Configuring Apache HDFS Encryption

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HDFS Encryption

HDFS data at rest encryption implements end-to-end encryption of data read from and written to HDFS. End-to-end encryption means that data is encrypted and decrypted only by the client. HDFS does not have access to unencrypted data or keys.

Ranger KMS Administration

The Ranger Key Management Service (Ranger KMS) is an open source, scalable cryptographic key management service supporting HDFS “data at rest” encryption.

Ranger KMS is based on the Hadoop KMS originally developed by the Apache community. The Hadoop KMS stores keys in a file-based Java keystore by default. Ranger extends the native Hadoop KMS functionality by allowing you to store keys in a secure database.

Ranger provides centralized administration of the key management server through the Ranger admin portal.

There are three main functions within the Ranger KMS:

- **Key management.** Ranger admin provides the ability to create, update or delete keys using the Web UI or REST APIs. All Hadoop KMS APIs work with Ranger KMS using the keyadmin username and password.
- **Access control policies.** Ranger admin also provides the ability to manage access control policies within Ranger KMS. The access policies control permissions to generate or manage keys, adding another layer of security for data encrypted in Hadoop.
- **Audit.** Ranger provides full audit trace of all actions performed by Ranger KMS.

Ranger KMS along with HDFS encryption are recommended for use in all environments. In addition to secure key storage using a database, Ranger KMS is also scalable, and multiple versions of Ranger KMS can be run behind a load balancer.

Related Information

- HDFS "Data at Rest" Encryption
- Hadoop KMS APIs

Store Master Key in a Hardware Security Module (HSM)

PCI compliance requires that keys are stored in Hardware Security Modules (HSMs) rather than a software KMS. For example, this is required for financial institutions working with customer credit/debit card terminals. This section explains how to store keys in an HSM.

Before you begin

You must have a separate partition for each KMS cluster.
### Installing Ranger KMS Hardware Security Module (HSM)

You can install the Ranger KMS HSM in three ways: manually, via Ambari with a plain text password, or via Ambari with JCEKS.

You must have a separate partition for each KMS cluster.

#### Before you begin
- Install the SafeNet Luna SA Client software (link below).
- You must have a separate partition for each KMS cluster.

#### Procedure
Refer to the instructions on the Apache Wiki (link below).

#### Related Information
- Install the SafeNet Luna SA Client Software
- Apache Wiki>Installing Ranger KMS HSM (Manually)

### Install Ranger KMS HSM via Ambari with plain text password

How to install the Ranger KMS HSM via Ambari with a plain text password.

#### Before you begin
- Install the SafeNet Luna SA Client software (link below).
- You must have a separate partition for each KMS cluster.

#### Procedure
1. Complete “Installing the Ranger Key Management Service”.
2. While configuring add the HSM related properties in Advanced dbks-site Menu (dbks-site.xml):
• ranger.ks.hsm.enabled=true
• ranger.ks.hsm.partition.name=Partition Name
• ranger.ks.hsm.partition.password=Partition Password
• ranger.ks.hsm.type=LunaProvider

3. Click on Next and follow the instructions to install Ranger KMS.

**Related Information**
Installing the Ranger Key Management Service
Install the SafeNet Luna SA Client Software

**Install Ranger KMS HSM via Ambari with JCEKS**
How to install the Ranger KMS HSM via Ambari with JCEKS.

**Before you begin**
• Install the SafeNet Luna SA Client software (link below).
• You must have a separate partition for each KMS cluster.

**Procedure**
1. Complete “Installing the Ranger Key Management Service”.
2. While configuring add the HSM related properties in Advanced dbks-site Menu (dbks-site.xml):
   • ranger.ks.hsm.enabled=true
   • ranger.ks.hsm.partition.name=Partition Name
   • ranger.ks.hsm.partition.password=Partition Password
   • ranger.ks.hsm.partition.password.alias=ranger.kms.hsm.partition.password
   • ranger.ks.hsm.type=LunaProvider
3. Click on **Next** and follow the instructions to install Ranger KMS. Ranger KMS will fail to start (expected behavior).

4. Execute this command on the cluster where Ranger KMS is installed:

```bash
python /usr/hdp/current/ranger-kms/ranger_credential_helper.py -l "/usr/hdp/current/ranger-kms/cred/lib/*" -f /etc/ranger/kms/rangerkms.jceks -k ranger.kms.hsm.partition.password -v <Partition_Password> -c 1
```

5. Restart the KMS from Ambari.

**Related Information**

- Installing the Ranger Key Management Service
- Install the SafeNet Luna SA Client Software

**Configure HSM for High Availability (HA)**

How to configure HSM for high availability.

**Before you begin**

You must have at least two Luna SA appliances with PED Authentication, or two with Password Authentication.

**Procedure**

1. Set up appliances for HA:
   a) Perform the network setup on both HA units: install the SafeNet Luna SA Client software (link below).
   b) In `hsm showPolicies`, ensure that `Allow Cloning=on` and `Allow Network Replication=on`.
   c) Initialize the HSMs on your Luna SA appliances. They must have the same cloning domain (i.e., must share the same red, domain PED Key if they are PED-authenticated) or they must share the same domain string if they are password-authenticated.
   d) Create a partition on each Luna SA. They do not need to have the same labels, but must have the same password.
   e) Record the serial number of each partition created on each Luna SA (use `partition show`).

2. Register clients with Luna SA HA:
   a) Proceed with normal client setup, “Prepare the Client for Network Trust Link” (link below).
   b) Register your client computer with both Luna SAs.
   c) Verify using `/vtl verify` command. It should show the numbers of partitions registered with client.

3. Create the HA GroupNote for your client version:
   - Version 5
   - Version 6
4. Version 5
a) After creating partitions on (at least) two Luna appliances, and setting up Network Trust Links between those partitions and your client, use LunaCM to configure HA on your client: Go to the directory: /usr/safenet/lunaclient/bin/.

b) To add members in haadmin, create a new group on the client: ./vtl haAdmin newGroup -serialNum HA Group Number -label Groupname -password password.
   For example: ./vtl haAdmin newGroup -serialNum 156453092 -label myHAgroup -password S@fenet123

c) Add members into your haadmin: ./vtl haAdmin addMember -group HA Group Number -serialNum serial_number -password password.
   For example: ./vtl haAdmin addMember -group 1156453092 -serialNum 156451030 -password S@fenet123

d) Enable synchronization of HAadmin Members: ./vtl haAdmin synchronize -group HA Group Number -password password.
   For example: ./vtl haAdmin synchronize -enable -group 1156453092 -password S@fenet123

e) To Enable HAOnly: ./vtl haAdmin HAOnly -enable.

f) Check haadmin status after synchronization: ./vtl haAdmin show.

   Note: After synchronization please verify kms master key copied to both partitions registered in hsm ha group. It takes time to copy master key to another partition.

5. Version 6
a) After creating partitions on (at least) two Luna appliances, and setting up Network Trust Links between those partitions and your client, use LunaCM to configure HA on your client:

1. Go to directory: /usr/safenet/lunaclient/bin/.
2. Select Lunacm: ./lunacm.

b) To add members in hagroup, create a new group on the client: haGroup creategroup -serialNumber serial_number -l label -p password.
   For example: lunacm:>haGroup creategroup -serialNumber 1047740028310 -l HAHSM3 -p S@fenet123

c) Use the hagroup addmember command to add new member into hagroup client: hagroup addMember -group groupname -serialNumber serial_number -password password.

   Field descriptions:
   • Label for the group (do NOT call the group just "HA"): groupname
   • The serial number of the first partition OR the slot number of the first partition: serial number
   • The password for the partition: password
   • Lunacm also generates and assigns a Serial Number to the group itself.

   For example: lunacm:>hagroup addMember -group rkmsgroup -serialNumber 1047749341551 -password S@fenet123

d) Use the hagroup addmember command to add another member to the HA group: hagroup addMember -group groupname -serialNumber serial_number -password password.
   For example: lunacm:>hagroup addMember -serialNumber 1047740028310 -g rkmslgroup -password S@fenet123

e) Check group member in group using "hagroup listGroups" command: hagroup listGroups.

f) Enable HAOnly: hagroup HAOnly -enable.

   g) Enable synchronization of HAgroup Members: hagroup synchronize -group groupname -password password -enable.
   
   For example: lunacm:>hagroup synchronize -group rkmslgroup -password S@fenet123 -enable

6. After configuring HSM HA, to run Ranger KMS in HSM HA mode you must specify the virtual group name created above in HSM_PARTITION_NAME property of install.properties and start Ranger KMS. Note: All other configuration for HSM in install.properties of Ranger KMS as mentioned in “Installing Ranger KMS HSM” will remain the same.

Related Information
Install the SafeNet Luna SA Client Software
HDP Configuring HDFS Encryption

Prepare the Client for Network Trust Link

Migrate between HSM and Ranger DB
If required, you can migrate from HSM to Ranger DB or Ranger DB to HSM.

Procedure
1. If running, stop the Ranger KMS server.
2. Go to the Ranger KMS directory: /usr/hdp/$version/ranger-kms.
   DB details must be correctly configured to which KMS needs migration to (located in the xml config file of Ranger KMS).
   For DB to HSM: HSM details must be the KMS HSM to which we are migrating.
3. Run:

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<th>Run</th>
<th>Example</th>
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<td>./DBMK2HSM.sh LunaProvider par19</td>
</tr>
<tr>
<td>HSM to DB</td>
<td>./HSMMK2DB.sh $provider $HSM_PARTITION_NAME</td>
<td>./HSMMK2DB.sh LunaProvider par19</td>
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4. Enter the partition password.
5. After the migration is completed: if you want to run Ranger KMS according to the new configuration (either with HSM enabled or disabled,) update the Ranger KMS properties if required.

