Apache NiFi 3

Managing a Data Flow

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Contents

Command and Control of the DataFlow

When a component is added to the NiFi canvas, it is in the Stopped state. In order to cause the component to be triggered, the component must be started. Once started, the component can be stopped at any time. From a Stopped state, the component can be configured, started, or disabled.

Starting a Component

In order to start a component, the following conditions must be met:

- The component's configuration must be valid.
- All defined Relationships for the component must be connected to another component or auto-terminated.
- The component must be stopped.
- The component must be enabled.
- The component must have no active tasks. For more information about active tasks, see the "Anatomy of …" sections under Monitoring of DataFlow.

Components can be started by selecting all of the components to start and then clicking the "Start" button (▶) in the Operate Palette or by right-clicking a single component and choosing Start from the context menu.

If starting a Process Group, all components within that Process Group (including child Process Groups) will be started, with the exception of those components that are invalid or disabled.

Once started, the status indicator of a Processor will change to a Play symbol (▶).

Stopping a Component

A component can be stopped any time that it is running. A component is stopped by right-clicking on the component and clicking Stop from the context menu, or by selecting the component and clicking the "Stop" button (■) in the Operate Palette.

If a Process Group is stopped, all of the components within the Process Group (including child Process Groups) will be stopped.

Once stopped, the status indicator of a component will change to the Stop symbol (■).

Stopping a component does not interrupt its currently running tasks. Rather, it stops scheduling new tasks to be performed. The number of active tasks is shown in the top-right corner of the Processor (See Anatomy of a Processor for more information).

Enabling/Disabling a Component

When a component is enabled, it is able to be started. Users may choose to disable components when they are part of a dataflow that is still being assembled, for example. Typically, if a component is not intended to be run, the component is disabled, rather than being left in the Stopped state. This helps to distinguish between components that are intentionally not running and those that may have been stopped temporarily (for instance, to change the component's configuration) and inadvertently were never restarted.

When it is desirable to re-enable a component, it can be enabled by selecting the component and clicking the "Enable" button (⚡) in the Operate Palette. This is available only when the selected component or components are disabled. Alternatively, a component can be enabled by checking the checkbox next to the "Enabled" option in the Settings tab of the Processor configuration dialog or the configuration dialog for a Port.

Once enabled, the component's status indicator will change to either Invalid (⚠) or Stopped (■), depending on whether or not the component is valid.

A component is then disabled by selecting the component and clicking the "Disable" button () in the Operate Palette, or by clearing the checkbox next to the "Enabled" option in the Settings tab of the Processor configuration dialog or the configuration dialog for a Port.

Only Ports and Processors can be enabled and disabled.

