Apache Kafka 3

Installing and configuring Apache Kafka

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Installing Kafka

This chapter describes how to install Kafka on an Ambari-managed cluster.

Prerequisites

Before installing Kafka, ZooKeeper must be installed and running on your cluster.

Note that the following underlying file systems are supported for use with Kafka:

- EXT4: supported and recommended
- EXT3: supported

Caution:

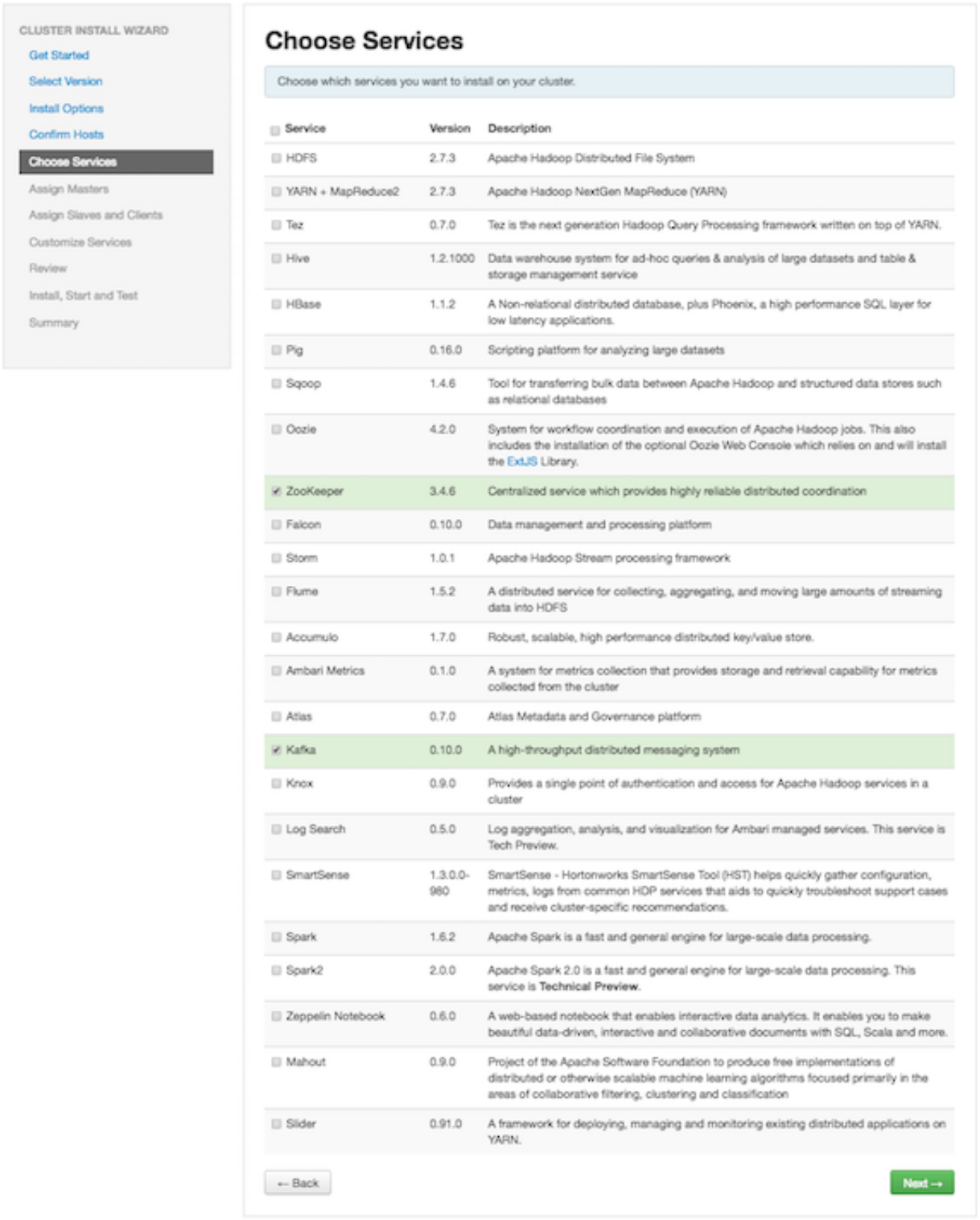
Encrypted file systems such as SafenetFS are not supported for Kafka. Index file corruption can occur.

Installing Kafka Using Ambari

Before you install Kafka using Ambari, refer to *Adding a Service* in the Ambari Operations Guide for background information about how to install Hortonworks Data Platform (HDP) components using Ambari. After Kafka is deployed and running, validate the installation. You can use the command-line interface to create a Kafka topic, send test messages, and consume the messages.

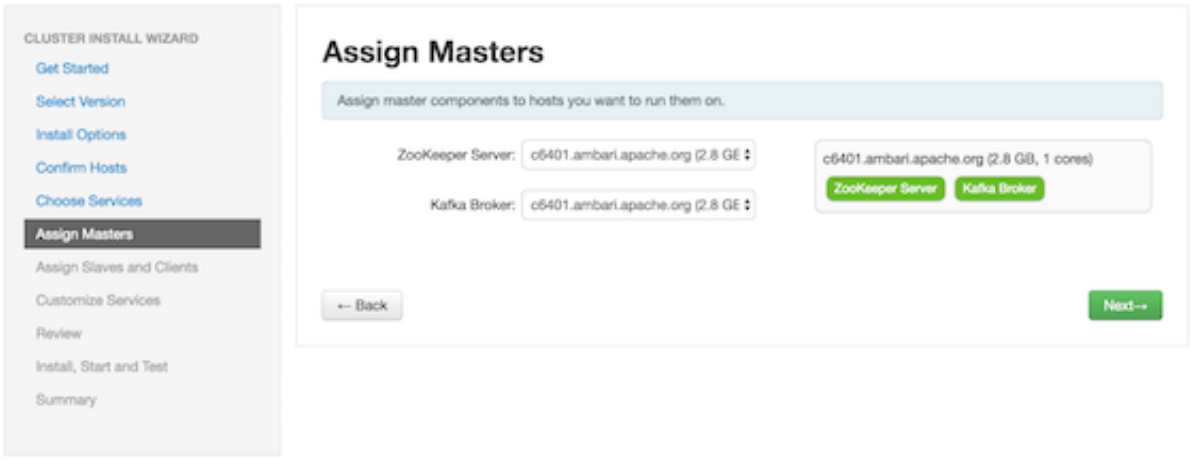
Procedure

1. Click the Ambari "Services" tab.
2. In the Ambari "Actions" menu, select "Add Service." This starts the Add Service wizard, displaying the Choose Services page. Some of the services are enabled by default.
3. Scroll through the alphabetic list of components on the Choose Services page, and select "Kafka".