What to do next

Warning:
Deleting the master key is a destructive operation. If the master key is lost, there is potential data loss, since data under encryption zones cannot be recovered. Therefore, it is a best practice to keep backups of the master key in DB as well as HSM.

- DB to HSM: When Ranger KMS is running with HSM enabled: from DB table “ranger_masterkey”, delete the Master Key row if it is not required as Master Key already being migrated to HSM.
- HSM to DB: When Ranger KMS is running with HSM disabled: from HSM, clear the Master Key object from the partition if it is not required as Master Key already being migrated to DB.

Optional: Clear Objects from the HSM Partition
How to clear objects from the HSM partition.

Procedure
1. SSH to the HSM Appliance Server.
   ssh admin@elab6.safenet-inc.com
2. Enter Password for the HSM Appliance Server when prompted.
3. Check the Partition Objects that you want to clear and enter the password for the partition when prompted:
   Partition showContents -par partition_name .
   partition showContents -par par14

   Note:
   All objects listed will be destroyed during step 3.
4. Clear the objects from HMS partition: Partition clear -par partition_name .
5. Enter Password for Partition when prompted.
   
   partition clear -par par14

### Enable Ranger KMS Audit

Ranger KMS supports audit to DB, HDFS, and Solr. Solr is well-suited for short-term auditing and UI access (for example, one month of data accessible via quick queries in the Web UI). HDFS is typically used for archival auditing. They are not mutually exclusive; we recommend configuring audit to both Solr and HDFS. First, make sure Ranger KMS logs are enabled by following these steps.

**Procedure**

1. Go to the Ambari UI: `http://<gateway>:8080`
2. Select `ranger-kms` from the service.
3. Click the Configs tab, and go to the accordion menu.
4. In the Advanced `ranger-kms-audit` list, set `xasecure.audit.is.enabled` to `true`.
5. Select "Audit to Solr" and/or "Audit to HDFS", depending on which database(s) you plan to use:

   ![Ambari UI Screenshot]

6. Save the configuration and restart the Ranger KMS service.
7. Check to see if the Ranger KMS Plugin is enabled:
   a) Go to the Ranger UI: `http://<gateway>:6080`
   b) Login with your `keyadmin` user ID and password (the defaults are `keyadmin`, `keyadmin`). The default repository will be added under KMS service.
   c) Run a test connection for the service. You should see a ‘connected successfully’ pop-up message. If the connection is not successful, make sure that the configured user exists (in KDC for a secure cluster).
   d) Choose the Audit > Plugin tab.
   e) Check whether plugins are communicating. The UI should display `Http Response code 200` for the respective plugin.

### Save Audits to Solr

How to save audits to Solr, when enabling Ranger KMS Audit.
Procedure

1. From the Ambari dashboard, select the Ranger service. Select Configs > Advanced, then scroll down and select Advanced ranger-admin-site. Set the following property value: ranger.audit.source.type = solr.

2. On the Ranger Configs tab, select Ranger Audit. The SolrCloud button should be set to ON. The SolrCloud configuration settings are loaded automatically when the SolrCloud button is set from OFF to ON, but you can also manually update the settings.

3. Restart the Ranger service.

4. Next, to enable Ranger KMS auditing to Solr, set the following properties in the Advanced ranger-kms-audit list:
   a) Check the box next to Enable audit to solr in the Ranger KMS component.
   b) Check the Audit provider summary enabled box, and make sure that xasecure.audit.is.enabled is set to true.
   c) Restart Ranger KMS.

Save Audits to HDFS

How to save audits to HDFS, when enabling Ranger KMS Audit.

About this task

There are no configuration changes needed for Ranger properties.

To save Ranger KMS audits to HDFS, set the following properties in the Advanced ranger-kms-audit list.

   Note: The following configuration settings must be changed in each Plugin.

Procedure

1. Check the box next to Enable Audit to HDFS in the Ranger KMS component.

2. Set the HDFS path to the path of the location in HDFS where you want to store audits:
   xasecure.audit.destination.hdfs.dir = hdfs://NAMENODE_FQDN:8020/ranger/audit.

3. Check the Audit provider summary enabled box, and make sure that xasecure.audit.is.enabled is set to true.

4. Make sure that the plugin's root user (kms) has permission to access HDFS Path hdfs://
   NAMENODE_FQDN:8020/ranger/audit.

5. Restart Ranger KMS.

6. Generate audit logs for the Ranger KMS.

7. (Optional) To verify audit to HDFS without waiting for the default sync delay (approximately 24 hours), restart Ranger KMS. Ranger KMS will start writing to HDFS after the changes are saved post-restart.

8. To check for audit data: hdfs dfs -ls /ranger/audit/.

9. Test Ranger KMS audit to HDFS:
   a) Under custom core-site.xml, set hadoop.proxyuser.kms.groups to "*" or to the service user.
   b) In the custom kms-site file, add hadoop.kms.proxyuser.keyadmin.users and set its value to "*". (If you are not using keyadmin to access Ranger KMS Admin, replace “keyadmin” with the user account used for authentication.)
   c) In the custom kms-site file, add hadoop.kms.proxyuser.keyadmin.hosts and set its value to "*". (If you are not using keyadmin to access Ranger KMS Admin, replace “keyadmin” with the user account used for authentication.)
   d) Choose:
      • Copy the core-site.xml to the component’s class path (/etc/ranger/kms/conf)
      • Link to /etc/hadoop/conf/core-site.xml under /etc/ranger/kms/conf (ln -s /etc/hadoop/conf/core-site.xml /etc/ranger/kms/conf/core-site.xml)
   e) Verify the service user principal. (For Ranger KMS it will be the http user.)
Enable SSL for Ranger KMS

How to enable SSL for Ranger KMS. If you do not have access to Public CA-issued certificates, complete the following steps to create and configure self-signed certificates.

**About this task**

Considerations:
- Copy keystore/truststore files into a different location (e.g. `/etc/security/serverKeys`) than the `/etc/<component>/` confolders.
- Make sure JKS file names are different from each other.
- Make sure correct permissions are applied.
- Make sure all passwords are secured.
- For the test connection to be successful after enabling SSL, self-signed certificates should be imported to the Ranger admin’s trust store (typically JDK cacerts).
- Property `ranger.plugin.service.policy.rest.ssl.config.file` should be verified; for example:
  ```
  ranger.plugin.kms.policy.rest.ssl.config.file ==> /etc/ranger/kms/conf/ranger-policymgr-ssl.xml
  ```

**Procedure**

1. Stop the Ranger KMS service:

   ![Service Actions](image)

2. Go to the Ranger KMS (and plugin) installation location, and create a self-signed certificate:

   ```
   cd /etc/ranger/kms/conf/
   keytool -genkey -keyalg RSA -alias rangerKMSAgent -keystore <ranger-kms-ks> -storepass myKeyFilePassword -validity 360 -keysize 2048
   chown kms:kms <ranger-kms-ks>
   chmod 400 <ranger-kms-ks>
   ```

   where

   `<ranger-kms-ks>` is the name of the Ranger KMS keystore (for example, ranger-plugin-keystore.jks)

3. Provide an identifiable string in response to the question "What is your first and last name?"

   **Important:** In case multiple servers need to communicate with Ranger admin for downloading policies for the same service/repository, make sure to use the repo name or a common string across all nodes. Remember exactly what you entered, because this value will be required for the Common Name for Certificate field on the edit repository page in the policy manager UI.

   To create the keystore, provide answers to the subsequent questions. Note: Press enter when prompted for a password.

4. Create a truststore for the Ranger KMS plugin, and add the public key of admin as a trusted entry into the truststore:

   ```
   cd /etc/ranger/kms/conf/
   ```
HDP Configuring HDFS Encryption

Ranger KMS Administration

5. Update below properties available in Advanced ranger-kms-policymgr-ssl:
   a) xasecure.policymgr.clientssl.keystore: Provide the location for the keystore that you created in the previous step.
   b) xasecure.policymgr.clientssl.keystore.password: Provide the password for the keystore (myKeyFilePassword).
   c) xasecure.policymgr.clientssl.truststore: Provide the location for the truststore that you created in the previous step.
   d) xasecure.policymgr.clientssl.truststore.password: Provide the password for the truststore (changeit).

