Computing Management Console server is running. Enter the following command from any directory:

   `service sashpcmc status`

   For more information, see To start the SAS High-Performance Computing Management Console server on page 28.

2. Open a web browser and, in the address field, enter the fully qualified domain name for the blade 0 host followed by port 10020.

   For example: `http://myserver.example.com:10020`

   The Login page appears.
3 Log on to SAS High-Performance Computing Management Console. The Console Management page appears.

4 Click **HPC Management**. The Console Management page appears.

5 Click **Users and Groups**. The Users and Groups page appears.
6 Click **Create a new user**.

The Create User page appears.

7 Enter information for the new user, using the security policies in place at your site.

Be sure to choose **Yes** for the following:
- **Propagate User**
- **Generate and Propagate SSH Keys**

When you are finished making your selections, click **Create**.

The New User Propagation page appears and lists the status of the create user command. Your task is successful if you see output similar to the following figure.

![New User Propagation Page](image-url)
Modifying a co-located Hadoop cluster is an optional fifth of eight steps required to install and configure the SAS High-Performance Analytics infrastructure.

1. Create a SAS Software Depot.
2. Check for documentation updates.
3. Prepare your analytics cluster.
4. (Optional) Deploy SAS High-Performance Computing Management Console.
   ▶ 5. (Optional) Modify co-located Hadoop.
6. Deploy the SAS High-Performance Analytics environment.
7. (Optional) Deploy the SAS Embedded Process for Hadoop.
8. (Optional) Configure the analytics environment for a remote parallel connection.
Overview of Modifying Co-located Hadoop

Some solutions, such as SAS Visual Analytics, rely on a SAS data store that is co-located with the SAS High-Performance Analytics environment on the analytics cluster.

The following figure shows the analytics environment co-located on a pre-existing Hadoop cluster. In this document, the NameNode is deployed on blade 0.

Figure 4.1  Analytics Cluster Co-located on the Hadoop Cluster

The SAS Plug-ins for Hadoop component provides services to your supported pre-existing Hadoop distribution that enable the SAS High-Performance Analytics environment to write SASHDAT file blocks evenly across the HDFS file system. This even distribution provides a balanced workload across the machines in the cluster and enables SAS analytic processes to read SASHDAT tables at very impressive rates.

With the exception of MapR Hadoop, modifying your supported Hadoop cluster for the analytics environment consists of the following steps:

1. Make sure that your Hadoop distribution meets the requirements on page 21.
2. Copy the SAS Plug-ins for Hadoop package to a temporary location and untar it.
3. Propagate several files from the package to specific Hadoop directories on every machine in your cluster.
4. Restart the HDFS service and any dependencies.

The SAS High-Performance Analytics infrastructure supports the following Hadoop distributions:
Modify the Existing Apache Hadoop Cluster, Version 2.7

If you want to co-locate the SAS High-Performance Analytics environment with a pre-existing Apache Hadoop cluster, you can modify your cluster with files from the SAS Plug-ins for Hadoop package. Apache Hadoop modified with SAS Plug-ins for Hadoop enables the SAS High-Performance Analytics environment to write SASHDAT file blocks evenly across the HDFS file system.

To modify line 2.7 or later of Apache Hadoop with SAS Plug-ins for Hadoop, follow these steps:

1. Make sure that you have reviewed all of the information contained in the section “Requirements for Co-located Hadoop” on page 21.

2. Log on to the Hadoop NameNode machine (blade 0) as root.

3. Create a directory, sas, under $HADOOP_HOME/share/hadoop.

4. The software that is needed for SAS Plug-ins for Hadoop is available from within the SAS Software Depot that was created by your site’s depot administrator:

   depot-installation-location/standalone_installs/
   SAS_Plug-ins_for_Hadoop/1_0/Linux_for_x64/hdatplugins.tar.gz

5. Copy the hdatplugins.tar.gz file to a temporary location and extract it:

   cp hdatplugins.tar.gz /tmp
   cd /tmp
   tar xzf hdatplugins.tar.gz

   A directory that is named hdatplugins is created.

6. Propagate the following three JAR files in hdatplugins to the
   $HADOOP_HOME/share/hadoop/sas directory on each machine in the
   Apache Hadoop cluster:
If you have already installed the SAS High-Performance Computing Management Console or the SAS High-Performance Analytics environment, you can issue a single `simcp` command to propagate JAR files across all machines in the cluster. For example:

```
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.jar
$HADOOP_HOME/share/hadoop/sas
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.hadoop.jar
$HADOOP_HOME/share/hadoop/sas
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.grid.provider.yarn.jar
$HADOOP_HOME/share/hadoop/sas
```

For more information, see Appendix 2, “SAS High-Performance Analytics Infrastructure Command Reference,” on page 85.

7 Propagate saslasrf in hdatplugins to the `$HADOOP_HOME/bin` directory on each machine in the Apache Hadoop cluster.

8 Propagate SAS_VERSION in hdatplugins to the `$HADOOP_HOME/` directory on each machine in the Apache Hadoop cluster.

9 Define the following properties in `$HADOOP_HOME/etc/hadoop/hdfs-site.xml` and propagate the changes across all nodes in your Hadoop cluster:

```
<property>
    <name>dfs.namenode.plugins</name>
    <value>com.sas.lasr.hadoop.NameNodeService</value>
</property>
<property>
    <name>dfs.datanode.plugins</name>
    <value>com.sas.lasr.hadoop.DataNodeService</value>
</property>
<property>
    <name>com.sas.lasr.hadoop.fileinfo</name>
    <value>ls -l {0}</value>
    <description>The command used to get the user, group, and permission information for a file.</description>
</property>
<property>
    <name>com.sas.lasr.service.allow.put</name>
    <value>true</value>
    <description>Flag indicating whether the PUT command is enabled when running as a service. The default is false.</description>
</property>
<property>
    <name>com.sas.lasr.hadoop.service.namenode.port</name>
    <value>15452</value>
</property>
```
Note: You can change the port for the SAS name node and data node plug-ins. This example shows the default ports (15452 and 15453, respectively).

10 Add the plug-in JAR files to the Hadoop class path in $HADOOP_HOME/etc/hadoop/hadoop-env.sh and propagate the changes across all nodes in your Hadoop cluster:

```bash
for f in $HADOOP_HOME/share/hadoop/sas/*.jar; do
  if [ "$HADOOP_CLASSPATH" ]; then
    export HADOOP_CLASSPATH=$HADOOP_CLASSPATH:$f
  else
    export HADOOP_CLASSPATH=$f
  fi
done
```

11 Restart the HDFS service and any dependencies.

12 If you are deploying SAS Visual Analytics, see "Hadoop Configuration Step for SAS Visual Analytics" on page 52.

---

**Modify the Existing Cloudera Hadoop Cluster, Version 5**

If you want to co-locate the SAS High-Performance Analytics environment with a pre-existing Cloudera 5 Hadoop (CDH) cluster, you can modify your cluster with files from the SAS Plug-ins for Hadoop package. CDH modified with SAS Plug-ins for Hadoop enables the SAS High-Performance Analytics environment to write SASHDAT file blocks evenly across the HDFS file system.

1 Untar the SAS Plug-ins for Hadoop tarball, and propagate five files (identified in the following steps) on every machine in your CDH cluster:

   a. Navigate to the SAS Plug-ins for Hadoop tarball in your SAS Software depot:
      
      ```bash
      cd depot-installation-location/standalone_installs/SAS_Plug-ins_for_Hadoop/1_0/Linux_for_x64/hdatplugins.tar.gz
      ```

   b. Copy hdatplugins.tar.gz to a temporary location where you have Write access.

   c. Untar hdatplugins.tar.gz:
      
      ```bash
      tar xzf hdatplugins.tar.gz
      ```
      
      The `hdatplugins` directory is created.

   d. Propagate the following three JAR files in `hdatplugins` into the CDH library path on every machine in the CDH cluster:
      
      - sas.lasr.jar
      - sas.lasr.hadoop.jar
If you have already installed the SAS High-Performance Computing Management Console or the SAS High-Performance Analytics environment, you can issue a single `simcp` command to propagate JAR files across all machines in the cluster. For example:

```
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.jar
/opt/cloudera/parcels/CDH-5.0.0-0.cdh5b1.p0.57/lib/hadoop/lib/
```

For more information, see Appendix 2, “SAS High-Performance Analytics Infrastructure Command Reference,” on page 85.

- Propagate `saslasrfd` in `hdatplugins` into the CDH `bin` directory on every machine in the CDH cluster. For example:

```
/opt/TKGrid/bin/simcp saslasrfd
/opt/cloudera/parcels/CDH-5.0.0-0.cdh5b1.p0.57/lib/hadoop/bin/
```

- Propagate `SAS_VERSION` in `hdatplugins` to the `$HADOOP_HOME` directory on each machine in the CDH cluster.

2. Log on to the Cloudera Manager as an administrator.

3. In `dfs.namenode.plugins`, add the following to the plug-in configuration for the NameNode:

```properties
com.sas.lasr.hadoop.NameNodeService
```

4. In `dfs.datanode.plugins`, add the following to the plug-in configuration for DataNodes:

```properties
com.sas.lasr.hadoop.DataNodeService
```

5. Add the following lines to the advanced configuration for service-wide. These lines are placed in the HDFS Service Advanced Configuration Snippet (Safety Valve) for `hdfs-site.xml`:

```xml
<property>
    <name>com.sas.lasr.service.allow.put</name>
    <value>true</value>
</property>
<property>
    <name>com.sas.lasr.hadoop.service.namenode.port</name>
    <value>15452</value>
</property>
<property>
    <name>com.sas.lasr.hadoop.service.datanode.port</name>
    <value>15453</value>
</property>
<property>
    <name>dfs.namenode.fs-limits.min-block-size</name>
    <value>0</value>
</property>
```
6 Add the following property to the **HDFS Client Advanced Configuration Snippet (Safety Valve) for hdfs-site.xml** under **Advanced** within the **Gateway Default Group**. Make sure that you change *path-to-data-dir* to the data directory location for your site (for example, <value>file:///dfs/dn</value>):

```
<property>
  <name>com.sas.lasr.service.allow.put</name>
  <value>true</value>
</property>
<property>
  <name>com.sas.lasr.hadoop.service.namenode.port</name>
  <value>15452</value>
</property>
<property>
  <name>com.sas.lasr.hadoop.service.datanode.port</name>
  <value>15453</value>
</property>
<property>
  <name> dfs.namenode.fs-limits.min-block-size</name>
  <value>0</value>
</property>
```

7 Add the location of JAVA_HOME to the **HDFS Client Environment Advanced Configuration Snippet for hadoop-env.sh (Safety Valve)**, located under **Advanced** in the **Gateway Default Group**. For example:

```
JAVA_HOME=/usr/lib/java/jdk1.7.0_07
```

**Note:** When Cloudera Manager prioritizes the HDFS client configuration, the client safety valve is used. When Cloudera Manager prioritizes anything else (such as YARN), the service safety valve is used. Therefore, updating both safety values is the best practice. For more information, see Cloudera documentation.

8 Save your changes and deploy the client configuration to each host in the cluster.

9 Restart the HDFS service and any dependencies in Cloudera Manager.

10 Create and mode the /test directory in HDFS for testing the cluster with SAS test jobs. You might need to set HADOOP_HOME first, and you must run the following commands as the user running HDFS (typically, hdfs).

```
$HADOOP_HOME/bin/hadoop fs -mkdir /test

$HADOOP_HOME/bin/hadoop fs -chmod 777 /test
```

11 If you are deploying SAS Visual Analytics, see “Hadoop Configuration Step for SAS Visual Analytics” on page 52.
Modify the Existing Cloudera Hadoop Cluster, Version 4

If you want to co-locate the SAS High-Performance Analytics environment with a pre-existing Cloudera 4 Hadoop (CDH) cluster, you can modify your cluster with files from the SAS Plug-ins for Hadoop package. CDH modified with SAS Plug-ins for Hadoop enables the SAS High-Performance Analytics environment to write SASHDAT file blocks evenly across the HDFS file system.

**TIP** In Cloudera 4.2 and earlier, you must install the enterprise license, even if you are below the stated limit of 50 nodes in the Hadoop cluster for requiring a license.

