APACHE kafka
A distributed streaming platform

Kafka 2.4 Documentation

1. GETTING STARTED

1.1 Introduction

Apache Kafka® is *a distributed streaming platform*. What exactly does that mean?

A streaming platform has three key capabilities:

- Publish and subscribe to streams of records, similar to a message queue or enterprise messaging system.
- Store streams of records in a fault-tolerant durable way.
- Process streams of records as they occur.

Kafka is generally used for two broad classes of applications:

- Building real-time streaming data pipelines that reliably get data between systems or applications
- Building real-time streaming applications that transform or react to the streams of data

To understand how Kafka does these things, let's dive in and explore Kafka's capabilities from the bottom up.

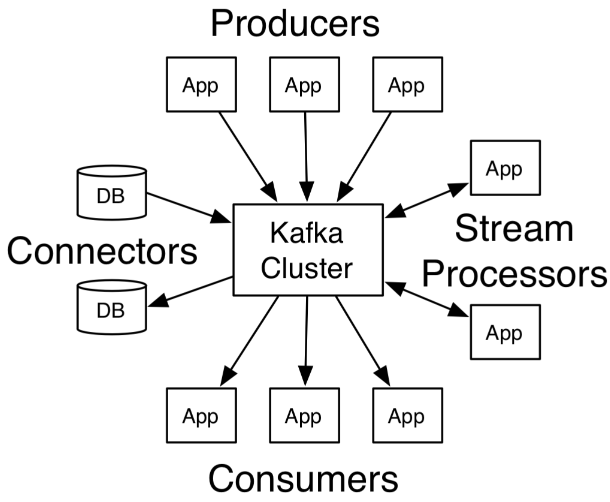
First a few concepts:

- Kafka is run as a cluster on one or more servers that can span multiple datacenters.
- The Kafka cluster stores streams of *records* in categories called *topics*.
- Each record consists of a key, a value, and a timestamp.

Kafka has four core APIs:

- The Producer API allows an application to publish a stream of records to one or more Kafka topics.
- The Consumer API allows an application to subscribe to one or more topics and process the stream of records produced to them.
- The Streams API allows an application to act as a *stream processor*, consuming an input stream from one or more topics and producing an output stream to one or more output topics, effectively transforming the input streams to output streams.
- The Connector API allows building and running reusable producers or consumers that connect Kafka topics to

existing applications or data systems. For example, a connector to a relational database might capture every change to a table.



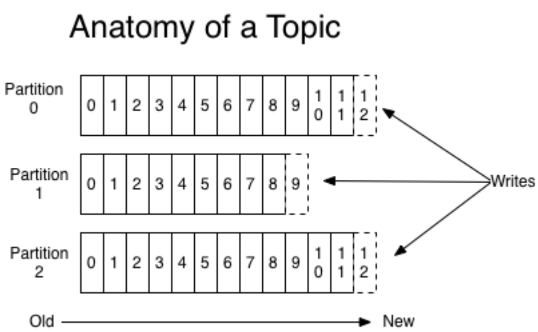
In Kafka the communication between the clients and the servers is done with a simple, high-performance, language agnostic [TCP protocol](). This protocol is versioned and maintains backwards compatibility with older version. We provide a Java client for Kafka, but clients are available in [many languages]().

Topics and Logs

Let's first dive into the core abstraction Kafka provides for a stream of records—the topic.

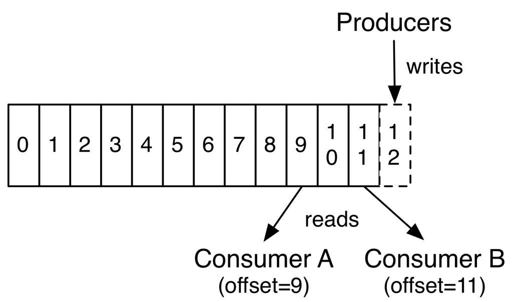
A topic is a category or feed name to which records are published. Topics in Kafka are always multi-subscriber; that is, a topic can have zero, one, or many consumers that subscribe to the data written to it.

For each topic, the Kafka cluster maintains a partitioned log that looks like this:



Each partition is an ordered, immutable sequence of records that is continually appended to—a structured commit log. The records in the partitions are each assigned a sequential id number called the *offset* that uniquely identifies each record within the partition.

The Kafka cluster durably persists all published records—whether or not they have been consumed—using a configurable retention period. For example, if the retention policy is set to two days, then for the two days after a record is published, it is available for consumption, after which it will be discarded to free up space. Kafka's performance is effectively constant with respect to data size so storing data for a long time is not a problem.



In fact, the only metadata retained on a per-consumer basis is the offset or position of that consumer in the log. This offset is controlled by the consumer: normally a consumer will advance its offset linearly as it reads records, but, in fact, since the position is controlled by the consumer it can consume records in any order it likes. For example a consumer can reset to an older offset to reprocess data from the past or skip ahead to the most recent record and start consuming from "now".

This combination of features means that Kafka consumers are very cheap—they can come and go without much impact on the cluster or on other consumers. For example, you can use our command line tools to "tail" the contents of any topic without changing what is consumed by any existing consumers.

The partitions in the log serve several purposes. First, they allow the log to scale beyond a size that will fit on a single server. Each individual partition must fit on the servers that host it, but a topic may have many partitions so it can handle an arbitrary amount of data. Second they act as the unit of parallelism—more on that in a bit.

Distribution

The partitions of the log are distributed over the servers in the Kafka cluster with each server handling data and requests for a share of the partitions. Each partition is replicated across a configurable number of servers for fault tolerance.

Each partition has one server which acts as the "leader" and zero or more servers which act as "followers". The leader handles all read and write requests for the partition while the followers passively replicate the leader. If the leader fails, one of the followers will automatically become the new leader. Each server acts as a leader for some of its partitions and a follower for others so load is well balanced within the cluster.

Geo-Replication

Kafka MirrorMaker provides geo-replication support for your clusters. With MirrorMaker, messages are replicated across multiple datacenters or cloud regions. You can use this in active/passive scenarios for backup and recovery; or in active/active scenarios to place data closer to your users, or support data locality requirements.

Producers

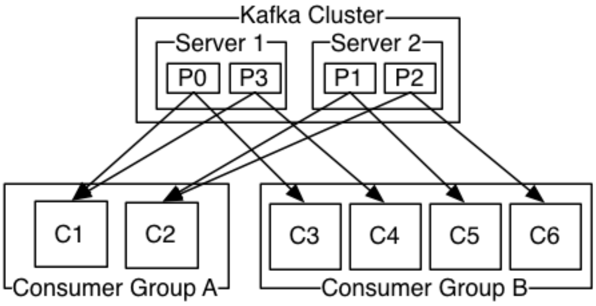
Producers publish data to the topics of their choice. The producer is responsible for choosing which record to assign to which partition within the topic. This can be done in a round-robin fashion simply to balance load or it can be done according to some semantic partition function (say based on some key in the record). More on the use of partitioning in a second!

Consumers

Consumers label themselves with a *consumer group* name, and each record published to a topic is delivered to one consumer instance within each subscribing consumer group. Consumer instances can be in separate processes or on separate machines.

If all the consumer instances have the same consumer group, then the records will effectively be load balanced over the consumer instances.

If all the consumer instances have different consumer groups, then each record will be broadcast to all the consumer processes.



A two server Kafka cluster hosting four partitions (P0-P3) with two consumer groups. Consumer group A has two consumer instances and group B has four.

More commonly, however, we have found that topics have a small number of consumer groups, one for each "logical subscriber". Each group is composed of many consumer instances for scalability and fault tolerance. This is nothing more than publish-subscribe semantics where the subscriber is a cluster of consumers instead of a single process.

The way consumption is implemented in Kafka is by dividing up the partitions in the log over the consumer instances so that each instance is the exclusive consumer of a "fair share" of partitions at any point in time. This process of maintaining membership in the group is handled by the Kafka protocol dynamically. If new instances join the group they will take over some partitions from other members of the group; if an instance dies, its partitions will be distributed to the remaining instances.

Kafka only provides a total order over records *within* a partition, not between different partitions in a topic. Per-partition ordering combined with the ability to partition data by key is sufficient for most applications. However, if you require a total order over records this can be achieved with a topic that has only one partition, though this will mean only one consumer process per consumer group.

Multi-tenancy

You can deploy Kafka as a multi-tenant solution. Multi-tenancy is enabled by configuring which topics can produce or consume data. There is also operations support for quotas. Administrators can define and enforce quotas on requests to control the broker resources that are used by clients. For more information, see the security documentation.

Guarantees

At a high-level Kafka gives the following guarantees:

- Messages sent by a producer to a particular topic partition will be appended in the order they are sent. That is, if a record M1 is sent by the same producer as a record M2, and M1 is sent first, then M1 will have a lower offset than M2 and appear earlier in the log.
- A consumer instance sees records in the order they are stored in the log.
- For a topic with replication factor N, we will tolerate up to N-1 server failures without losing any records committed to the log.

More details on these guarantees are given in the design section of the documentation.

Kafka as a Messaging System

How does Kafka's notion of streams compare to a traditional enterprise messaging system?

Messaging traditionally has two models: queuing and publish-subscribe. In a queue, a pool of consumers may read from a server and each record goes to one of them; in publish-subscribe the record is broadcast to all consumers. Each of these two models has a strength and a weakness. The strength of queuing is that it allows you to divide up the processing of data over multiple consumer instances, which lets you scale your processing. Unfortunately, queues aren't multi-subscriber—once one process reads the data it's gone. Publish-subscribe allows you broadcast data to multiple processes, but has no way of scaling processing since every message goes to every subscriber.

The consumer group concept in Kafka generalizes these two concepts. As with a queue the consumer group allows you to divide up processing over a collection of processes (the members of the consumer group). As with publish-subscribe, Kafka allows you to broadcast messages to multiple consumer groups.

The advantage of Kafka's model is that every topic has both these properties—it can scale processing and is also multi-subscriber—there is no need to choose one or the other.

Kafka has stronger ordering guarantees than a traditional messaging system, too.

A traditional queue retains records in-order on the server, and if multiple consumers consume from the queue then the server hands out records in the order they are stored. However, although the server hands out records in order, the records are delivered asynchronously to consumers, so they may arrive out of order on different consumers. This effectively means the ordering of the records is lost in the presence of parallel consumption. Messaging systems often work around this by having a notion of "exclusive consumer" that allows only one process to consume from a queue, but of course this means that there is no parallelism in processing.

Kafka does it better. By having a notion of parallelism—the partition—within the topics, Kafka is able to provide both ordering guarantees and load balancing over a pool of consumer processes. This is achieved by assigning the partitions in the topic to the consumers in the consumer group so that each partition is consumed by exactly one consumer in the group. By doing this we ensure that the consumer is the only reader of that partition and consumes the data in order. Since there are many partitions this still balances the load over many consumer instances. Note however that there cannot be more consumer instances in a consumer group than partitions.