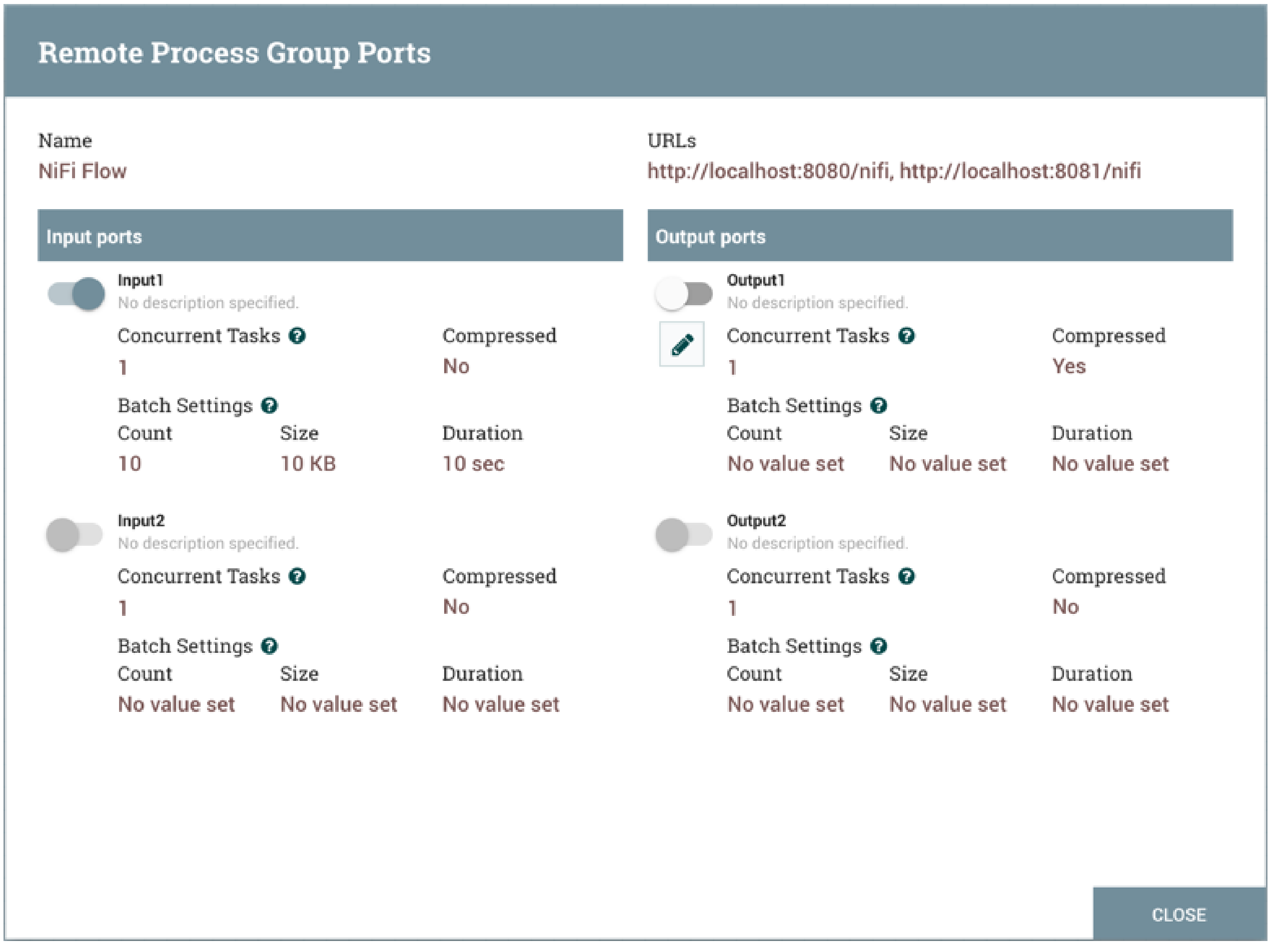
Remote Process Group Transmission

Remote Process Groups provide a mechanism for sending data to or retrieving data from a remote instance of NiFi. When a Remote Process Group (RPG) is added to the canvas, it is added with the Transmission Disabled, as indicated by the icon () in the top-left corner. When Transmission is Disabled, it can be enabled by right-clicking on the RPG and clicking the "Enable transmission" menu item. This will cause all ports for which there is a Connection to begin transmitting data. This will cause the status indicator to then change to the Transmission Enabled icon (◎).

If there are problems communicating with the Remote Process Group, a Warning indicator (⚠) may instead be present in the top-left corner. Hovering over this Warning indicator with the mouse will provide more information about the problem.

Individual Port Transmission

There are times when the DFM may want to either enable or disable transmission for only a specific port within the Remote Process Group. This can be accomplished by right-clicking on the Remote Process Group and choosing the "Manage remote ports" menu item. This provides a configuration dialog from which ports can be configured:



Remote Process Group Ports

Name: NiFi Flow

URLs: http://localhost:8080/nifi, http://localhost:8081/nifi

Input ports

Input1
No description specified.
Concurrent Tasks: 1
Compressed: No
Batch Settings
Count: 10
Size: 10 KB
Duration: 10 sec

Input2
No description specified.
Concurrent Tasks: 1
Compressed: No
Batch Settings
Count: No value set
Size: No value set
Duration: No value set

Output ports

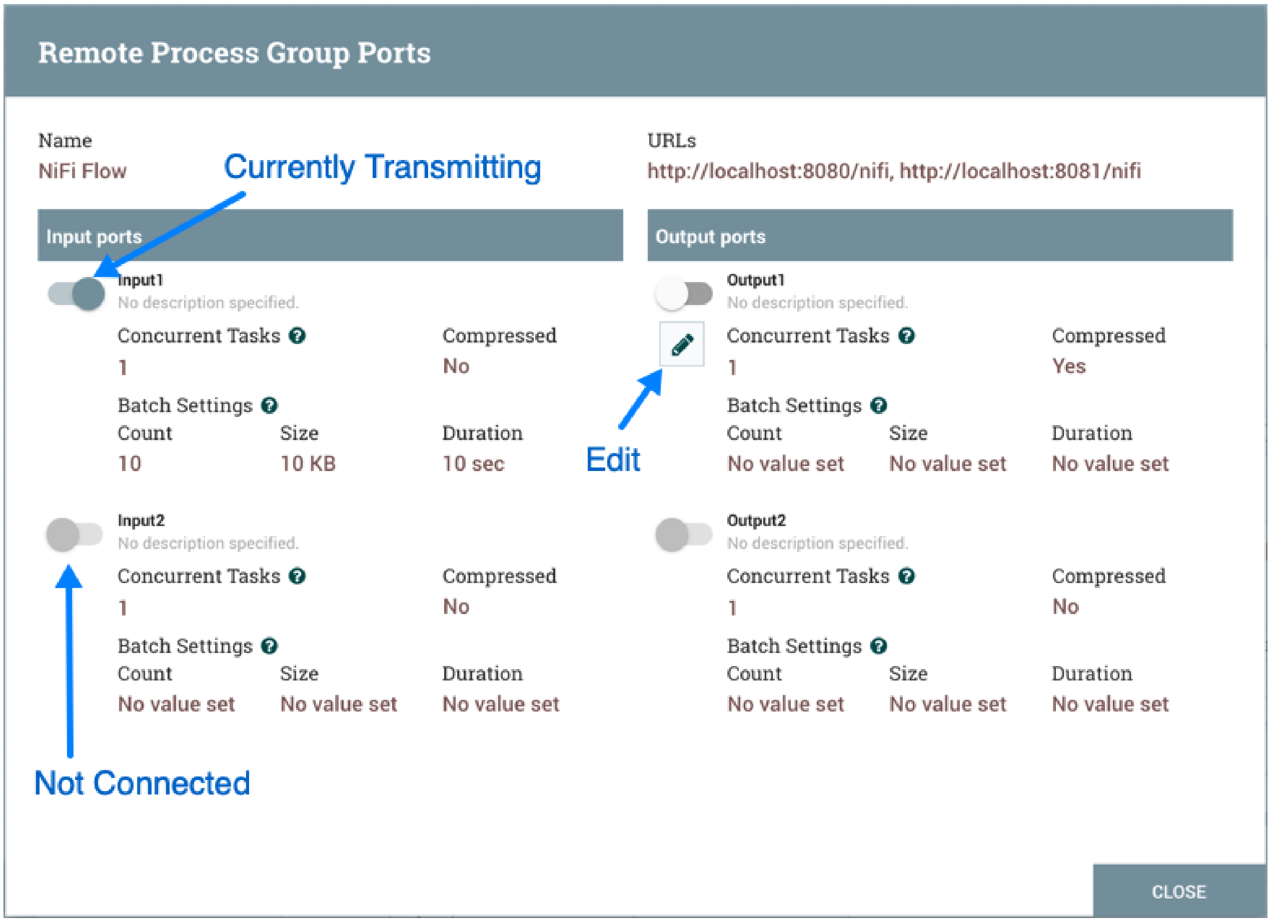
Output1
No description specified.
Concurrent Tasks: 1
Compressed: Yes
Batch Settings
Count: No value set
Size: No value set
Duration: No value set

Output2
No description specified.
Concurrent Tasks: 1
Compressed: No
Batch Settings
Count: No value set
Size: No value set
Duration: No value set

The left-hand side lists all of the Input Ports that the remote instance of NiFi allows data to be sent to. The right-hand side lists all of the Output Ports from which this instance is able to pull data. If the remote instance is using secure communications (the URL of the NiFi instance begins with https://, rather than http://), any ports that the remote instance has not made available to this instance will not be shown.