1. Untar the SAS Plug-ins for Hadoop tarball, and propagate five files (identified in the following steps) on every machine in your CDH cluster:
   a. Navigate to the SAS Plug-ins for Hadoop tarball in your SAS Software depot:
      ```bash
      cd depot-installation-location/standalone_installs/
      SAS_Plug-ins_for_Hadoop/1_0/Linux_for_x64/
      ```
   b. Copy `hdatplugins.tar.gz` to a temporary location where you have Write access.
   c. Untar `hdatplugins.tar.gz`:
      ```bash
      tar xzf hdatplugins.tar.gz
      ```
      The `hdatplugins` directory is created.
   d. Propagate the following three JAR files in `hdatplugins` into the CDH library path on every machine in the CDH cluster:
      - `sas.lasr.jar`
      - `sas.lasr.hadoop.jar`
      - `sas.grid.provider.yarn.jar`

**TIP** If you have already installed the SAS High-Performance Computing Management Console or the SAS High-Performance Analytics environment, you can issue a single `simcp` command to propagate JAR files across all machines in the cluster. For example:

```bash
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.jar
/opt/cloudera/parcels/CDH-4.4.0-1.cdh4.4.0.p0.39/lib/hadoop/lib/
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.hadoop.jar
/opt/cloudera/parcels/CDH-4.4.0-1.cdh4.4.0.p0.39/lib/hadoop/lib/
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.grid.provider.yarn.jar
/opt/cloudera/parcels/CDH-4.4.0-1.cdh4.4.0.p0.39/lib/hadoop/lib/
```

For more information, see Appendix 2, “SAS High-Performance Analytics Infrastructure Command Reference,” on page 85.
1. Propagate saslasrfd in `hdatplugins` into the CDH `bin` directory to the CDH cluster on every machine in the CDH cluster. For example:

   /opt/TKGrid/bin/simcp saslasrfd
   /opt/cloudera/parcels/CDH-4.4.0-1.cdh4.4.0.p0.39/lib/hadoop/bin/

2. Propagate `SAS_VERSION` in `hdatplugins` to the `$HADOOP_HOME` directory on each machine in the CDH cluster.

3. Log on to the Cloudera Manager as an administrator.

4. Add the following to the plug-in configuration for the NameNode:

   `com.sas.lasr.hadoop.NameNodeService`

5. Add the following to the plug-in configuration for DataNodes:

   `com.sas.lasr.hadoop.DataNodeService`

6. Add the following lines to the advanced configuration for service-wide. These lines are placed in the `HDFS Service Configuration Safety Valve` property for `hdfs-site.xml`:

   ```xml
   <property>
   <name>com.sas.lasr.service.allow.put</name>
   <value>true</value>
   </property>
   <property>
   <name>com.sas.lasr.hadoop.service.namenode.port</name>
   <value>15452</value>
   </property>
   <property>
   <name>com.sas.lasr.hadoop.service.datanode.port</name>
   <value>15453</value>
   </property>
   <property>
   <name>dfs.namenode.fs-limits.min-block-size</name>
   <value>0</value>
   </property>
   ```

7. Restart all Cloudera Manager services.

8. Add the following to the `HDFS Client Configuration Safety Valve`:

   ```xml
   <property>
   <name>com.sas.lasr.service.allow.put</name>
   <value>true</value>
   </property>
   <property>
   <name>com.sas.lasr.hadoop.service.namenode.port</name>
   <value>15452</value>
   </property>
   <property>
   <name>com.sas.lasr.hadoop.service.datanode.port</name>
   <value>15453</value>
   </property>
   <property>
   <name>dfs.namenode.fs-limits.min-block-size</name>
   <value>0</value>
   </property>
   ```
9 Add the location of JAVA_HOME to the **Client Environment Safety Valve** for hadoop-env.sh. For example:

```
JAVA_HOME=/usr/lib/java/jdk1.7.0_07
```

10 Save your changes and deploy the client configuration to each host in the cluster.

11 If you are deploying SAS Visual Analytics, see “**Hadoop Configuration Step for SAS Visual Analytics**” on page 52.

**TIP** Remember the value of HADOOP_HOME as the SAS High-Performance Analytics environment prompts for this during its install. By default, these are the values for Cloudera:

- Cloudera 4.5:
  `/opt/cloudera/parcels/CDH-4.5.0-1.cdh4.5.0.p0.30`
- Cloudera 4.2 and earlier:
  `/opt/cloudera/parcels/CDH-4.2.0-1.cdh4.2.0.po.10/lib/Hadoop`

---

### Modify the Existing Hortonworks Data Platform Hadoop Cluster

If you want to co-locate the SAS High-Performance Analytics environment with a pre-existing Hortonworks Data Platform (HDP) cluster, you can modify your cluster with files from the SAS Plug-ins for Hadoop package. HDP modified with SAS Plug-ins for Hadoop enables the SAS High-Performance Analytics environment to write SASHDAT file blocks evenly across the HDFS file system.

1 Log on to Ambari as an administrator, and stop all HDP services.

2 Untar the SAS Plug-ins for Hadoop tarball, and propagate five files (identified in the following steps) on every machine in your Hortonworks Hadoop cluster:

   a Navigate to the SAS Plug-ins for Hadoop tarball in your SAS Software depot:
      ```
      cd depot-installation-location/standalone_installs/
      SAS_Plug-ins_for_Hadoop/1_0/Linux_for_x64/
      ```

   b Copy `hdatplugins.tar.gz` to a temporary location where you have Write access.

   c Untar `hdatplugins.tar.gz`:
      ```
      tar xzf hdatplugins.tar.gz
      ```

      The `hdatplugins` directory is created.

   d Propagate the following three JAR files in `hdatplugins` into the HDP library path on every machine in the HDP cluster:
      ```
      sas.lasr.jar
      ```
- sas.lasr.hadoop.jar
- sas.grid.provider.yarn.jar

**TIP** If you have already installed the SAS High-Performance Computing Management Console or the SAS High-Performance Analytics environment, you can issue a single `simcp` command to propagate JAR files across all machines in the cluster. For example:

```
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.jar
/usr/hdp/2.2.0.0-2041/hadoop/lib
```
```
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.hadoop.jar
/usr/hdp/2.2.0.0-2041/hadoop/lib
```
```
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.grid.provider.yarn.jar
/usr/hdp/2.2.0.0-2041/hadoop/lib
```

For more information, see Appendix 2, “SAS High-Performance Analytics Infrastructure Command Reference,” on page 85.

1. Propagate `saslasrfd` in `hdatplugins` into the HDP bin directory on every machine in the HDP cluster. For example:

```
/opt/TKGrid/bin/simcp saslasrfd /usr/hdp/2.2.0.0-2041/hadoop/bin/
```

2. Propagate `SAS_VERSION` in `hdatplugins` to the `$HADOOP_HOME` directory on each machine in the HDP cluster.

3. In the Ambari interface, create a custom hdfs-site.xml and add the following properties:

   ```
   dfs.namenode.plugins
   com.sas.lasr.hadoop.NameNodeService
   
   dfs.datanode.plugins
   com.sas.lasr.hadoop.DataNodeService
   
   com.sas.lasr.service.allow.put
   true
   
   com.sas.lasr.hadoop.service.namenode.port
   15452
   
   com.sas.lasr.hadoop.service.datanode.port
   15453
   
   dfs.namenode.fs-limits.min-block-size
   0
   ```

4. Save the properties and restart all HDP services.

5. If you are deploying SAS Visual Analytics, see “Hadoop Configuration Step for SAS Visual Analytics” on page 52.
Modify the Existing IBM BigInsights Hadoop Cluster

If you want to co-locate the SAS High-Performance Analytics environment with a pre-existing IBM BigInsights Hadoop cluster, you can modify your cluster with files from the SAS Plug-ins for Hadoop package. BigInsights modified with SAS Plug-ins for Hadoop enables the SAS High-Performance Analytics environment to write SASHDAT file blocks evenly across the HDFS file system.

1. Untar the SAS Plug-ins for Hadoop tarball, and propagate five files (identified in the following steps) on every machine in your BigInsights Hadoop cluster:

   a. Navigate to the SAS Plug-ins for Hadoop tarball in your SAS Software depot:
      
      ```
      cd depot-installation-location/standalone_installs/
      SAS_Plug-ins_for_Hadoop/1_0/Linux_for_x64/
      ```

   b. Copy hdatplugins.tar.gz to a temporary location where you have Write access.

   c. Untar hdatplugins.tar.gz:
      
      ```
      tar xzf hdatplugins.tar.gz
      ```
      
      The hdatplugins directory is created.

   d. Propagate the following three JAR files in hdatplugins into the library path on every machine in the BigInsights cluster:
      
      - sas.lasr.jar
      - sas.lasr.hadoop.jar
      - sas.grid.provider.yarn.jar

      **Note:** The default location for `HADOOP_HOME` is `/opt/ibm/biginsights/IHC`. The default location for `BIGINSIGHTS_HOME` is `/opt/ibm/biginsights`.

      **TIP**  If you have already installed the SAS High-Performance Computing Management Console or the SAS High-Performance Analytics environment, you can issue a single `simcp` command to propagate JAR files across all machines in the cluster. For example:
      
      ```
      /opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.jar
      $HADOOP_HOME/share/hadoop/hdfs/lib
      /opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.hadoop.jar
      $HADOOP_HOME/share/hadoop/hdfs/lib
      /opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.grid.provider.yarn.jar
      $HADOOP_HOME/share/hadoop/hdfs/lib
      ```

      For more information, see Appendix 2, “SAS High-Performance Analytics Infrastructure Command Reference,” on page 85.
Propagate sasrfsd in hdatplugins into the $HADOOP_HOME/bin directory on every machine in the BigInsights cluster. For example:

```
/opt/TKGrid/bin/simcp sasrfsd $HADOOP_HOME/bin
```

2 Propagate SAS_VERSION in hdatplugins to the $HADOOP_HOME directory on each machine in the HDP cluster.

3 On the machine where you initially installed BigInsights, add the following properties for SAS for the HDFS configuration to the file

$BIGINSIGHTS_HOME/hdm/hadoop-conf-staging/hdfs-site.xml. Adjust values appropriately for your deployment:

```
<property>
  <name>dfs.namenode.plugins</name>
  <value>com.sas.lasr.hadoop.NameNodeService</value>
</property>

<property>
  <name>dfs.datanode.plugins</name>
  <value>com.sas.lasr.hadoop.DataNodeService</value>
</property>

<property>
  <name>com.sas.lasr.service.allow.put</name>
  <value>true</value>
</property>

<property>
  <name>com.sas.lasr.hadoop.service.namenode.port</name>
  <value>15452</value>
</property>

<property>
  <name>com.sas.lasr.hadoop.service.datanode.port</name>
  <value>15453</value>
</property>

<property>
  <name>dfs.namenode.fs-limits.min-block-size</name>
  <value>0</value>
</property>
```

4 Synchronize this new configuration by running the following command on the machine where you initially deployed BigInsights:

```
$BIGINSIGHTS_HOME/bin/syncconf.sh.
```

5 On the machine where you initially deployed BigInsights, log on as the biadmin user and run the following commands to restart the cluster with the new configuration:

```
stop-all.sh
start-all.sh
```

6 Note the location of HADOOP_HOME. You will need to refer to this value when installing the SAS High-Performance Analytics environment.

7 If you are deploying SAS Visual Analytics, see “Hadoop Configuration Step for SAS Visual Analytics” on page 52.
Modify the Existing MapR Hadoop Cluster

To configure your existing MapR Hadoop cluster to interoperate with the SAS High-Performance Analytics environment, follow these steps:

1. On all the SAS High-Performance Analytics environment nodes (the name node and all its worker nodes), create an identical mountpoint for your MapR file system.
   For more information, see [http://doc.mapr.com/display/MapR/Setting+Up+MapR+NFS](http://doc.mapr.com/display/MapR/Setting+Up+MapR+NFS).

2. When deploying the SAS High-Performance Analytics environment, enter this NFS mountpoint when prompted (for example, `/mapr/my.cluster.com`).
   For more information, see Table 5.2 on page 59.

3. If you are deploying SAS Visual Analytics, see “Hadoop Configuration Step for SAS Visual Analytics” on page 52.

After you have deployed SAS, for SAS LASR Server, add a server that loads from the NFS mountpoint. You can populate data in all the normal ways: copy to the SASHDAT engine, save an in-memory table, or use PROC IMXFer from a server running on a conventional Hadoop distribution.