Kafka as a Storage System

Any message queue that allows publishing messages decoupled from consuming them is effectively acting as a storage system for the in-flight messages. What is different about Kafka is that it is a very good storage system.

Data written to Kafka is written to disk and replicated for fault-tolerance. Kafka allows producers to wait on acknowledgement so that a write isn't considered complete until it is fully replicated and guaranteed to persist even if the server written to fails.

The disk structures Kafka uses scale well—Kafka will perform the same whether you have 50 KB or 50 TB of persistent data on the server.

As a result of taking storage seriously and allowing the clients to control their read position, you can think of Kafka as a kind of special purpose distributed filesystem dedicated to high-performance, low-latency commit log storage, replication, and propagation.

For details about the Kafka's commit log storage and replication design, please read this page.

Kafka for Stream Processing

It isn't enough to just read, write, and store streams of data, the purpose is to enable real-time processing of streams.

In Kafka a stream processor is anything that takes continual streams of data from input topics, performs some processing on this input, and produces continual streams of data to output topics.

For example, a retail application might take in input streams of sales and shipments, and output a stream of reorders and price adjustments computed off this data.

It is possible to do simple processing directly using the producer and consumer APIs. However for more complex transformations Kafka provides a fully integrated Streams API. This allows building applications that do non-trivial processing that compute aggregations off of streams or join streams together.

This facility helps solve the hard problems this type of application faces: handling out-of-order data, reprocessing input as code changes, performing stateful computations, etc.

The streams API builds on the core primitives Kafka provides: it uses the producer and consumer APIs for input, uses Kafka for stateful storage, and uses the same group mechanism for fault tolerance among the stream processor instances.

Putting the Pieces Together

This combination of messaging, storage, and stream processing may seem unusual but it is essential to Kafka's role as a streaming platform.

A distributed file system like HDFS allows storing static files for batch processing. Effectively a system like this allows storing and processing *historical* data from the past.

A traditional enterprise messaging system allows processing future messages that will arrive after you subscribe. Applications built in this way process future data as it arrives.

Kafka combines both of these capabilities, and the combination is critical both for Kafka usage as a platform for streaming applications as well as for streaming data pipelines.

By combining storage and low-latency subscriptions, streaming applications can treat both past and future data the same way. That is a single application can process historical, stored data but rather than ending when it reaches the last record it can keep processing as future data arrives. This is a generalized notion of stream processing that subsumes batch processing as well as message-driven applications.

Likewise for streaming data pipelines the combination of subscription to real-time events make it possible to use Kafka for very low-latency pipelines; but the ability to store data reliably make it possible to use it for critical data where the delivery of data must be guaranteed or for integration with offline systems that load data only periodically or may go down for extended periods of time for maintenance. The stream processing facilities make it possible to transform data as it arrives.

For more information on the guarantees, APIs, and capabilities Kafka provides see the rest of the documentation.

1.2 Use Cases

Here is a description of a few of the popular use cases for Apache Kafka®. For an overview of a number of these areas in action, see this blog post.

Messaging

Kafka works well as a replacement for a more traditional message broker. Message brokers are used for a variety of reasons (to decouple processing from data producers, to buffer unprocessed messages, etc). In comparison to most messaging systems Kafka has better throughput, built-in partitioning, replication, and fault-tolerance which makes it a good solution for large scale message processing applications.

In our experience messaging uses are often comparatively low-throughput, but may require low end-to-end latency and often depend on the strong durability guarantees Kafka provides.

In this domain Kafka is comparable to traditional messaging systems such as ActiveMQ or RabbitMQ.

Website Activity Tracking

The original use case for Kafka was to be able to rebuild a user activity tracking pipeline as a set of real-time publish-subscribe feeds. This means site activity (page views, searches, or other actions users may take) is published to central topics with one topic per activity type. These feeds are available for subscription for a range of use cases including real-time processing, real-time monitoring, and loading into Hadoop or offline data warehousing systems for offline processing and reporting.

Activity tracking is often very high volume as many activity messages are generated for each user page view.

Metrics

Kafka is often used for operational monitoring data. This involves aggregating statistics from distributed applications to produce centralized feeds of operational data.

Log Aggregation

Many people use Kafka as a replacement for a log aggregation solution. Log aggregation typically collects physical log files off servers and puts them in a central place (a file server or HDFS perhaps) for processing. Kafka abstracts away the details of files and gives a cleaner abstraction of log or event data as a stream of messages. This allows for lower-latency processing and easier support for multiple data sources and distributed data consumption. In comparison to log-centric systems like Scribe or Flume, Kafka offers equally good performance, stronger durability guarantees due to replication, and much lower end-to-end latency.

Stream Processing

Many users of Kafka process data in processing pipelines consisting of multiple stages, where raw input data is consumed from Kafka topics and then aggregated, enriched, or otherwise transformed into new topics for further consumption or follow-up processing. For example, a processing pipeline for recommending news articles might crawl article content from RSS feeds and publish it to an "articles" topic; further processing might normalize or deduplicate this content and publish the cleansed article content to a new topic; a final processing stage might attempt to recommend this content to users. Such processing pipelines create graphs of real-time data flows based on the individual topics. Starting in 0.10.0.0, a light-weight but powerful stream processing library called Kafka Streams is available in Apache Kafka to perform such data processing as described above. Apart from Kafka Streams, alternative open source stream processing tools include Apache Storm and Apache Samza.

Event Sourcing

Event sourcing is a style of application design where state changes are logged as a time-ordered sequence of records. Kafka's support for very large stored log data makes it an excellent backend for an application built in this style.

Commit Log

Kafka can serve as a kind of external commit-log for a distributed system. The log helps replicate data between nodes and acts as a re-syncing mechanism for failed nodes to restore their data. The log compaction feature in Kafka helps support this usage. In this usage Kafka is similar to Apache BookKeeper project.

1.3 Quick Start

This tutorial assumes you are starting fresh and have no existing Kafka or ZooKeeper data. Since Kafka console scripts are different for Unix-based and Windows platforms, on Windows platforms use `bin\windows\` instead of `bin/`, and change the script extension to `.bat`.

Step 1: Download the code

Download the 2.4.0 release and un-tar it.

```
> tar -xzf kafka_2.12-2.4.0.tgz
> cd kafka_2.12-2.4.0
```

Step 2: Start the server

Kafka uses ZooKeeper so you need to first start a ZooKeeper server if you don't already have one. You can use the convenience script packaged with kafka to get a quick-and-dirty single-node ZooKeeper instance.

```
> bin/zookeeper-server-start.sh config/zookeeper.properties
[2013-04-22 15:01:37,495] INFO Reading configuration from: config/zookeeper.properties (org.apache.zookeeper.s
...
```

Now start the Kafka server:

```
> bin/kafka-server-start.sh config/server.properties
[2013-04-22 15:01:47,028] INFO Verifying properties (kafka.utils.VerifiableProperties)
[2013-04-22 15:01:47,051] INFO Property socket.send.buffer.bytes is overridden to 1048576 (kafka.utils.Verifia
...
```

Step 3: Create a topic

Let's create a topic named "test" with a single partition and only one replica:

```
> bin/kafka-topics.sh --create --bootstrap-server localhost:9092 --replication-factor 1 --partitions 1 --topic
```

We can now see that topic if we run the list topic command:

```
> bin/kafka-topics.sh --list --bootstrap-server localhost:9092
test
```

Alternatively, instead of manually creating topics you can also configure your brokers to auto-create topics when a non-existent topic is published to.

Step 4: Send some messages

Kafka comes with a command line client that will take input from a file or from standard input and send it out as messages to the Kafka cluster. By default, each line will be sent as a separate message.

Run the producer and then type a few messages into the console to send to the server.

```
> bin/kafka-console-producer.sh --broker-list localhost:9092 --topic test
This is a message
This is another message
```

Step 5: Start a consumer

Kafka also has a command line consumer that will dump out messages to standard output.

```
> bin/kafka-console-consumer.sh --bootstrap-server localhost:9092 --topic test --from-beginning
This is a message
This is another message
```

If you have each of the above commands running in a different terminal then you should now be able to type messages into the producer terminal and see them appear in the consumer terminal.

All of the command line tools have additional options; running the command with no arguments will display usage information documenting them in more detail.

Step 6: Setting up a multi-broker cluster

So far we have been running against a single broker, but that's no fun. For Kafka, a single broker is just a cluster of size one, so nothing much changes other than starting a few more broker instances. But just to get feel for it, let's expand our cluster to three nodes (still all on our local machine).

First we make a config file for each of the brokers (on Windows use the `copy` command instead):

```
> cp config/server.properties config/server-1.properties
> cp config/server.properties config/server-2.properties
```

Now edit these new files and set the following properties:

```
config/server-1.properties:
    broker.id=1
    listeners=PLAINTEXT://:9093
    log.dirs=/tmp/kafka-logs-1

config/server-2.properties:
    broker.id=2
    listeners=PLAINTEXT://:9094
    log.dirs=/tmp/kafka-logs-2
```

The `broker.id` property is the unique and permanent name of each node in the cluster. We have to override the port and log directory only because we are running these all on the same machine and we want to keep the brokers from all trying to register on the same port or overwrite each other's data.

We already have Zookeeper and our single node started, so we just need to start the two new nodes:

```
> bin/kafka-server-start.sh config/server-1.properties &
...
> bin/kafka-server-start.sh config/server-2.properties &
...
```

Now create a new topic with a replication factor of three:

```
> bin/kafka-topics.sh --create --bootstrap-server localhost:9092 --replication-factor 3 --partitions 1 --topic
```

Okay but now that we have a cluster how can we know which broker is doing what? To see that run the "describe topics" command:

```
> bin/kafka-topics.sh --describe --bootstrap-server localhost:9092 --topic my-replicated-topic
Topic:my-replicated-topic   PartitionCount:1    ReplicationFactor:3 Configs:
    Topic: my-replicated-topic  Partition: 0    Leader: 1   Replicas: 1,2,0 Isr: 1,2,0
```

Here is an explanation of output. The first line gives a summary of all the partitions, each additional line gives information about one partition. Since we have only one partition for this topic there is only one line.

- "leader" is the node responsible for all reads and writes for the given partition. Each node will be the leader for a randomly selected portion of the partitions.
- "replicas" is the list of nodes that replicate the log for this partition regardless of whether they are the leader or even if they are currently alive.
- "isr" is the set of "in-sync" replicas. This is the subset of the replicas list that is currently alive and caught-up to the leader.

Note that in my example node 1 is the leader for the only partition of the topic.