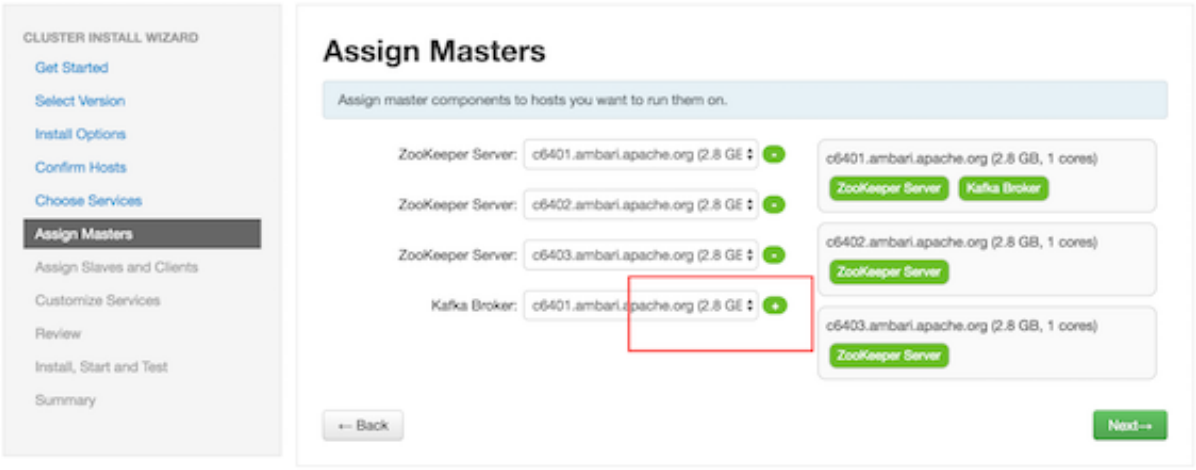
4. Click **Next** to continue.
5. On the Assign Masters page, review the node assignments for Kafka nodes.

   The following screen shows node assignment for a single-node Kafka cluster:

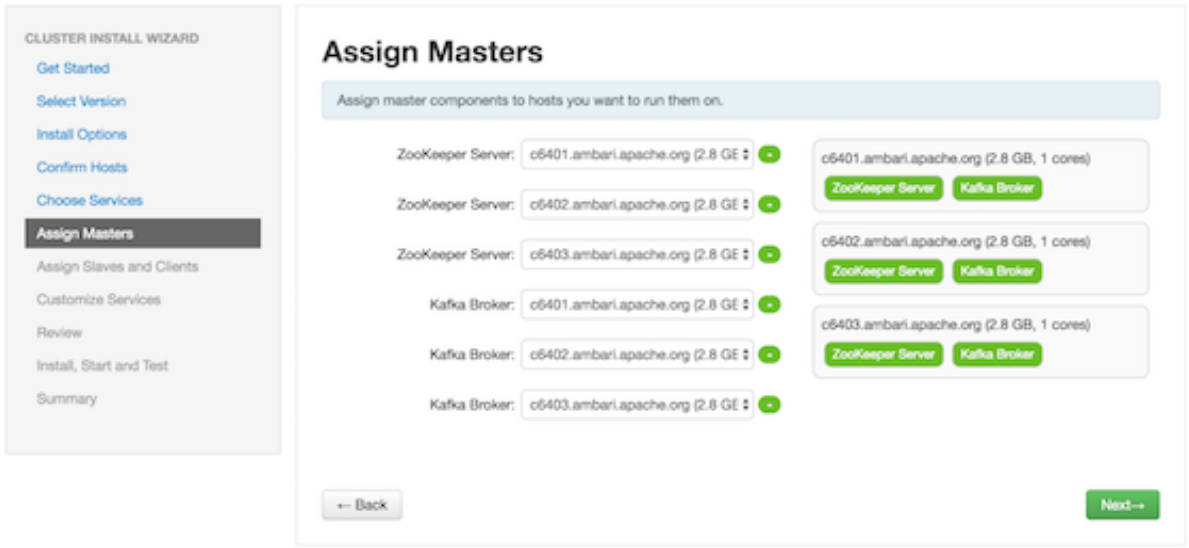


6. If you want Kafka to run with high availability, you must assign more than one node for Kafka brokers, resulting in Kafka brokers running on multiple nodes.

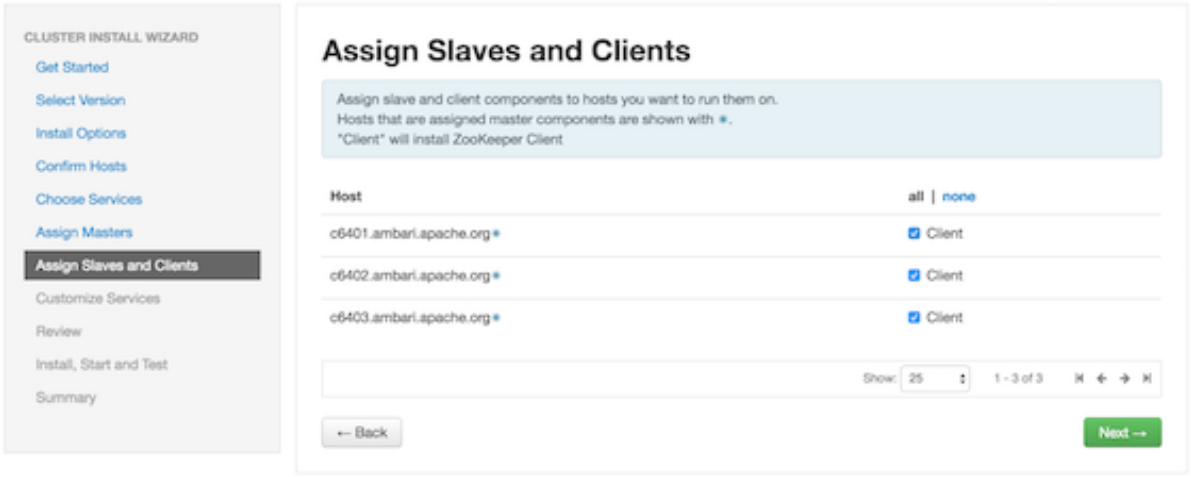
   Click the "+" symbol to add more broker nodes to the cluster:



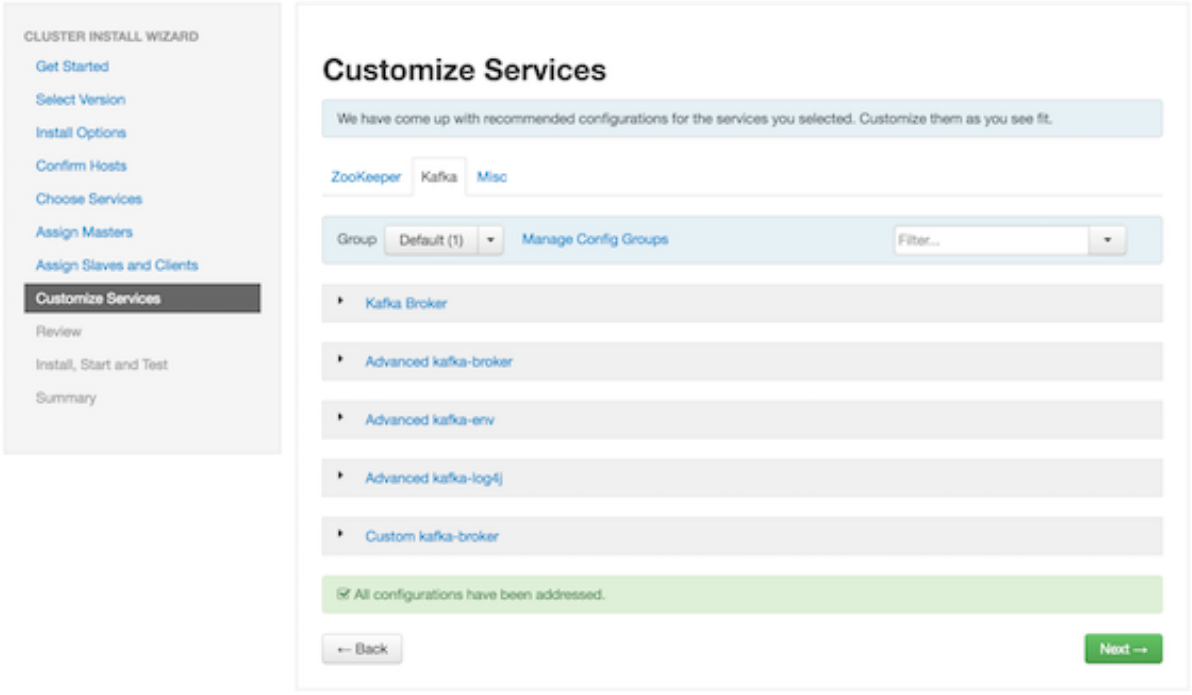
   The following screen shows node assignment for a multi-node Kafka cluster:



7. Click **Next** to continue.
8. On the Assign Slaves and Clients page, choose the nodes that you want to run ZooKeeper clients:

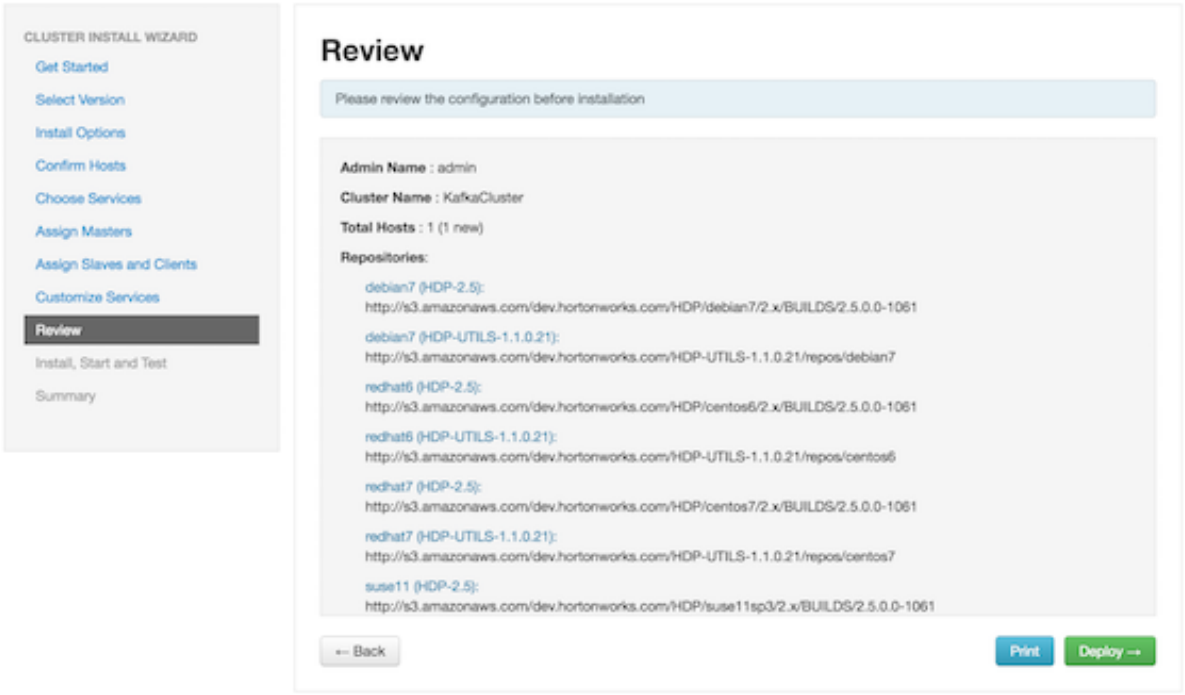


9. Click **Next** to continue.
10. Ambari displays the Customize Services page, which lists a series of services:



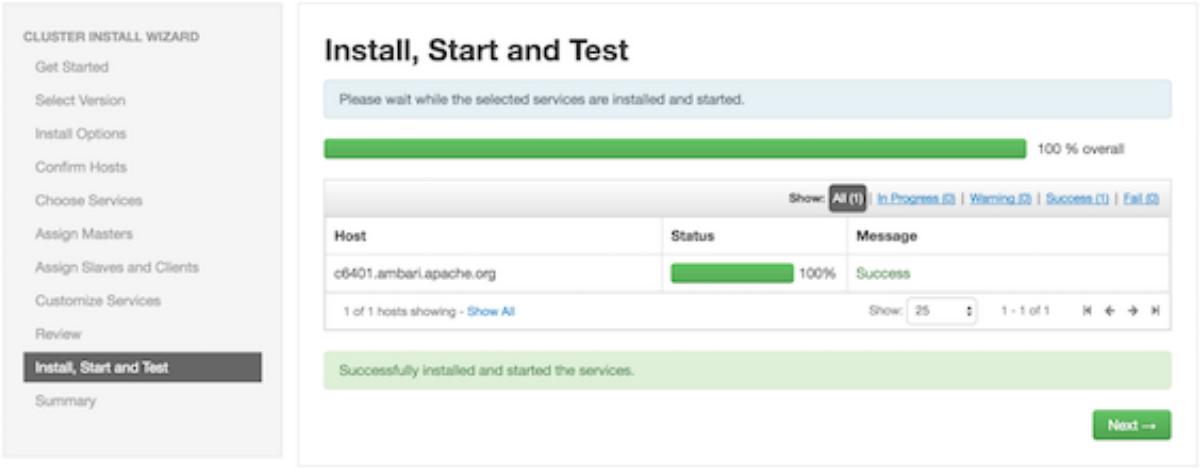
For your initial configuration you should use the default values set by Ambari. If Ambari prompts you with the message "Some configurations need your attention before you can proceed," review the list of properties and provide the required information.

11. Click **Next** to continue.
12. When the wizard displays the Review page, ensure that all HDP components correspond to HDP 2.5 or later:

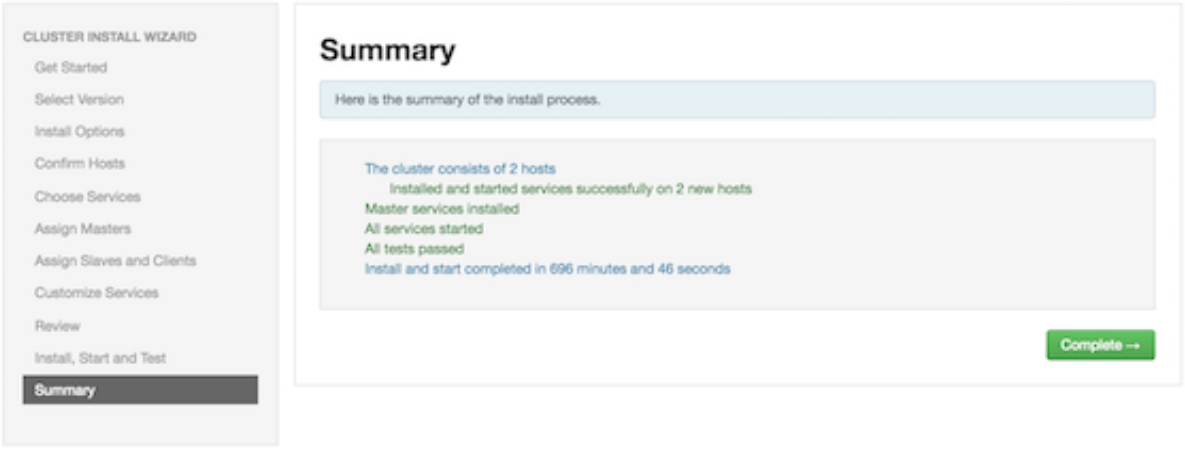


13. Click **Deploy** to begin installation.

14. Ambari displays the Install, Start and Test page. Monitor the status bar and messages for progress updates:



15. When the wizard presents a summary of results, click "Complete" to finish installing Kafka:



What to do next

After Kafka is deployed and running, validate the installation. You can use the command-line interface to create a Kafka topic, send test messages, and consume the messages.

Configuring Kafka for a Production Environment

This chapter covers topics related to Kafka configuration, including:

- Preparing the environment
- Customizing settings for brokers, producers, and consumers
- Configuring ZooKeeper for use with Kafka
- Enabling audit to HDFS when running Kafka on a secure cluster

Preparing the Environment

The following factors can affect Kafka performance:

- Operating system settings
- File system selection
- Disk drive configuration
- Java version
- Ethernet bandwidth

Operating System Settings

Consider the following when configuring Kafka:

- Kafka uses page cache memory as a buffer for active writers and readers, so after you specify JVM size (using -Xmx and -Xms Java options), leave the remaining RAM available to the operating system for page caching.
- Kafka needs open file descriptors for files and network connections. You should set the file descriptor limit to at least 128000.
- You can increase the maximum socket buffer size to enable high-performance data transfer.

File System Selection

Kafka uses regular Linux disk files for storage. We recommend using the EXT4 or XFS file system. Improvements to the XFS file system show improved performance characteristics for Kafka workloads without compromising stability.

Caution:

- Do not use mounted shared drives or any network file systems with Kafka, due to the risk of index failures and (in the case of network file systems) issues related to the use of MemoryMapped files to store the offset index.
- Encrypted file systems such as SafenetFS are not supported for Kafka. Index file corruption can occur.

Disk Drive Considerations

For throughput, we recommend dedicating multiple drives to Kafka data. More drives typically perform better with Kafka than fewer. Do not share these Kafka drives with any other application or use them for Kafka application logs.

You can configure multiple drives by specifying a comma-separated list of directories for the log.dirs property in the server.properties file. Kafka uses a round-robin approach to assign partitions to directories specified in log.dirs; the default value is /tmp/kafka-logs.

The num.io.threads property should be set to a value equal to or greater than the number of disks dedicated for Kafka. Recommendation: start by setting this property equal to the number of disks.

Depending on how you configure flush behavior (see "Log Flush Management"), a faster disk drive is beneficial if the log.flush.interval.messages property is set to flush the log file after every 100,000 messages (approximately).

Kafka performs best when data access loads are balanced among partitions, leading to balanced loads across disk drives. In addition, data distribution across disks is important. If one disk becomes full and other disks have available space, this can cause performance issues. To avoid slowdowns or interruptions to Kafka services, you should create usage alerts that notify you when available disk space is low.

RAID can potentially improve load balancing among the disks, but RAID can cause performance bottleneck due to slower writes. In addition, it reduces available disk space. Although RAID can tolerate disk failures, rebuilding RAID array is I/O-intensive and effectively disables the server. Therefore, RAID does not provide substantial improvements in availability.

Java Version

With Apache Kafka on HDP 2.5, you should use the latest update for Java version 1.8 and make sure that G1 garbage collection support is enabled. (G1 support is enabled by default in recent versions of Java.) If you prefer to use Java 1.7, make sure that you use update u51 or later.