Note: If a port that is expected to be shown is not shown in this dialog, ensure that the instance has proper permissions and that the Remote Process Group's flow is current. This can be checked by closing the Remote Process Group Ports dialog and looking at the bottom-left corner of the Remote Process Group. The date and time when the flow was last refreshed is displayed. If the flow appears to be outdated, it can be updated by right-clicking on the Remote Process Group and selecting "Refresh remote". (See Anatomy of a Remote Process Group for more information).

Each port is shown with its Name, its Description, configured number of Concurrent Tasks, and whether or not data sent to this port will be Compressed. Additionally, the port's configured Batch Settings (Count, Size and Duration) are displayed. To the left of this information is a toggle switch to turn the port on or off. Ports that have no connections attached to them are grayed out:



Remote Process Group Ports

Name
NiFi Flow

URLs
http://localhost:8080/nifi, http://localhost:8081/nifi

Currently Transmitting

Edit

Not Connected

Input ports

Input1
No description specified.

Concurrent Tasks: 1
Compressed: No
Batch Settings: Count 10, Size 10 KB, Duration 10 sec

Input2
No description specified.

Concurrent Tasks: 1
Compressed: No
Batch Settings: Count No value set, Size No value set, Duration No value set

Output ports

Output1
No description specified.

Concurrent Tasks: 1
Compressed: Yes
Batch Settings: Count No value set, Size No value set, Duration No value set

Output2
No description specified.

Concurrent Tasks: 1
Compressed: No
Batch Settings: Count No value set, Size No value set, Duration No value set

The on/off toggle switch provides a mechanism to enable and disable transmission for each port in the Remote Process Group independently. Those ports that are connected but are not currently transmitting can be configured by clicking the pencil icon (✎) below the on/off toggle switch. Clicking this icon will allow the DFM to change the number of Concurrent Tasks, whether or not compression should be used when transmitting data to or from this port, and Batch Settings.

For an Input Port, the batch settings control how NiFi sends data to the remote input port in a transaction. NiFi will transfer flow files, as they are queued in incoming relationships, until any of the limits (Count, Size, Duration) is met. If none of the settings are configured, a 500 milliseconds batch duration is used by default.

For an Output Port, the batch settings tells the remote NiFi how NiFi prefers to receive data from the remote output port in a transaction. The remote NiFi will use the specified settings (Count, Size, Duration) to control the transfer of flow files. If none of the settings are configured, a 5 seconds batch duration is used by default.

Encrypted Content Repository

While OS-level access control can offer some security over the flowfile content data written to the disk in a repository, there are scenarios where the data may be sensitive, compliance and regulatory requirements exist, or NiFi is running on hardware not under the direct control of the organization (cloud, etc.). In this case, the content repository allows for all data to be encrypted before being persisted to the disk. For more information on the internal workings of the content repository, see NiFi In-Depth - Content Repository.

What is it?

The EncryptedFileSystemRepository is a new implementation of the content repository which encrypts all content data before it is written to the repository. This allows for storage on systems where OS-level access controls are not sufficient to protect the data while still allowing querying and access to the data through the NiFi UI/API.

How does it work?

The FileSystemRepository was introduced in NiFi 0.2.1 and provided the only persistent content repository implementation. The encrypted version wraps that implementation with functionality to return to the Session (usually StandardProcessSession) a special OutputStream/InputStream which encrypt and decrypt the serialized bytes respectively. This allows all components to continue interacting with the content repository interface in the same way as before and continue operating on content data in a streaming manner, without requiring any changes to handle the data protection.

The fully qualified class org.apache.nifi.content.EncryptedFileSystemRepository is specified as the content repository implementation in nifi.properties as the value of nifi.content.repository.implementation. In addition, new properties must be populated to allow successful initialization.

StaticKeyProvider

The StaticKeyProvider implementation defines keys directly in nifi.properties. Individual keys are provided in hexadecimal encoding. The keys can also be encrypted like any other sensitive property in nifi.properties using the ./encrypt-config.sh tool in the NiFi Toolkit.

The following configuration section would result in a key provider with two available keys, "Key1" (active) and "AnotherKey".

```
nifi.content.repository.encryption.key.provider.implementation=org.apache.nifi.security
nifi.content.repository.encryption.key.id=Key1
nifi.content.repository.encryption.key=0123456789ABCDEFFEDCBA98765432100123456789ABCDEFF
nifi.content.repository.encryption.key.id.AnotherKey=01010101010101010101010101010101010
```

FileBasedKeyProvider

The FileBasedKeyProvider implementation reads from an encrypted definition file of the format:

```
key1=NGCpDpxBZNN0DBodz0p1SDbTjC2FG5kp1pCmdUKJlxxtcMSo6GC4fMlTyy1mPeKOxzLut3DRX
+51j6PCO5SznA==
key2=GYxPbMMDbnraXs09eGJudAM5jTvVYp05XtImkAg4JY4rIbmHOiVUUI6OeOf7ZW
+hH42jtPgNW9pSkkQ9HWY/vQ==
key3=SFe11xuz7J89Y/IQ7YbJPOL0/YKZRFL/
VUxJgEHxxlXpd/8ELA7wwN59K1KTr3BURCcFP5YGmwrSKfr4OE4Vlg==
key4=kZprfcTSTH69UuOU3jMkZfrtiVR/eqWmmbdku3bQcUJ/
+UToecNB5lzOVEMBChyEXppyXXC35Wa6GEXFK6PMKw==
key5=c6FzfnKm7UR7xqI2NFpZ+fEKBfSU7+1NvRw
+XWQ9U39MONWqk5gvoyOCdFR1kUgeg46jrN5dGXk13sRqE0GETQ==
```

Each line defines a key ID and then the Base64-encoded cipher text of a 16 byte IV and wrapped AES-128, AES-192, or AES-256 key depending on the JCE policies available. The individual keys are wrapped by AES/GCM encryption using the master key defined by nifi.bootstrap.sensitive.key in conf/bootstrap.conf.