We can run the same command on the original topic we created to see where it is:

```
> bin/kafka-topics.sh --describe --bootstrap-server localhost:9092 --topic test
Topic:test  PartitionCount:1    ReplicationFactor:1 Configs:
    Topic: test Partition: 0    Leader: 0   Replicas: 0 Isr: 0
```

So there is no surprise there—the original topic has no replicas and is on server 0, the only server in our cluster when we created it.

Let's publish a few messages to our new topic:

```
> bin/kafka-console-producer.sh --broker-list localhost:9092 --topic my-replicated-topic
...
my test message 1
my test message 2
^C
```

Now let's consume these messages:

```
> bin/kafka-console-consumer.sh --bootstrap-server localhost:9092 --from-beginning --topic my-replicated-topic
...
my test message 1
my test message 2
^C
```

Now let's test out fault-tolerance. Broker 1 was acting as the leader so let's kill it:

```
> ps aux | grep server-1.properties
7564 ttys002    0:15.91 /System/Library/Frameworks/JavaVM.framework/Versions/1.8/Home/bin/java...
> kill -9 7564
```

On Windows use:

```
> wmic process where "caption = 'java.exe' and commandline like '%server-1.properties%'" get processid
ProcessId
6016
> taskkill /pid 6016 /f
```

Leadership has switched to one of the followers and node 1 is no longer in the in-sync replica set:

```
> bin/kafka-topics.sh --describe --bootstrap-server localhost:9092 --topic my-replicated-topic
Topic:my-replicated-topic   PartitionCount:1    ReplicationFactor:3 Configs:
    Topic: my-replicated-topic  Partition: 0    Leader: 2   Replicas: 1,2,0 Isr: 2,0
```

But the messages are still available for consumption even though the leader that took the writes originally is down:

```
> bin/kafka-console-consumer.sh --bootstrap-server localhost:9092 --from-beginning --topic my-replicated-topic
...
my test message 1
my test message 2
^C
```

Step 7: Use Kafka Connect to import/export data

Writing data from the console and writing it back to the console is a convenient place to start, but you'll probably want to use data from other sources or export data from Kafka to other systems. For many systems, instead of writing custom integration code you can use Kafka Connect to import or export data.

Kafka Connect is a tool included with Kafka that imports and exports data to Kafka. It is an extensible tool that runs *connectors*, which implement the custom logic for interacting with an external system. In this quickstart we'll see how to run Kafka Connect with simple connectors that import data from a file to a Kafka topic and export data from a Kafka topic to a file.

First, we'll start by creating some seed data to test with:

```
> echo -e "foo\nbar" > test.txt
```

Or on Windows:

```
> echo foo> test.txt
> echo bar>> test.txt
```

Next, we'll start two connectors running in *standalone* mode, which means they run in a single, local, dedicated process. We provide three configuration files as parameters. The first is always the configuration for the Kafka Connect process, containing common configuration such as the Kafka brokers to connect to and the serialization format for data. The remaining configuration files each specify a connector to create. These files include a unique connector name, the connector class to instantiate, and any other configuration required by the connector.

```
> bin/connect-standalone.sh config/connect-standalone.properties config/connect-file-source.properties config/
```

These sample configuration files, included with Kafka, use the default local cluster configuration you started earlier and create two connectors: the first is a source connector that reads lines from an input file and produces each to a Kafka topic and the second is a sink connector that reads messages from a Kafka topic and produces each as a line in an output file.

During startup you'll see a number of log messages, including some indicating that the connectors are being instantiated. Once the Kafka Connect process has started, the source connector should start reading lines from `test.txt` and producing them to the topic `connect-test`, and the sink connector should start reading messages from the topic `connect-test` and write them to the file `test.sink.txt`. We can verify the data has been delivered through the entire pipeline by examining the contents of the output file:

```
> more test.sink.txt
foo
bar
```

Note that the data is being stored in the Kafka topic `connect-test`, so we can also run a console consumer to see the data in the topic (or use custom consumer code to process it):

```
> bin/kafka-console-consumer.sh --bootstrap-server localhost:9092 --topic connect-test --from-beginning
{"schema":{"type":"string","optional":false},"payload":"foo"}
{"schema":{"type":"string","optional":false},"payload":"bar"}
...
```

The connectors continue to process data, so we can add data to the file and see it move through the pipeline:

```
> echo Another line>> test.txt
```

You should see the line appear in the console consumer output and in the sink file.

Step 8: Use Kafka Streams to process data

Kafka Streams is a client library for building mission-critical real-time applications and microservices, where the input and/or output data is stored in Kafka clusters. Kafka Streams combines the simplicity of writing and deploying standard Java and Scala applications on the client side with the benefits of Kafka's server-side cluster technology to make these applications highly scalable, elastic, fault-tolerant, distributed, and much more. This quickstart example will demonstrate how to run a streaming application coded in this library.

1.4 Ecosystem

There are a plethora of tools that integrate with Kafka outside the main distribution. The ecosystem page lists many of these, including stream processing systems, Hadoop integration, monitoring, and deployment tools.

1.5 Upgrading From Previous Versions

Upgrading from 0.8.x, 0.9.x, 0.10.0.x, 0.10.1.x, 0.10.2.x, 0.11.0.x, 1.0.x, 1.1.x, 2.0.x or 2.1.x or 2.2.x or 2.3.x to 2.4.0

If you are upgrading from a version prior to 2.1.x, please see the note below about the change to the schema used to store consumer offsets. Once you have changed the inter.broker.protocol.version to the latest version, it will not be possible to downgrade to a version prior to 2.1.

For a rolling upgrade:

1. Update server.properties on all brokers and add the following properties. CURRENT_KAFKA_VERSION refers to the version you are upgrading from. CURRENT_MESSAGE_FORMAT_VERSION refers to the message format version currently in use. If you have previously overridden the message format version, you should keep its current value. Alternatively, if you are upgrading from a version prior to 0.11.0.x, then CURRENT_MESSAGE_FORMAT_VERSION should be set to match CURRENT_KAFKA_VERSION.
   - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (e.g. 0.10.0, 0.11.0, 1.0, 2.0, 2.2).
   - log.message.format.version=CURRENT_MESSAGE_FORMAT_VERSION (See potential performance impact following the upgrade for the details on what this configuration does.)

   If you are upgrading from version 0.11.0.x or above, and you have not overridden the message format, then you only need to override the inter-broker protocol version.

   - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (0.11.0, 1.0, 1.1, 2.0, 2.1, 2.2, 2.3).
2. Upgrade the brokers one at a time: shut down the broker, update the code, and restart it. Once you have done so, the brokers will be running the latest version and you can verify that the cluster's behavior and performance meets expectations. It is still possible to downgrade at this point if there are any problems.
3. Once the cluster's behavior and performance has been verified, bump the protocol version by editing `inter.broker.protocol.version` and setting it to 2.4.
4. Restart the brokers one by one for the new protocol version to take effect. Once the brokers begin using the latest protocol version, it will no longer be possible to downgrade the cluster to an older version.
5. If you have overridden the message format version as instructed above, then you need to do one more rolling restart to upgrade it to its latest version. Once all (or most) consumers have been upgraded to 0.11.0 or later, change log.message.format.version to 2.4 on each broker and restart them one by one. Note that the older Scala clients, which are no longer maintained, do not support the message format introduced in 0.11, so to avoid conversion costs (or to take advantage of exactly once semantics), the newer Java clients must be used.

Additional Upgrade Notes:

1. ZooKeeper has been upgraded to 3.5.6. ZooKeeper upgrade from 3.4.X to 3.5.6 can fail if there are no snapshot files in 3.4 data directory. This usually happens in test upgrades where ZooKeeper 3.5.6 is trying to load an existing 3.4 data dir in which no snapshot file has been created. For more details about the issue please refer to ZOOKEEPER-3056. A fix is given in ZOOKEEPER-3056, which is to set `snapshot.trust.empty=true` config in `zookeeper.properties` before the upgrade. But we have observed data loss in standalone cluster upgrades when using `snapshot.trust.empty=true` config. For more details about the issue please refer to ZOOKEEPER-3644. So we recommend the safe workaround of copying empty snapshot file to the 3.4 data directory, if there are no snapshot files in 3.4 data directory. For more details about the workaround please refer to ZooKeeper Upgrade FAQ.
2. An embedded Jetty based AdminServer added in ZooKeeper 3.5. AdminServer is enabled by default in ZooKeeper and is started on port 8080. AdminServer is disabled by default in the ZooKeeper config (`zookeeper.properties`) provided by the Apache Kafka distribution. Make sure to update your local `zookeeper.properties` file with `admin.enableServer=false` if you wish to disable the AdminServer. Please refer AdminServer config to configure the AdminServer.

Notable changes in 2.4.0

- A new Admin API has been added for partition reassignments. Due to changing the way Kafka propagates reassignment information, it is possible to lose reassignment state in failure edge cases while upgrading to the new version. It is not recommended to start reassignments while upgrading.
- ZooKeeper has been upgraded from 3.4.14 to 3.5.6. TLS and dynamic reconfiguration are supported by the new version.
- The `bin/kafka-preferred-replica-election.sh` command line tool has been deprecated. It has been replaced by `bin/kafka-leader-election.sh`.