For more information, see the SAS LASR Analytic Server Reference Guide.

Modify the Existing Pivotal HD Hadoop Cluster

If you want to co-locate the SAS High-Performance Analytics environment with a pre-existing Pivotal HD (PHD) Hadoop cluster, you can modify your cluster with files from the SAS Plug-ins for Hadoop package. PHD modified with SAS Plug-ins for Hadoop enables the SAS High-Performance Analytics environment to write SASHDAT file blocks evenly across the HDFS file system.

1. Log on to Pivotal Command Center (PCC) as gpadmin. (The default password is Gpadmin1.)

2. Untar the SAS Plug-ins for Hadoop tarball, and propagate five files (identified in the following steps) on every machine in your PHD cluster:
   a. Navigate to the SAS Plug-ins for Hadoop tarball in your SAS Software depot:
      ```
      cd depot-installation-location/standalone_installs/
      SAS_Plug-ins_for_Hadoop/1_0/Linux_for_x64/
      ```
   b. Copy hdatplugins.tar.gz to a temporary location where you have Write access.
   c. Untar hdatplugins.tar.gz:
tar xzf hdatplugins.tar.gz

The hdatplugins directory is created.

d Propagate the following three JAR files in hdatplugins into the library path on every machine in the PHD cluster:
- sas.lasr.jar
- sas.lasr.hadoop.jar
- sas.grid.provider.yarn.jar

**TIP** If you have already installed the SAS High-Performance Computing Management Console or the SAS High-Performance Analytics environment, you can issue a single `simcp` command to propagate JAR files across all machines in the cluster. For example:
```
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.jar
/usr/lib/gphd/hadoop/lib/
```
```
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.hadoop.jar
/usr/lib/gphd/hadoop/lib/
```
```
/opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.grid.provider.yarn.jar
/usr/lib/gphd/hadoop/lib/
```

For more information, see Appendix 2, “SAS High-Performance Analytics Infrastructure Command Reference,” on page 85.

e Propagate saslasrfd in hdatplugins into the PHD bin directory on every machine in the PHD cluster. For example:
```
/opt/TKGrid/bin/simcp saslasrfd /usr/lib/gphd/hadoop/bin/
```

3 Propagate SAS_VERSION in hdatplugins to the $HADOOP_HOME directory on each machine in the PHD cluster.

4 In the PCC, for YARN, make sure that Resource Manager, History Server, and Node Managers have unique host names.

5 In the PCC, make sure that the Zookeeper Server contains a unique host name.

6 Add the following properties for SAS for the HDFS configuration to the file hdfs-site.xml:

```xml
<property>
    <name>dfs.namenode.plugins</name>
    <value>com.sas.lasr.hadoop.NameNodeService</value>
</property>
<property>
    <name>dfs.datanode.plugins</name>
    <value>com.sas.lasr.hadoop.DataNodeService</value>
</property>
<property>
    <name>com.sas.lasr.service.allow.put</name>
    <value>true</value>
</property>
<property>
    <name>com.sas.lasr.hadoop.service.namenode.port</name>
    <value>15452</value>
</property>
```
7 Save your changes.

8 Restart your cluster using PCC and verify that HDFS is running in the dashboard.

9 If you are deploying SAS Visual Analytics, see “Hadoop Configuration Step for SAS Visual Analytics” on page 52.

---

**Hadoop Configuration Step for SAS Visual Analytics**

If you deploying SAS Visual Analytics, then there are two directories that you must create in the HDFS file system, with the following permissions:

```
hadoop fs -mkdir /hps
hadoop fs -mkdir /vapublic
hadoop fs -chmod 777 /hps
hadoop fs -chmod 1777 /vapublic
```
Installing and configuring the SAS High-Performance Analytics environment is the sixth of eight steps.

1. Create a SAS Software Depot.
2. Check for documentation updates.
3. Prepare your analytics cluster.
4. (Optional) Deploy SAS High-Performance Computing Management Console.
5. (Optional) Modify co-located Hadoop.

▶ 6. Deploy the SAS High-Performance Analytics environment.
7. (Optional) Deploy the SAS Embedded Process for Hadoop.
8. (Optional) Configure the analytics environment for a remote parallel connection.

This chapter describes how to install and configure all of the components for the SAS High-Performance Analytics environment on the machines in the cluster.
Overview of Deploying the Analytics Environment

Deploying the SAS High-Performance Analytics environment requires installing and configuring components on the root node machine and on the remaining machines in the cluster. In this document, the root node is deployed on blade 0.

The following figure shows the SAS High-Performance Analytics environment co-located on your Hadoop cluster:

*Figure 5.1  Analytics Environment Co-Located on the Hadoop Cluster*

Note: For deployments that use Hadoop for the co-located data provider and access SASHDAT tables exclusively, SAS/ACCESS and SAS Embedded Process are not needed.
The following figure shows the SAS High-Performance Analytics environment using a serial connection through the SAS/ACCESS Interface to your remote data store:

**Figure 5.2  Analytics Environment Remote from Your Data Store (Serial Connection)**

**TIP** There might be solution-specific criteria that you should consider when determining your analytics cluster location. For more information, see the installation or administration guide for your specific SAS solution.
The following figure shows the SAS High-Performance Analytics environment using a parallel connection through the SAS Embedded Process to your remote data store:

**Figure 5.3 Analytics Environment Remote from Your Data Store (Parallel Connection)**

The SAS High-Performance Analytics environment is packaged in separate executables. Refer to the following table for more information:
<table>
<thead>
<tr>
<th>Order to install</th>
<th>Filename</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>TKGrid/Linux_x86_64.sh</td>
<td>Analytics environment installation script for Red Hat Linux 6 and other equivalent, kernel-level Linux systems.</td>
</tr>
<tr>
<td></td>
<td>TKGrid/Linux_x86_64_rhel5.sh</td>
<td>Analytics environment installation script for Red Hat Linux (pre-version 6) and SUSE Linux 10 systems.</td>
</tr>
<tr>
<td>2</td>
<td>TKTGDat.sh</td>
<td>SAS linguistic binary files required to perform text analysis in SAS LASR Analytic Server with SAS Visual Analytics and to run PROC HPTMINE and HPTMSCORE with SAS Text Miner.</td>
</tr>
<tr>
<td>3 (optional)</td>
<td>TKGrid_SEC_x86_64.sh</td>
<td>Installation script for enabling the analytics environment to read and write encrypted SASHDAT files.</td>
</tr>
<tr>
<td>4 (optional)</td>
<td>TKGrid_REP_x86_64.sh</td>
<td>Script for configuring the SAS High-Performance Analytics environment with a SAS Embedded Process for Red Hat Linux 6 and other equivalent, kernel-level Linux systems.</td>
</tr>
<tr>
<td></td>
<td>TKGrid_REP_x86_64_rhel5.sh</td>
<td>Script for configuring the SAS High-Performance Analytics environment with a SAS Embedded Process for Red Hat Linux (pre-version 6) and SUSE Linux 10 systems.</td>
</tr>
</tbody>
</table>

### Encrypting SASHDAT Files

Starting with release 2.94, the SAS High-Performance Analytics environment supports reading and writing files using AES encryption with 256-bit keys. (This feature is very similar to the AES encryption provided by the SAS BASE Engine.) SASHDAT encryption is designed to bolster privacy protection for data at rest—that is, data stored in SASHDAT for analytic purposes.

Remember that SASHDAT data is typically not the system of record, but rather a copy of operational data that has been arranged for the purposes of analytics. In addition to encrypting data, many SAS users also anonymize their data when preparing it for analytics.

To enable the SAS High-Performance Analytics environment to read and write SASHDAT using encryption, you must install the TKGrid_SEC package. For more information, see “Configuring the Analytics Environment for SASHDAT Encryption” on page 61.
Install the Analytics Environment

The SAS High-Performance Analytics environment components are installed with two shell scripts. Follow these steps to install:

1. Make sure that you have reviewed all of the information contained in the section “Preparing to Deploy the SAS High-Performance Analytics Environment” on page 21.

2. The software that is needed for the SAS High-Performance Analytics environment is available from within the SAS Software Depot that was created by the site depot administrator: depot-installation-location/standalone_installs/SAS_High-Performance_Node_Installation/3_5/Linux_for_x64.

3. Copy the file that is appropriate for your operating system to the /tmp directory of the root node of the cluster:
   - Red Hat Linux (pre-version 6) and SUSE Linux 10:
     TKGrid_Linux_x86_64_rhel5.sh
   - Red Hat Linux 6 and other equivalent, kernel-level Linux systems:
     TKGrid_Linux_x86_64.sh

4. Copy TKTGDat.sh to the /tmp directory of the root node of the cluster.
   Note: TKTGDat.sh contains the SAS linguistic binary files required to perform text analysis in SAS LASR Analytic Server with SAS Visual Analytics and to run PROC HPTMINE and HPTMSCORE with SAS Text Miner.

5. Log on to the machine that will serve as the root node of the cluster or the data appliance with a user account that has the necessary permissions.
   For more information, see “User Accounts for the SAS High-Performance Analytics Environment” on page 21.

6. Change directories to the desired installation location, such as /opt.
   Record the location of where you installed the analytics environment, as other configuration programs will prompt you for this path later in the deployment process.

7. Run the TKGrid shell script in this directory.
   The shell script creates the TKGrid subdirectory and places all files under that directory.

8. Respond to the prompts from the shell script:
Table 5.2 Configuration Parameters for the TKGrid Shell Script

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TKGrid Configuration Utility. Running on 'machine-name' Using stdin for options. Shared install or replicate to each node? (Y=SHARED/n=replicated)</td>
<td>If you are installing to a local drive on each node, then specify n and press Enter to indicate that this is a replicated installation. If you are installing to a drive that is shared across all the nodes (for example, NFS), then specify y and press Enter.</td>
</tr>
<tr>
<td>Enter additional paths to include in LD_LIBRARY_PATH, separated by colons (;)</td>
<td>If you have any external library paths that you want to be accessible to the SAS High-Performance Analytics environment, enter the paths here and press Enter. Otherwise, press Enter.</td>
</tr>
<tr>
<td>Enter NFS mount to MAPR directory (ie: /mapr/my.cluster.com, default is none).</td>
<td>If you want the analytics environment to be able to read and write MapR data directly, enter the NFS mount here (for example, /mapr/my.cluster.com). The mount point must exist on all nodes, including the name node. The TKGrid script sets the environment variable, TKMPI_OUTPUTHDFSPREFIX, to point to this share. For more information, see <a href="http://doc.mapr.com/display/MapR/Accessing+Data+with+NFS">http://doc.mapr.com/display/MapR/Accessing+Data+with+NFS</a>.</td>
</tr>
</tbody>
</table>
| Enter additional options to mpirun. | If you have any mpirun options to add, specify them and press Enter. If you are using Kerberos, specify the following option and press Enter: `-genvlist \`env | sed -e s/=.*/,/ | sed /KRBSCCNAME/d | tr -d '\n'TKPATH,LD_LIBRARY_PATH
Note: Enter the above option on one line. Do not add any carriage returns or other whitespace characters. If you have no additional options, press Enter. |
<p>| Enter path to use for Utility files. (default is /tmp). | SAS High-Performance Analytics applications might write scratch files. By default, these files are created in the /tmp directory. To accept the default, press Enter. Or, to redirect the files to a different location, specify the path and press Enter. Note: If the directory that you specified does not exist, you must create it manually. |
| Enter path to Hadoop. (default is Hadoop not installed). | If your site uses Hadoop, enter the installation directory (the value of the variable, HADOOP_HOME) and press Enter. If your site does not use Hadoop, press Enter. |
| Force Root Rank to run on headnode? (y/N) | If the appliance resides behind a firewall and only the root node can connect back to the client machines, specify y and press Enter. Otherwise, specify n and press Enter. |
| Enter full path to machine list. The head node 'head-node-machine-name' should be listed first. | Specify the name of the file that you created in the section “List the Machines in the Cluster or Appliance” (for example, /etc/gridhosts) and press Enter. |</p>
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enter maximum runtime for grid jobs (in seconds). Default 7200 (2 hours).</td>
<td>If a SAS High-Performance Analytics application executes for more than the maximum allowable run time, it is automatically terminated. You can adjust that run-time limit here. To accept the default, press Enter. Or, specify a different maximum run time (in seconds) and press Enter.</td>
</tr>
<tr>
<td>Enter value for UMASK. (default is unset.)</td>
<td>To set no umask value, press Enter. Or, specify a umask value and press Enter. For more information, see “Consider Umask Settings” on page 22.</td>
</tr>
</tbody>
</table>

9 If you selected a replicated installation at the first prompt, you are now prompted to choose the technique for distributing the contents to the appliance nodes:

The install can now copy this directory to all the machines listed in 'filename' using scp, skipping the first entry.