Data Protection vs. Key Protection

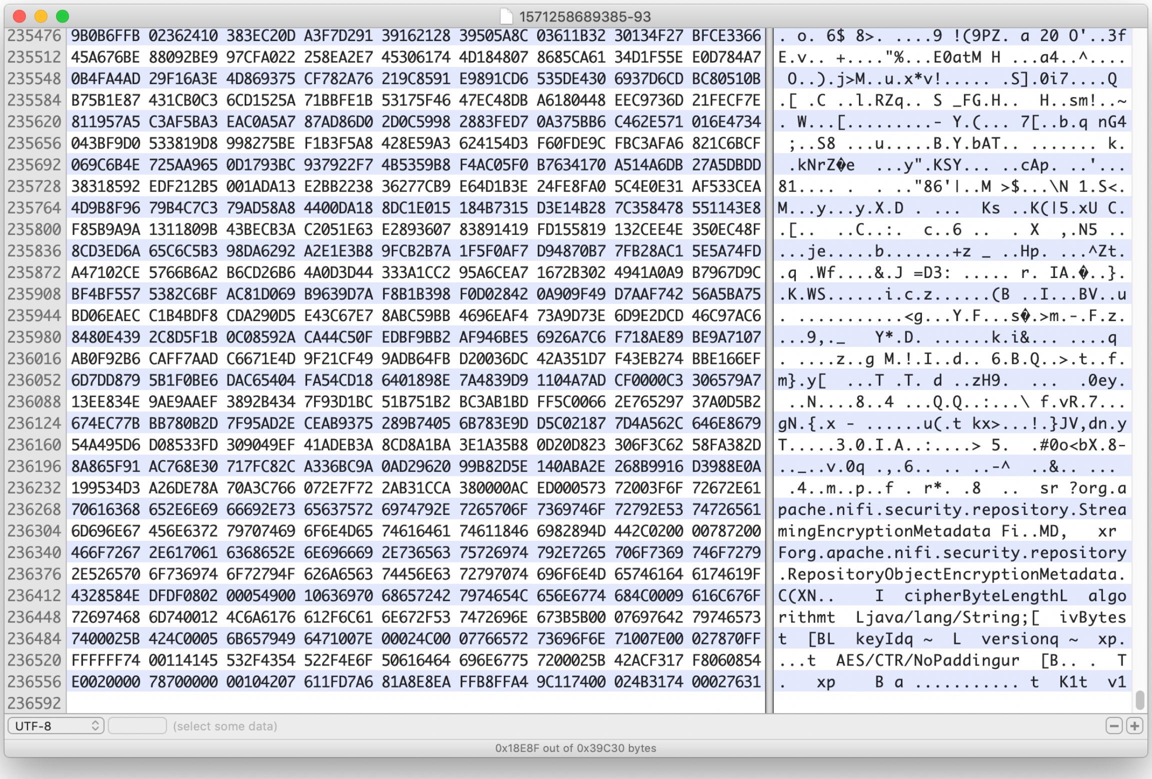
Even though the flowfile content is encrypted using AES/CTR to handle streaming data, if using the Config Encrypt Tool or FileBasedKeyProvider, those keys will be protected using AES/GCM to provide authenticated encryption over the key material.

Key Rotation

Simply update nifi.properties to reference a new key ID in nifi.content.repository.encryption.key.id. Previously-encrypted content claims can still be decrypted as long as that key is still available in the key definition file or nifi.content.repository.encryption.key.id.<OldKeyID> as the key ID is serialized alongside the encrypted content.