- The methods `electPreferredLeaders` in the Java `AdminClient` class have been deprecated in favor of the methods `electLeaders`.
- Scala code leveraging the `NewTopic(String, int, short)` constructor with literal values will need to explicitly call `toShort` on the second literal.
- The argument in the constructor `GroupAuthorizationException(String)` is now used to specify an exception message. Previously it referred to the group that failed authorization. This was done for consistency with other exception types and to avoid potential misuse. The constructor `TopicAuthorizationException(String)` which was previously used for a single unauthorized topic was changed similarly.
- The internal `PartitionAssignor` interface has been deprecated and replaced with a new `ConsumerPartitionAssignor` in the public API. Some methods/signatures are slightly different between the two interfaces. Users implementing a custom PartitionAssignor should migrate to the new interface as soon as possible.
- The `DefaultPartitioner` now uses a sticky partitioning strategy. This means that records for specific topic with null keys and no assigned partition will be sent to the same partition until the batch is ready to be sent. When a new batch is created, a new partition is chosen. This decreases latency to produce, but it may result in uneven distribution of records across partitions in edge cases. Generally users will not be impacted, but this difference may be noticeable in tests and other situations producing records for a very short amount of time.
- The blocking `KafkaConsumer#committed` methods have been extended to allow a list of partitions as input parameters rather than a single partition. It enables fewer request/response iterations between clients and brokers fetching for the committed offsets for the consumer group. The old overloaded functions are deprecated and we would recommend users to make their code changes to leverage the new methods (details can be found in KIP-520).
- We've introduced a new `INVALID_RECORD` error in the produce response to distinguish from the `CORRUPT_MESSAGE` error. To be more concrete, previously when a batch of records were sent as part of a single request to the broker and one or more of the records failed the validation due to various causes (mismatch magic bytes, crc checksum errors, null key for log compacted topics, etc), the whole batch would be rejected with the same and misleading `CORRUPT_MESSAGE`, and the caller of the producer client would see the corresponding exception from either the future object of `RecordMetadata` returned from the `send` call as well as in the `Callback#onCompletion(RecordMetadata metadata, Exception exception)` Now with the new error code and improved error messages of the exception, producer callers would be better informed about the root cause why their sent records were failed.
- We are introducing incremental cooperative rebalancing to the clients' group protocol, which allows consumers to keep all of their assigned partitions during a rebalance and at the end revoke only those which must be migrated to another consumer for overall cluster balance. The `ConsumerCoordinator` will choose the latest `RebalanceProtocol` that is commonly supported by all of the consumer's supported assignors. You can use the new built-in `CooperativeStickyAssignor` or plug in your own custom cooperative assignor. To do so you must implement the `ConsumerPartitionAssignor` interface and include `RebalanceProtocol.COOPERATIVE` in the list returned by `ConsumerPartitionAssignor#supportedProtocols`. Your custom assignor can then leverage the `ownedPartitions` field in each consumer's `Subscription` to give partitions back to their previous owners whenever possible. Note that when a partition is to be reassigned to another consumer, it *must* be removed from the new assignment until it has been revoked from its original owner. Any consumer that has to revoke a partition will trigger a followup rebalance to allow the revoked partition to safely be assigned to its new owner. See the ConsumerPartitionAssignor RebalanceProtocol javadocs for more information.
  To upgrade from the old (eager) protocol, which always revokes all partitions before rebalancing, to cooperative rebalancing, you must follow a specific upgrade path to get all clients on the same `ConsumerPartitionAssignor` that supports the cooperative protocol. This can be done with two rolling bounces, using the `CooperativeStickyAssignor` for the example: during the first one, add "cooperative-sticky" to the list of supported assignors for each member (without removing the previous assignor -- note that if previously using the default, you must include that explicitly as well). You then bounce and/or upgrade it. Once the entire group is on 2.4+ and all members have the "cooperative-sticky" among their supported assignors, remove the other assignor(s) and perform a second rolling bounce so that by the end all members support only the cooperative protocol. For further details on the cooperative rebalancing protocol and upgrade path, see KIP-429.
- There are some behavioral changes to the `ConsumerRebalanceListener`, as well as a new API. Exceptions thrown during any of the listener's three callbacks will no longer be swallowed, and will instead be re-thrown all the way up to the `Consumer.poll()` call. The `onPartitionsLost` method has been added to allow users to react to abnormal circumstances where a consumer may have lost ownership of its partitions (such as a missed rebalance) and cannot commit offsets. By default, this will simply call the existing `onPartitionsRevoked` API to align with previous behavior. Note however that `onPartitionsLost` will not be called when the set of lost partitions is empty. This means that no callback will be invoked at the beginning of the first rebalance of a new consumer joining the group.
  The semantics of the `ConsumerRebalanceListener's` callbacks are further changed when following the cooperative rebalancing protocol described above. In addition to `onPartitionsLost`, `onPartitionsRevoked` will also never be called when the set of revoked partitions is empty. The callback will generally be invoked only at the end of a rebalance, and only on the set of partitions that are

being moved to another consumer. The `onPartitionsAssigned` callback will however always be called, even with an empty set of partitions, as a way to notify users of a rebalance event (this is true for both cooperative and eager). For details on the new callback semantics, see the ConsumerRebalanceListener javadocs.

Upgrading from 0.8.x, 0.9.x, 0.10.0.x, 0.10.1.x, 0.10.2.x, 0.11.0.x, 1.0.x, 1.1.x, 2.0.x or 2.1.x or 2.2.x to 2.3.0

If you are upgrading from a version prior to 2.1.x, please see the note below about the change to the schema used to store consumer offsets. Once you have changed the inter.broker.protocol.version to the latest version, it will not be possible to downgrade to a version prior to 2.1.

For a rolling upgrade:

1. Update server.properties on all brokers and add the following properties. CURRENT_KAFKA_VERSION refers to the version you are upgrading from. CURRENT_MESSAGE_FORMAT_VERSION refers to the message format version currently in use. If you have previously overridden the message format version, you should keep its current value. Alternatively, if you are upgrading from a version prior to 0.11.0.x, then CURRENT_MESSAGE_FORMAT_VERSION should be set to match CURRENT_KAFKA_VERSION.
   - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (e.g. 0.8.2, 0.9.0, 0.10.0, 0.10.1, 0.10.2, 0.11.0, 1.0, 1.1).
   - log.message.format.version=CURRENT_MESSAGE_FORMAT_VERSION (See potential performance impact following the upgrade for the details on what this configuration does.)

   If you are upgrading from 0.11.0.x, 1.0.x, 1.1.x, 2.0.x, or 2.1.x, and you have not overridden the message format, then you only need to override the inter-broker protocol version.
   - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (0.11.0, 1.0, 1.1, 2.0, 2.1, 2.2).
2. Upgrade the brokers one at a time: shut down the broker, update the code, and restart it. Once you have done so, the brokers will be running the latest version and you can verify that the cluster's behavior and performance meets expectations. It is still possible to downgrade at this point if there are any problems.
3. Once the cluster's behavior and performance has been verified, bump the protocol version by editing `inter.broker.protocol.version` and setting it to 2.3.
4. Restart the brokers one by one for the new protocol version to take effect. Once the brokers begin using the latest protocol version, it will no longer be possible to downgrade the cluster to an older version.
5. If you have overridden the message format version as instructed above, then you need to do one more rolling restart to upgrade it to its latest version. Once all (or most) consumers have been upgraded to 0.11.0 or later, change log.message.format.version to 2.3 on each broker and restart them one by one. Note that the older Scala clients, which are no longer maintained, do not support the message format introduced in 0.11, so to avoid conversion costs (or to take advantage of exactly once semantics), the newer Java clients must be used.

Notable changes in 2.3.0

- We are introducing a new rebalancing protocol for Kafka Connect based on incremental cooperative rebalancing. The new protocol does not require stopping all the tasks during a rebalancing phase between Connect workers. Instead, only the tasks that need to be exchanged between workers are stopped and they are started in a follow up rebalance. The new Connect protocol is enabled by default beginning with 2.3.0. For more details on how it works and how to enable the old behavior of eager rebalancing, checkout incremental cooperative rebalancing design.
- We are introducing static membership towards consumer user. This feature reduces unnecessary rebalances during normal application upgrades or rolling bounces. For more details on how to use it, checkout static membership design.
- Kafka Streams DSL switches its used store types. While this change is mainly transparent to users, there are some corner cases that may require code changes. See the Kafka Streams upgrade section for more details.
- Kafka Streams 2.3.0 requires 0.11 message format or higher and does not work with older message format.

Upgrading from 0.8.x, 0.9.x, 0.10.0.x, 0.10.1.x, 0.10.2.x, 0.11.0.x, 1.0.x, 1.1.x, 2.0.x or 2.1.x to 2.2.0

If you are upgrading from a version prior to 2.1.x, please see the note below about the change to the schema used to store consumer offsets. Once you have changed the inter.broker.protocol.version to the latest version, it will not be possible to downgrade to a version prior to 2.1.

For a rolling upgrade:

1. Update server.properties on all brokers and add the following properties. CURRENT_KAFKA_VERSION refers to the version you are upgrading from. CURRENT_MESSAGE_FORMAT_VERSION refers to the message format version currently in use. If you have previously overridden the message format version, you should keep its current value. Alternatively, if you are upgrading from a version prior to 0.11.0.x, then CURRENT_MESSAGE_FORMAT_VERSION should be set to match CURRENT_KAFKA_VERSION.
    - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (e.g. 0.8.2, 0.9.0, 0.10.0, 0.10.1, 0.10.2, 0.11.0, 1.0, 1.1).
    - log.message.format.version=CURRENT_MESSAGE_FORMAT_VERSION (See potential performance impact following the upgrade for the details on what this configuration does.)

    If you are upgrading from 0.11.0.x, 1.0.x, 1.1.x, or 2.0.x and you have not overridden the message format, then you only need to override the inter-broker protocol version.

    - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (0.11.0, 1.0, 1.1, 2.0).
2. Upgrade the brokers one at a time: shut down the broker, update the code, and restart it. Once you have done so, the brokers will be running the latest version and you can verify that the cluster's behavior and performance meets expectations. It is still possible to downgrade at this point if there are any problems.
3. Once the cluster's behavior and performance has been verified, bump the protocol version by editing `inter.broker.protocol.version` and setting it to 2.2.
4. Restart the brokers one by one for the new protocol version to take effect. Once the brokers begin using the latest protocol version, it will no longer be possible to downgrade the cluster to an older version.
5. If you have overridden the message format version as instructed above, then you need to do one more rolling restart to upgrade it to its latest version. Once all (or most) consumers have been upgraded to 0.11.0 or later, change log.message.format.version to 2.2 on each broker and restart them one by one. Note that the older Scala clients, which are no longer maintained, do not support the message format introduced in 0.11, so to avoid conversion costs (or to take advantage of exactly once semantics), the newer Java clients must be used.

Notable changes in 2.2.1

- Kafka Streams 2.2.1 requires 0.11 message format or higher and does not work with older message format.

Notable changes in 2.2.0

- The default consumer group id has been changed from the empty string (`""`) to `null`. Consumers who use the new default group id will not be able to subscribe to topics, and fetch or commit offsets. The empty string as consumer group id is deprecated but will be supported until a future major release. Old clients that rely on the empty string group id will now have to explicitly provide it as part of their consumer config. For more information see KIP-289.
- The `bin/kafka-topics.sh` command line tool is now able to connect directly to brokers with `--bootstrap-server` instead of zookeeper. The old `--zookeeper` option is still available for now. Please read KIP-377 for more information.
- Kafka Streams depends on a newer version of RocksDBs that requires MacOS 10.13 or higher.

Upgrading from 0.8.x, 0.9.x, 0.10.0.x, 0.10.1.x, 0.10.2.x, 0.11.0.x, 1.0.x, 1.1.x, or 2.0.0 to 2.1.0

Note that 2.1.x contains a change to the internal schema used to store consumer offsets. Once the upgrade is complete, it will not be possible to downgrade to previous versions. See the rolling upgrade notes below for more detail.