Perform copy? (YES/no)

Press Enter if you want the installation program to perform the replication. Enter no if you are distributing the contents of the installation directory by some other technique.

10 Next, in the same directory from which you ran the TKGrid shell script, run TKTGDat.sh.

The shell script creates the TGTKDat subdirectory and places all files in that directory.

11 Respond to the prompts from the shell script:

Table 5.3 Configuration Prompts for the TKTGDat Shell Script

| TTKG Configuration Utility. Running on 'machine-name' Using stdin for options. Shared install or replicate to each node? (Y=SHARED/n=replicated) | If you are installing to a local drive on each node, then specify n and press Enter to indicate that this is a replicated installation. If you are installing to a drive that is shared across all the nodes (for example, NFS), then specify y and press Enter. |
| Enter full path to machine list. | Specify the name of the file that you created in the section “List the Machines in the Cluster or Appliance” (for example, /etc/gridhosts) and press Enter. |

12 If you selected a replicated installation at the first prompt, you are now prompted to choose the technique for distributing the contents to the appliance nodes:

The install can now copy this directory to all the machines listed in 'filename' using scp, skipping the first entry.

Perform copy? (YES/no)
If you want the installation program to perform the replication, specify yes and press Enter. If you are distributing the contents of the installation directory by some other technique, specify no and press Enter.

13 If you are planning to use the High-Performance Analytics environment in a locale other than English, you must copy the appropriate locale files from `SASFoundation/9.4/misc/tktg` to the `TKTGDat` directory on every machine in the analytics cluster.

In this example, the simultaneous command, `simcp`, is used to copy the Japanese locale files to the `TKTGDat` directory on each machine in the analytics cluster:

```
/opt/TKGrid/bin/simcp /opt/SASHome/SASFoundation/9.4/misc/tktg/jp* /opt/TKTGDat
```

14 Make one of the following choices:

- To enable the SAS High-Performance Analytics environment to read and write SASHDAT using encryption, proceed to “Configuring the Analytics Environment for SASHDAT Encryption” on page 61.
- To configure the analytics environment for a SAS Embedded Process, proceed to “Configuring for Access to a Data Store with a SAS Embedded Process” on page 75.
- To validate your analytics environment, proceed to “Validating the Analytics Environment Deployment” on page 62.

---

**Configuring the Analytics Environment for SASHDAT Encryption**

In release 2.94, the SAS High-Performance Analytics environment supports reading and writing files using AES encryption with 256-bit keys. (This feature is very similar to the AES encryption provided by the SAS BASE Engine.)

**Note:** For U.S. export purposes, SAS designates each product based on the encryption algorithms and the product’s functional capability. The ability to encrypt SASHDAT files is available to most commercial and government users inside and outside the U.S. However, some countries (for example, Russia, China, and France) have import restrictions on products that contain encryption, and the U.S. prohibits the export of encryption software to specific embargoed or restricted destinations.

To enable the SAS High-Performance Analytics environment to read and write SASHDAT using encryption, follow these steps:

1. The software that is needed for the SAS High-Performance Analytics environment is available from within the SAS Software Depot that was created by the site depot administrator: `depot-installation-location/standalone_installs/SAS_High-Performance_Encryption_Installation/3_5/Linux_for_x64`.

2. Copy `TKGrid_SEC_x86_64.sh` to the `/tmp` directory of the root node of the cluster.
Log on to the machine that will serve as the root node of the cluster or the data appliance with a user account that has the necessary permissions.

For more information, see "User Accounts for the SAS High-Performance Analytics Environment" on page 21.

Change directories to the desired installation location, such as /opt.

Run the TKGrid_SEC_x86_64 shell script in this directory.

Respond to the prompts from the shell script:

<table>
<thead>
<tr>
<th>Table 5.4 Configuration Prompts for the TKGrid_SEC_x86_64 Shell Script</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Shared install or replicate to each node?</strong></td>
</tr>
<tr>
<td><em>(Y=SHARED/n=replicated)</em></td>
</tr>
<tr>
<td>If you are installing to a local drive on each node,</td>
</tr>
<tr>
<td>then specify n and press Enter to indicate that this is</td>
</tr>
<tr>
<td>a replicated installation. If you are installing to a drive</td>
</tr>
<tr>
<td>that is shared across all the nodes (for example, NFS), then</td>
</tr>
<tr>
<td>specify Y and press Enter.</td>
</tr>
</tbody>
</table>

If you selected a replicated installation at the first prompt, you are now prompted to choose the technique for distributing the contents to the appliance nodes:

The install can now copy this directory to all the machines listed in 'filename' using scp, skipping the first entry.

Perform copy?
*(YES/no)*

Press Enter if you want the installation program to perform the replication. Enter no if you are distributing the contents of the installation directory by some other technique.

Note: The contents of TKGrid_SEC must be distributed to every machine in the analytics cluster.

The shell script creates a lib2 subdirectory and a file named VERSION2.

**TIP** If you are using Hadoop as your data provider, make sure that you follow the steps described for your distribution of Hadoop in Chapter 4, "Modifying Co-Located Hadoop," on page 37.

To validate your analytics environment, proceed to “Validating the Analytics Environment Deployment” on page 62.

---

**Validating the Analytics Environment Deployment**

**Overview of Validating**

You have at least two methods to validate your SAS High-Performance Analytics environment deployment:

- "Use simsh to Validate" on page 63.
Use simsh to Validate

To validate your SAS High-Performance Analytics environment deployment by issuing a `simsh` command, follow these steps:

1. Log on to one of the machines in the analytics cluster.

2. Enter the following command:

   ```
   /HPA-environment-installation-directory/bin/simsh hostname
   ```

   This command invokes the `hostname` command on each machine in the cluster. The host name for each machine is printed to the screen.

   You should see a list of known hosts similar to the following:

   ```
   myblade006.example.com: myblade006.example.com
   myblade007.example.com: myblade007.example.com
   myblade004.example.com: myblade004.example.com
   myblade005.example.com: myblade005.example.com
   ```

3. Proceed to Chapter 6, “Configuring the Analytics Environment for a Remote Parallel Connection,” on page 67.

Use MPI to Validate

To validate your SAS High-Performance Analytics environment deployment by issuing a Message Passing Interface (MPI) command, follow these steps:

1. Log on to the root node using the SAS High-Performance Analytics environment installation account.

2. Enter the following command:

   ```
   /HPA-environment-installation-directory/TKGrid/mpich2-install/bin/mpirun -f /etc/gridhosts hostname
   ```

   You should see a list of known hosts similar to the following:

   ```
   myblade006.example.com
   myblade007.example.com
   myblade004.example.com
   myblade005.example.com
   ```

3. Proceed to Chapter 6, “Configuring the Analytics Environment for a Remote Parallel Connection,” on page 67.
Resource Management for the Analytics Environment

Resource Settings File

You can set limits on any TKGrid process running across the SAS High-Performance Analytics environment with a resource settings file supplied by SAS. Located in /opt/TKGrid/, resource.settings is in the format of a shell script. When the analytics environment starts, the environment variables contained in the file are set and last for the duration of the run.

Initially, all of the settings in resource.settings are commented. Uncomment the variables and add values that make sense for your site. For more information, see “Using CGroups to Manage CPU” in SAS LASR Analytic Server: Reference Guide.

When you are finished editing, copy resource.settings to every machine in the analytics environment:

```
/opt/TKGrid/bin/simcp /opt/TKGrid/resource.settings /opt/TKGrid
```

If YARN is used on the cluster, then you can configure the analytics environment to participate in the resource accounting that YARN performs. For more information, see “Managing Resources” in SAS LASR Analytic Server: Reference Guide.

resource.settings consists of the following:

```
# if [ "$USER" = "lasradm" ]; then
# Custom settings for any process running under the lasradm account.
#   export TKMPI_ULIMIT="-v 50000000"
#   export TKMPI_MEMSIZE=50000
#   export TKMPI_CGROUP="cgexec -g cpu:75"
# fi

# if [ "$TKMPI_APPNAME" = "lasr" ]; then
# Custom settings for a lasr process running under any account.
#   export TKMPI_ULIMIT="-v 50000000"
#   export TKMPI_MEMSIZE=50000
#   export TKMPI_CGROUP="cgexec -g cpu:75"
# fi

# Allow other users to read server and tables, but not add or term.
#   export TKMPI_UMASK=0033

# Allow no access by other users to lasr server.
#   export TKMPI_UMASK=0077

# To exclude from YARN resource manager.
#   unset TKMPI_RESEURCENAMEAGER

# Use default nice for LASR
#   unset TKMPI_NICE
# fi
```
Request Memory with TKMPI_INFO

When programmers use TKMPI_INFO in their SAS code, the SAS High-Performance Analytics environment can better decide how much memory to request.

Consider this example: the $TKMPI_APPNAME variable is set to lasr for both a SAS Analytic LASR Server (PROC LASR CREATE) and for a SAS Analytic LASR Server Proxy used when loading a table (PROC LASR ADD). This makes it impossible to set a YARN memory limit differently for these two cases. Most likely, a SAS Analytic LASR Server would want a large amount of memory and the proxy server would require a smaller amount.

Here is an example of how you might use TKMPI_INFO in a SAS program to solve the memory issue:

```sas
options set=TKMPI_INFO="LASRSTART";
proc lasr create port=17761;
performance nodes=2; run;

options set=TKMPI_INFO="LASRLOAD";
proc lasr add data=sashelp.cars port=17761; run
```

In resource.settings, you might add an entry similar to the following:

```bash
if [ "TKMPI_APPNAME" = "lasr" ]; then
  if [ "$TKMPI_INFO" = "LASRSTART" ];
    export TKMPI_MEMSIZE=60000
  fi
  if [ "$TKMPI_INFO" = "LASRLOAD" ];
    export TKMPI_MEMSIZE=4000
  fi
fi
```

Note that TKMPI_INFO is not limited to SAS Analytic LASR Server. TKMPI_INFO can also be used for any other HPA PROC. You could use the variable to pass any type of information you need to resource.settings (for example, SMALL, MEDIUM, LARGE classes).
Infrastructure Deployment Process Overview

Configuring your data storage is the last of eight steps for deploying the SAS High-Performance Analytics infrastructure.

1. Create a SAS Software Depot.
2. Check for documentation updates.
3. Prepare your analytics cluster.
4. (Optional) Deploy SAS High-Performance Computing Management Console.
5. (Optional) Modify co-located Hadoop.
6. Deploy the SAS High-Performance Analytics environment.
7. (Optional) Deploy the SAS Embedded Process for Hadoop.
8. (Optional) Configure the analytics environment for a remote parallel connection.

Overview of Configuring the Analytics Environment for a Remote Parallel Connection

The SAS/ACCESS Interface and SAS Embedded Process provide a high-speed parallel connection that delivers data from the co-located SAS data source to the SAS High-Performance Analytics environment on the analytic cluster. After you have installed SAS/ACCESS and its embedded process, you configure the analytics environment for the particular access interface that you will use with a shell script, TKGrid_REP.

For information about installing the SAS Embedded Process, see the SAS In-Database Products: Administrator's Guide.
Preparing for a Remote Parallel Connection

Overview of Preparing for a Remote Parallel Connection

Before you can configure the SAS High-Performance Analytics environment to use the SAS Embedded Process for a parallel connection with your data store, you must locate particular JAR files and gather particular information about your data provider.

From the following list, choose the topic for your respective remote data provider:
Prepare for Hadoop

Overview of Preparing for Hadoop

Note: In the third maintenance release of SAS 9.4, SAS Embedded Process supports the Cloudera, Hortonworks, IBM BigInsights, MapR, and Pivotal HD distributions of Hadoop. For more specific version information, see the SAS 9.4 Support for Hadoop.

Preparing for a remote parallel connection to Hadoop consists of the following steps:

1. downloading and running a tracer script, hadooptracer.py, supplied by SAS. hadooptracer.py traces the system calls of various Hadoop client tools and uses this data to identify the appropriate client JAR files that the SAS High-Performance Analytics environment requires for Hadoop client machine to Hadoop server environment connectivity.