Writing and Reading Content Claims

Once the repository is initialized, all content claim write operations are serialized using RepositoryObjectStreamEncryptor (the only currently existing implementation is RepositoryObjectAESCTREncryptor) to an OutputStream. The actual implementation is EncryptedContentRepositoryOutputStream, which encrypts the data written by the component via StandardProcessSession inline and the encryption metadata (keyId, algorithm, version, IV) is serialized and prepended. The complete OutputStream is then written to the repository on disk as normal.



```
235476 9B0B6FFB 02362410 383EC20D A3F7D291 39162128 39505A8C 03611B32 30134F27 BFCE3366 . o. 6$ 8>. ....9 !(9PZ. a 20 O'..3f
235512 45A676BE 88092BE9 97CFA022 258EA2E7 45306174 4D184807 8685CA61 34D1F55E E0D784A7 E.v.. +...."%...E0atM H ...a4..^....
235548 0B4FA4AD 29F16A3E 4D869375 CF782A76 219C8591 E9891CD6 535DE430 6937D6CD BC80510B  O..).j>M..u.x*v!..... .S].0i7....Q
235584 B75B1E87 431CB0C3 6CD1525A 71BBFE1B 53175F46 47EC48DB A6180448 EEC9736D 21FECF7E .[ .C ..l.RZq.. S _FG.H..  H..sm!..~
235620 811957A5 C3AF5BA3 EAC0A5A7 87AD86D0 2D0C5998 2883FED7 0A375BB6 C462E571 016E4734 . W...[.........- Y.(... 7[..b.q nG4
235656 043BF9D0 533819D8 998275BE F1B3F5A8 428E59A3 624154D3 F60FDE9C FBC3AFA6 821C6BCF  ;..S8 ...u.....B.Y.bAT.. ....... k.
235692 069C6B4E 725AA965 0D1793BC 937922F7 4B5359B8 F4AC05F0 B7634170 A514A6DB 27A5DBDD  .kNrZ�e  ...y".KSY... ..cAp. ..'...
235728 38318592 EDF212B5 001ADA13 E2BB2238 36277CB9 E64D1B3E 24FE8FA0 5C4E0E31 AF533CEA 81.... .  . .."86'|..M >$...\N 1.S<.
235764 4D9B8F96 79B4C7C3 79AD58A8 4400DA18 8DC1E015 184B7315 D3E14B28 7C358478 551143E8 M...y...y.X.D . ...  Ks ..K(|5.xU C.
235800 F85B9A9A 1311809B 43BECB3A C2051E63 E2893607 83891419 FD155819 132CEE4E 350EC48F .[..  ..C..:.  c..6 ..  . X  ,.N5 ..
235836 8CD3ED6A 65C6C5B3 98DA6292 A2E1E3B8 9FCB2B7A 1F5F0AF7 D94870B7 7FB28AC1 5E5A74FD ...je.....b.......+z _ ..Hp. ...^Zt.
235872 A47102CE 5766B6A2 B6CD26B6 4A0D3D44 333A1CC2 95A6CEA7 1672B302 4941A0A9 B7967D9C .q .Wf....&.J =D3: ..... r. IA.�..}.
235908 BF4BF557 5382C6BF AC81D069 B9639D7A F8B1B398 F0D02842 0A909F49 D7AAF742 56A5BA75 .K.WS......i.c.z......(B ..I...BV..u
235944 BD06EAEC C1B4BDF8 CDA290D5 E43C67E7 8ABC59BB 4696EAF4 73A9D73E 6D9E2DCD 46C97AC6 . ...........<g...Y.F...s�.>m.-.F.z.
235980 8480E439 2C8D5F1B 0C08592A CA44C50F EDBF9BB2 AF946BE5 6926A7C6 F718AE89 BE9A7107 ...9,._   Y*.D. ......k.i&... ....q
236016 AB0F92B6 CAFF7AAD C6671E4D 9F21CF49 9ADB64FB D20036DC 42A351D7 F43EB274 BBE166EF . ....z..g M.!.I..d.. 6.B.Q..>.t..f.
236052 6D7DD879 5B1F0BE6 DAC65404 FA54CD18 6401898E 7A4839D9 1104A7AD CF0000C3 306579A7 m}.y[  ...T .T. d ..zH9.  ...  .0ey.
236088 13EE834E 9AE9AAEF 3892B434 7F93D1BC 51B751B2 BC3AB1BD FF5C0066 2E765297 37A0D5B2  ..N....8..4 ...Q.Q..:...\ f.vR.7...
236124 674EC77B BB780B2D 7F95AD2E CEAB9375 289B7405 6B783E9D D5C02187 7D4A562C 646E8679 gN.{.x - ......u(.t kx>...!.}JV,dn.y
236160 54A495D6 D08533FD 309049EF 41ADEB3A 8CD8A1BA 3E1A35B8 0D20D823 306F3C62 58FA382D T.....3.0.I.A..:....> 5.  .#0o<bX.8-
236196 8A865F91 AC768E30 717FC82C A336BC9A 0AD29620 99B82D5E 140ABA2E 268B9916 D3988E0A .._...v.0q .,.6.. .. ..-^  ..&.. ...
236232 199534D3 A26DE78A 70A3C766 072E7F72 2AB31CCA 380000AC ED000573 72003F6F 72672E61  .4..m..p..f . r*. .8  ..  sr ?org.a
236268 70616368 652E6E69 66692E73 65637572 6974792E 7265706F 7369746F 72792E53 74726561 pache.nifi.security.repository.Strea
236304 6D696E67 456E6372 79707469 6F6E4D65 74616461 74611846 6982894D 442C0200 00787200 mingEncryptionMetadata Fi..MD,   xr
236340 466F7267 2E617061 6368652E 6E696669 2E736563 75726974 792E7265 706F7369 746F7279 Forg.apache.nifi.security.repository
236376 2E526570 6F736974 6F72794F 626A6563 74456E63 72797074 696F6E4D 65746164 6174619F .RepositoryObjectEncryptionMetadata.
236412 4328584E DFDF0802 00054900 10636970 68657242 7974654C 656E6774 684C0009 616C676F C(XN..    I  cipherByteLengthL  algo
236448 72697468 6D740012 4C6A6176 612F6C61 6E672F53 7472696E 673B5B00 07697642 79746573 rithmt  Ljava/lang/String;[  ivBytes
236484 7400025B 424C0005 6B657949 6471007E 00024C00 07766572 73696F6E 71007E00 027870FF t  [BL  keyIdq ~  L  versionq ~  xp.
236520 FFFFFF74 00114145 532F4354 522F4E6F 50616464 696E6775 7200025B 42ACF317 F8060854 ...t  AES/CTR/NoPaddingur  [B.. .  T
236556 E0020000 78700000 00104207 611FD7A6 81A8E8EA FFB8FFA4 9C117400 024B3174 00027631 .   xp    B a .......... t  K1t  v1
236592
```

On content claim read, the process is reversed. The encryption metadata (RepositoryObjectEncryptionMetadata) is parsed and used to decrypt the serialized bytes, which are then deserialized into a CipherInputStream object. The delegation to the normal repository file system interaction allows for "random-access" (i.e. immediate seek without decryption of unnecessary content claims).

Within the NiFi UI/API, there is no detectable difference between an encrypted and unencrypted content repository. The Provenance Query operations to view content work as expected with no change to the process.