6. Add the plugin's self-signed cert into Admin's trustedCACerts:

   cd /etc/ranger/admin/conf
   keytool -export -keystore <ranger-kms-ks> -alias rangerKMSAgent -file <cert-filename> -storepass myKeyFilePassword
   keytool -import -file <cert-filename> -alias rangerKMSAgentTrust -keystore <ranger-admin-ts> -storepass changeit

where

<ranger-kms-ks> is the path to the Ranger KMS keystore (for example, /etc/ranger/kms/conf/ranger-plugin-keystore.jks)
<cert-filename> is the name of the certificate file (for example, ranger-kmsAgent-trust.cer)
<ranger-admin-ts> is the name of the Ranger Admin truststore file (for example, the JDK cacerts file)

7. Log into the Policy Manager UI (as keyadmin user) and click on the Edit button of your KMS repository. Provide the CN name of the keystore for Common Name For Certificate (commonNameForCertificate), and save it. This property is not added by default.
8. Configure the Ranger KMS Server:
   a) Go to the Ranger KMS config location and create a self-signed certificate:

   ```bash
   cd /etc/ranger/kms/conf
   keytool -genkey -keyalg RSA -alias rangerkms -keystore <ranger-kms-ks> -storepass rangerkms -validity 360 -keysize 2048
   chown kms:kms ranger-kms-keystore.jks
   chmod 400 ranger-kms-keystore.jks
   ```

   where

   `<ranger-kms-ks>` is the name of the Ranger KMS keystore (for example, ranger-plugin-keystore.jks)

   Provide an identifiable string in response to the question "What is your first and last name?". To create the
   keystore, provide answers to all subsequent questions to create the keystore. Note: Press enter when prompted
   for a password.

   b) Edit the following properties and values in Advanced ranger-kms-site:

   - `ranger.service.https.attrib.keystore.file`: Add file path of ranger-kms-keystore.jks
   - `ranger.service.https.attrib.client.auth`: want
   - `ranger.service.https.attrib.keystore.keyalias`: Add the alias used for creating ranger-kms-keystore.jks
   - `ranger.service.https.attrib.keystore.pass`: Add password used for creating ranger-kms-keystore.jks
   - `ranger.service.https.attrib.ssl.enabled`: true

c) Update kms_port in Advanced kms-env to 9393. Ambari will recommend the value to
   `{{ranger.service.https.port}}`.

d) Save your changes and start Ranger KMS.

e) In your browser (or from Curl) when you access the Ranger KMS UI using the HTTPS protocol on the
   `ranger.service.https.port` listed in Ambari, the browser should respond that it does not trust the site. Proceed,
   and you should be able to access Ranger KMS on HTTPS with the self-signed cert that you just created.
f) Export the Ranger KMS certificate:

```
cd /usr/hdp/<version>/ranger-kms/conf
keytool -export -keystore <ranger-kms-ks> -alias rangerkms -file <cert-filename>
```

where

- `<ranger-kms-ks>` is the name of the Ranger KMS keystore (for example, ranger-kms-keystore.jks)
- `<cert-filename>` is the name of the certificate file (for example, ranger-kms-trust.cer)

g) Import the Ranger KMS certificate into the Ranger admin truststore:

```
```

where

- `<cert-filename>` is the name of the certificate file (for example, ranger-kms-trust.cer)
- `<ranger-admin-ts>` is the name of the Ranger Admin truststore file (for example, JDK cacerts)

**Note:**

Make sure Ranger Admin’s truststore properties (ranger.truststore.file and ranger.truststore.password) are correctly configured in ranger-admin-site.xml.

h) Import the Ranger KMS certificate into the Hadoop client truststore:

```
```

where

- `<cert-filename>` is the name of the certificate file (for example, ranger-kms-trust.cer)
- `<ts-filename>` is the name of Hadoop client truststore file (for example, /etc/security/clientKeys/all.jks)

i) Restart Ranger Admin and Ranger KMS.

j) Login to Policy Manager UI with keyadmin credentials. Under default KMS Repo configuration, replace KMS URL configuration value with the new SSL-enabled KMS URL.

Previous KMS URL = kms://http@ internal host name :http_port /kms

New KMS URL = kms://https@ internal host name :https_port /kms

k) Now in the Policy Manager UI>Audit>Plugin tab, you should see an entry for your service name with HTTP Response Code = 200.

### Install Multiple Ranger KMS

Multiple services can be set up for high availability of Ranger KMS. HDFS interacts with the active process. Follow these steps to install Ranger KMS on multiple nodes.

**Before you begin**

An instance with more than one node.

**Procedure**

1. First install Ranger KMS on a single node (see “Installing the Ranger Key Management Service”).
2. Next, add the Ranger KMS service to another node. In the Ambari Web UI for the additional node, go to Ranger KMS service # Summary # Service Actions # Add Ranger KMS server.
3. After adding Ranger KMS server, Ambari will show a pop-up message.

4. Press OK. Ambari will modify two HDFS properties, hadoop.security.key.provider.path and dfs.encryption.key.provider.uri.

5. Restart the HDFS service:

6. For the Ranger KMS service, go to the Advanced kms-site list and change the following property values:

   ```
   hadoop.kms.cache.enable=false
   hadoop.kms.cache.timeout.ms=0
   hadoop.kms.current.key.cache.timeout.ms=0
   hadoop.kms.authentication.signer.secret.provider=zookeeper
   hadoop.kms.authentication.signer.secret.provider.zookeeper.connection.string={zookeeper-node1}:2181,{zookeeper-node2}:2181,{zookeeper-node3}:2181...
   hadoop.kms.authentication.signer.secret.provider.zookeeper.auth.type=none
   ```

7. From Ambari > Ranger KMS > Configs > Advanced > Custom kms-site, add the following property values:

   ```
   hadoop.kms.authentication.zk-dt-secret-manager.enable=true
   ```

8. Save your configuration changes and restart the Ranger KMS service.

9. Next, check connectivity from Ranger admin for the newly-added Ranger KMS server:
   a) Go to the Ranger UI: http://<gateway>:6080.
   b) Login with your keyadmin user ID and password (the defaults are keyadmin, keyadmin; these should be changed as soon as possible after installation). The default repository will be added under Ranger KMS service.
   c) Under Config properties of the Ranger KMS URL, add the newly added Ranger KMS server FQDN. For example:

      Previous Ranger KMS URL = kms://http@<internal host name>:9292/kms
      New Ranger KMS URL = kms://http@<RangerKMS-node1>;<RangerKMS-node2>;;...:9292/kms

   d) Run a test connection for the service. You should see a ‘connected successfully’ message.
   e) Choose the Audit > Plugin tab.
   f) Check whether plugins are communicating. The UI should display HTTP Response Code = 200 for the respective plugin.

**Related Information**

**Installing the Ranger Key Management Service**
Using the Ranger Key Management Service

Ranger KMS can be accessed at the Ranger admin URL, http://$hostname:6080. Note, however, that the login user for Ranger KMS is different than that for Ranger. Logging on as the Ranger KMS admin user leads to a different set of screens.

Role Separation

By default, Ranger admin uses a different admin user (keyadmin) to manage access policies and keys for Ranger KMS.

The person accessing Ranger KMS via the keyadmin user should be a different person than the administrator who works with regular Ranger access policies. This approach separates encryption work (encryption keys and policies) from Hadoop cluster management and access policy management.

Accessing the Ranger KMS Web UI

How and where to access the Ranger KMS Web UI.

To access Ranger KMS, log in as user keyadmin, password keyadmin.

Note:
Change the password after you log in.

After logging in, you will see the Service Manager screen. To view or edit Ranger KMS repository properties, click on the edit button next to the repository name:

You will see a list of service details and config properties for the repository:
List and Create Keys
How to list and create keys, when using the Ranger KMS.

Procedure
To list existing keys:
1. Log in to Ranger as user keyadmin, password $keyadmin.
2. Choose the Encryption tab at the top of the Ranger Web UI screen.
3. Select the Ranger KMS service from the drop-down list.
The existing keys are displayed.

To create a new key:

4. Click on "Add New Key".
5. Add a valid key name.
6. Select the cipher name. Ranger supports AES/CTR/NoPadding as the cipher suite.
7. Specify the key length, 128 or 256 bits.
8. Add other attributes as needed, and click **Save**.

---

**Roll Over an Existing Key**

How to roll over an existing key, when using the Ranger KMS.
About this task

Rolling over (or "rotating") a key retains the same key name, but the key will have a different version. This operation re-encrypts existing file keys, but does not re-encrypt the actual file. Keys can be rolled over at any time.

After a key is rotated in Ranger KMS, new files will have the file key encrypted by the new master key for the encryption zone.

Procedure

1. Log in to Ranger as user keyadmin, password $keyadmin.
2. To rotate a key, click the edit button next to the key name in the list of keys:

   ![Key Rotation Procedure](image)

3. Edit the key information, and then press Save.
4. When asked to confirm the rollover, click "OK":

   ![Confirm Rollover](image)

Delete a Key

How to delete a key, when using the Ranger KMS.

About this task

**Attention:**

Deleting a key associated with an existing encryption zone will result in data loss.

Procedure

1. Log in to Ranger as user keyadmin, password $keyadmin.
2. Choose the Encryption tab at the top of the Ranger Web UI screen.
3. Select Ranger KMS service from the drop-down list.
4. Click on the delete symbol next to the key.
5. You will see a confirmation pop-up window; confirm or cancel.