Here are several recommended settings for the JVM:

```
-Xmx6g
-Xms6g
-XX:MetaspaceSize=96m
-XX:+UseG1GC
-XX:MaxGCPauseMillis=20
-XX:InitiatingHeapOccupancyPercent=35
-XX:G1HeapRegionSize=16M
-XX:MinMetaspaceFreeRatio=50
-XX:MaxMetaspaceFreeRatio=80
```

To set JVM heap size for the Kafka broker, export KAFKA_HEAP_OPTS; for example:

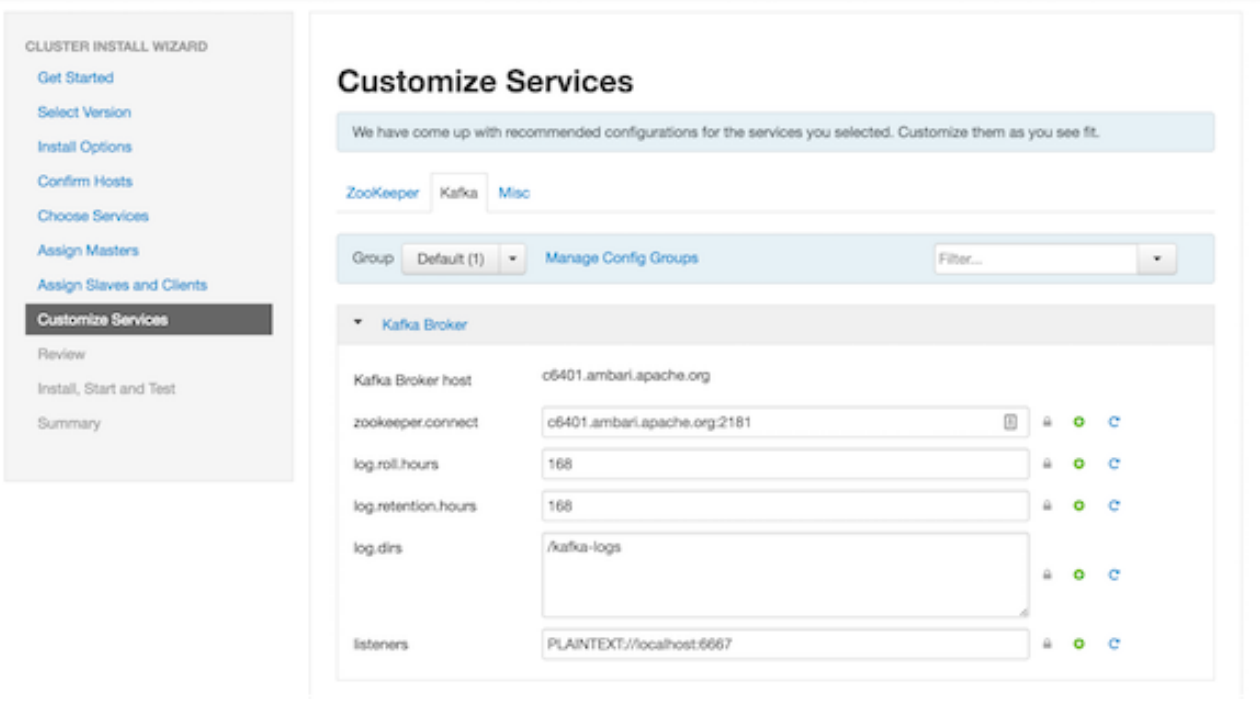
```
                    export KAFKA_HEAP_OPTS="-Xmx2g -Xms2g"
./kafka-server-start.sh
```

Ethernet Bandwidth

Ethernet bandwidth can have an impact on Kafka performance; make sure it is sufficient for your throughput requirements.

Customizing Kafka Settings on an Ambari-Managed Cluster

To customize configuration settings during the Ambari installation process, click the "Kafka" tab on the Customize Services page:

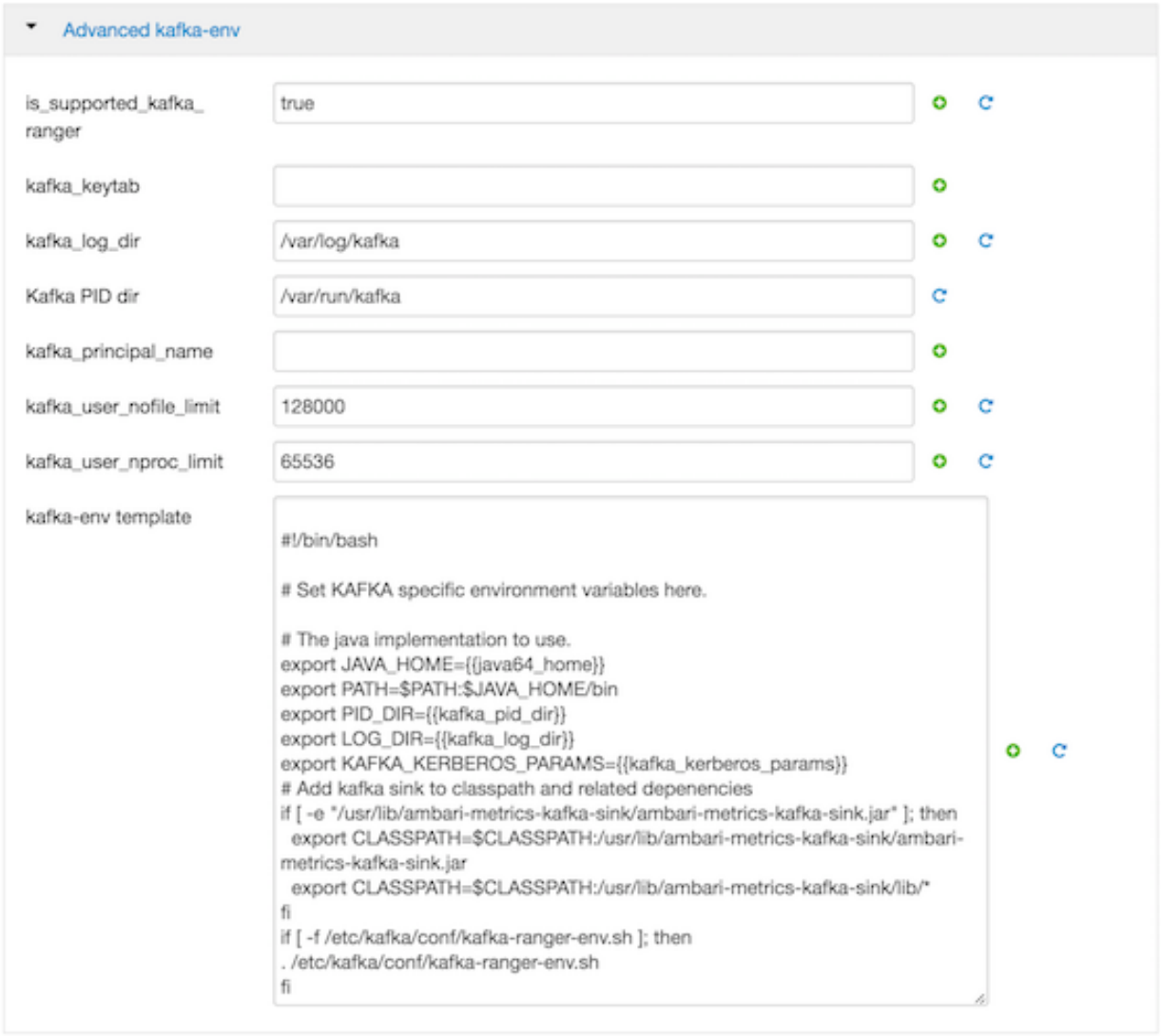


If you want to access configuration settings after installing Kafka using Ambari:

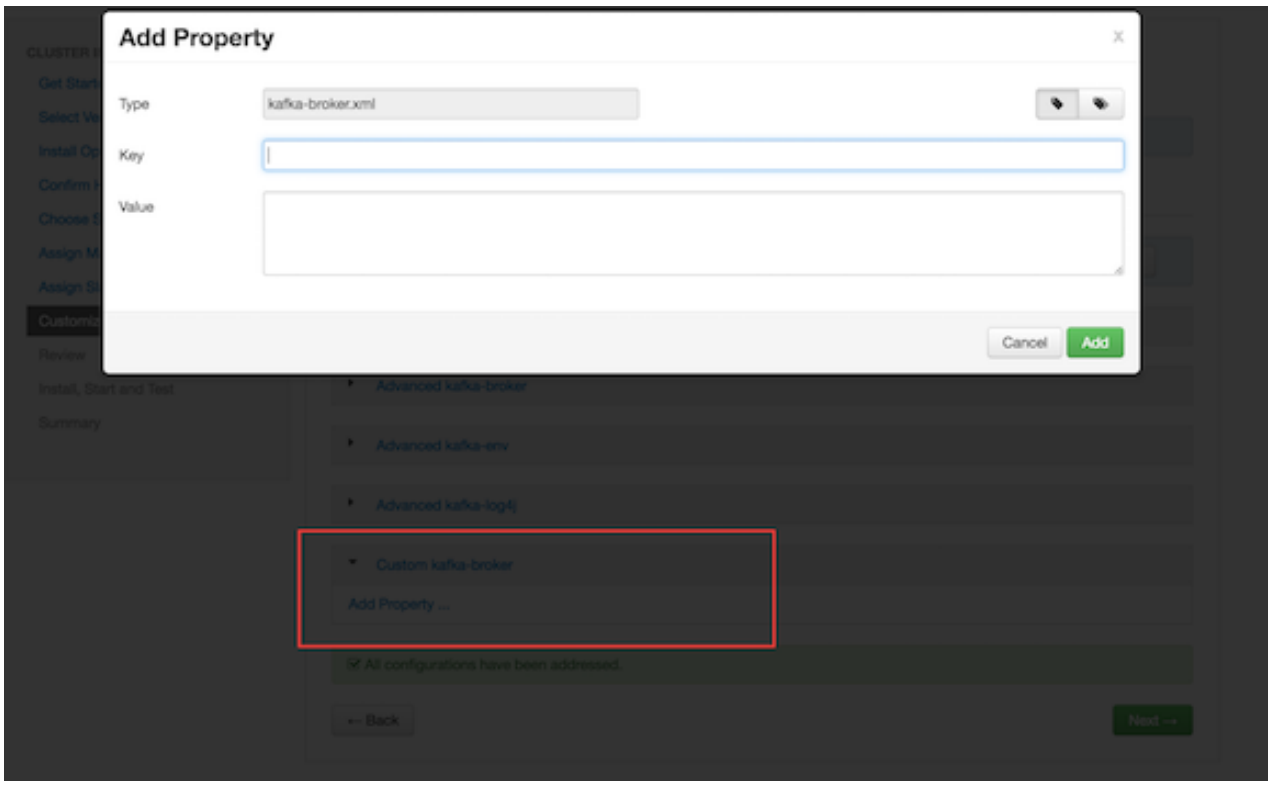
1. Click Kafka on the Ambari dashboard.
2. Choose Configs.

To view and modify settings, either scroll through categories and expand a category (such as "Kafka Broker", as shown in the graphic), or use the "Filter" box to search for a property.

Settings in the Advanced kafka-env category are configured by Ambari; you should not modify these settings:



To add configuration properties that are not listed by default in Ambari, navigate to the Custom kafka-broker category:



Kafka Broker Settings

The following subsections describe configuration settings that influence the performance of Kafka brokers.

Connection Settings

Review the following connection setting in the Advanced kafka-broker category, and modify as needed:

zookeeper.session.timeout.ms

Specifies ZooKeeper session timeout, in milliseconds. The default value is 30000 ms.

If the server fails to signal heartbeat to ZooKeeper within this period of time, the server is considered to be dead. If you set this value too low, the server might be falsely considered dead; if you set it too high it may take too long to recognize a truly dead server.

If you see frequent disconnection from the ZooKeeper server, review this setting. If long garbage collection pauses cause Kafka to lose its ZooKeeper session, you might need to configure longer timeout values.

advertised.listeners

If you have manually set listeners to advertised.listeners=PLAINTEXT://$HOSTNAME:$PORT, after enabling Kerberos, change the listener configuration to advertised.listeners=SASL_PLAINTEXT://$HOSTNAME:$PORT.

Important:

Do not change the following connection settings:

zookeeper.connect	A comma-separated list of ZooKeeper hostname:port pairs. Ambari sets this value. Do not change this setting.

Topic Settings

For each topic, Kafka maintains a structured commit log with one or more partitions. These topic partitions form the basic unit of parallelism in Kafka. In general, the more partitions there are in a Kafka cluster, the more parallel consumers can be added, resulting in higher throughput.