Potential Issues

- Switching between unencrypted and encrypted repositories

  - If a user has an existing repository (FileSystemRepository) that is not encrypted and switches their configuration to use an encrypted repository, the application writes an error to the log but starts up. However, previous content claims are not accessible through the provenance query interface and new content claims will overwrite the existing claims. The same behavior occurs if a user switches from an encrypted repository to an unencrypted repository. Automatic roll-over is a future effort (https://issues.apache.org/jira/browse/NIFI-6783) but NiFi is not intended for long-term storage of content claims so the impact should be minimal. There are two scenarios for roll-over:
    - Encrypted # unencrypted - if the previous repository implementation was encrypted, these claims should be handled seamlessly as long as the key provider available still has the keys used to encrypt the claims (see *Key Rotation*.)
    - Unencrypted # encrypted - if the previous repository implementation was unencrypted, these claims should be handled seamlessly as the previously written claims simply need to be read with a plaintext InputStream and then be written back with the EncryptedContentRepositoryOutputStream
  - There is also a future effort to provide a standalone tool in NiFi Toolkit to encrypt/decrypt an existing content repository to make the transition easier. The translation process could take a long time depending on the size of the existing repository, and being able to perform this task outside of application startup would be valuable (https://issues.apache.org/jira/browse/NIFI-6783).
- Multiple repositories - No additional effort or testing has been applied to multiple repositories at this time. It is possible/likely issues will occur with repositories on different physical devices. There is no option to provide a heterogenous environment (i.e. one encrypted, one plaintext repository).
- Corruption - when a disk is filled or corrupted, there have been reported issues with the repository becoming corrupted and recovery steps are necessary. This is likely to continue to be an issue with the encrypted repository, although still limited in scope to individual claims (i.e. an entire repository file won't be irrecoverable due to the encryption). Some testing has been performed on scenarios where disk space is exhausted. While the flow can no longer write additional content claims to the repository in that case, the NiFi application continues to function properly, and successfully written content claims are still available via the Provenance Query operations. Stopping NiFi and removing the content repository (or moving it to a larger disk) resolves the issue.

Encrypted FlowFile Repository

While OS-level access control can offer some security over the flowfile attribute and content claim data written to the disk in a repository, there are scenarios where the data may be sensitive, compliance and regulatory requirements exist, or NiFi is running on hardware not under the direct control of the organization (cloud, etc.). In this case, the flowfile repository allows for all data to be encrypted before being persisted to the disk. For more information on the internal workings of the flowfile repository, see NiFi In-Depth - FlowFile Repository.

What is it?

The EncryptedSequentialAccessWriteAheadLog is a new implementation of the flowfile write-ahead log which encrypts all flowfile attribute data before it is written to the repository. This allows for storage on systems where OS-level access controls are not sufficient to protect the data while still allowing querying and access to the data through the NiFi UI/API.

How does it work?

The SequentialAccessWriteAheadLog was introduced in NiFi 1.6.0 and provided a faster flowfile repository implementation. The encrypted version wraps that implementation with functionality to transparently encrypt and decrypt the serialized RepositoryRecord objects during file system interaction. During all writes to disk (swapping, snapshotting, journaling, and checkpointing), the flowfile containers are serialized to bytes based on a schema, and this serialized form is encrypted before writing. This allows the snapshot handler to continue interacting with the flowfile repository interface in the same way as before and continue operating on flowfile data in a random access manner, without requiring any changes to handle the data protection.

The fully qualified class org.apache.nifi.wali.EncryptedSequentialAccessWriteAheadLog is specified as the flowfile repository write-ahead log implementation in nifi.properties as the value of nifi.flowfile.repository.wal.implementation. In addition, new properties must be populated to allow successful initialization.

StaticKeyProvider

The StaticKeyProvider implementation defines keys directly in nifi.properties. Individual keys are provided in hexadecimal encoding. The keys can also be encrypted like any other sensitive property in nifi.properties using the ./encrypt-config.sh tool in the NiFi Toolkit.

The following configuration section would result in a key provider with two available keys, "Key1" (active) and "AnotherKey".

```
nifi.flowfile.repository.encryption.key.provider.implementation=org.apache.nifi.security
nifi.flowfile.repository.encryption.key.id=Key1
nifi.flowfile.repository.encryption.key=0123456789ABCDEFFEDCBA98765432100123456789ABCDEF
nifi.flowfile.repository.encryption.key.id.AnotherKey=0101010101010101010101010101010101
```

FileBasedKeyProvider

The FileBasedKeyProvider implementation reads from an encrypted definition file of the format:

```
key1=NGCpDpxBZNN0DBodz0p1SDbTjC2FG5kp1pCmdUKJlxxtcMSo6GC4fMlTyy1mPeKOxzLut3DRX
+51j6PCO5SznA==
key2=GYxPbMMDbnraXs09eGJudAM5jTvVYp05XtImkAg4JY4rIbmHOiVUUI6OeOf7ZW
+hH42jtPgNW9pSkkQ9HWY/vQ==
key3=SFe11xuz7J89Y/IQ7YbJPOL0/YKZRFL/
VUxJgEHxxlXpd/8ELA7wwN59K1KTr3BURCcFP5YGmwrSKfr4OE4Vlg==
key4=kZprfcTSTH69UuOU3jMkZfrtiVR/eqWmmbdku3bQcUJ/
+UToecNB5lzOVEMBChyEXppyXXC35Wa6GEXFK6PMKw==
key5=c6FzfnKm7UR7xqI2NFpZ+fEKBfSU7+1NvRw
+XWQ9U39MONWqk5gvoyOCdFR1kUgeg46jrN5dGXk13sRqE0GETQ==
```

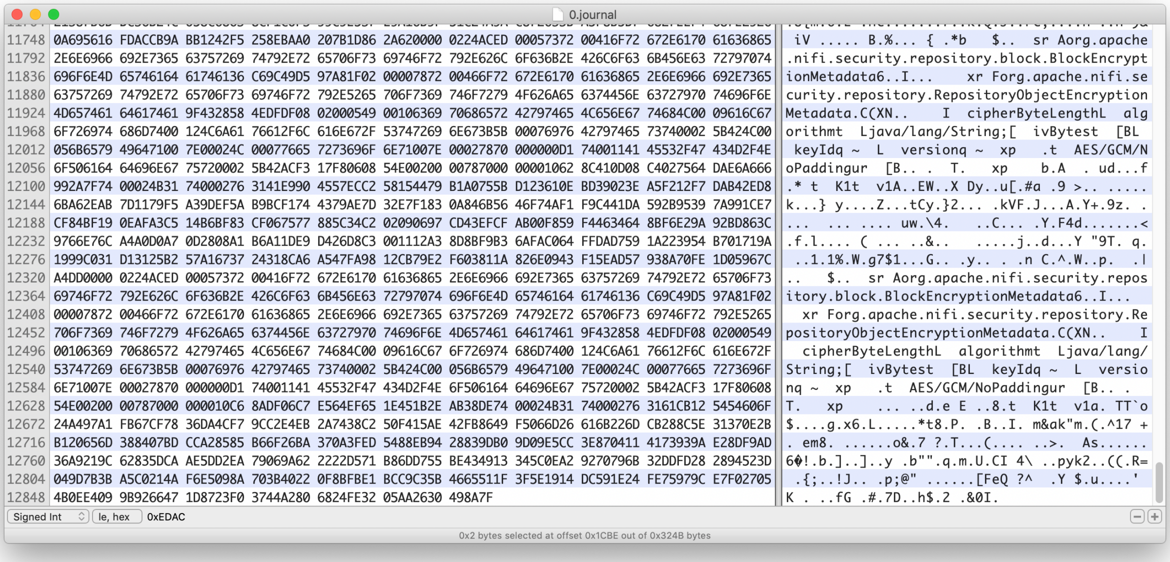
Each line defines a key ID and then the Base64-encoded cipher text of a 16 byte IV and wrapped AES-128, AES-192, or AES-256 key depending on the JCE policies available. The individual keys are wrapped by AES/GCM encryption using the master key defined by nifi.bootstrap.sensitive.key in conf/bootstrap.conf.