   The script also copies these Hadoop client JAR files to a location on the Hadoop Hive node that you specify. You then manually copy this directory to the machine where you will deploy the SAS High-Performance environment root node. See “Run the Hadoop Tracer Script” on page 71.

2. recording information about your Hadoop deployment that you will need when configuring the analytics environment for a remote data store.

   See “Hadoop Checklists” on page 72.

3. determining the version of the JRE used by Hadoop and installing that same JRE on the analytics cluster.

   See “Install the JRE on the Analytics Cluster” on page 73.

Prerequisites for the Hadoop Tracer Script

In order to run the Hadoop tracer script, you must meet these prerequisites:

- Python 2.6 (or later) and strace must be installed.

- We recommend that your Hadoop Hive node machine must have a temporary directory named tmp under the root directory (/tmp).

  By default, the script uses a single directory (/tmp) as its temporary and output directories. However, you can change these using various script options.

- The user running the script must have the following:
  - a Linux account with SSH access (password or private key), to the Hive node or NameNode.
Run the Hadoop Tracer Script

To download and run the Hadoop tracer script, follow these steps:

1. Make sure that your system meets the prerequisites.
   
   See “Prerequisites for the Hadoop Tracer Script”.

2. On a machine from which you can also access your Hadoop Hive node, create a temporary directory where you will download the script.

   Here is an example:
   ```
   mkdir hadoopfiles_temp
   ```

3. Download the hadooptracer.zip file from the following FTP site to the directory that you created: 

4. If there is not a `/tmp` directory on your Hadoop Hive node, create it.

   By default, the script uses a single directory (`/tmp`) as its temporary and output directories. However, you can change these using various script options. See Step 8.

5. Using a transfer method, such as PSFTP, SFTP, SCP, or FTP, transfer the ZIP file to the Hive node on your Hadoop cluster.

   Here is an example:
   ```
   scp /opt/sas/hadoopfiles_temp/hadooptracer.zip
   root@hive_node.example.com:/tmp
   ```

6. On the Hadoop Hive node, change to the `/tmp` directory and unzip hadooptracer.zip.

   Here is an example:
   ```
   cd /tmp
   tar xzf hadooptracer.zip
   ```

7. Enter the following command to grant Execute permissions on the script file:

   ```
   chmod 755 ./hadooptracer.py
   ```

8. Run the script with these options:

   ```
   python hadooptracer.py --filterby=latest --postprocess
   ```

   Note: hadooptracer.py ignores --postprocess on Cloudera Hadoop clusters.

**TIP** For more information about script options, run the script with the `-h` option.
The script does the following:

a. traces the system calls of various Hadoop client tools and uses this data to identify the appropriate client JAR files.

b. copies the client JAR files to /tmp/jars.

c. writes its log to /tmp/hadooptracer.log.

Note: Some error messages in the console output for hadooptracer.py are normal and do not necessarily indicate a problem with the JAR and configuration file collection process. However, if the files are not collected as expected or if you experience problems connecting to Hadoop with the collected files, contact SAS Technical Support and include the hadooptracer.log file.

9 When the script finishes executing, delete the following files:

- derby*.jar
- spark-examples*.jar
- ranger-plugins-audit*.jar
- avatica*.jar
- hadoop-0.20.2-dev-core*.jar

10 Copy the JAR files that hadooptracer.py writes in /tmp/jars to a directory on the SAS High-Performance Analytics environment root node machine. As the analytics environment configuration script prompts you for this directory later, be sure to note it in Table 6.1.

Hadoop Checklists

Before you can configure the SAS High-Performance Analytics environment to use the SAS Embedded Process for a parallel connection with your Hadoop data store, there are certain requirements that must be met.

Note: In the third maintenance release of SAS 9.4, the SAS Embedded Process supports the IBM BigInsights, Cloudera, Hortonworks, MapR, and Pivotal HD distributions of Hadoop. For more detailed information, see the SAS Foundation system requirements documentation for your operating environment.

1 Record the path to the Hadoop client JAR files required by the analytics environment in the table that follows:

<table>
<thead>
<tr>
<th>Example</th>
<th>Actual Path of the Required Hadoop JAR Files on Your Analytics Environment Root Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>/opt/hadoop_jars</td>
<td>(Hadoop client JAR files)</td>
</tr>
</tbody>
</table>

Note: The location of the common and core JAR files listed in Table 6.1 should be the same location that you copied the client JAR files to in Step 10 on page 72.
2 Record the location (JAVA_HOME) of the 64-bit Java Runtime Engine (JRE) used by the analytics environment in the table that follows:

<table>
<thead>
<tr>
<th>Example</th>
<th>Actual Path of the JRE on Your Analytics Environment Root Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>/opt/java/jre1.7.0_07</td>
<td></td>
</tr>
</tbody>
</table>

Note: This is the location of the JRE that the SAS High-Performance Analytics environment uses, not the location of the JRE that Hadoop uses.

Install the JRE on the Analytics Cluster

The SAS High-Performance Analytics environment requires a 64-bit Java Runtime Engine (JRE) when the environment is configured for a remote parallel connection.

Note: The JRE used by the analytics environment must match the version of the JRE used by your Hadoop cluster.

As the analytics environment configuration script prompts you for the location of this JRE (JAVA_HOME), be sure to note it in Table 6.2.

Prepare for a Greenplum Data Computing Appliance

Before you can configure the SAS High-Performance Analytics environment to use the SAS Embedded Process for a parallel connection with your Greenplum Data Computing Appliance, there are certain requirements that must be met.

1 Install the Greenplum client on the Greenplum Master Server (blade 0) in your analytics cluster.
   For more information, refer to your Greenplum documentation.

2 Record the path to the Greenplum client in the table that follows:

<table>
<thead>
<tr>
<th>Example</th>
<th>Actual Path of the Greenplum Client on Your System</th>
</tr>
</thead>
<tbody>
<tr>
<td>/usr/local/greenplum-db</td>
<td></td>
</tr>
</tbody>
</table>

Prepare for a HANA Cluster

Before you can configure the SAS High-Performance Analytics environment to use the SAS Embedded Process for a parallel connection with your HANA cluster, there are certain requirements that must be met.

1 Install the HANA client on blade 0 in your analytics cluster.
For more information, refer to your HANA documentation.

2 Record the path to the HANA client in the table that follows:

<table>
<thead>
<tr>
<th>Example</th>
<th>Actual Path of the HANA Client on Your System</th>
</tr>
</thead>
<tbody>
<tr>
<td>/usr/local/lib/hdbclient</td>
<td></td>
</tr>
</tbody>
</table>

Prepare for an Oracle Exadata Appliance

Before you can configure the SAS High-Performance Analytics environment to use the SAS Embedded Process for a parallel connection with your Oracle Exadata appliance, there are certain requirements that must be met.

1 Install the Oracle client on blade 0 in your analytics cluster.
   For more information, refer to your Oracle documentation.

2 Record the path to the Oracle client in the table that follows. (This should be the absolute path to libclntsh.so):

<table>
<thead>
<tr>
<th>Example</th>
<th>Actual Path of the Oracle Client on Your System</th>
</tr>
</thead>
<tbody>
<tr>
<td>/usr/local/ora11gr2/product/11.2.0/client_1/lib</td>
<td></td>
</tr>
</tbody>
</table>

3 Record the value of the Oracle TNS_ADMIN environment variable in the table that follows. (Typically, this is the directory that contains the tnsnames.ora file):

<table>
<thead>
<tr>
<th>Example</th>
<th>Oracle TNS_ADMIN Environment Variable Value on Your System</th>
</tr>
</thead>
<tbody>
<tr>
<td>/my_server/oracle</td>
<td></td>
</tr>
</tbody>
</table>

Prepare for a Teradata Managed Server Cabinet

Before you can configure the SAS High-Performance Analytics environment to use the SAS Embedded Process for a parallel connection with your Teradata Managed Server Cabinet, there are certain requirements that must be met.

1 Install the Teradata client on blade 0 in your analytics cluster.
   For more information, refer to your Teradata documentation.
2 Record the path to the Teradata client in the table that follows. (This should be the absolute path to the directory that contains the odbc_64 subdirectory):

<table>
<thead>
<tr>
<th>Example</th>
<th>Actual Location of the Teradata Client on Your System</th>
</tr>
</thead>
<tbody>
<tr>
<td>/opt/teradata/client/13.10</td>
<td></td>
</tr>
</tbody>
</table>

## Configuring for Access to a Data Store with a SAS Embedded Process

### Overview of Configuring for Access to a Data Store with a SAS Embedded Process

The process involved for configuring the SAS High-Performance Analytics environment with a SAS Embedded Process consists of the following steps:

1. Prepare for the data provider that the analytics environment will query.
   
   For more information, see “Preparing for a Remote Parallel Connection” on page 69.
   
   Note: Other third-party data providers besides Hadoop are supported. For more information, see the SAS In-Database Products: Administrator’s Guide.

2. Review the considerations for configuring the analytics environment for use with a remote data store.
   
   For more information, see “How the Configuration Script Works” on page 75.

3. Configure the analytics environment for a remote data store.
   
   For more information, see “Configure for Access to a Data Store with a SAS Embedded Process” on page 76.

### How the Configuration Script Works

You configure the SAS High-Performance Analytics environment with a SAS Embedded Process using a shell script. The script enables you to configure the environment for the various third-party data stores supported by the SAS Embedded Process.

The analytics environment is designed on the principle, install once, configure many. For example, suppose that your site has three remote data stores from three different third-party vendors whose data you want to analyze. You run the analytics environment configuration script one time and provide the information for each data store vendor as you are prompted for it. (When prompted for a data store vendor that you do not have, simply ignore that set of prompts.)
When you have different versions of the same vendor’s data store, specifying the vendor’s latest client data libraries usually works. However, this choice can be problematic for different versions of Hadoop, where a later set of JAR files is not typically backwardly compatible with earlier versions, or for sites that use Hadoop implementations from more than one vendor. (The configuration script does not delineate between different Hadoop vendors.) In these situations, you must run the analytics environment configuration script once for each different Hadoop version or vendor. As the configuration script creates a TKGrid_REP directory underneath the current directory, it is important to run the script a second time from a different directory.

To illustrate how you might manage configuring the analytics environment for two different Hadoop vendors, consider this example: suppose your site uses Cloudera Hadoop 4 and Hortonworks Data Platform 2. When running the analytics environment script to configure for Cloudera 4, you would create a directory similar to:

```
  cdh4
```

When configuring the analytics environment for Cloudera, you would run the script from the cdh4 directory. When complete, the script creates a TKGrid_REP child directory:

```
  cdh4/TKGrid_REP
```

For Hortonworks, you would create a directory similar to:

```
  hdp2
```

When configuring the analytics environment for Hortonworks, you would run the script from the hdp2 directory. When complete, the script creates a TKGrid_REP child directory:

```
  hdp2/TKGrid_REP
```

**Configure for Access to a Data Store with a SAS Embedded Process**

To configure the High-Performance Analytics environment for a remote data store, follow these steps:

1. Make sure that you have reviewed all of the information contained in the section “Preparing for a Remote Parallel Connection” on page 69.

2. Make sure that you understand how the analytics environment configuration script works, as described in “How the Configuration Script Works” on page 75.

3. The software that is needed for the analytics environment is available from within the SAS Software Depot that was created by the site depot administrator: `depot-installation-location/standalone_installs/SAS_High-Performance_Node_Installation/3_5/Linux_for_x64`.

4. Copy the TKGrid_REP file that is appropriate for your operating system to the `/tmp` directory of the root node of the analytic cluster.

5. Log on to the machine that will serve as the root node of the cluster with a user account that has the necessary permissions.
For more information, see "User Accounts for the SAS High-Performance Analytics Environment" on page 21.

6 Change directories to the desired installation location, such as /opt.

7 Run the shell script in this directory.

The shell script creates the TKGrid_REP subdirectory and places all files under that directory.