You can calculate the number of partitions based on your throughput requirements. If throughput from a producer to a single partition is P and throughput from a single partition to a consumer is C, and if your target throughput is T, the minimum number of required partitions is

max (T/P, T/C).

Note also that more partitions can increase latency:

- End-to-end latency in Kafka is defined as the difference in time from when a message is published by the producer to when the message is read by the consumer.
- Kafka only exposes a message to a consumer after it has been committed, after the message is replicated to all in-sync replicas.
- Replication of one thousand partitions from one broker to another can take up 20ms. This is too long for some real-time applications.
- In the new Kafka producer, messages are accumulated on the producer side; producers buffer the message per partition. This approach allows users to set an upper bound on the amount of memory used for buffering incoming messages. After enough data is accumulated or enough time has passed, accumulated messages are removed and sent to the broker. If you define more partitions, messages are accumulated for more partitions on the producer side.
- Similarly, the consumer fetches batches of messages per partition. Consumer memory requirements are proportional to the number of partitions that the consumer subscribes to.

Important Topic Properties

Review the following settings in the Advanced kafka-broker category, and modify as needed:

auto.create.topics.enable	Enable automatic creation of topics on the server. If this property is set to true, then attempts to produce, consume, or fetch metadata for a nonexistent topic automatically create the topic with the default replication factor and number of partitions. The default is enabled.
default.replication.factor	Specifies default replication factors for automatically created topics. For high availability production systems, you should set this value to at least 3.
num.partitions	Specifies the default number of log partitions per topic, for automatically created topics. The default value is 1. Change this setting based on the requirements related to your topic and partition design.
delete.topic.enable	Allows users to delete a topic from Kafka using the admin tool, for Kafka versions 0.9 and later. Deleting a topic through the admin tool will have no effect if this setting is turned off. By default this feature is turned off (set to false).

Log Settings

Review the following settings in the Kafka Broker category, and modify as needed:

log.roll.hours

The maximum time, in hours, before a new log segment is rolled out. The default value is 168 hours (seven days).

This setting controls the period of time after which Kafka will force the log to roll, even if the segment file is not full. This ensures that the retention process is able to delete or compact old data.

log.retention.hours

The number of hours to keep a log file before deleting it. The default value is 168 hours (seven days).

When setting this value, take into account your disk space and how long you would like messages to be available. An active consumer can read quickly and deliver messages to their destination.

The higher the retention setting, the longer the data will be preserved. Higher settings generate larger log files, so increasing this setting might reduce your overall storage capacity.

log.dirs

A comma-separated list of directories in which log data is kept. If you have multiple disks, list all directories under each disk.

Review the following setting in the Advanced kafka-broker category, and modify as needed:

log.retention.bytes

The amount of data to retain in the log for each topic partition. By default, log size is unlimited.

Note that this is the limit for each partition, so multiply this value by the number of partitions to calculate the total data retained for the topic.

If log.retention.hours and log.retention.bytes are both set, Kafka deletes a segment when either limit is exceeded.

log.segment.bytes

The log for a topic partition is stored as a directory of segment files. This setting controls the maximum size of a segment file before a new segment is rolled over in the log. The default is 1 GB.

Log Flush Management

Kafka writes topic messages to a log file immediately upon receipt, but the data is initially buffered in page cache. A log flush forces Kafka to flush topic messages from page cache, writing the messages to disk.

We recommend using the default flush settings, which rely on background flushes done by Linux and Kafka. Default settings provide high throughput and low latency, and they guarantee recovery through the use of replication.

If you decide to specify your own flush settings, you can force a flush after a period of time, or after a specified number of messages, or both (whichever limit is reached first). You can set property values globally and override them on a per-topic basis.

There are several important considerations related to log file flushing:

- Durability: unflushed data is at greater risk of loss in the event of a crash. A failed broker can recover topic partitions from its replicas, but if a follower does not issue a fetch request or consume from the leader's log-end

offset within the time specified by replica.lag.time.max.ms (which defaults to 10 seconds), the leader removes the follower from the in-sync replica ("ISR"). When this happens there is a slight chance of message loss if you do not explicitly set log.flush.interval.messages. If the leader broker fails and the follower is not caught up with the leader, the follower can still be under ISR for those 10 seconds and messages during leader transition to follower can be lost.

- Increased latency: data is not available to consumers until it is flushed (the fsync implementation in most Linux filesystems blocks writes to the file system).
- Throughput: a flush operation is typically an expensive operation.
- Disk usage patterns are less efficient.
- Page-level locking in background flushing is much more granular.

log.flush.interval.messages specifies the number of messages to accumulate on a log partition before Kafka forces a flush of data to disk.

log.flush.scheduler.interval.ms specifies the amount of time (in milliseconds) after which Kafka checks to see if a log needs to be flushed to disk.

log.segment.bytes specifies the size of the log file. Kafka flushes the log file to disk whenever a log file reaches its maximum size.

log.roll.hours specifies the maximum length of time before a new log segment is rolled out (in hours); this value is secondary to log.roll.ms. Kafka flushes the log file to disk whenever a log file reaches this time limit.

Compaction Settings

Review the following settings in the Advanced kafka-broker category, and modify as needed:

log.cleaner.dedupe.buffer.size

Specifies total memory used for log deduplication across all cleaner threads.

By default, 128 MB of buffer is allocated. You may want to review this and other log.cleaner configuration values, and adjust settings based on your use of compacted topics (__consumer_offsets and other compacted topics).

log.cleaner.io.buffer.size

Specifies the total memory used for log cleaner I/O buffers across all cleaner threads. By default, 512 KB of buffer is allocated. You may want to review this and other log.cleaner configuration values, and adjust settings based on your usage of compacted topics (__consumer_offsets and other compacted topics).

General Broker Settings

Review the following settings in the Advanced kafka-broker category, and modify as needed:

auto.leader.rebalance.enable

Enables automatic leader balancing. A background thread checks and triggers leader balancing (if needed) at regular intervals. The default is enabled.

unclean.leader.election.enable

This property allows you to specify a preference of availability or durability. This is an important setting: If availability is more important than avoiding data loss, ensure that this property is set to true. If preventing data loss is more important than availability, set this property to false.