Key Rotation

Simply update nifi.properties to reference a new key ID in nifi.flowfile.repository.encryption.key.id. Previously-encrypted flowfile records can still be decrypted as long as that key is still available in the key definition file or nifi.flowfile.repository.encryption.key.id.<OldKeyID> as the key ID is serialized alongside the encrypted record.

Writing and Reading FlowFiles

Once the repository is initialized, all flowfile record write operations are serialized using RepositoryObjectBlockEncryptor (the only currently existing implementation is RepositoryObjectAESGCMEncryptor) to the provided DataOutputStream. The original stream is swapped with a temporary wrapped stream, which encrypts the data written by the wrapped serializer/deserializer via EncryptedSchemaRepositoryRecordSerde inline and the encryption metadata (keyId, algorithm, version, IV, cipherByteLength) is serialized and prepended. The complete length and encrypted bytes are then written to the original DataOutputStream on disk as normal.



```
11748 0A695616 FDACCB9A BB1242F5 258EBAA0 207B1D86 2A620000 0224ACED 00057372 00416F72 672E6170 61636865   iV ..... B.%... { .*b   $..  sr Aorg.apache
11792 2E6E6966 692E7365 63757269 74792E72 65706F73 69746F72 792E626C 6F636B2E 426C6F63 6B456E63 72797074  .nifi.security.repository.block.BlockEncrypt
11836 696F6E4D 65746164 61746136 C69C49D5 97A81F02 00007872 00466F72 672E6170 61636865 2E6E6966 692E7365  ionMetadata6..I...    xr Forg.apache.nifi.se
11880 63757269 74792E72 65706F73 69746F72 792E5265 706F7369 746F7279 4F626A65 6374456E 63727970 74696F6E  curity.repository.RepositoryObjectEncryption
11924 4D657461 64617461 9F432858 4EDFDF08 02000549 00106369 70686572 42797465 4C656E67 74684C00 09616C67  Metadata.C(XN..    I  cipherByteLengthL  alg
11968 6F726974 686D7400 124C6A61 76612F6C 616E672F 53747269 6E673B5B 00076976 42797465 73740002 5B424C00  orithmt  Ljava/lang/String;[  ivBytest  [BL
12012 056B6579 49647100 7E00024C 00077665 7273696F 6E71007E 00027870 000000D1 74001141 45532F47 434D2F4E   keyIdq ~  L  versionq ~  xp   .t  AES/GCM/N
12056 6F506164 64696E67 75720002 5B42ACF3 17F80608 54E00200 00787000 00001062 8C410D08 C4027564 DAE6A666  oPaddingur  [B.. .  T.   xp    b.A  . ud...f
12100 992A7F74 00024B31 74000276 3141E990 4557ECC2 58154479 B1A0755B D123610E BD39023E A5F212F7 DAB42ED8  .* t  K1t  v1A..EW..X Dy..u[.#a .9 >.. .....
12144 6BA62EAB 7D1179F5 A39DEF5A B9BCF174 4379AE7D 32E7F183 0A846B56 46F74AF1 F9C441DA 592B9539 7A991CE7  k...} y....Z...tCy.}2... .kVF.J...A.Y+.9z. .
12188 CF84BF19 0EAFA3C5 14B6BF83 CF067577 885C34C2 02090697 CD43EFCF AB00F859 F4463464 8BF6E29A 92BD863C  ...  ... .... uw.\4.   ..C... .Y.F4d.......<
12232 9766E76C A4A0D0A7 0D2808A1 B6A11DE9 D426D8C3 001112A3 8D8BF9B3 6AFAC064 FFDAD759 1A223954 B701719A  .f.l.... ( ... ..&..   .....j..d...Y "9T. q.
12276 1999C031 D13125B2 57A16737 24318CA6 A547FA98 12CB79E2 F603811A 826E0943 F15EAD57 938A70FE 1D05967C   ..1.1%.W.g7$1...G.. .y.. . .n C.^.W..p.  .|
12320 A4DD0000 0224ACED 00057372 00416F72 672E6170 61636865 2E6E6966 692E7365 63757269 74792E72 65706F73  ..   $..  sr Aorg.apache.nifi.security.repos
12364 69746F72 792E626C 6F636B2E 426C6F63 6B456E63 72797074 696F6E4D 65746164 61746136 C69C49D5 97A81F02  itory.block.BlockEncryptionMetadata6..I...
12408 00007872 00466F72 672E6170 61636865 2E6E6966 692E7365 63757269 74792E72 65706F73 69746F72 792E5265    xr Forg.apache.nifi.security.repository.Re
12452 706F7369 746F7279 4F626A65 6374456E 63727970 74696F6E 4D657461 64617461 9F432858 4EDFDF08 02000549  positoryObjectEncryptionMetadata.C(XN..    I
12496 00106369 70686572 42797465 4C656E67 74684C00 09616C67 6F726974 686D7400 124C6A61 76612F6C 616E672F    cipherByteLengthL  algorithmt  Ljava/lang/
12540 53747269 6E673B5B 00076976 42797465 73740002 5B424C00 056B6579 49647100 7E00024C 00077665 7273696F  String;[  ivBytest  [BL  keyIdq ~  L  versio
12584 6E71007E 00027870 000000D1 74001141 45532F47 434D2F4E 6F506164 64696E67 75720002 5B42ACF3 17F80608  nq ~  xp   .t  AES/GCM/NoPaddingur  [B.. .
12628 54E00200 00787000 000010C6 8ADF06C7 E564EF65 1E451B2E AB38DE74 00024B31 74000276 3161CB12 5454606F  T.   xp    ... ..d.e E ..8.t  K1t  v1a. TT`o
12672 24A497A1 FB67CF78 36DA4CF7 9CC2E4EB 2A7438C2 50F415AE 42FB8649 F5066D26 616B226D CB288C5E 31370E2B  $....g.x6.L.....*t8.P. .B..I. m&ak"m.(.^17 +
12716 B120656D 388407BD CCA28585 B66F26BA 370A3FED 5488EB94 28839DB0 9D09E5CC 3E870411 4173939A E28DF9AD  . em8. ......o&.7 ?.T...(.... ..>.  As......
12760 36A9219C 62835DCA AE5DD2EA 79069A62 2222D571 B86DD755 BE434913 345C0EA2 9270796B 32DDFD28 2894523D  6�!.b.]..]..y .b"".q.m.U.CI 4\ ..pyk2..((.R=
12804 049D7B3B A5C0214A F6E5098A 703B4022 0F8BFBE1 BCC9C35B 4665511F 3F5E1914 DC591E24 FE75979C E7F02705   .{;..!J.. .p;@" ......[FeQ ?^  .Y $.u....'
12848 4B0EE409 9B926647 1D8723F0 3744A280 6824FE32 05AA2630 498A7F                                         K . ..fG .#.7D..h$.2 .&0I.
```