8 Respond to the prompts from the configuration program:

<table>
<thead>
<tr>
<th>Table 6.8 Configuration Parameters for the TKGrid_REP Shell Script</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>TKGrid Remote EP Addon Configuration Utility.</td>
</tr>
<tr>
<td>Running on 'machine-name'</td>
</tr>
<tr>
<td>Using stdin for options.</td>
</tr>
<tr>
<td>Do you want to configure remote access to Teradata? (yes/NO)</td>
</tr>
<tr>
<td>Enter path of Teradata client install. i.e.: /opt/teradata/client/13.10</td>
</tr>
<tr>
<td>Do you want to configure remote access to Greenplum? (yes/NO)</td>
</tr>
<tr>
<td>Enter path of Greenplum client install. i.e.: /usr/local/greenplum-db</td>
</tr>
<tr>
<td>Do you want to configure remote access to Hadoop? (yes/NO)</td>
</tr>
<tr>
<td>Enter path of 64 bit JRE i.e.: /usr/java/jdk1.7.0_09/jre</td>
</tr>
<tr>
<td>Enter path of the directory (or directories separated by :)</td>
</tr>
<tr>
<td>containing the Hadoop client JAR files.</td>
</tr>
<tr>
<td>Enter any JRE Options you need added for the Java invocation, or just Enter if none.</td>
</tr>
<tr>
<td>Do you want to configure remote access to Oracle? (yes/NO)</td>
</tr>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Enter path of Oracle client libraries, i.e.: /usr/local/ora11gr2/product/11.2.0/client_1/lib</td>
</tr>
<tr>
<td>Enter path of TNS_ADMIN, or just enter if not needed.</td>
</tr>
<tr>
<td>Do you want to configure remote access to SAP HANA? (yes/NO)</td>
</tr>
<tr>
<td>Enter path of HANA client install. i.e.: /usr/local/lib/hdbclient</td>
</tr>
<tr>
<td>Shared install or replicate to each node? (Y=SHARED/n=replicated)</td>
</tr>
<tr>
<td>Enter path to TKGrid install</td>
</tr>
<tr>
<td>Enter additional paths to include in LD_LIBRARY_PATH, separated by colons (;)</td>
</tr>
</tbody>
</table>

9 If you selected a replicated installation at the first prompt, you are now prompted to choose the technique for distributing the contents to the appliance nodes:

The install can now copy this directory to all the machines listed in 'pathname' using scp, skipping the first entry. Perform copy? (YES/no)

Press Enter if you want the installation program to perform the replication. Enter no if you are distributing the contents of the installation directory by some other technique.

10 You have finished deploying the analytics environment for a remote data source. If you have not done so already, install the appropriate SAS Embedded Process on the remote data appliance or machine cluster for your respective data provider.

For more information, see SAS In-Database Products: Administrator’s Guide.

11 To validate your analytics environment, proceed to “Validating the Analytics Environment Deployment” on page 62.
Appendix 1

Updating the SAS High-Performance Analytics Infrastructure

Analytics Infrastructure Dependencies

Note the following dependencies when updating the SAS High-Performance Analytics infrastructure:

- If you update the analytics environment, you must also update your co-located Hadoop cluster.
- Update Hadoop first, followed by the analytics environment.

For more information, see “Overview of Updating Co-located Hadoop” on page 79.

Updating Co-located Hadoop

Overview of Updating Co-located Hadoop

Follow the instructions appropriate for your co-located Hadoop distribution:

- "Updating SAS High-Performance Deployment for Hadoop (Prior to Version 3.0)".
- "Updating Co-located Distributions of Hadoop".
Updating Co-located Distributions of Hadoop

This topic affects the following supported Hadoop distributions that are co-located with the SAS High-Performance Analytics environment:

- Apache Hadoop (version 2.7 and later)
- Cloudera Hadoop
- Hortonworks Data Platform Hadoop
- IBM BigInsights Hadoop
- MapR Hadoop
- Pivotal HD Hadoop

Note: If you are using SAS High-Performance Deployment for Hadoop, see "Updating SAS High-Performance Deployment for Hadoop (Prior to Version 3.0)".

Before upgrading your Hadoop distribution, remove or disable these properties to prevent HDFS startup failures:

- dfs.namenode.plugins=com.sas.lasr.hadoop.NameNodeService
- dfs.datanode.plugins=com.sas.lasr.hadoop.DataNodeService

After you have upgraded your co-located Hadoop, redo the steps in Chapter 4, "Modifying Co-Located Hadoop," on page 37 appropriate for your Hadoop distribution. Performing these steps ensure that the SAS executable file and SAS JAR files are placed into the correct upgraded Hadoop paths and the configuration properties are in place to enable them.

Updating SAS High-Performance Deployment for Hadoop (Prior to Version 3.0)

Which Version of SAS High-Performance Deployment for Hadoop Have I Deployed?

SAS has discontinued SAS High-Performance Deployment for Hadoop.

If you are running a version of SAS High-Performance Deployment for Hadoop prior to version 3.0, then you must update your Hadoop distribution with files from the SAS Plug-ins for Hadoop package.

To verify the version of SAS High-Performance Deployment for Hadoop that you are running, run the following command:

```
more $HADOOP_HOME/SAS_VERSION
```

If the output matches the following, then you do not have to upgrade:

```
SAS Hadoop Extensions Version 3.0
```

Overview of Updating SAS High-Performance Deployment for Hadoop

Updating SAS High-Performance Deployment for Hadoop prior to version 3.0 consists of the following steps:
Follow the steps in “Preparing to Update SAS High-Performance Deployment for Hadoop”.

Follow the steps in “Update SAS High-Performance Deployment for Hadoop”, which are as follows:

1. Copy the SAS Plug-ins for Hadoop package to a temporary location and untar it.
2. Propagate several files from the package to specific Hadoop directories on every machine in your cluster.
3. Restart the HDFS service and any dependencies.

Preparing to Update SAS High-Performance Deployment for Hadoop

Before starting the SAS High-Performance Deployment for Hadoop update, perform the following steps:

1. If one does not already exist, create a SAS Software Depot that contains the installation software that you will use to update Hadoop.
   
   For more information, see Creating a SAS Software Depot in the SAS Intelligence Platform: Installation and Configuration Guide.

2. Log on to the Hadoop NameNode as the hdfs user.

3. Run the following command to make sure that the Hadoop file system is healthy:
   
   `hadoop fsck /`
   
   Correct any issues before proceeding.

4. Stop any other processes, such as YARN, running on the Hadoop cluster.

   Confirm that all processes have stopped across all the cluster machines. (You might have to become another user to have the necessarily privileges to stop all processes.)

5. As the hdfs user, run the command `$HADOOP_HOME/sbin/stop-dfs.sh` to stop HDFS daemons, and confirm that all processes have ceased on all the machines in the cluster.

   **TIP** Check that there are no Java processes owned by hadoop running on any machine: `ps -ef | grep hadoop`. If you find any Java processes owned by the hdfs user account, terminate them. You can issue a single simsh command to simultaneously check all the machines in the cluster: `/HPA-environment-installation-directory/bin/simsh ps -ef | grep hdfs`.

6. Back up the Hadoop name directory (`hadoop-name` by default).

   Perform a file system backup using tar (or whatever tool or process that your site uses for backups).
Update SAS High-Performance Deployment for Hadoop

To update versions prior to 3.0 of SAS High-Performance Deployment for Hadoop, follow these steps:

1. If your version of SAS High-Performance Deployment for Hadoop is version 3.0, then you do not have to update Hadoop. For more information, see “Which Version of SAS High-Performance Deployment for Hadoop Have I Deployed?” on page 80.

2. Make sure that you have completed all the steps in, “Preparing to Update SAS High-Performance Deployment for Hadoop” on page 81.

3. Log on to the Hadoop NameNode machine (blade 0) as root.

   The software that is needed for SAS Plug-ins for Hadoop is available from within the SAS Software Depot that was created by your site’s depot administrator:

   `depot-installation-location/standalone_installs/SAS_Plug-ins_for_Hadoop/1_0/Linux_for_x64/hdatplugins.tar.gz`

4. Copy the hdatplugins.tar.gz file to a temporary location and extract it:

   ```
   cp hdatplugins.tar.gz /tmp
   cd /tmp
   tar xzf hdatplugins.tar.gz
   ```

   A directory that is named hdatplugins is created.

5. Propagate the following three JAR files in hdatplugins to the $HADOOP_HOME/share/hadoop/sas directory on each machine in the Hadoop cluster:

   - sas.lasr.jar
   - sas.lasr.hadoop.jar
   - sas.grid.provider.yarn.jar

   **CAUTION!** If your distribution of SAS High-Performance Deployment for Hadoop is based on Apache Hadoop version 0.23, then you must propagate these JAR files to $HADOOP_HOME/share/hadoop/hdfs/lib instead.

   **TIP** If you have already installed the SAS High-Performance Computing Management Console or the SAS High-Performance Analytics environment, you can issue a single `simcp` command to propagate JAR files across all machines in the cluster. For example:

   ```
   /opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.jar $HADOOP_HOME/share/hadoop/sas
   /opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.lasr.hadoop.jar $HADOOP_HOME/share/hadoop/sas
   /opt/TKGrid/bin/simcp /tmp/hdatplugins/sas.grid.provider.yarn.jar $HADOOP_HOME/share/hadoop/sas
   ```

   For more information, see Appendix 2, “SAS High-Performance Analytics Infrastructure Command Reference,” on page 85.

6. Propagate saslasrfd in hdatplugins to the $HADOOP_HOME/share/hadoop/sas/bin directory on each machine in the Hadoop cluster.
Update the Analytics Environment

You have the following options for managing updates to the SAS High-Performance Analytics environment:

- Delete the SAS High-Performance Analytics environment and install the newer version.
  See the procedure later in this topic.
- Rename the root installation directory for the current SAS High-Performance Analytics environment, and install the newer version under the previous root installation directory.
  See “Install the Analytics Environment” on page 58.
- Do nothing to the current SAS High-Performance Analytics environment, and install the new version under a new installation directory.
  See “Install the Analytics Environment” on page 58.

When you change the path of the SAS High-Performance Analytics environment, you have to also have to reconfigure the SAS LASR Analytic Server to point to the new path. See “Add a SAS LASR Analytic Server” in the SAS Visual Analytics Administration Guide.

Updating your deployment of the SAS High-Performance Analytics environment consists of deleting the deployment and reinstalling the newer version. To update the SAS High-Performance Analytics environment, follow these steps:

1. If you are also updating your co-located Hadoop deployment, update Hadoop first, then the SAS High-Performance Analytics environment.
   For more information, see “Updating Co-located Hadoop” on page 79.

2. Check that there are no analytics environment processes running on any machine:
   ```
   ps -ef | grep TKGrid
   ```
   If you find any TKGrid processes, terminate them.

   **TIP** You can issue a single `simsh` command to simultaneously check all the machines in the cluster:
   ```
   /HPA-environment-installation-directory/bin/simsh ps -ef | grep TKGrid.
   ```

3. Delete the analytics environment installation directory on every machine in the cluster:
You can issue a single `simsh` command to simultaneously remove the environment install directories on all the machines in the cluster:

```
/HPA-environment-installation-directory/bin/simsh rm -r -f /HPA-environment-installation-directory
```

4 Re-install the analytics environment using the shell script as described in "Install the Analytics Environment" on page 58.

---

### Updating the SAS High-Performance Computing Management Console

#### Overview of Updating the Management Console

Starting in version 2.6 of SAS High-Performance Computing Management Console, there is no longer support for memory management through CGroups.

Before upgrading the management console to version 2.6 (or later), make sure that you manually record any memory settings and then clear them on the CGroup Resource Management page. You can manually transfer these memory settings to the SAS High-Performance Analytics environment resource settings file. Or, if you are implementing YARN, transfer these settings to YARN. For more information, see the SAS LASR Analytic Server Reference Guide.

#### Update the Management Console Using RPM

To update your deployment of SAS High-Performance Computing Management Console, follow these steps:

1. Make sure that you have manually recorded and then cleared any memory settings in the management console. For more information, see "Overview of Updating the Management Console" on page 84.

2. Stop the server by entering the following command as the root user:
   ```
   service sashpcmc stop
   ```

3. Update the management console using the following RPM command:
   ```
   rpm -U --prefix=install-directory
   /SAS-Software-Depot-root-directory/standalone_installs/
   SAS_High-Performance_Computing_Management_Console/2_7/Linux_for_x64/
   sashpcmc-2.7.x86_64.rpm
   ```
   In this command, `install-directory` is the location where the management console is installed and `SAS-Software-Depot-root-directory` is the location where your SAS Software Depot resides.