Ranger KMS Properties

This topic describes configuration properties for the Ranger Key Management Service (KMS).
### Table 1: Properties in Advanced dbks-site Menu (dbks-site.xml)

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ranger.ks.masterkey.credential.alias</td>
<td>ranger.ks.masterkey.password</td>
<td>Credential alias used for masterkey.</td>
</tr>
<tr>
<td>ranger.ks.jpa.jdbc.user</td>
<td>rangerkms</td>
<td>Database username used for operation.</td>
</tr>
<tr>
<td>ranger.ks.jpa.jdbc.password</td>
<td>_ (default it’s encrypted)</td>
<td>Database user’s password.</td>
</tr>
<tr>
<td>ranger.ks.jpa.jdbc.driver</td>
<td>net.sf.log4jdbc.DriverSpy</td>
<td>Driver used for database.</td>
</tr>
<tr>
<td>ranger.ks.jpa.jdbc.dialect</td>
<td>org.eclipse.persistence.platform.MySQLPlatform</td>
<td>Dialect used for database.</td>
</tr>
<tr>
<td>ranger.ks.jpa.jdbc.credential.provider.path</td>
<td>/etc/ranger/kms/rangerkms.jceks</td>
<td>Credential provider path.</td>
</tr>
<tr>
<td>ranger.ks.jpa.jdbc.credential.alias</td>
<td>ranger.ks.jdbc.password</td>
<td>Credential alias used for password.</td>
</tr>
<tr>
<td>ranger.db.encrypt.key.password</td>
<td>_ (Default; it’s encrypted)</td>
<td>Password used for encrypting the Master Key.</td>
</tr>
<tr>
<td>hadoop.kms.blacklist.DECRYPT_EEK</td>
<td>hdfs</td>
<td>Blacklist for decrypt EncryptedKey CryptoExtension operations. This can have multiple user IDs in a comma separated list, e.g. stormuser,yarn,hdfs.</td>
</tr>
</tbody>
</table>

### Table 2: Properties in Advanced kms-env

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kms User</td>
<td>kms</td>
<td>Ranger KMS process will be started using this user.</td>
</tr>
<tr>
<td>Kms Group</td>
<td>kms</td>
<td>Ranger KMS process will be started using this group.</td>
</tr>
<tr>
<td>LD library path</td>
<td></td>
<td>LD library path (basically used when the db flavor is SQLA). Example: /opt/sqlanywhere17/lib64</td>
</tr>
<tr>
<td>kms_port</td>
<td>9292</td>
<td>Port used by Ranger KMS.</td>
</tr>
<tr>
<td>kms_log_dir</td>
<td>/var/log/ranger/kms</td>
<td>Directory where the Ranger KMS log will be generated.</td>
</tr>
</tbody>
</table>

### Table 3: Properties in Advanced kms-properties (install.properties)

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>db_user</td>
<td>rangerkms</td>
<td>Database username used for the operation.</td>
</tr>
<tr>
<td>db_root_user</td>
<td></td>
<td>Database root username. Default is blank. Specify the root user.</td>
</tr>
<tr>
<td>db_root_password</td>
<td></td>
<td>Database root user’s password. Default is blank. Specify the root user password.</td>
</tr>
<tr>
<td>db_password</td>
<td></td>
<td>Database user’s password for the operation. Default is blank. Specify the Ranger KMS database password.</td>
</tr>
<tr>
<td>db_name</td>
<td>rangerkms</td>
<td>Database name for Ranger KMS.</td>
</tr>
<tr>
<td>db_host</td>
<td>&lt;FQDN of instance where the Ranger KMS is installed&gt;</td>
<td>Hostname where the database is installed. Note: Check the hostname for DB and change it accordingly.</td>
</tr>
<tr>
<td>SQL_CONNECTOR_JAR</td>
<td>/usr/share/java/mysql-connector.jar</td>
<td>Location of DB client library.</td>
</tr>
</tbody>
</table>
### HDP Configuring HDFS Encryption

#### Ranger KMS Administration

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>REPOSITORY_CONFIG_USERNAME</td>
<td>keyadmin</td>
<td>User used in default repo for Ranger KMS.</td>
</tr>
<tr>
<td>REPOSITORY_CONFIG_PASSWORD</td>
<td>keyadmin</td>
<td>Password for user used in default repo for Ranger KMS.</td>
</tr>
<tr>
<td>KMS_MASTER_KEY_PASSWD</td>
<td></td>
<td>Password used for encrypting the Master Key. Default value is blank. Set the master key to any string.</td>
</tr>
<tr>
<td>DB_FLAVOR</td>
<td>MYSQL</td>
<td>Database flavor used for Ranger KMS. Supported values: MYSQL, SQA, ORACLE, POSTGRES, MSSQL</td>
</tr>
</tbody>
</table>

### Table 4: Properties in Advanced kms-site (kms-site.xml)

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>hadoop.security.keystore.JavaKeyStoreProvider.password</td>
<td>none</td>
<td>If using the JavaKeyStoreProvider, the password for the keystore file.</td>
</tr>
<tr>
<td>hadoop.kms.key.provider.uri</td>
<td>dbks://http@localhost:9292/kms</td>
<td>URI of the backing KeyProvider for the KMS.</td>
</tr>
<tr>
<td>hadoop.kms.current.key. cache.timeout.ms</td>
<td>30000</td>
<td>Expiry time for the KMS current key cache, in milliseconds. This affects getCurrentKey operations.</td>
</tr>
<tr>
<td>hadoop.kms.cache.timeout.ms</td>
<td>600000</td>
<td>Expiry time for the KMS key version and key metadata cache, in milliseconds. This affects getKeyVersion and getMetadata.</td>
</tr>
<tr>
<td>hadoop.kms.cache.enable</td>
<td>true</td>
<td>Whether the KMS will act as a cache for the backing KeyProvider. When the cache is enabled, operations like getKeyVersion, getMetadata, and getCurrentKey will sometimes return cached data without consulting the backing KeyProvider. Cached values are flushed when keys are deleted or modified. Note: This setting is beneficial if Single KMS and single mode are used. If this is set to true when multiple KMSs are used, or when the key operations are from different modes (Ranger UI, CURL, or hadoop command), it might cause inconsistency.</td>
</tr>
<tr>
<td>hadoop.kms.authentication.type</td>
<td>simple</td>
<td>Authentication type for the Ranger KMS. Can be either “simple” or “kerberos”.</td>
</tr>
<tr>
<td>hadoop.kms.authentication.signer.secret.provider.zookeeper.path</td>
<td>/hadoop-kms/hadoop-auth-signature-secret</td>
<td>The ZooKeeper ZNode path where the Ranger KMS instances will store and retrieve the secret from.</td>
</tr>
<tr>
<td>hadoop.kms.authentication.signer.secret.provider.zookeeper.kerberos.principal</td>
<td>kms#HOSTNAME#</td>
<td>The Kerberos service principal used to connect to ZooKeeper</td>
</tr>
<tr>
<td>hadoop.kms.authentication.signer.secret.provider.zookeeper.keytab</td>
<td>/etc/hadoop/conf/kms.keytab</td>
<td>The absolute path for the Kerberos keytab with the credentials to connect to ZooKeeper.</td>
</tr>
<tr>
<td>hadoop.kms.authentication.signer.secret.provider.zookeeper.connection.string</td>
<td>#HOSTNAME#:#PORT#,...</td>
<td>The ZooKeeper connection string, a list of hostnames and port comma separated. For example: &lt;FQDN for first instance&gt;:2181,&lt;FQDN for second instance&gt;:2181</td>
</tr>
<tr>
<td>Property Name</td>
<td>Default Value</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------------------------------------------------------------------</td>
<td>---------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>hadoop.kms.authentication. signer.secret.provider.zookeeper.auth.type</td>
<td>kerberos</td>
<td>ZooKeeper authentication type: 'none' or 'sasl' (Kerberos)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The value &quot;none&quot; means the default authentication will be used (not, &quot;no authentication is used.&quot;) Using &quot;none&quot; means:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In a non-kerberized unsecure cluster: no security on the Zookeeper connection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• In a kerberized secure cluster: Kerberos/ SASL is used to connect to Zookeeper with the Ranger KMS's &quot;<em>Client</em>&quot; Login Context</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The value &quot;sasl&quot; means that KMS would use an independent &quot;ZKSignerSecretProviderClient&quot; Login Context, but this is not yet supported on HDP.</td>
</tr>
<tr>
<td>hadoop.kms.authentication. signer.secret.provider</td>
<td>random</td>
<td>Indicates how the secret to sign authentication cookies will be stored. Options are 'random' (default), 'string', and 'zookeeper'.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If you have multiple Ranger KMS instances, specify 'zookeeper'.</td>
</tr>
<tr>
<td>hadoop.kms.authentication. kerberos.principal</td>
<td>HTTP/localhost</td>
<td>The Kerberos principal to use for the HTTP endpoint. The principal must start with HTTP/ as per the Kerberos HTTP SPNEGO specification.</td>
</tr>
<tr>
<td>hadoop.kms.authentication. kerberos.name.rules</td>
<td>DEFAULT</td>
<td>Rules used to resolve Kerberos principal names.</td>
</tr>
<tr>
<td>hadoop.kms.authentication. kerberos.keytab</td>
<td>${user.home}/kms.keytab</td>
<td>Path to the keytab with credentials for the configured Kerberos principal.</td>
</tr>
<tr>
<td>hadoop.kms.audit. aggregation.window.ms</td>
<td>10000</td>
<td>Specified in ms. Duplicate audit log events within this aggregation window are quashed to reduce log traffic. A single message for aggregated events is printed at the end of the window, along with a count of the number of aggregated events.</td>
</tr>
</tbody>
</table>

Table 5: Properties in Advanced ranger-kms-audit (ranger-kms-audit.xml)