On flowfile record read, the process is reversed. The encryption metadata (RepositoryObjectEncryptionMetadata) is parsed and used to decrypt the serialized bytes, which are then deserialized into a DataInputStream object.

During swaps and recoveries, the flowfile records are deserialized and reserialized, so if the active key has been changed, the flowfile records will be re-encrypted with the new active key.

Within the NiFi UI/API, there is no detectable difference between an encrypted and unencrypted flowfile repository. All framework interactions with flowfiles work as expected with no change to the process.

Potential Issues

- Switching between unencrypted and encrypted repositories
  - If a user has an existing write-ahead repository (WriteAheadFlowFileRepository) that is not encrypted (uses the SequentialAccessWriteAheadLog) and switches their configuration to use an encrypted repository, the application handles this and all flowfile records will be recovered on startup. Future writes (including re-serialization of these same flowfiles) will be encrypted. If a user switches from an encrypted repository to an unencrypted repository, the flowfiles cannot be recovered, and it is recommended to delete the existing flowfile repository before switching in this direction. Automatic roll-over is a future effort (https://issues.apache.org/jira/browse/NIFI-6994) but NiFi is not intended for long-term storage of flowfile records so the impact should be minimal. There are two scenarios for roll-over:
    - Encrypted # unencrypted - if the previous repository implementation was encrypted, these records should be handled seamlessly as long as the key provider available still has the keys used to encrypt the claims (see *Key Rotation*.)
    - Unencrypted # encrypted - currently handled seamlesssly for SequentialAccessWriteAheadLog but there are other initial implementations which could be handled
  - There is also a future effort to provide a standalone tool in NiFi Toolkit to encrypt/decrypt an existing flowfile repository to make the transition easier. The translation process could take a long time depending on the size of the existing repository, and being able to perform this task outside of application startup would be valuable (https://issues.apache.org/jira/browse/NIFI-6994).
- Multiple repositories - No additional effort or testing has been applied to multiple repositories at this time. Current implementations of the flowfile repository allow only for one repository, though it can reside across multiple volumes and partitions. It is possible/likely issues will occur with repositories on different physical devices. There is no option to provide a heterogenous environment (i.e. one encrypted, one plaintext partition/directory).

- Corruption - when a disk is filled or corrupted, there have been reported issues with the repository becoming corrupted and recovery steps are necessary. This is likely to continue to be an issue with the encrypted repository, although still limited in scope to individual records (i.e. an entire repository file won't be irrecoverable due to the encryption). It is important for the continued operation of NiFi to ensure that the disk storing the flowfile repository does not run out of available space.

Experimental Warning

While all Apache licensed code is provided "on an "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND, either express or implied" (see https://www.apache.org/licenses/LICENSE-2.0), some features of Apache NiFi may be marked experimental. Experimental features may:

- have undergone less extensive testing than is normal for standard NiFi features
- interact with unstable external dependencies
- be subject to change (any exposed APIs should not be considered covered under the minor release backward compatibility guidelines of https://semver.org)
- potentially cause data loss
- not be directly supported by the community in the event issues arise

Every attempt is made to provide more detailed and specific information around the nature of the experimental warning on a per-feature basis. Questions around specific experimental features should be directed to the dev@nifi.apache.org.

Other Management Features

In addition to the Summary Page, Data Provenance Page, Template Management Page, and Bulletin Board Page, there are other tools in the Global Menu (see NiFi User Interface) that are useful to the DFM. Select Flow Configuration History to view all the changes that have been made to the dataflow. The history can aid in troubleshooting, such as if a recent change to the dataflow has caused a problem and needs to be fixed. The DFM can see what changes have been made and adjust the flow as needed to fix the problem. While NiFi does not have an "undo" feature, the DFM can make new changes to the dataflow that will fix the problem.

Two other tools in the Global Menu are Controller Settings and Users. The Controller Settings page provides the ability to change the name of the NiFi instance, add comments describing the NiFi instance, and set the maximum number of threads that are available to the application. It also provides tabs where DFMs may add and configure Controller Services and Reporting Tasks. The Users page is used to manage user access, which is described in the System Administrator’s Guide.