4. Log on to the console to validate your update.
Appendix 2

SAS High-Performance Analytics Infrastructure Command Reference

The **simsh** and **simcp** commands are installed with SAS High-Performance Computing Management Console and the SAS High-Performance Analytics environment. The default path to the commands is `/HPCMC-installation-directory/webmin/utilbin` and `/HPA-environment-installation-directory/bin`, respectively. Any user account that can access the commands and has passwordless secure shell configured can use them.

**TIP** Add one of the earlier referenced installation paths to your system PATH variable to make invoking **simsh** and **simcp** easier.

The **simsh** command uses secure shell to invoke the specified command on every machine that is listed in the `/etc/gridhosts` file. The following command demonstrates invoking the **hostname** command on each machine in the cluster:

```
/HPCMC-install-dir/webmin/utilbin/simsh hostname
```

**TIP** You can use SAS High-Performance Computing Management Console to create and manage your grid hosts file. For more information, see the nSAS High-Performance Computing Management Console: User’s Guide.

The **simcp** command is used to copy a file from one machine to the other machines in the cluster. Passwordless secure shell and an `/etc/gridhosts` file are required. The following command is an example of copying the `/etc/hosts` file to each machine in the cluster:

```
/HPA-environment-installation-directory/bin/simcp /etc/hosts /etc
```
The following environment variables can be used on the client side to control the connection to the SAS High-Performance Analytics environment. You can set these environment variables in the following ways:

- invoke them in your SAS program using `options set=`
- add them to your shell before running the SAS program
- add them to your `sasenv_local` configuration file, if you want them used in all SAS programs

**GRIDHOST**
identifies the root node on the SAS High-Performance Analytics environment to which the client connects.

The values for `GRIDHOST` and `GRIDINSTALLLOC` can both be specified in the `GRIDHOST` variable, separated by a colon (similar to the format used by `scp`). For example:

```
GRIDHOST=my_machine_cluster_001:/opt/TKGrid
```

**GRIDINSTALLLOC**
identifies the location on the machine cluster where the SAS High-Performance Analytics environment is installed. For example:

```
GRIDINSTALLLOC=/opt/TKGrid
```

**GRIDMODE**
SYM | ASYM
toggles the SAS High-Performance Analytics environment between symmetric (default) and asymmetric mode.

**GRIDRSHCOMMAND**
" " | " ssh-path"
(optional) specifies `rsh` or `ssh` used to launch the SAS High-Performance Analytics environment.

If unspecified or a null value is supplied, a SAS implementation of the SSH protocol is used.

`ssh-path` specifies the path to the SSH executable that you want to use. This can be useful in deployments where export controls restrict SAS from delivering software that uses cryptography. For example:

```
option set=GRIDRSHCOMMAND="/usr/bin/ssh";
```
GRIDPORTRANGE=
identifies the port range for the client to open. The root node connects back
to the client using ports in the specified range. For example:

```
option set=GRIDPORTRANGE=7000-8000;
```

GRIDREPLYHOST=
specifies the name of the client machine to which the SAS High-Performance
Analytics environment connects. GRIDREPLYHOST is used when the client
has more than one network card or when you need to specify a full network
name.

GRIDREPLYHOST can be useful when you need to specify a fully qualified
domain name, when the client has more than one network interface card, or
when you need to specify an IP address for a client with a dynamically
assigned IP address that domain name resolution has not registered yet. For
example:

```
GRIDREPLYHOST=myclient.example.com
```
Overview of Deploying on SELinux and IPTables

This document describes how to prepare Security Enhanced Linux (SELinux) and IPTables for a SAS High-Performance Analytics infrastructure deployment.

Security Enhanced Linux (SELinux) is a feature in some versions of Linux that provides a mechanism for supporting access control security policies. IPTables is a firewall—a combination of a packet-filtering framework and generic table structure for defining rulesets. SELinux and IPTables is available in most new distributions of Linux, both community-based and enterprise-ready. For sites that require added security, the use of SELinux and IPTables is an accepted approach for many IT departments.

Because of the limitless configuration possibilities, this document is based on the default configuration for SELinux and IPTables running on Red Hat Enterprise Linux (RHEL) 6.3. You might need to adjust the directions accordingly, especially for complex SELinux and IPTables configurations.
Prepare the Management Console

**SELinux Modifications for the Management Console**

After generating and propagating root’s SSH keys throughout the cluster or data appliance, you must run the following command on every machine or blade to restore the security context on the files in `/root/.ssh`:

```
restorecon -R -v /root/.ssh
```

**IPTables Modifications for the Management Console**

Add the following line to `/etc/sysconfig/iptables` to allow connections to the port on which the management console is listening (10020 by default). Open the port only on the machine on which the management console is running:

```
-A INPUT -m state --state NEW -m tcp -p tcp --dport 10020 -j ACCEPT
```

Prepare the Analytics Environment

**SELinux Modifications for the Analytics Environment**

After generating and propagating root’s SSH keys throughout the cluster or data appliance, you must run the following command on every machine or blade to restore the security context on the files in `/root/.ssh`:

```
restorecon -R -v /root/.ssh
```

**IPTables Modifications for the Analytics Environment**

If you are deploying the SAS LASR Analytic Server, then you must define one port per server in `/etc/sysconfig/iptables`. (The port number is defined in the SAS code that starts the SAS LASR Analytic server.) If you have more than one server running simultaneously, you need all these ports defined in the form of a range.

Here is an example of an iptables entry for a single server (one port):

```
-A INPUT -m state --state NEW -m tcp -p tcp --dport 10010 -j ACCEPT
```

Here is an example of an iptables entry for five servers (port range):

```
-A INPUT -m state --state NEW -m tcp -p tcp --dport 10010:10014 -j ACCEPT
```

`MPICH_PORT_RANGE` must also be opened in IPTables by editing the `/etc/sysconfig/iptables` file and adding the port range.
Here is an example for five servers:

```
-A INPUT -m state --state NEW -m tcp -p tcp --dport 10010:10029 -j ACCEPT
```

Edit `/etc/sysconfig/iptables` and then copy this file across the machine cluster or data appliance. Lastly, restart the IPTables service.

### Analytics Environment Post-Installation Modifications

The SAS High-Performance Analytics environment uses Message Passing Interface (MPI) communications, which requires you to define one port range per active job across the machine cluster or data appliance.

(A port range consists of a minimum of four ports per active job. Every running monitoring server counts as a job on the cluster or appliance.)

For example, if you have five jobs running simultaneously across the machine cluster or data appliance, you need a minimum of 20 ports in the range.

The following example is an entry in tkmpirsh.sh for five jobs:

```
export MPICH_PORT_RANGE=18401:18420
```

Edit tkmpirsh.sh using the number of jobs appropriate for your site. (tkmpirsh.sh is located in `/installation-directory/TKgrid/`). Then, copy tkmpirsh.sh across the machine cluster or data appliance.

### iptables File

This topic lists the complete `/etc/sysconfig/iptables` file. The additions to iptables described in this document are highlighted.

```
*filter
:INPUT ACCEPT [0:0]
:FORWARD ACCEPT [0:0]
:OUTPUT ACCEPT [0:0]
-A INPUT -m state --state ESTABLISHED,RELATED -j ACCEPT
-A INPUT -p icmp -j ACCEPT
-A INPUT -i lo -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 22 -j ACCEPT
# Needed by SAS HPC MC
-A INPUT -m state --state NEW -m tcp -p tcp --dport 10020 -j ACCEPT
# Needed for HDFS (Hadoop)
A INPUT -m state --state NEW -m tcp -p tcp --dport 54310 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 54311 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 50470 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 50475 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 50010 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 50020 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 50070 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 50075 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 50090 -j ACCEPT
```
-A INPUT -m state --state NEW -m tcp -p tcp --dport 50100 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 50105 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 50030 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 50060 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 15452 -j ACCEPT
-A INPUT -m state --state NEW -m tcp -p tcp --dport 15453 -j ACCEPT
# End of HDFS Additions
# Needed for LASR Server Ports.
-A INPUT -m state --state NEW -m tcp -p tcp --dport 17401:17405 -j ACCEPT
# End of LASR Additions
# Needed for MPICH.
-A INPUT -m state --state NEW -m tcp -p tcp --dport 18401:18420 -j ACCEPT
# End of MPICH additions.
-A INPUT -j REJECT --reject-with icmp-host-prohibited
-A FORWARD -j REJECT --reject-with icmp-host-prohibited
Setting Up Passwordless Secure Shell (SSH)

What Is Passwordless SSH?

Secure Shell (SSH) is a network protocol that allows data to be exchanged using a secure channel between two networked devices. Passwordless SSH enables an identity to connect from one device to another without specifying a password. The identity can log on without a credential challenge, or it can invoke commands on the other device without a credential challenge.

Who Needs Passwordless SSH?

For a non-distributed server, passwordless SSH is not applicable.

For a distributed server, the requirements for passwordless SSH are as follows:

- Each user that needs to start and stop servers and load and unload tables must have an account that is configured for passwordless SSH on each machine in the cluster.

- If you use automated loading, the service account under which the scheduled task runs must be configured for passwordless SSH on each machine in the cluster. This is necessary to perform tasks such as starting and stopping the server and loading and unloading tables.

- For deployments that include SAS Visual Analytics, the service account for SAS LASR Analytic Server Monitor must be configured for passwordless SSH on each machine in the cluster. This is necessary to monitor hardware resources and processes for a distributed SAS LASR Analytic Server. This service account can be the same as the SAS installer account.

How to Set Up Passwordless SSH

You can use a point-and-click interface to generate SSH keys and configure them for passwordless SSH automatically for administrator accounts. See the SAS High-Performance Computing Management Console: User’s Guide.

Here are some tips:

- In the SAS High-Performance Computing Management Console, be sure to select the Generate and Propagate SSH Keys option on the Create User page. This ensures that passwordless SSH is configured correctly for the account.
After you add user or group accounts to the machines in the cluster, you must restart the HDFS service if it is co-located. An error message such as the following indicates that a user is not recognized:

```
ERROR: host02.example.com (192.168.1.240) User does not belong to .
```

### Generate SSH Keys Manually

The recommended method is to use the SAS High-Performance Computing Management Console to generate SSH keys (as described in the preceding topic).

If you must generate SSH keys manually (for example, for existing user IDs), use the following steps:

1. Generate a private/public key pair on a Linux system. Enter the following command to generate the keys without requiring a passphrase:

   ```
   ssh-keygen -t rsa -P ""
   ```

2. After the keys are generated, if passwordless SSH is required, then add the public key to the list of authorized keys by entering this command on the command line:

   ```
   cat ~/.ssh/id_rsa.pub >> ~/.ssh/authorized_keys
   ```

3. Check permissions on the `.ssh` directory and the files in your `.ssh` directory. The directory must be readable and writable by you only. The `id_rsa` file must be readable by you only. To verify access, enter the following command, and check the results:

   ```
   ls -asl ~/.ssh
   ```

   ```
   drwx------ 2 datamgr datamgr 4096 Jan 23 10:27 .
   drwx------ 4 datamgr datamgr 4096 Jan 12 19:09 ..
   -rw-r--r-- 1 datamgr datamgr  397 Jan 23 10:27 authorized_keys
   -rw------- 1 datamgr datamgr  1675 Jan 23 10:00 id_rsa
   -rw-r--r-- 1 datamgr datamgr  397 Jan 13 10:00 id_rsa.pub
   -rw-r--r-- 1 datamgr datamgr 1705 Jan 23 10:27 known_hosts
   ```

   a. The directory permissions for the `.ssh` directory indicate that access is denied for all users other than the directory owner.

   b. The `id_rsa` file is the private key. Read access and Write access are available to the file owner only.

   **Note:** If the machines in the cluster are not configured to access the home directories for the users, create local home directories for the users. Copy the `.ssh` directory for each user to his or her local home directory. Make sure that the permissions are preserved.

### About Passwordless SSH and Windows Clients

If you need to access a distributed SAS LASR Analytic Server from a Windows client, then you need to perform the following steps to copy your SSH keys to the Windows machine:

1. Determine your Windows home directory. Enter the following command in a command window:
echo %HOMEDRIVE%%HOMEPATH%

The results are typically something like C:\Users\sasdemo.