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Audit provider summary enabled</td>
<td></td>
<td>Enable audit provider summary.</td>
</tr>
<tr>
<td>xasecure.audit.is.enabled</td>
<td>true</td>
<td>Enable audit.</td>
</tr>
<tr>
<td>xasecure.audit.destination.solr.zookeepers</td>
<td>none</td>
<td>Specify solr zookeeper string.</td>
</tr>
<tr>
<td>xasecure.audit.destination.solr.urls</td>
<td>{{ranger_audit_solr_urls}}</td>
<td>Specify solr URL.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note: In Ambari this value is populated from the Ranger Admin by default.</td>
</tr>
<tr>
<td>Audit to SOLR</td>
<td></td>
<td>Enable audit to solr.</td>
</tr>
<tr>
<td>xasecure.audit.destination.hdfs.dir</td>
<td>hdfs://NAMENODE_HOST:8020/ranger/audit</td>
<td>HDFS directory to write audit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Note: Make sure the service user has required permissions.</td>
</tr>
<tr>
<td>xasecure.audit.destination.hdfs.batch.filespool.dir</td>
<td>/var/log/ranger/kms/audit/hdfs/spool</td>
<td>Directory for HDFS audit spool.</td>
</tr>
<tr>
<td>Audit to HDFS</td>
<td></td>
<td>Enable hdfs audit.</td>
</tr>
</tbody>
</table>
### Table 6: Properties in Advanced ranger-kms-policymgr-ssl

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>xasecure.policymgr.clientssl.truststore.password</td>
<td>changeit</td>
<td>Password for the truststore.</td>
</tr>
<tr>
<td>xasecure.policymgr.clientssl.truststore</td>
<td>/usr/hdp/current/ranger-kms/conf/ranger-plugin-truststore.jks</td>
<td>jks file for truststore</td>
</tr>
<tr>
<td>xasecure.policymgr.clientssl.keystore.password</td>
<td>myKeyFilePassword</td>
<td>Password for keystore</td>
</tr>
</tbody>
</table>

### Table 7: Properties in Advanced ranger-kms-security

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Default Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ranger.plugin.kms.service.name</td>
<td>&lt;default name for Ranger KMS Repo&gt;</td>
<td>Name of the Ranger service containing policies for the KMS instance. Note: In Ambari the default value is &lt;clusterName&gt;_kms.</td>
</tr>
<tr>
<td>ranger.plugin.kms.policy.source.impl</td>
<td>org.apache.ranger.admin.client.RangerAdminRESTClient</td>
<td>Class to retrieve policies from the source.</td>
</tr>
<tr>
<td>ranger.plugin.kms.policy.rest.url</td>
<td>{{policymgr_mgr_url}}</td>
<td>URL for Ranger Admin.</td>
</tr>
<tr>
<td>ranger.plugin.kms.policy.rest.ssl.config.file</td>
<td>/etc/ranger/kms/conf/ranger-policymgr-ssl.xml</td>
<td>Path to the file containing SSL details for contacting the Ranger Admin.</td>
</tr>
<tr>
<td>ranger.plugin.kms.policy.pollIntervalMs</td>
<td>30000</td>
<td>Time interval to poll for changes in policies.</td>
</tr>
<tr>
<td>ranger.plugin.kms.policy.cache.dir</td>
<td>/etc/ranger/[^repo_name]*/policycache</td>
<td>Directory where Ranger policies are cached after successful retrieval from the source.</td>
</tr>
</tbody>
</table>
Troubleshooting Ranger KMS

Troubleshooting suggestions for Ranger KMS.

Table 8: Troubleshooting Suggestions

<table>
<thead>
<tr>
<th>Issue</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not able to install Ranger KMS</td>
<td>Check to see if ranger admin is running, verify DB.</td>
</tr>
<tr>
<td>Not able to start Ranger KMS</td>
<td>Check the Ranger KMS log. If there is a message about illegal key size, make sure unlimited strength JCE is available.</td>
</tr>
<tr>
<td>Hadoop key commands fail</td>
<td>Make sure Ranger KMS client properties are updated in hdfs config.</td>
</tr>
<tr>
<td>Not able to create keys from Ranger UI</td>
<td>Make sure that the keyadmin user (or any custom user) configured in the KMS repository is added to proxy properties in the custom kms-site.xml file.</td>
</tr>
</tbody>
</table>

HDFS ’Data at Rest’ Encryption

Encryption is a form of data security that is required in industries such as healthcare and the payment card industry. Hadoop provides several ways to encrypt stored data.

- The lowest level of encryption is volume encryption, which protects data after physical theft or accidental loss of a disk volume. The entire volume is encrypted; this approach does not support finer-grained encryption of specific files or directories. In addition, volume encryption does not protect against viruses or other attacks that occur while a system is running.
- Application level encryption (encryption within an application running on top of Hadoop) supports a higher level of granularity and prevents “rogue admin” access, but adds a layer of complexity to the application architecture.
- A third approach, HDFS data at rest encryption, encrypts selected files and directories stored (“at rest”) in HDFS. This approach uses specially designated HDFS directories known as “encryption zones.”

This chapter focuses on the third approach, HDFS data at rest encryption. The chapter is intended as an introductory quick start to HDFS data at rest encryption. Content will be updated regularly.

HDFS Encryption Overview

HDFS data at rest encryption implements end-to-end encryption of data read from and written to HDFS. End-to-end encryption means that data is encrypted and decrypted only by the client. HDFS does not have access to unencrypted data or keys.

HDFS encryption involves several elements:

- Encryption key: A new level of permission-based access protection, in addition to standard HDFS permissions.
- HDFS encryption zone: A special HDFS directory within which all data is encrypted upon write, and decrypted upon read.
  - Each encryption zone is associated with an encryption key that is specified when the zone is created.
  - Each file within an encryption zone has a unique encryption key, called the “data encryption key” (DEK).
  - HDFS does not have access to DEKs. HDFS DataNodes only see a stream of encrypted bytes. HDFS stores “encrypted data encryption keys” (EDEKs) as part of the file’s metadata on the NameNode.
  - Clients decrypt an EDEK and use the associated DEK to encrypt and decrypt data during write and read operations.
- Ranger Key Management Service (Ranger KMS): An open source key management service based on Hadoop’s KeyProvider API.
For HDFS encryption, the Ranger KMS has three basic responsibilities:

- Provide access to stored encryption zone keys.
- Generate and manage encryption zone keys, and create encrypted data keys to be stored in Hadoop.
- Audit all access events in Ranger KMS.

Note: This chapter is intended for security administrators who are interested in configuring and using HDFS encryption. For more information about Ranger KMS, see “Ranger KMS Administration”.

HDFS Encryption Components

Role Separation

Access to the key encryption/decryption process is typically restricted to end users. This means that encrypted keys can be safely stored and handled by HDFS, because the HDFS admin user does not have access to them.

This role separation requires two types of HDFS administrator accounts:

- HDFS service user: the system-level account associated with HDFS (hdfs by default).
- HDFS admin user: an account in the hdfs supergroup, which is used by HDFS administrators to configure and manage HDFS.

Note: For clear segregation of duties, we recommend that you restrict use of the hdfs account to system/interprocess use. Do not provide its password to physical users. A (human) user who administers HDFS should only access HDFS through an admin user account created specifically for that purpose. For more information about creating an HDFS admin user, see “Create an HDFS Admin User”.

Other services may require a separate admin account for clusters with HDFS encryption zones. For service-specific information, see “Configuring HDP Services for HDFS Encryption”.

25
Related Information
Configuring HDP Services for HDFS Encryption
Ranger KMS Administration
Create an HDFS Admin User

Configuring and Starting the Ranger Key Management Service (Ranger KMS)

In a typical environment, a security administrator will set up the Ranger Key Management Service. For information about installing and configuring the Ranger KMS, see “Ranger KMS Administration”.

Related Information
Ranger KMS Administration

Configuring and Using HDFS "Data at Rest" Encryption

After the Ranger KMS has been set up and the NameNode and HDFS clients have been configured, an HDFS administrator can use the hadoop key and hdfs crypto command-line tools to create encryption keys and set up new encryption zones.

Note: You should create a separate HDFS Admin user account for HDFS Data at Rest Encryption.

The overall workflow is as follows:

1. Create an HDFS encryption zone key that will be used to encrypt the file-level data encryption key for every file in the encryption zone. This key is stored and managed by Ranger KMS.
2. Create a new HDFS folder. Specify required permissions, owner, and group for the folder.
3. Using the new encryption zone key, designate the folder as an encryption zone.
4. Configure client access. The user associated with the client application needs sufficient permission to access encrypted data. In an encryption zone, the user needs file/directory access (through Posix permissions or Ranger access control), as well as access for certain key operations. To set up ACLs for key-related operations, see “Ranger KMS Administration”.

After permissions are set, Java API clients and HDFS applications with sufficient HDFS and Ranger KMS access privileges can write and read to/from files in the encryption zone.

Related Information
Ranger KMS Administration

Preparing the Environment

HDP supports hardware acceleration with Advanced Encryption Standard New Instructions (AES-NI). Compared with the software implementation of AES, hardware acceleration offers an order of magnitude faster encryption/decryption.

CPU Support for AES NI optimization
To use AES-NI optimization you need CPU and library support, described in the following subsections.

AES-NI optimization requires an extended CPU instruction set for AES hardware acceleration.

There are several ways to check for this; for example:

$ cat /proc/cpuinfo | grep aes
Look for output with flags and 'aes'.
Library Support for AES NI optimization

You will need a version of the libcrypto.so library that supports hardware acceleration, such as OpenSSL 1.0.1e. (Many OS versions have an older version of the library that does not support AES-NI.)

A version of the libcrypto.so library with AES-NI support must be installed on HDFS cluster nodes and MapReduce client hosts -- that is, any host from which you issue HDFS or MapReduce requests. The following instructions describe how to install and configure the libcrypto.so library.