This setting operates as follows:

	• If unclean.leader.election.enable is set to true (enabled), an out-of-sync replica will be elected as leader when there is no live in-sync replica (ISR). This preserves the availability of the partition, but there is a chance of data loss. • If unclean.leader.election.enable is set to false and there are no live in-sync replicas, Kafka returns an error and the partition will be unavailable. This property is set to true by default, which favors availability. If durability is preferable to availability, set unclean.leader.election to false.
controlled.shutdown.enable	Enables controlled shutdown of the server. The default is enabled.
min.insync.replicas	When a producer sets acks to "all", min.insync.replicas specifies the minimum number of replicas that must acknowledge a write for the write to be considered successful. If this minimum cannot be met, then the producer will raise an exception. When used together, min.insync.replicas and producer acks allow you to enforce stronger durability guarantees. You should set min.insync.replicas to 2 for replication factor equal to 3.
message.max.bytes	Specifies the maximum size of message that the server can receive. It is important that this property be set with consideration for the maximum fetch size used by your consumers, or a producer could publish messages too large for consumers to consume. Note that there are currently two versions of consumer and producer APIs. The value of message.max.bytes must be smaller than the max.partition.fetch.bytes setting in the new consumer, or smaller than the fetch.message.max.bytes setting in the old consumer. In addition, the value must be smaller than replica.fetch.max.bytes.
replica.fetch.max.bytes	Specifies the number of bytes of messages to attempt to fetch. This value must be larger than message.max.bytes.
broker.rack	The rack awareness feature distributes replicas of a partition across different racks. You can specify that a broker belongs to a particular rack through the "Custom kafka-broker" menu option. For more information about the rack awareness feature, see http://kafka.apache.org/documentation.html#basic_ops_racks.

Kafka Producer Settings

If performance is important and you have not yet upgraded to the new Kafka producer (client version 0.9.0.1 or later), consider doing so. The new producer is generally faster and more fully featured than the previous client.

To use the new producer client, add the associated maven dependency on the client jar; for example:

```
<dependency>
    <groupId>org.apache.kafka</groupId>
    <artifactId>kafka-clients</artifactId>
    <version>0.9.0.0</version>
</dependency>
```

For more information, see the KafkaProducer javadoc.

The following subsections describe several types of configuration settings that influence the performance of Kafka producers.

Important Producer Settings

The lifecycle of a request from producer to broker involves several configuration settings:

1. The producer polls for a batch of messages from the batch queue, one batch per partition. A batch is ready when one of the following is true:
   - batch.size is reached. Note: Larger batches typically have better compression ratios and higher throughput, but they have higher latency.
   - linger.ms (time-based batching threshold) is reached. Note: There is no simple guideilne for setting linger.ms values; you should test settings on specific use cases. For small events (100 bytes or less), this setting does not appear to have much impact.
   - Another batch to the same broker is ready.
   - The producer calls flush() or close().
2. The producer groups the batch based on the leader broker.
3. The producer sends the grouped batch to the broker.

The following paragraphs list additional settings related to the request lifecycle:

max.in.flight.requests.per.connection (pipelining)

The maximum number of unacknowledged requests the client will send on a single connection before blocking. If this setting is greater than 1, pipelining is used when the producer sends the grouped batch to the broker. This improves throughput, but if there are failed sends there is a risk of out-of-order delivery due to retries (if retries are enabled). Note also that excessive pipelining reduces throughput.

compression.type

Compression is an important part of a producer's work, and the speed of different compression types differs a lot.

To specify compression type, use the compression.type property. It accepts standard compression codecs ('gzip', 'snappy', 'lz4'), as well as 'uncompressed' (the default, equivalent to no compression), and 'producer' (uses the compression codec set by the producer).

Compression is handled by the user thread. If compression is slow it can help to add more threads. In addition, batching efficiency impacts the compression ratio: more batching leads to more efficient compression.

acks

The acks setting specifies acknowledgments that the producer requires the leader to receive before considering a request complete. This setting defines the durability level for the producer.

Acks	Throughput	Latency	Durability
0	High	Low	No Guarantee. The producer does not wait for acknowledgment from the server.
1	Medium	Medium	Leader writes the record to its local log, and responds without awaiting full acknowledgment from all followers.
-1	Low	High	Leader waits for the full set of in-sync replicas (ISRs) to acknowledge the record. This guarantees that the record is not lost as long as at least one IRS is active.

flush()

The new Producer API supports an optional flush() call, which makes all buffered records immediately available to send (even if linger.ms is greater than 0).

When using flush(), the number of bytes between two flush() calls is an important factor for performance.

- In microbenchmarking tests, a setting of approximately 4MB performed well for events 1KB in size.
- A general guideline is to set batch.size equal to the total bytes between flush()calls divided by number of partitions:

  (total bytes between flush()calls) / (partition count)

Additional Considerations

A producer thread going to the same partition is faster than a producer thread that sends messages to multiple partitions.

If a producer reaches maximum throughput but there is spare CPU and network capacity on the server, additional producer processes can increase overall throughput.

Performance is sensitive to event size: larger events are more likely to have better throughput. In microbenchmarking tests, 1KB events streamed faster than 100-byte events.

Kafka Consumer Settings

You can usually obtain good performance from consumers without tuning configuration settings. In microbenchmarking tests, consumer performance was not as sensitive to event size or batch size as was producer performance. Both 1KG and 100B events showed similar throughput.

One basic guideline for consumer performance is to keep the number of consumer threads equal to the partition count.

Configuring ZooKeeper for Use with Kafka

Here are several recommendations for ZooKeeper configuration with Kafka:

- Do not run ZooKeeper on a server where Kafka is running.
- When using ZooKeeper with Kafka you should dedicate ZooKeeper to Kafka, and not use ZooKeeper for any other components.
- Make sure you allocate sufficient JVM memory. A good starting point is 4GB.
- To monitor the ZooKeeper instance, use JMX metrics.

Configuring ZooKeeper for Multiple Applications

If you plan to use the same ZooKeeper cluster for different applications (such as Kafka cluster1, Kafka cluster2, and HBase), you should add a chroot path so that all Kafka data for a cluster appears under a specific path.

The following example shows a sample chroot path:

c6401.ambari.apache.org:2181:/kafka-root, c6402.ambari.apache.org:2181:/kafka-root

You must create this chroot path yourself before starting the broker, and consumers must use the same connection string.

Enabling Audit to HDFS for a Secure Cluster

To enable audit to HDFS when running Storm on a secure cluster, perform the steps listed at the bottom of *Manually Updating Ambari HDFS Audit Settings* in the HDP Security Guide.