For a rolling upgrade:

1. Update server.properties on all brokers and add the following properties. CURRENT_KAFKA_VERSION refers to the version you are upgrading from. CURRENT_MESSAGE_FORMAT_VERSION refers to the message format version currently in use. If you have previously overridden the message format version, you should keep its current value. Alternatively, if you are upgrading from a version prior to 0.11.0.x, then CURRENT_MESSAGE_FORMAT_VERSION should be set to match CURRENT_KAFKA_VERSION.
    - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (e.g. 0.8.2, 0.9.0, 0.10.0, 0.10.1, 0.10.2, 0.11.0, 1.0, 1.1).
    - log.message.format.version=CURRENT_MESSAGE_FORMAT_VERSION (See potential performance impact following the upgrade for the details on what this configuration does.)

    If you are upgrading from 0.11.0.x, 1.0.x, 1.1.x, or 2.0.x and you have not overridden the message format, then you only need to override the inter-broker protocol version.

- inter.broker.protocol.version=CURRENT_KAFKA_VERSION (0.11.0, 1.0, 1.1, 2.0).

2. Upgrade the brokers one at a time: shut down the broker, update the code, and restart it. Once you have done so, the brokers will be running the latest version and you can verify that the cluster's behavior and performance meets expectations. It is still possible to downgrade at this point if there are any problems.
3. Once the cluster's behavior and performance has been verified, bump the protocol version by editing `inter.broker.protocol.version` and setting it to 2.1.
4. Restart the brokers one by one for the new protocol version to take effect. Once the brokers begin using the latest protocol version, it will no longer be possible to downgrade the cluster to an older version.
5. If you have overridden the message format version as instructed above, then you need to do one more rolling restart to upgrade it to its latest version. Once all (or most) consumers have been upgraded to 0.11.0 or later, change log.message.format.version to 2.1 on each broker and restart them one by one. Note that the older Scala clients, which are no longer maintained, do not support the message format introduced in 0.11, so to avoid conversion costs (or to take advantage of exactly once semantics), the newer Java clients must be used.

Additional Upgrade Notes:

1. Offset expiration semantics has slightly changed in this version. According to the new semantics, offsets of partitions in a group will not be removed while the group is subscribed to the corresponding topic and is still active (has active consumers). If group becomes empty all its offsets will be removed after default offset retention period (or the one set by broker) has passed (unless the group becomes active again). Offsets associated with standalone (simple) consumers, that do not use Kafka group management, will be removed after default offset retention period (or the one set by broker) has passed since their last commit.
2. The default for console consumer's `enable.auto.commit` property when no `group.id` is provided is now set to `false`. This is to avoid polluting the consumer coordinator cache as the auto-generated group is not likely to be used by other consumers.
3. The default value for the producer's `retries` config was changed to `Integer.MAX_VALUE`, as we introduced `delivery.timeout.ms` in KIP-91, which sets an upper bound on the total time between sending a record and receiving acknowledgement from the broker. By default, the delivery timeout is set to 2 minutes.
4. By default, MirrorMaker now overrides `delivery.timeout.ms` to `Integer.MAX_VALUE` when configuring the producer. If you have overridden the value of `retries` in order to fail faster, you will instead need to override `delivery.timeout.ms`.
5. The `ListGroup` API now expects, as a recommended alternative, `Describe Group` access to the groups a user should be able to list. Even though the old `Describe Cluster` access is still supported for backward compatibility, using it for this API is not advised.
6. KIP-336 deprecates the ExtendedSerializer and ExtendedDeserializer interfaces and propagates the usage of Serializer and Deserializer. ExtendedSerializer and ExtendedDeserializer were introduced with KIP-82 to provide record headers for serializers and deserializers in a Java 7 compatible fashion. Now we consolidated these interfaces as Java 7 support has been dropped since.

Notable changes in 2.1.0

- Jetty has been upgraded to 9.4.12, which excludes TLS_RSA_* ciphers by default because they do not support forward secrecy, see https://github.com/eclipse/jetty.project/issues/2807 for more information.
- Unclean leader election is automatically enabled by the controller when `unclean.leader.election.enable` config is dynamically updated by using per-topic config override.
- The `AdminClient` has added a method `AdminClient#metrics()`. Now any application using the `AdminClient` can gain more information and insight by viewing the metrics captured from the `AdminClient`. For more information see KIP-324
- Kafka now supports Zstandard compression from KIP-110. You must upgrade the broker as well as clients to make use of it. Consumers prior to 2.1.0 will not be able to read from topics which use Zstandard compression, so you should not enable it for a topic until all downstream consumers are upgraded. See the KIP for more detail.

Upgrading from 0.8.x, 0.9.x, 0.10.0.x, 0.10.1.x, 0.10.2.x, 0.11.0.x, 1.0.x, or 1.1.x to 2.0.0

Kafka 2.0.0 introduces wire protocol changes. By following the recommended rolling upgrade plan below, you guarantee no downtime during the upgrade. However, please review the notable changes in 2.0.0 before upgrading.

For a rolling upgrade:

1. Update server.properties on all brokers and add the following properties. CURRENT_KAFKA_VERSION refers to the version you are upgrading from. CURRENT_MESSAGE_FORMAT_VERSION refers to the message format version currently in use. If you have previously

overridden the message format version, you should keep its current value. Alternatively, if you are upgrading from a version prior to 0.11.0.x, then CURRENT_MESSAGE_FORMAT_VERSION should be set to match CURRENT_KAFKA_VERSION.

- inter.broker.protocol.version=CURRENT_KAFKA_VERSION (e.g. 0.8.2, 0.9.0, 0.10.0, 0.10.1, 0.10.2, 0.11.0, 1.0, 1.1).
- log.message.format.version=CURRENT_MESSAGE_FORMAT_VERSION (See potential performance impact following the upgrade for the details on what this configuration does.)

If you are upgrading from 0.11.0.x, 1.0.x, or 1.1.x and you have not overridden the message format, then you only need to override the inter-broker protocol format.

- inter.broker.protocol.version=CURRENT_KAFKA_VERSION (0.11.0, 1.0, 1.1).

2. Upgrade the brokers one at a time: shut down the broker, update the code, and restart it.
3. Once the entire cluster is upgraded, bump the protocol version by editing `inter.broker.protocol.version` and setting it to 2.0.
4. Restart the brokers one by one for the new protocol version to take effect.
5. If you have overridden the message format version as instructed above, then you need to do one more rolling restart to upgrade it to its latest version. Once all (or most) consumers have been upgraded to 0.11.0 or later, change log.message.format.version to 2.0 on each broker and restart them one by one. Note that the older Scala consumer does not support the new message format introduced in 0.11, so to avoid the performance cost of down-conversion (or to take advantage of exactly once semantics), the newer Java consumer must be used.

Additional Upgrade Notes:

1. If you are willing to accept downtime, you can simply take all the brokers down, update the code and start them back up. They will start with the new protocol by default.
2. Bumping the protocol version and restarting can be done any time after the brokers are upgraded. It does not have to be immediately after. Similarly for the message format version.
3. If you are using Java8 method references in your Kafka Streams code you might need to update your code to resolve method ambiguities. Hot-swapping the jar-file only might not work.
4. ACLs should not be added to prefixed resources, (added in KIP-290), until all brokers in the cluster have been updated.

   NOTE: any prefixed ACLs added to a cluster, even after the cluster is fully upgraded, will be ignored should the cluster be downgraded again.

Notable changes in 2.0.0

- KIP-186 increases the default offset retention time from 1 day to 7 days. This makes it less likely to "lose" offsets in an application that commits infrequently. It also increases the active set of offsets and therefore can increase memory usage on the broker. Note that the console consumer currently enables offset commit by default and can be the source of a large number of offsets which this change will now preserve for 7 days instead of 1. You can preserve the existing behavior by setting the broker config `offsets.retention.minutes` to 1440.
- Support for Java 7 has been dropped, Java 8 is now the minimum version required.
- The default value for `ssl.endpoint.identification.algorithm` was changed to `https`, which performs hostname verification (man-in-the-middle attacks are possible otherwise). Set `ssl.endpoint.identification.algorithm` to an empty string to restore the previous behaviour.
- KAFKA-5674 extends the lower interval of `max.connections.per.ip` minimum to zero and therefore allows IP-based filtering of inbound connections.
- KIP-272 added API version tag to the metric `kafka.network:type=RequestMetrics,name=RequestsPerSec,request={Produce|FetchConsumer|FetchFollower|...}`. This metric now becomes `kafka.network:type=RequestMetrics,name=RequestsPerSec,request={Produce|FetchConsumer|FetchFollower|...},version={0|1|2|3|...}`. This will impact JMX monitoring tools that do not automatically aggregate. To get the total count for a specific request type, the tool needs to be updated to aggregate across different versions.
- KIP-225 changed the metric "records.lag" to use tags for topic and partition. The original version with the name format "{topic}-{partition}.records-lag" has been removed.
- The Scala consumers, which have been deprecated since 0.11.0.0, have been removed. The Java consumer has been the recommended option since 0.10.0.0. Note that the Scala consumers in 1.1.0 (and older) will continue to work even if the brokers are upgraded to 2.0.0.