RHEL/CentOS 6.5 or later

On HDP cluster nodes, the installed version of libcrypto.so supports AES-NI, but you will need to make sure that the symbolic link exists:

$ sudo ln -s /usr/lib64/libcrypto.so.1.0.1e /usr/lib64/libcrypto.so

On MapReduce client hosts, install the openssl-devel package:

$ sudo yum install openssl-devel

Verifying AES NI Support

To verify that a client host is ready to use the AES-NI instruction set optimization for HDFS encryption, use the following command:

hadoop checknative

You should see a response similar to the following:

```
   native-bzip2 library system-native
14/12/12 13:48:39 INFO zlib.ZlibFactory: Successfully loaded & initialized
   native-zlib library
Native library checking:
   hadoop: true /usr/lib/hadoop/lib/native/libhadoop.so.1.0.0
   zlib: true /lib64/libz.so.1
   snappy: true /usr/lib64/libsnappy.so.1
   lz4: true revision:99
   bzip2: true /lib64/libbz2.so.1
   openssl: true /usr/lib64/libcrypto.so
```

If you see true in the openssl row, Hadoop has detected the right version of libcrypto.so and optimization will work. If you see false in this row, you do not have the correct version.

Create an Encryption Key

Create a "master" encryption key for the new encryption zone. Each key will be specific to an encryption zone. You can create a new encryption key via Ranger KMS (recommended) or the CLI.

About this task

Ranger supports AES/CTR/NoPadding as the cipher suite. (The associated property is listed under HDFS -> Configs in the Advanced hdfs-site list.)

Key size can be 128 or 256 bits.

Recommendation: create a new superuser for key management. In the following examples, superuser encr creates the key. This separates the data access role from the encryption role, strengthening security.

Procedure

- To create an Encryption Key using Ranger KMS (Recommended):
  a) Log in to Ranger as user keyadmin, password $keyadmin.
b) In the Ranger Web UI screen, choose the Encryption tab at the top of the screen.
c) Select the KMS service from the drop-down list.

d) Click on "Add New Key":
e) Add a valid key name.
f) Select the cipher name. Ranger supports AES/CTR/NoPadding as the cipher suite.
g) Specify the key length, 128 or 256 bits.
h) Add other attributes as needed, and then save the key.

• To create an Encryption Key using the CLI:
  a) The full syntax of the hadoop key create command is as follows:

```
[create <keyname> [-cipher <cipher>]
[-size <size>]
[-description <description>]```

HDP Configuring HDFS Encryption

HDFS "Data at Rest" Encryption

[-attr <attribute=value>]
[-provider <provider>]
[-help]]

# su - encr
# hadoop key create <key_name> [-size <number-of-bits>]

The default key size is 128 bits. The optional -size parameter supports 256-bit keys, and requires the Java Cryptography Extension (JCE) Unlimited Strength Jurisdiction Policy File on all hosts in the cluster. For installation information, see “Installing the JCE”.

# su - encr
# hadoop key create key1

To verify creation of the key, list the metadata associated with the current user: # hadoop key list -metadata

Related Information
Using the Ranger Key Management Service
Install the JCE for Kerberos

Create an Encryption Zone

How to create an encryption zone when configuring HDFS encryption.

About this task

Each encryption zone must be defined using an empty directory and an existing encryption key. An encryption zone cannot be created on top of a directory that already contains data.

Recommendation: use one unique key for each encryption zone.

Use the crypto createZone command to create a new encryption zone. The syntax is:

:createZone -keyName <keyName> -path <path>

where:

• -keyName: specifies the name of the key to use for the encryption zone.
• -path specifies the path of the encryption zone to be created. It must be an empty directory.

Procedure

1. As HDFS administrator, create a new empty directory.
   # hdfs dfs -mkdir /zone_encr

2. Using the encryption key, make the directory an encryption zone.
   # hdfs crypto -createZone -keyName key1 -path /zone_encr
   When finished, the NameNode will recognize the folder as an HDFS encryption zone.

3. To verify creation of the new encryption zone, run the crypto -listZones command as an HDFS administrator: -listZones.

   Note:

   The following property (in the hdfs-default.xml file) causes listZone requests to be batched. This improves NameNode performance. The property specifies the maximum number of zones that will be returned in a batch.

   dfs.namenode.list.encryption.zones.num.responses

   The default is 100.
You should see the encryption zone and its key. For example:

```
$ hdfs crypto -listZones
/zon_encr  key1
```

What to do next

(Optional) To remove an encryption zone, delete the root directory of the zone. For example: hdfs dfs -rm -R /zone_encr.

Copying Files to or from an Encryption Zone

Information on how to copy existing files to or from an encryption zone, use a tool like distcp.

Note: for separation of administrative roles, do not use the hdfs user to create encryption zones. Instead, designate another administrative account for creating encryption keys and zones. See “Appendix: Creating an HDFS Admin User” for more information.

The files will be encrypted using a file-level key generated by the Ranger Key Management Service.

DistCp Considerations

DistCp is commonly used to replicate data between clusters for backup and disaster recovery purposes. This operation is typically performed by the cluster administrator, via an HDFS superuser account.

To retain this workflow when using HDFS encryption, a new virtual path prefix has been introduced, /.reserved/raw/. This virtual path gives super users direct access to the underlying encrypted block data in the file system, allowing super users to distcp data without requiring access to encryption keys. This also avoids the overhead of decrypting and re-encrypting data. The source and destination data will be byte-for-byte identical, which would not be true if the data were re-encrypted with a new EDEK.

Attention:

When using /.reserved/raw/ to distcp encrypted data, make sure you preserve extended attributes with the -px flag. This is necessary because encrypted attributes such as the EDEK are exposed through extended attributes; they must be preserved to be able to decrypt the file. For example:

```
```

This means that if the distcp operation is initiated at or above the encryption zone root, it will automatically create a new encryption zone at the destination (if one does not already exist).

Recommendation: To avoid potential mishaps, first create identical encryption zones on the destination cluster.

Copying between encrypted and unencrypted locations

By default, distcp compares file system checksums to verify that data was successfully copied to the destination. When copying between an unencrypted and encrypted location, file system checksums will not match because the underlying block data is different. In this case, specify the -skipcrccheck and -update flags to avoid verifying checksums.

Related Information

Create an HDFS Admin User

Reading and Writing Files from or to an Encryption Zone

Clients and HDFS applications with sufficient HDFS and Ranger KMS permissions can read and write files from/to an encryption zone.
Overview of the client write process

1. The client writes to the encryption zone.
2. The NameNode checks to make sure that the client has sufficient write access permissions. If so, the NameNode asks Ranger KMS to create a file-level key, encrypted with the encryption zone master key.
3. The Namenode stores the file-level encrypted data encryption key (EDEK) generated by Ranger KMS as part of the file's metadata, and returns the EDEK to the client.
4. The client asks Ranger KMS to decode the EDEK (to DEK), and uses the DEK to write encrypted data. Ranger KMS checks for permissions for the user before decrypting EDEK and producing the DEK for the client.

Overview of the client read process

1. The client issues a read request for a file in an encryption zone.
2. The NameNode checks to make sure that the client has sufficient read access permissions. If so, the NameNode returns the file's EDEK and the encryption zone key version that was used to encrypt the EDEK.
3. The client asks Ranger KMS to decrypt the EDEK. Ranger KMS checks for permissions to decrypt EDEK for the end user.
4. Ranger KMS decrypts and returns the (unencrypted) data encryption key (DEK).
5. The client uses the DEK to decrypt and read the file.

The preceding steps take place through internal interactions between the DFSClient, the NameNode, and Ranger KMS.

Examples

In the following example, the /zone_encr directory is an encrypted zone in HDFS.

To verify this, use the crypto -listZones command (as an HDFS administrator). This command lists the root path and the zone key for the encryption zone. For example:

```
# hdfs crypto -listZones
/zone_encr  key1
```

Additionally, the /zone_encr directory has been set up for read/write access by the hive user:

```
# hdfs dfs -ls /
...
drwxr-x---   - hive   hive            0 2015-01-11 23:12 /zone_encr
```

The hive user can, therefore, write data to the directory.

The following examples use the copyFromLocal command to move a local file into HDFS.

```
[hive@blue ~]# hdfs dfs -copyFromLocal web.log /zone_encr
[hive@blue ~]# hdfs dfs -ls /zone_encr
Found 1 items
-rw-r--r--   1 hive hive       1310 2015-01-11 23:28 /zone_encr/web.log
```

The hive user can read data from the directory, and can verify that the file loaded into HDFS is readable in its unencrypted form.