2 You can use Windows Explorer to drag-and-drop the .ssh directory from your UNIX home directory, or you can use a command like the following to copy it:

xcopy driverLetter:\.ssh* "%HOMEDRIVE%%HOMEPATH%\.ssh" /s /i

These steps are typically necessary for deployments that use SAS Studio on a Windows client or SAS solutions that use Windows machines for the server tier.

**Troubleshooting**

If access problems occur, use the following steps to help diagnose any SSH configuration errors:

1 Impersonate the user or ask the user to perform the following command that requires passwordless SSH:

   /opt/TKGrid/bin/simsh hostname

   If each of the machines in the cluster responds with a host name, then no passwordless SSH configuration error exists.

2 As root, log on to one of the machines in the cluster and monitor the logon access:

   tail -f /var/log/secure

3 Review the messages in the /var/log/secure file. The following example shows that the file system access permissions for /home/sas are not set correctly:

   Mar 14 22:12:36 hostname sshd[11235]: pam_unix(sshd:session): session opened for user root by (uid=0)
   Mar 14 22:12:57 hostname sshd[11266]: Authentication refused: bad ownership or modes for directory /home/sas
Recommended Reading

Here is the recommended reading list for this title:

- Configuration Guide for SAS Foundation for Microsoft Windows for x64.
- SAS/ACCESS for Relational Databases: Reference.
- SAS Guide to Software Updates.
- SAS and Hadoop Technology: Deployment Scenarios
- SAS and Hadoop Technology: Overview.
- SAS In-Database Products: Administrator’s Guide.
- SAS Intelligence Platform: Installation and Configuration Guide.
- SAS Intelligence Platform: Security Administration Guide.
- SAS LASR Analytic Server Reference Guide.
- SAS 9.4 Support for Hadoop.

For a complete list of SAS publications, go to sas.com/store/books. If you have questions about which titles you need, please contact a SAS Representative:

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Fax: 1-919-677-4444
Email: sasbook@sas.com
Web address: sas.com/store/books
browser
See web browser.

colocated data provider
a distributed data source, such as SAS Visual Analytics Hadoop or a third-party vendor database, that has SAS High-Performance Analytics software installed on the same machines. The SAS software on each machine processes the data that is local to the machine or that the data source makes available as the result of a query.

data set
See SAS data set.

data warehouse (warehouse)
a collection of pre-categorized data that is extracted from one or more sources for the purpose of query, reporting, and analysis. Data warehouses are generally used for storing large amounts of data that originates in other corporate applications or that is extracted from external data sources.

deployment plan
information about what software should be installed and configured on each machine in a SAS deployment. A deployment plan is stored in a plan.xml file.

encryption
the conversion of data by the use of algorithms or other means into an unintelligible form in order to secure data (for example, passwords) in transmission and in storage.

Extensible Markup Language (XML)
a markup language that structures information by tagging it for content, meaning, or use. Structured information contains both content (for example, words or numbers) and an indication of what role the content plays. For example, content in a section heading has a different meaning from content in a database table.

foundation services
See SAS Foundation Services.

grid host
the machine to which the SAS client makes an initial connection in a SAS High-Performance Analytics application.

Hadoop Distributed File System (HDFS)
a portable, scalable framework, written in Java, for managing large files as blocks of equal size. The files are replicated across multiple host machines in a Hadoop cluster in order to provide fault tolerance.
HDFS
See Hadoop Distributed File System.

high-performance root node
See root node.

identity
See metadata identity.

Integrated Windows authentication (IWA)
a Microsoft technology that facilitates use of authentication protocols such as Kerberos. In the SAS implementation, all participating components must be in the same Windows domain or in domains that trust each other.

Internet Protocol Version 6 (IPv6)
a protocol that specifies the format for network addresses for all computers that are connected to the Internet. This protocol, which is the successor of Internet Protocol Version 4, uses hexadecimal notation to represent 128-bit address spaces. The format can consist of up to eight groups of four hexadecimal characters, delimited by colons, as in FE80:0000:0000:0000:0202:B3FF:FE1E:8329. As an alternative, a group of consecutive zeros could be replaced with two colons, as in FE80::0202:B3FF:FE1E:8329.

IPv6

IWA
See Integrated Windows authentication.

JAR (Java Archive)
the name of a package file format that is typically used to aggregate many Java class files and associated metadata and resources (text, images, etc.) into one file to distribute application software or libraries on the Java platform.

Java
a set of technologies for creating software programs in both stand-alone environments and networked environments, and for running those programs safely. Java is an Oracle Corporation trademark.

Java Archive
See JAR.

Java Database Connectivity (JDBC)
a standard interface for accessing SQL databases. JDBC provides uniform access to a wide range of relational databases. It also provides a common base on which higher-level tools and interfaces can be built.

Java Development Kit (JDK)
a software development environment that is available from Oracle Corporation. The JDK includes a Java Runtime Environment (JRE), a compiler, a debugger, and other tools for developing Java applets and applications.
JDBC
See Java Database Connectivity.

JDK
See Java Development Kit.

localhost
the keyword that is used to specify the machine on which a program is executing. If a client specifies localhost as the server address, the client connects to a server that runs on the same machine.

login
a SAS copy of information about an external account. Each login includes a user ID and belongs to one SAS user or group. Most logins do not include a password.

Message Passing Interface (MPI)
a standardized and portable message-passing system that was designed to function on a wide variety of parallel computers. SAS Analytics applications implement MPI for use in high-performance computing environments.

metadata identity (identity)
a metadata object that represents an individual user or a group of users in a SAS metadata environment. Each individual and group that accesses secured resources on a SAS Metadata Server should have a unique metadata identity within that server.

metadata object
a set of attributes that describe a table, a server, a user, or another resource on a network. The specific attributes that a metadata object includes vary depending on which metadata model is being used.

middle tier
in a SAS business intelligence system, the architectural layer in which web applications and related services execute. The middle tier receives user requests, applies business logic and business rules, interacts with processing servers and data servers, and returns information to users.

MPI
See Message Passing Interface.

object spawner (spawner)
a program that instantiates object servers that are using an IOM bridge connection. The object spawner listens for incoming client requests for IOM services.

planned deployment
a method of installing and configuring a SAS business intelligence system. This method requires a deployment plan that contains information about the different hosts that are included in the system and the software and SAS servers that are to be deployed on each host. The deployment plan then serves as input to the SAS Deployment Wizard.

root node (high-performance root node)
in a SAS High-Performance Analytics application, the software that distributes and coordinates the workload of the worker nodes. In most
deployments the root node runs on the machine that is identified as the grid host. SAS High-Performance Analytics applications assign the highest MPI rank to the root node.

**SAS Application Server**

a logical entity that represents the SAS server tier, which in turn comprises servers that execute code for particular tasks and metadata objects.

**SAS authentication**

a form of authentication in which the target SAS server is responsible for requesting or performing the authentication check. SAS servers usually meet this responsibility by asking another component (such as the server's host operating system, an LDAP provider, or the SAS Metadata Server) to perform the check. In a few cases (such as SAS internal authentication to the metadata server), the SAS server performs the check for itself. A configuration in which a SAS server trusts that another component has pre-authenticated users (for example, web authentication) is not part of SAS authentication.

**SAS configuration directory**

the location where configuration information for a SAS deployment is stored. The configuration directory contains configuration files, logs, scripts, repository files, and other items for the SAS software that is installed on the machine.

**SAS data set (data set)**

a file whose contents are in one of the native SAS file formats. There are two types of SAS data sets: SAS data files and SAS data views.

**SAS Deployment Manager**

a cross-platform utility that manages SAS deployments. The SAS Deployment Manager supports functions such as updating passwords for your SAS deployment, rebuilding SAS web applications, and removing configurations.

**SAS Deployment Wizard**

a cross-platform utility that installs and initially configures many SAS products. Using a SAS installation data file and, when appropriate, a deployment plan for its initial input, the wizard prompts the customer for other necessary input at the start of the session, so that there is no need to monitor the entire deployment.

**SAS Foundation Services (foundation services)**

a set of core infrastructure services that programmers can use in developing distributed applications that are integrated with the SAS platform. These services provide basic underlying functions that are common to many applications. These functions include making client connections to SAS application servers, dynamic service discovery, user authentication, profile management, session context management, metadata and content repository access, information publishing, and stored process execution.

**SAS installation data file**

*See SID file.*
SAS installation directory
the location where your SAS software is installed. This location is the parent
directory to the installation directories of all SAS products. The SAS
installation directory is also referred to as SAS Home in the SAS Deployment
Wizard.

SAS IOM workspace (workspace)
in the IOM object hierarchy for a SAS Workspace Server, an object that
represents a single session in SAS.

SAS Metadata Server
a multi-user server that enables users to read metadata from or write
metadata to one or more SAS Metadata Repositories.

SAS Pooled Workspace Server
a SAS Workspace Server that is configured to use server-side pooling. In this
configuration, the SAS object spawner maintains a collection of workspace
server processes that are available for clients.

SAS Software Depot
a file system that consists of a collection of SAS installation files that
represents one or more orders. The depot is organized in a specific format
that is meaningful to the SAS Deployment Wizard, which is the tool that is
used to install and initially configure SAS. The depot contains the SAS
Deployment Wizard executable, one or more deployment plans, a SAS
installation data file, order data, and product data.

SAS Stored Process Server
a SAS IOM server that is launched in order to fulfill client requests for SAS
Stored Processes.

SAS Workspace Server
a SAS server that provides access to SAS Foundation features such as the
SAS programming language and SAS libraries.

SASHDAT file format
a SAS proprietary data format that is optimized for high performance and
computing efficiency. For distributed servers, SASHDAT files are read in
parallel. When used with the Hadoop Distributed File System (HDFS), the file
takes advantage of data replication for fault-tolerant data access.

SASHOME directory
the location in a file system where an instance of SAS software is installed on
a computer. The location of the SASHOME directory is established at the
initial installation of SAS software by the SAS Deployment Wizard. That
location becomes the default installation location for any other SAS software
that is installed on the same computer.

server context
a SAS IOM server concept that describes how SAS Application Servers
manage client requests. A SAS Application Server has an awareness (or
context) of how it is being used and makes decisions based on that
awareness. For example, when a SAS Data Integration Studio client submits
code to its SAS Application Server, the server determines what type of code
is submitted and directs it to the correct physical server for processing (in this
case, a SAS Workspace Server).
server description file
a file that is created by a SAS client when the LASR procedure executes to create a server. The file contains information about the machines that are used by the server. It also contains the name of the server signature file that controls access to the server.

SID file (SAS installation data file)
a control file containing license information that is required in order to install SAS.

single sign-on (SSO)
an authentication model that enables users to access a variety of computing resources without being repeatedly prompted for their user IDs and passwords. For example, single sign-on can enable a user to access SAS servers that run on different platforms without interactively providing the user's ID and password for each platform. Single sign-on can also enable someone who is using one application to launch other applications based on the authentication that was performed when the user initially logged on.

SOE
See software order email.

software order email (SOE)
an email message, sent to a customer site, that announces arrival of the software and describes the order. It explains the initial installation steps and might also contain instructions for using Electronic Software Delivery (ESD), if applicable.

spawner
See object spawner.

SSO
See single sign-on.

trusted user
a privileged service account that can act on behalf of other users on a connection to the metadata server.

unrestricted identity
a user or group that has all capabilities and permissions in the metadata environment due to membership in the META: Unrestricted Users Role (or listing in the adminUsers.txt file with a preceding asterisk).

update mode
an operating state of the SAS Deployment Wizard in which users are required to install software updates before they can perform any other deployment tasks. The SAS Deployment Wizard automatically goes into update mode when it determines that the current SAS order contains new versions or maintenance updates to the deployed products in a given SAS installation directory.

warehouse
See data warehouse.
**web application**

An application that is accessed via a web browser over a network such as the Internet or an intranet. SAS web applications are Java Enterprise Edition (JEE) applications that are delivered via web application archive (WAR) files. The applications can depend on Java and non-Java web technologies.

**web authentication**

A configuration in which users of web applications and web services are verified at the web perimeter, and the metadata server trusts that verification.

**web browser (browser)**

A software application that is used to view web content, and also to download or upload information. The browser submits URL (Uniform Resource Locator) requests to a web server and then translates the HTML code into a visual display.

**worker node**

In a SAS High-Performance Analytics application, the role of the software that receives the workload from the root node.

**workspace**

See SAS IOM workspace.

**XML**

See Extensible Markup Language.
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