- The Scala producers, which have been deprecated since 0.10.0.0, have been removed. The Java producer has been the recommended option since 0.9.0.0. Note that the behaviour of the default partitioner in the Java producer differs from the default partitioner in the Scala producers. Users migrating should consider configuring a custom partitioner that retains the previous behaviour. Note that the Scala producers in 1.1.0 (and older) will continue to work even if the brokers are upgraded to 2.0.0.
- MirrorMaker and ConsoleConsumer no longer support the Scala consumer, they always use the Java consumer.
- The ConsoleProducer no longer supports the Scala producer, it always uses the Java producer.
- A number of deprecated tools that rely on the Scala clients have been removed: ReplayLogProducer, SimpleConsumerPerformance, SimpleConsumerShell, ExportZkOffsets, ImportZkOffsets, UpdateOffsetsInZK, VerifyConsumerRebalance.
- The deprecated kafka.tools.ProducerPerformance has been removed, please use org.apache.kafka.tools.ProducerPerformance.
- New Kafka Streams configuration parameter `upgrade.from` added that allows rolling bounce upgrade from older version.
- KIP-284 changed the retention time for Kafka Streams repartition topics by setting its default value to `Long.MAX_VALUE` .
- Updated `ProcessorStateManager` APIs in Kafka Streams for registering state stores to the processor topology. For more details please read the Streams Upgrade Guide.
- In earlier releases, Connect's worker configuration required the `internal.key.converter` and `internal.value.converter` properties. In 2.0, these are no longer required and default to the JSON converter. You may safely remove these properties from your Connect standalone and distributed worker configurations:
  `internal.key.converter=org.apache.kafka.connect.json.JsonConverter`
  `internal.key.converter.schemas.enable=false`
  `internal.value.converter=org.apache.kafka.connect.json.JsonConverter`
  `internal.value.converter.schemas.enable=false`
- KIP-266 adds a new consumer configuration `default.api.timeout.ms` to specify the default timeout to use for `KafkaConsumer` APIs that could block. The KIP also adds overloads for such blocking APIs to support specifying a specific timeout to use for each of them instead of using the default timeout set by `default.api.timeout.ms` . In particular, a new `poll(Duration)` API has been added which does not block for dynamic partition assignment. The old `poll(long)` API has been deprecated and will be removed in a future version. Overloads have also been added for other `KafkaConsumer` methods like `partitionsFor` , `listTopics` , `offsetsForTimes` , `beginningOffsets` , `endOffsets` and `close` that take in a `Duration` .
- Also as part of KIP-266, the default value of `request.timeout.ms` has been changed to 30 seconds. The previous value was a little higher than 5 minutes to account for maximum time that a rebalance would take. Now we treat the JoinGroup request in the rebalance as a special case and use a value derived from `max.poll.interval.ms` for the request timeout. All other request types use the timeout defined by `request.timeout.ms`
- The internal method `kafka.admin.AdminClient.deleteRecordsBefore` has been removed. Users are encouraged to migrate to `org.apache.kafka.clients.admin.AdminClient.deleteRecords` .
- The AclCommand tool `--producer` convenience option uses the KIP-277 finer grained ACL on the given topic.
- KIP-176 removes the `--new-consumer` option for all consumer based tools. This option is redundant since the new consumer is automatically used if --bootstrap-server is defined.
- KIP-290 adds the ability to define ACLs on prefixed resources, e.g. any topic starting with 'foo'.
- KIP-283 improves message down-conversion handling on Kafka broker, which has typically been a memory-intensive operation. The KIP adds a mechanism by which the operation becomes less memory intensive by down-converting chunks of partition data at a time which helps put an upper bound on memory consumption. With this improvement, there is a change in `FetchResponse` protocol behavior where the broker could send an oversized message batch towards the end of the response with an invalid offset. Such oversized messages must be ignored by consumer clients, as is done by `KafkaConsumer` .

  KIP-283 also adds new topic and broker configurations `message.downconversion.enable` and `log.message.downconversion.enable` respectively to control whether down-conversion is enabled. When disabled, broker does not perform any down-conversion and instead sends an `UNSUPPORTED_VERSION` error to the client.
- Dynamic broker configuration options can be stored in ZooKeeper using kafka-configs.sh before brokers are started. This option can be used to avoid storing clear passwords in server.properties as all password configs may be stored encrypted in ZooKeeper.
- ZooKeeper hosts are now re-resolved if connection attempt fails. But if your ZooKeeper host names resolve to multiple addresses and some of them are not reachable, then you may need to increase the connection timeout `zookeeper.connection.timeout.ms` .

New Protocol Versions

- KIP-279: OffsetsForLeaderEpochResponse v1 introduces a partition-level `leader_epoch` field.

- KIP-219: Bump up the protocol versions of non-cluster action requests and responses that are throttled on quota violation.
- KIP-290: Bump up the protocol versions ACL create, describe and delete requests and responses.

Upgrading a 1.1 Kafka Streams Application

- Upgrading your Streams application from 1.1 to 2.0 does not require a broker upgrade. A Kafka Streams 2.0 application can connect to 2.0, 1.1, 1.0, 0.11.0, 0.10.2 and 0.10.1 brokers (it is not possible to connect to 0.10.0 brokers though).
- Note that in 2.0 we have removed the public APIs that are deprecated prior to 1.0; users leveraging on those deprecated APIs need to make code changes accordingly. See Streams API changes in 2.0.0 for more details.

Upgrading from 0.8.x, 0.9.x, 0.10.0.x, 0.10.1.x, 0.10.2.x, 0.11.0.x, or 1.0.x to 1.1.x

Kafka 1.1.0 introduces wire protocol changes. By following the recommended rolling upgrade plan below, you guarantee no downtime during the upgrade. However, please review the notable changes in 1.1.0 before upgrading.

For a rolling upgrade:

1. Update server.properties on all brokers and add the following properties. CURRENT_KAFKA_VERSION refers to the version you are upgrading from. CURRENT_MESSAGE_FORMAT_VERSION refers to the message format version currently in use. If you have previously overridden the message format version, you should keep its current value. Alternatively, if you are upgrading from a version prior to 0.11.0.x, then CURRENT_MESSAGE_FORMAT_VERSION should be set to match CURRENT_KAFKA_VERSION.
    - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (e.g. 0.8.2, 0.9.0, 0.10.0, 0.10.1, 0.10.2, 0.11.0, 1.0).
    - log.message.format.version=CURRENT_MESSAGE_FORMAT_VERSION (See potential performance impact following the upgrade for the details on what this configuration does.)

   If you are upgrading from 0.11.0.x or 1.0.x and you have not overridden the message format, then you only need to override the inter-broker protocol format.
    - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (0.11.0 or 1.0).
2. Upgrade the brokers one at a time: shut down the broker, update the code, and restart it.
3. Once the entire cluster is upgraded, bump the protocol version by editing `inter.broker.protocol.version` and setting it to 1.1.
4. Restart the brokers one by one for the new protocol version to take effect.
5. If you have overridden the message format version as instructed above, then you need to do one more rolling restart to upgrade it to its latest version. Once all (or most) consumers have been upgraded to 0.11.0 or later, change log.message.format.version to 1.1 on each broker and restart them one by one. Note that the older Scala consumer does not support the new message format introduced in 0.11, so to avoid the performance cost of down-conversion (or to take advantage of exactly once semantics), the newer Java consumer must be used.

Additional Upgrade Notes:

1. If you are willing to accept downtime, you can simply take all the brokers down, update the code and start them back up. They will start with the new protocol by default.
2. Bumping the protocol version and restarting can be done any time after the brokers are upgraded. It does not have to be immediately after. Similarly for the message format version.
3. If you are using Java8 method references in your Kafka Streams code you might need to update your code to resolve method ambiguities. Hot-swapping the jar-file only might not work.

Notable changes in 1.1.1

- New Kafka Streams configuration parameter `upgrade.from` added that allows rolling bounce upgrade from version 0.10.0.x
- See the **Kafka Streams upgrade guide** for details about this new config.

Notable changes in 1.1.0

- The kafka artifact in Maven no longer depends on log4j or slf4j-log4j12. Similarly to the kafka-clients artifact, users can now choose the logging back-end by including the appropriate slf4j module (slf4j-log4j12, logback, etc.). The release tarball still includes log4j and slf4j-log4j12.
- KIP-225 changed the metric "records.lag" to use tags for topic and partition. The original version with the name format "{topic}-{partition}.records-lag" is deprecated and will be removed in 2.0.0.
- Kafka Streams is more robust against broker communication errors. Instead of stopping the Kafka Streams client with a fatal exception, Kafka Streams tries to self-heal and reconnect to the cluster. Using the new `AdminClient` you have better control of how often Kafka Streams retries and can configure fine-grained timeouts (instead of hard coded retries as in older version).
- Kafka Streams rebalance time was reduced further making Kafka Streams more responsive.
- Kafka Connect now supports message headers in both sink and source connectors, and to manipulate them via simple message transforms. Connectors must be changed to explicitly use them. A new `HeaderConverter` is introduced to control how headers are (de)serialized, and the new "SimpleHeaderConverter" is used by default to use string representations of values.
- kafka.tools.DumpLogSegments now automatically sets deep-iteration option if print-data-log is enabled explicitly or implicitly due to any of the other options like decoder.

New Protocol Versions

- KIP-226 introduced DescribeConfigs Request/Response v1.
- KIP-227 introduced Fetch Request/Response v7.

Upgrading a 1.0 Kafka Streams Application

- Upgrading your Streams application from 1.0 to 1.1 does not require a broker upgrade. A Kafka Streams 1.1 application can connect to 1.0, 0.11.0, 0.10.2 and 0.10.1 brokers (it is not possible to connect to 0.10.0 brokers though).
- See Streams API changes in 1.1.0 for more details.

Upgrading from 0.8.x, 0.9.x, 0.10.0.x, 0.10.1.x, 0.10.2.x or 0.11.0.x to 1.0.0

Kafka 1.0.0 introduces wire protocol changes. By following the recommended rolling upgrade plan below, you guarantee no downtime during the upgrade. However, please review the notable changes in 1.0.0 before upgrading.

For a rolling upgrade:

1. Update server.properties on all brokers and add the following properties. CURRENT_KAFKA_VERSION refers to the version you are upgrading from. CURRENT_MESSAGE_FORMAT_VERSION refers to the message format version currently in use. If you have previously overridden the message format version, you should keep its current value. Alternatively, if you are upgrading from a version prior to 0.11.0.x, then CURRENT_MESSAGE_FORMAT_VERSION should be set to match CURRENT_KAFKA_VERSION.
    - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (e.g. 0.8.2, 0.9.0, 0.10.0, 0.10.1, 0.10.2, 0.11.0).
    - log.message.format.version=CURRENT_MESSAGE_FORMAT_VERSION (See potential performance impact following the upgrade for the details on what this configuration does.)

   If you are upgrading from 0.11.0.x and you have not overridden the message format, you must set both the message format version and the inter-broker protocol version to 0.11.0.

    - inter.broker.protocol.version=0.11.0
    - log.message.format.version=0.11.0
2. Upgrade the brokers one at a time: shut down the broker, update the code, and restart it.
3. Once the entire cluster is upgraded, bump the protocol version by editing `inter.broker.protocol.version` and setting it to 1.0.
4. Restart the brokers one by one for the new protocol version to take effect.
5. If you have overridden the message format version as instructed above, then you need to do one more rolling restart to upgrade it to its latest version. Once all (or most) consumers have been upgraded to 0.11.0 or later, change log.message.format.version to 1.0 on each broker and restart them one by one. If you are upgrading from 0.11.0 and log.message.format.version is set to 0.11.0, you can update the config and skip the rolling restart. Note that the older Scala consumer does not support the new message format introduced in 0.11, so to avoid the performance cost of down-conversion (or to take advantage of exactly once semantics), the newer Java consumer must be used.

Additional Upgrade Notes:

1. If you are willing to accept downtime, you can simply take all the brokers down, update the code and start them back up. They will start with the new protocol by default.
2. Bumping the protocol version and restarting can be done any time after the brokers are upgraded. It does not have to be immediately after. Similarly for the message format version.

Notable changes in 1.0.2

- New Kafka Streams configuration parameter `upgrade.from` added that allows rolling bounce upgrade from version 0.10.0.x
- See the **Kafka Streams upgrade guide** for details about this new config.

Notable changes in 1.0.1

- Restored binary compatibility of AdminClient's Options classes (e.g. CreateTopicsOptions, DeleteTopicsOptions, etc.) with 0.11.0.x. Binary (but not source) compatibility had been broken inadvertently in 1.0.0.