```
[hive@blue ~]# hdfs dfs -copyToLocal /zone_encr/web.log read.log
[hive@blue ~]# diff web.log read.log
```

Users without access to KMS keys will be able to see file names (via the -ls command), but they will not be able to write data or read from the encrypted zone. For example, the hdfs user lacks sufficient permissions, and cannot access the data in /zone_encr:

```
[hdfs@blue ~]# hdfs dfs -copyFromLocal install.log /zone_encr
```

Deleting Files from an Encryption Zone with Trash Enabled

Information on deleting files from an encryption zone with trash enabled.

The trash location for encrypted HDFS files is different than the default trash location for unencrypted files (/user/$USER/.Trash/Current/OriginalPathToDeletedFile).

When trash is enabled and an encrypted file is deleted, the file is moved to the .Trash subdirectory under the root of the encryption zone as /EncryptionZoneRoot/.Trash/$USER/Current/OriginalPathToDeletedFile. The file remains encrypted without additional decryption/re-encryption overhead during the move to trash. The move operation preserves the name of the user who executes the deletion, and the full path of the deleted file.

Example

For example, if user hdp-admin deletes file /zone_name/file1 using the following command:

```
 hdfs dfs -rm /zone_name/file1
```

file1 will remain encrypted, and it will be moved to the following location within the encryption zone:

```
/zone_name/.Trash/hdp-admin/Current/zone_name/file1
```

A trash checkpoint will be created for the .Trash subdirectory in each encryption zone. Checkpoints will be deleted/created according to the value of fs.trash.checkpoint.interval (number of minutes between trash checkpoints). A checkpoint for this example would be:

```
/zone_name/.Trash/hdp-admin/<CheckPointTimeStamp>/zone_name/file1
```

Related Information

HDFS-8831

Create an HDFS Admin User

How to create an HDFS admin user.

About this task

To capitalize on the capabilities of HDFS data at rest encryption, you will need two separate types of HDFS administrative accounts:

- HDFS administrative user: an account in the hdfs supergroup that is used to manage encryption keys and encryption zones. Examples in this chapter use an administrative user account named encr.
- HDFS service user: the system-level account traditionally associated with HDFS. By default this is user hdfs in HDP. This account owns the HDFS DataNode and NameNode processes.

Note:

This is a system-only account. Physical users should not be given access to this account.

Complete the following steps to create a new HDFS administrative user. 

Note: These steps use sample values for group (operator) and user account (opt1).

Procedure

1. Create a new group called operator.
2. Add a new user (for example, opt1) to the group.
3. Add principal opt1@EXAMPLE.COM and create a keytab.
4. Login as opt1, and do a kinit operation.
5. In Ambari, replace the current value of dfs.permissions.superusergroup with the group name “operator”.

   **Note:**
   You can assign only one administrator group for the dfs.permissions.superusergroup parameter.

6. In Ambari, add hdfs.operator to dfs.clusteradministrators:

   ![Advanced hdfs-site](image)

7. Add opt1 to the KMS blacklist. Set the corresponding property in Ambari:
   hadoop.kms.blacklist.DECRYPT_EEK=opt1.

8. Restart HDFS.

### What to do next

**Validation**

Make sure the opt1 account has HDFS administrative access:

hdfs dfsadmin -report

Make sure the opt1 account cannot access encrypted files. For example, if /data/test/file.txt is in an encryption zone, the following command should return an error:

hdfs dfs -cat /data/test/file.txt

**Additional Administrative User Accounts**

If you plan to use HDFS data at rest encryption with YARN, we recommend that you create a separate administrative user account for YARN administration.

If you plan to use HDFS data at rest encryption with Oozie, refer to the “Oozie” section of this chapter.

### Related Information

- Configuring Oozie for HDFS Encryption

### Configuring HDP Services for HDFS Encryption

Information on configuring HDP services for HDFS Encryption.

HDFS data at rest encryption is supported on the following HDP components:

**Note:**

You should create a separate Admin user account for HDFS Data at Rest Encryption for each of the following supported components.

- HBase
- Hive
- Hive on Tez
- MapReduce
- Oozie
- Spark
- Sqoop
HDP Configuring HDFS Encryption

- Storm
- WebHDFS
- YARN

HDFS data at rest encryption is not supported on the following components:

- Accumulo
- Falcon
- HDP Search

The remainder of this section describes scenarios and access considerations for accessing HDFS-encrypted files from supporting HDP components.

**Note:**
When HDFS encryption is configured, Spark is able to access data without any further configuration steps or code changes. HDFS encryption is transparent for Spark users.

**Configure HBase for HDFS Encryption**
How to configure HBase for HDFS encryption.

**About this task**
HBase stores all of its data under its root directory in HDFS, configured with `hbase.rootdir`. The only other directory that the HBase service will read or write is `hbase.bulkload.staging.dir`.

On HDP clusters, `hbase.rootdir` is typically configured as `/apps/hbase/data`, and `hbase.bulkload.staging.dir` is configured as `/apps/hbase/staging`. HBase data, including the root directory and staging directory, can reside in an encryption zone on HDFS.

The HBase service user needs to be granted access to the encryption key in the Ranger KMS, because it performs tasks that require access to HBase data (unlike Hive or HDFS).

By design, HDFS-encrypted files cannot be bulk-loaded from one encryption zone into another encryption zone, or from an encryption zone into an unencrypted directory. Encrypted files can only be copied. An attempt to load data from one encryption zone into another will result in a copy operation. Within an encryption zone, files can be copied, moved, bulk-loaded, and renamed.

**Recommendations**
- Make the parent directory for the HBase root directory and bulk load staging directory an encryption zone, instead of just the HBase root directory. This is because HBase bulk load operations need to move files from the staging directory into the root directory.
- In typical deployments, `/apps/hbase` can be made an encryption zone.
- Do not create encryption zones as subdirectories under `/apps/hbase`, because HBase may need to rename files across those subdirectories.
- The landing zone for unencrypted data should always be within the destination encryption zone.

**Procedure**
- On a cluster without HBase currently installed:
  a) Create the `/apps/hbase` directory, and make it an encryption zone.
  b) Configure `hbase.rootdir=/apps/hbase/data`.
  c) Configure `hbase.bulkload.staging.dir=/apps/hbase/staging`.
- On a cluster with HBase already installed, perform the following steps:
  a) Stop the HBase service.
  b) Rename the `/apps/hbase` directory to `/apps/hbase-tmp`.
  c) Create an empty `/apps/hbase` directory, and make it an encryption zone.
d) DistCp -skipcrccheck -update all data from /apps/hbase-tmp to /apps/hbase, preserving user-group permissions and extended attributes.
e) Start the HBase service and verify that it is working as expected.
f) Remove the /apps/hbase-tmp directory.

What to do next

Changes in Behavior after HDFS Encryption is Enabled

The HBase bulk load process is a MapReduce job that typically runs under the user who owns the source data. HBase data files created as a result of the job are then bulk loaded in to HBase RegionServers. During this process, HBase RegionServers move the bulk-loaded files from the user's directory and move (rename) the files into the HBase root directory (/apps/hbase/data). When data at rest encryption is used, HDFS cannot do a rename across encryption zones with different keys.

Workaround: run the MapReduce job as the hbase user, and specify an output directory that resides in the same encryption zone as the HBase root directory.

Configuring Hive for HDFS Encryption

Hive data is stored in the directories /warehouse/tablespace/external and /warehouse/tablespace/managed. Create the encryption zone at /warehouse/tablespace to enable encryption of data in both the specified directories.

Configure Hive Tables for HDFS Encryption

Before enabling encryption zones, decide whether to store your Hive tables across one zone or multiple encryption zones.

Procedure

For a Single Encryption Zone

1. To configure a single encryption zone for your entire Hive warehouse:
   a) Rename /warehouse/tablespace to /warehouse/tablespace-old.
   b) Create an encryption zone at /warehouse/tablespace.
   c) distcp all of the data from /warehouse/tablespace-old to /warehouse/tablespace.
2. To configure the Hive scratch directory (hive.exec.scratchdir) so that it resides inside the encryption zone:
   a) Set the directory to /warehouse/tablespace/tmp.
   b) Make sure that the permissions for /warehouse/tablespace/tmp are set to 1777.

What to do next

For multiple Encryption Zones

To access encrypted databases and tables with different encryption keys, configure multiple encryption zones.

For example, to configure two encrypted tables, ez1.db and ez2.db, in two different encryption zones:

1. Create two new encryption zones, /warehouse/tablespace/managed/ez1.db and /warehouse/tablespace/managed/ez2.db.
2. Load data into Hive tables ez1.db and ez2.db as usual, using LOAD statements.

Related Information

Loading Data into an Encrypted Table

Loading Data into an Encrypted Table

By design, HDFS-encrypted files cannot be moved or loaded from one encryption zone into another encryption zone, or from an encryption zone into an unencrypted directory. Encrypted files can only be copied.

Within an encryption zone, files can be copied, moved, loaded, and renamed.

Recommendations:
When loading unencrypted data into encrypted tables (e.g., LOAD DATA INPATH), we recommend placing the source data (to be encrypted) into a landing zone within the destination encryption zone.

An attempt to load data from one encryption zone into another will result in a copy operation. Distcp will be used to speed up the process if the size of the files being copied is higher than the value specified by the hive.exec.copyfile.maxsize property. The default limit is 32 MB.

Here are two approaches for loading unencrypted data into an encrypted table:

- To load unencrypted data into an encrypted table, use the LOAD DATA ... statement.
  
  If the source data does not reside inside the encryption zone, the LOAD statement will result in a copy. If your data is already inside HDFS, though, you can use distcp to speed up the copying process.

- If the data is already inside a Hive table, create a new table with a LOCATION inside an encryption zone, as follows:

  CREATE TABLE encrypted_table [STORED AS] LOCATION ... AS SELECT * FROM <unencrypted_table>

  **Note:**
  
  The location specified in the CREATE TABLE statement must be within an encryption zone. If you create a table that points LOCATION to an unencrypted directory, your data will not be encrypted. You must copy your data to an encryption zone, and then point LOCATION to that encryption zone.

If your source data is already encrypted, use the CREATE TABLE statement. Point LOCATION to the encrypted source directory where your data resides:

CREATE TABLE encrypted_table [STORED AS] LOCATION ... AS SELECT * FROM <encrypted_source_directory>

This is the fastest way to create encrypted tables.

**Encrypting Other Hive Directories**

Reference information on encrypting other Hive directories.

- **LOCALSCRATCHDIR**: The MapJoin optimization in Hive writes HDFS tables to a local directory and then uploads them to distributed cache. To enable encryption, either disable MapJoin (set hive.auto.convert.join to false) or encrypt the local Hive Scratch directory (hive.exec.local.scratchdir). Performance note: disabling MapJoin will result in slower join performance.

- **DOWNLOADED_RESOURCES_DIR**: Jars that are added to a user session and stored in HDFS are downloaded to hive.downloaded.resources.dir. If you want these Jar files to be encrypted, configure hive.downloaded.resources.dir to be part of an encryption zone. This directory needs to be accessible to the HiveServer2.

- NodeManager Local Directory List: Hive stores Jars and MapJoin files in the distributed cache, so if you'd like to use MapJoin or encrypt Jars and other resource files, the YARN configuration property NodeManager Local Directory List (yarn.nodemanager.local-dirs) must be configured to a set of encrypted local directories on all nodes.

  Alternatively, to disable MapJoin, set hive.auto.convert.join to false.

**Additional Changes in Behavior with HDFS-Encrypted Tables**

Additional behavioral changes with HDFS-encrypted tables.

- Users reading data from read-only encrypted tables must have access to a temp directory that is encrypted with at least as strong encryption as the table.

- By default, temp data related to HDFS encryption is written to a staging directory identified by the hive-exec.stagingdir property created in the hive-site.xml file associated with the table folder.

- As of HDP-2.6.0, Hive INSERT OVERWRITE queries require a Ranger URI policy to allow write operations, even if the user has write privilege granted through HDFS policy. To fix the failing Hive INSERT OVERWRITE queries:

  1. Create a new policy under the Hive repository.
  2. In the dropdown where you see Database, select URI.
Configure YARN for HDFS Encryption

How to configure YARN for HDFS encryption.

About this task

Recommendation: Make /apps/history a single encryption zone. History files are moved between the intermediate and done directories, and HDFS encryption will not allow you to move encrypted files across encryption zones.

Procedure

1. On a cluster with MapReduce over YARN installed, create the /apps/history directory and make it an encryption zone.

2. If /apps/history already exists and is not empty:
   a) Create an empty /apps/history-tmp directory.
   b) Make /apps/history-tmp an encryption zone.
   c) Copy (distcp) all data from /apps/history into /apps/history-tmp.
   d) Remove /apps/history.
   e) Rename /apps/history-tmp to /apps/history.

Configuring Oozie for HDFS Encryption

How to configure Oozie for HDFS encryption.

Recommendations

A new Oozie administrator role (oozie-admin) has been created in HDP 2.3.

This role enables role separation between the Oozie daemon and administrative tasks. Both the oozie-admin role and the oozie role must be specified in the adminusers.txt file. This file is installed in HDP 2.3 with both roles specified. Both are also defined in Ambari 2.1 as well. Modification is only required if administrators choose to change the default administrative roles for Oozie.

If oozie-admin is used as the Oozie administrator user in your cluster, then the role is automatically managed by ambari.

If you plan to create an Oozie admin user other than oozie-admin, add the chosen username to adminusers.txt under the $OOZIE_HOME/conf directory.

Here is a sample adminusers.txt file:

```bash
# Licensed to the Apache Software Foundation (ASF) under one
# or more contributor license agreements. See the NOTICE file
# distributed with this work for additional information
# regarding copyright ownership. The ASF licenses this file
# to you under the Apache License, Version 2.0 (the
# "License"); you may not use this file except in compliance
# with the License. You may obtain a copy of the License at
#
#    http://www.apache.org/licenses/LICENSE-2.0
#
37
```
Configuring Sqoop for HDFS Encryption

Reference information on configuring HBase for Sqoop encryption.

Following are considerations for using Sqoop to import or export HDFS-encrypted data.

Recommendations

- **For Hive:**
  
  Make sure that you are using Sqoop with the `--target-dir` parameter set to a directory that is inside the Hive encryption zone. Specify the `-D` option after sqoop import.

  For example:

  ```
  sqoop import \
  -D sqoop.test.import.rootDir=<root-directory> \ 
  --target-dir <directory-inside-encryption-zone> \ 
  <additional-arguments>
  ```

- **For append or incremental import:**

  Make sure that the `sqoop.test.import.rootDir` property points to the encryption zone specified in the `--target-dir` argument.

- **For HCatalog:**

  No special configuration is required.

Configure WebHDFS for HDFS Encryption

How to configure HBase for WebHDFS encryption.

About this task

Recommendations

WebHDFS is supported for writing and reading files to and from encryption zones.

Procedure

To access encrypted files via WebHDFS, complete the following steps:

1. To enable WebHDFS in `hdfs-site.xml`, set the `dfs.webhdfs.enabled` property to true:

   ```
   <property>
   <name>dfs.webhdfs.enabled</name>
   <value>true</value>
   </property>
   ```

2. Make sure that you have separate HDFS administrative and service users, as described in “Create an HDFS Admin User”.


3. Remove the HDFS service user from the blacklist:

KMS supports a blacklist and a whitelist for key access (through kms-acls.xml). By default the hdfs service user is included in the blacklist for decrypt_eek operations. To support WebHDFS, the HDFS service user must not be on the key access blacklist.

a) To edit the blacklist using Ambari, go to Ranger KMS -> Configs, and search for "blacklist" or open the Advanced dbks-site list.
b) Remove hdfs from the hadoop.kms.blacklist.DECRYPT_EEK property:

c) Restart Ranger KMS.

4. The HDFS service user must have GENERATE_EEK and DECRYPT_EEK permissions. To add the permissions using the Ranger Web UI, select the Access Manager tab-> Resource Based Policies (the default Access Manager view). Select the key store, select the policy, and click the edit icon. In the Permissions column click the edit icon and check the boxes for GenerateEEK and DecryptEEK. Then click Save.
5. Because the HDFS service user will have access to all keys, the HDFS service user should not be the administrative user. Specify a different administrative user in hdfs-site.xml for the administrative user.

Related Information
- Create an HDFS Admin User
- Ranger KMS Administration

Running DataNodes as Non-Root

How to run DataNodes as non-Root.

Historically, part of the security configuration for HDFS involved starting the DataNode as the root user, and binding to privileged ports for the server endpoints. This was done to address a security issue whereby if a MapReduce task was running and the DataNode stopped running, it would be possible for the MapReduce task to bind to the DataNode port and potentially do something malicious. The solution to this scenario was to run the DataNode as the root user and use privileged ports. Only the root user can access privileged ports.

You can now use Simple Authentication and Security Layer (SASL) to securely run DataNodes as a non-root user. SASL is used to provide secure communication at the protocol level.

Note:
- Make sure to execute a migration from using root to start DataNodes to using SASL to start DataNodes in a very specific sequence across the entire cluster. Otherwise, there could be a risk of application downtime.

In order to migrate an existing cluster that used root authentication to start using SASL instead, first ensure that HDP 2.2 or later has been deployed to all cluster nodes as well as any external applications that need to connect to the cluster. Only the HDFS client in versions HDP 2.2 and later can connect to a DataNode that uses SASL for authentication of data transfer protocol, so it is vital that all callers have the correct version before migrating. After HDP 2.2 or later has been deployed everywhere, update the configuration of any external applications to enable SASL. If an HDFS client is enabled for SASL, it can connect successfully to a DataNode running with either root authentication or SASL authentication. Changing configuration for all clients guarantees that subsequent configuration changes on DataNodes will not disrupt the applications. Finally, each individual DataNode can be
migrated by changing its configuration and restarting. It is acceptable to temporarily have a mix of some DataNodes running with root authentication and some DataNodes running with SASL authentication during this migration period, because an HDFS client enabled for SASL can connect to both.

### Configuring DataNode SASL

Use the following steps to configure DataNode SASL to securely run a DataNode as a non-root user.

**Procedure**

1. Shut down the DataNode using the applicable commands in “Controlling HDP Services Manually”.
2. Enable SASL:
   a) Configure the following properties in the `/etc/hadoop/conf/hdfs-site.xml` file to enable DataNode SASL:
      
      The `dfs.data.transfer.protection` property enables DataNode SASL. You can set this property to one of the following values:
      - **authentication** -- Establishes mutual authentication between the client and the server.
      - **integrity** -- in addition to authentication, it guarantees that a man-in-the-middle cannot tamper with messages exchanged between the client and the server.
      - **privacy** -- in addition to the features offered by authentication and integrity, it also fully encrypts the messages exchanged between the client and the server.

      b) In addition to setting a value for the `dfs.data.transfer.protection` property, you must set the `dfs.http.policy` property to HTTPS_ONLY. You must also specify ports for the DataNode RPC and HTTP Servers.

        ```xml
        <property>
          <name>dfs.data.transfer.protection</name>
          <value>integrity</value>
        </property>

        <property>
          <name>dfs.datanode.address</name>
          <value>0.0.0.0:10019</value>
        </property>

        <property>
          <name>dfs.datanode.http.address</name>
          <value>0.0.0.0:10022</value>
        </property>

        <property>
          <name>dfs.http.policy</name>
          <value>HTTPS_ONLY</value>
        </property>
        ```

3. Update Environment Settings. Edit the following setting in the `/etc/hadoop/conf/hadoop-env.sh` file, as shown below:

   ```bash
   #On secure datanodes, user to run the datanode as after dropping privileges
   export HADOOP_SECURE_DN_USER=
   ```

   The export HADOOP_SECURE_DN_USER= line enables the legacy security configuration, and must be set to an empty value in order for SASL to be enabled.

4. Start the DataNode services.