Notable changes in 1.0.0

- Topic deletion is now enabled by default, since the functionality is now stable. Users who wish to to retain the previous behavior should set the broker config `delete.topic.enable` to `false`. Keep in mind that topic deletion removes data and the operation is not reversible (i.e. there is no "undelete" operation)
- For topics that support timestamp search if no offset can be found for a partition, that partition is now included in the search result with a null offset value. Previously, the partition was not included in the map. This change was made to make the search behavior consistent with the case of topics not supporting timestamp search.
- If the `inter.broker.protocol.version` is 1.0 or later, a broker will now stay online to serve replicas on live log directories even if there are offline log directories. A log directory may become offline due to IOException caused by hardware failure. Users need to monitor the per-broker metric `offlineLogDirectoryCount` to check whether there is offline log directory.
- Added KafkaStorageException which is a retriable exception. KafkaStorageException will be converted to NotLeaderForPartitionException in the response if the version of client's FetchRequest or ProducerRequest does not support KafkaStorageException.
- -XX:+DisableExplicitGC was replaced by -XX:+ExplicitGCInvokesConcurrent in the default JVM settings. This helps avoid out of memory exceptions during allocation of native memory by direct buffers in some cases.
- The overridden `handleError` method implementations have been removed from the following deprecated classes in the `kafka.api` package: `FetchRequest`, `GroupCoordinatorRequest`, `OffsetCommitRequest`, `OffsetFetchRequest`, `OffsetRequest`, `ProducerRequest`, and `TopicMetadataRequest`. This was only intended for use on the broker, but it is no longer in use and the implementations have not been maintained. A stub implementation has been retained for binary compatibility.
- The Java clients and tools now accept any string as a client-id.
- The deprecated tool `kafka-consumer-offset-checker.sh` has been removed. Use `kafka-consumer-groups.sh` to get consumer group details.
- SimpleAclAuthorizer now logs access denials to the authorizer log by default.
- Authentication failures are now reported to clients as one of the subclasses of `AuthenticationException`. No retries will be performed if a client connection fails authentication.
- Custom `SaslServer` implementations may throw `SaslAuthenticationException` to provide an error message to return to clients indicating the reason for authentication failure. Implementors should take care not to include any security-critical information in the exception message that should not be leaked to unauthenticated clients.
- The `app-info` mbean registered with JMX to provide version and commit id will be deprecated and replaced with metrics providing these attributes.
- Kafka metrics may now contain non-numeric values. `org.apache.kafka.common.Metric#value()` has been deprecated and will return `0.0` in such cases to minimise the probability of breaking users who read the value of every client metric (via a `MetricsReporter` implementation or by calling the `metrics()` method). `org.apache.kafka.common.Metric#metricValue()` can be used to retrieve numeric and non-numeric metric values.
- Every Kafka rate metric now has a corresponding cumulative count metric with the suffix `-total` to simplify downstream processing. For example, `records-consumed-rate` has a corresponding metric named `records-consumed-total`.

- Mx4j will only be enabled if the system property `kafka_mx4jenable` is set to `true` . Due to a logic inversion bug, it was previously enabled by default and disabled if `kafka_mx4jenable` was set to `true` .
- The package `org.apache.kafka.common.security.auth` in the clients jar has been made public and added to the javadocs. Internal classes which had previously been located in this package have been moved elsewhere.
- When using an Authorizer and a user doesn't have required permissions on a topic, the broker will return TOPIC_AUTHORIZATION_FAILED errors to requests irrespective of topic existence on broker. If the user have required permissions and the topic doesn't exists, then the UNKNOWN_TOPIC_OR_PARTITION error code will be returned.
- config/consumer.properties file updated to use new consumer config properties.

New Protocol Versions

- KIP-112: LeaderAndIsrRequest v1 introduces a partition-level `is_new` field.
- KIP-112: UpdateMetadataRequest v4 introduces a partition-level `offline_replicas` field.
- KIP-112: MetadataResponse v5 introduces a partition-level `offline_replicas` field.
- KIP-112: ProduceResponse v4 introduces error code for KafkaStorageException.
- KIP-112: FetchResponse v6 introduces error code for KafkaStorageException.
- KIP-152: SaslAuthenticate request has been added to enable reporting of authentication failures. This request will be used if the SaslHandshake request version is greater than 0.

Upgrading a 0.11.0 Kafka Streams Application

- Upgrading your Streams application from 0.11.0 to 1.0 does not require a broker upgrade. A Kafka Streams 1.0 application can connect to 0.11.0, 0.10.2 and 0.10.1 brokers (it is not possible to connect to 0.10.0 brokers though). However, Kafka Streams 1.0 requires 0.10 message format or newer and does not work with older message formats.
- If you are monitoring on streams metrics, you will need make some changes to the metrics names in your reporting and monitoring code, because the metrics sensor hierarchy was changed.
- There are a few public APIs including `ProcessorContext#schedule()` , `Processor#punctuate()` and `KStreamBuilder` , `TopologyBuilder` are being deprecated by new APIs. We recommend making corresponding code changes, which should be very minor since the new APIs look quite similar, when you upgrade.
- See Streams API changes in 1.0.0 for more details.

Upgrading a 0.10.2 Kafka Streams Application

- Upgrading your Streams application from 0.10.2 to 1.0 does not require a broker upgrade. A Kafka Streams 1.0 application can connect to 1.0, 0.11.0, 0.10.2 and 0.10.1 brokers (it is not possible to connect to 0.10.0 brokers though).
- If you are monitoring on streams metrics, you will need make some changes to the metrics names in your reporting and monitoring code, because the metrics sensor hierarchy was changed.
- There are a few public APIs including `ProcessorContext#schedule()` , `Processor#punctuate()` and `KStreamBuilder` , `TopologyBuilder` are being deprecated by new APIs. We recommend making corresponding code changes, which should be very minor since the new APIs look quite similar, when you upgrade.
- If you specify customized `key.serde` , `value.serde` and `timestamp.extractor` in configs, it is recommended to use their replaced configure parameter as these configs are deprecated.
- See Streams API changes in 0.11.0 for more details.

Upgrading a 0.10.1 Kafka Streams Application

- Upgrading your Streams application from 0.10.1 to 1.0 does not require a broker upgrade. A Kafka Streams 1.0 application can connect to 1.0, 0.11.0, 0.10.2 and 0.10.1 brokers (it is not possible to connect to 0.10.0 brokers though).
- You need to recompile your code. Just swapping the Kafka Streams library jar file will not work and will break your application.
- If you are monitoring on streams metrics, you will need make some changes to the metrics names in your reporting and monitoring code, because the metrics sensor hierarchy was changed.
- There are a few public APIs including `ProcessorContext#schedule()` , `Processor#punctuate()` and `KStreamBuilder` , `TopologyBuilder` are being deprecated by new APIs. We recommend making corresponding code changes, which should be very minor

since the new APIs look quite similar, when you upgrade.

- If you specify customized `key.serde`, `value.serde` and `timestamp.extractor` in configs, it is recommended to use their replaced configure parameter as these configs are deprecated.
- If you use a custom (i.e., user implemented) timestamp extractor, you will need to update this code, because the `TimestampExtractor` interface was changed.
- If you register custom metrics, you will need to update this code, because the `StreamsMetric` interface was changed.
- See Streams API changes in 1.0.0, Streams API changes in 0.11.0 and Streams API changes in 0.10.2 for more details.

Upgrading a 0.10.0 Kafka Streams Application

- Upgrading your Streams application from 0.10.0 to 1.0 does require a broker upgrade because a Kafka Streams 1.0 application can only connect to 0.1, 0.11.0, 0.10.2, or 0.10.1 brokers.
- There are couple of API changes, that are not backward compatible (cf. Streams API changes in 1.0.0, Streams API changes in 0.11.0, Streams API changes in 0.10.2, and Streams API changes in 0.10.1 for more details). Thus, you need to update and recompile your code. Just swapping the Kafka Streams library jar file will not work and will break your application.
- Upgrading from 0.10.0.x to 1.0.2 requires two rolling bounces with config `upgrade.from="0.10.0"` set for first upgrade phase (cf. KIP-268). As an alternative, an offline upgrade is also possible.
  - prepare your application instances for a rolling bounce and make sure that config `upgrade.from` is set to `"0.10.0"` for new version 0.11.0.3
  - bounce each instance of your application once
  - prepare your newly deployed 1.0.2 application instances for a second round of rolling bounces; make sure to remove the value for config `upgrade.mode`
  - bounce each instance of your application once more to complete the upgrade
- Upgrading from 0.10.0.x to 1.0.0 or 1.0.1 requires an offline upgrade (rolling bounce upgrade is not supported)
  - stop all old (0.10.0.x) application instances
  - update your code and swap old code and jar file with new code and new jar file
  - restart all new (1.0.0 or 1.0.1) application instances

Upgrading from 0.8.x, 0.9.x, 0.10.0.x, 0.10.1.x or 0.10.2.x to 0.11.0.0

Kafka 0.11.0.0 introduces a new message format version as well as wire protocol changes. By following the recommended rolling upgrade plan below, you guarantee no downtime during the upgrade. However, please review the notable changes in 0.11.0.0 before upgrading.

Starting with version 0.10.2, Java clients (producer and consumer) have acquired the ability to communicate with older brokers. Version 0.11.0 clients can talk to version 0.10.0 or newer brokers. However, if your brokers are older than 0.10.0, you must upgrade all the brokers in the Kafka cluster before upgrading your clients. Version 0.11.0 brokers support 0.8.x and newer clients.

For a rolling upgrade:

1. Update server.properties on all brokers and add the following properties. CURRENT_KAFKA_VERSION refers to the version you are upgrading from. CURRENT_MESSAGE_FORMAT_VERSION refers to the current message format version currently in use. If you have not overridden the message format previously, then CURRENT_MESSAGE_FORMAT_VERSION should be set to match CURRENT_KAFKA_VERSION.
   - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (e.g. 0.8.2, 0.9.0, 0.10.0, 0.10.1 or 0.10.2).
   - log.message.format.version=CURRENT_MESSAGE_FORMAT_VERSION (See potential performance impact following the upgrade for the details on what this configuration does.)
2. Upgrade the brokers one at a time: shut down the broker, update the code, and restart it.
3. Once the entire cluster is upgraded, bump the protocol version by editing `inter.broker.protocol.version` and setting it to 0.11.0, but do not change `log.message.format.version` yet.
4. Restart the brokers one by one for the new protocol version to take effect.
5. Once all (or most) consumers have been upgraded to 0.11.0 or later, then change log.message.format.version to 0.11.0 on each broker and restart them one by one. Note that the older Scala consumer does not support the new message format, so to avoid the performance cost of down-conversion (or to take advantage of exactly once semantics), the new Java consumer must be used.

Additional Upgrade Notes:

1. If you are willing to accept downtime, you can simply take all the brokers down, update the code and start them back up. They will start with the new protocol by default.
2. Bumping the protocol version and restarting can be done any time after the brokers are upgraded. It does not have to be immediately after. Similarly for the message format version.
3. It is also possible to enable the 0.11.0 message format on individual topics using the topic admin tool (`bin/kafka-topics.sh`) prior to updating the global setting `log.message.format.version` .
4. If you are upgrading from a version prior to 0.10.0, it is NOT necessary to first update the message format to 0.10.0 before you switch to 0.11.0.

Upgrading a 0.10.2 Kafka Streams Application

- Upgrading your Streams application from 0.10.2 to 0.11.0 does not require a broker upgrade. A Kafka Streams 0.11.0 application can connect to 0.11.0, 0.10.2 and 0.10.1 brokers (it is not possible to connect to 0.10.0 brokers though).
- If you specify customized `key.serde` , `value.serde` and `timestamp.extractor` in configs, it is recommended to use their replaced configure parameter as these configs are deprecated.
- See Streams API changes in 0.11.0 for more details.

Upgrading a 0.10.1 Kafka Streams Application

- Upgrading your Streams application from 0.10.1 to 0.11.0 does not require a broker upgrade. A Kafka Streams 0.11.0 application can connect to 0.11.0, 0.10.2 and 0.10.1 brokers (it is not possible to connect to 0.10.0 brokers though).
- You need to recompile your code. Just swapping the Kafka Streams library jar file will not work and will break your application.
- If you specify customized `key.serde` , `value.serde` and `timestamp.extractor` in configs, it is recommended to use their replaced configure parameter as these configs are deprecated.
- If you use a custom (i.e., user implemented) timestamp extractor, you will need to update this code, because the `TimestampExtractor` interface was changed.
- If you register custom metrics, you will need to update this code, because the `StreamsMetric` interface was changed.
- See Streams API changes in 0.11.0 and Streams API changes in 0.10.2 for more details.

Upgrading a 0.10.0 Kafka Streams Application

- Upgrading your Streams application from 0.10.0 to 0.11.0 does require a broker upgrade because a Kafka Streams 0.11.0 application can only connect to 0.11.0, 0.10.2, or 0.10.1 brokers.
- There are couple of API changes, that are not backward compatible (cf. Streams API changes in 0.11.0, Streams API changes in 0.10.2, and Streams API changes in 0.10.1 for more details). Thus, you need to update and recompile your code. Just swapping the Kafka Streams library jar file will not work and will break your application.
- Upgrading from 0.10.0.x to 0.11.0.3 requires two rolling bounces with config `upgrade.from="0.10.0"` set for first upgrade phase (cf. KIP-268). As an alternative, an offline upgrade is also possible.
  - prepare your application instances for a rolling bounce and make sure that config `upgrade.from` is set to `"0.10.0"` for new version 0.11.0.3
  - bounce each instance of your application once
  - prepare your newly deployed 0.11.0.3 application instances for a second round of rolling bounces; make sure to remove the value for config `upgrade.mode`
  - bounce each instance of your application once more to complete the upgrade
- Upgrading from 0.10.0.x to 0.11.0.0, 0.11.0.1, or 0.11.0.2 requires an offline upgrade (rolling bounce upgrade is not supported)
  - stop all old (0.10.0.x) application instances
  - update your code and swap old code and jar file with new code and new jar file
  - restart all new (0.11.0.0 , 0.11.0.1, or 0.11.0.2) application instances

Notable changes in 0.11.0.3

- New Kafka Streams configuration parameter `upgrade.from` added that allows rolling bounce upgrade from version 0.10.0.x
- See the **Kafka Streams upgrade guide** for details about this new config.

Notable changes in 0.11.0.0

- Unclean leader election is now disabled by default. The new default favors durability over availability. Users who wish to to retain the previous behavior should set the broker config `unclean.leader.election.enable` to `true`.
- Producer configs `block.on.buffer.full`, `metadata.fetch.timeout.ms` and `timeout.ms` have been removed. They were initially deprecated in Kafka 0.9.0.0.
- The `offsets.topic.replication.factor` broker config is now enforced upon auto topic creation. Internal auto topic creation will fail with a GROUP_COORDINATOR_NOT_AVAILABLE error until the cluster size meets this replication factor requirement.
- When compressing data with snappy, the producer and broker will use the compression scheme's default block size (2 x 32 KB) instead of 1 KB in order to improve the compression ratio. There have been reports of data compressed with the smaller block size being 50% larger than when compressed with the larger block size. For the snappy case, a producer with 5000 partitions will require an additional 315 MB of JVM heap.
- Similarly, when compressing data with gzip, the producer and broker will use 8 KB instead of 1 KB as the buffer size. The default for gzip is excessively low (512 bytes).
- The broker configuration `max.message.bytes` now applies to the total size of a batch of messages. Previously the setting applied to batches of compressed messages, or to non-compressed messages individually. A message batch may consist of only a single message, so in most cases, the limitation on the size of individual messages is only reduced by the overhead of the batch format. However, there are some subtle implications for message format conversion (see below for more detail). Note also that while previously the broker would ensure that at least one message is returned in each fetch request (regardless of the total and partition-level fetch sizes), the same behavior now applies to one message batch.
- GC log rotation is enabled by default, see KAFKA-3754 for details.
- Deprecated constructors of RecordMetadata, MetricName and Cluster classes have been removed.
- Added user headers support through a new Headers interface providing user headers read and write access.
- ProducerRecord and ConsumerRecord expose the new Headers API via `Headers headers()` method call.
- ExtendedSerializer and ExtendedDeserializer interfaces are introduced to support serialization and deserialization for headers. Headers will be ignored if the configured serializer and deserializer are not the above classes.
- A new config, `group.initial.rebalance.delay.ms`, was introduced. This config specifies the time, in milliseconds, that the `GroupCoordinator` will delay the initial consumer rebalance. The rebalance will be further delayed by the value of `group.initial.rebalance.delay.ms` as new members join the group, up to a maximum of `max.poll.interval.ms`. The default value for this is 3 seconds. During development and testing it might be desirable to set this to 0 in order to not delay test execution time.
- `org.apache.kafka.common.Cluster#partitionsForTopic`, `partitionsForNode` and `availablePartitionsForTopic` methods will return an empty list instead of `null` (which is considered a bad practice) in case the metadata for the required topic does not exist.
- Streams API configuration parameters `timestamp.extractor`, `key.serde`, and `value.serde` were deprecated and replaced by `default.timestamp.extractor`, `default.key.serde`, and `default.value.serde`, respectively.
- For offset commit failures in the Java consumer's `commitAsync` APIs, we no longer expose the underlying cause when instances of `RetriableCommitFailedException` are passed to the commit callback. See KAFKA-5052 for more detail.

New Protocol Versions

- KIP-107: FetchRequest v5 introduces a partition-level `log_start_offset` field.
- KIP-107: FetchResponse v5 introduces a partition-level `log_start_offset` field.
- KIP-82: ProduceRequest v3 introduces an array of `header` in the message protocol, containing `key` field and `value` field.
- KIP-82: FetchResponse v5 introduces an array of `header` in the message protocol, containing `key` field and `value` field.

Notes on Exactly Once Semantics

Kafka 0.11.0 includes support for idempotent and transactional capabilities in the producer. Idempotent delivery ensures that messages are delivered exactly once to a particular topic partition during the lifetime of a single producer. Transactional delivery allows producers to send data to multiple partitions such that either all messages are successfully delivered, or none of them are. Together, these capabilities enable "exactly once semantics" in Kafka. More details on these features are available in the user guide, but below we add a few specific notes on enabling them in an upgraded cluster. Note that enabling EoS is not required and there is no impact on the broker's behavior if unused.

1. Only the new Java producer and consumer support exactly once semantics.
2. These features depend crucially on the 0.11.0 message format. Attempting to use them on an older format will result in unsupported version errors.
3. Transaction state is stored in a new internal topic `__transaction_state`. This topic is not created until the the first attempt to use a transactional request API. Similar to the consumer offsets topic, there are several settings to control the topic's configuration. For example, `transaction.state.log.min.isr` controls the minimum ISR for this topic. See the configuration section in the user guide for a full list of options.
4. For secure clusters, the transactional APIs require new ACLs which can be turned on with the `bin/kafka-acls.sh`. tool.
5. EoS in Kafka introduces new request APIs and modifies several existing ones. See KIP-98 for the full details

Notes on the new message format in 0.11.0

The 0.11.0 message format includes several major enhancements in order to support better delivery semantics for the producer (see KIP-98) and improved replication fault tolerance (see KIP-101). Although the new format contains more information to make these improvements possible, we have made the batch format much more efficient. As long as the number of messages per batch is more than 2, you can expect lower overall overhead. For smaller batches, however, there may be a small performance impact. See here for the results of our initial performance analysis of the new message format. You can also find more detail on the message format in the KIP-98 proposal.

One of the notable differences in the new message format is that even uncompressed messages are stored together as a single batch. This has a few implications for the broker configuration `max.message.bytes`, which limits the size of a single batch. First, if an older client produces messages to a topic partition using the old format, and the messages are individually smaller than `max.message.bytes`, the broker may still reject them after they are merged into a single batch during the up-conversion process. Generally this can happen when the aggregate size of the individual messages is larger than `max.message.bytes`. There is a similar effect for older consumers reading messages down-converted from the new format: if the fetch size is not set at least as large as `max.message.bytes`, the consumer may not be able to make progress even if the individual uncompressed messages are smaller than the configured fetch size. This behavior does not impact the Java client for 0.10.1.0 and later since it uses an updated fetch protocol which ensures that at least one message can be returned even if it exceeds the fetch size. To get around these problems, you should ensure 1) that the producer's batch size is not set larger than `max.message.bytes`, and 2) that the consumer's fetch size is set at least as large as `max.message.bytes`.

Most of the discussion on the performance impact of upgrading to the 0.10.0 message format remains pertinent to the 0.11.0 upgrade. This mainly affects clusters that are not secured with TLS since "zero-copy" transfer is already not possible in that case. In order to avoid the cost of down-conversion, you should ensure that consumer applications are upgraded to the latest 0.11.0 client. Significantly, since the old consumer has been deprecated in 0.11.0.0, it does not support the new message format. You must upgrade to use the new consumer to use the new message format without the cost of down-conversion. Note that 0.11.0 consumers support backwards compatibility with 0.10.0 brokers and upward, so it is possible to upgrade the clients first before the brokers.

Upgrading from 0.8.x, 0.9.x, 0.10.0.x or 0.10.1.x to 0.10.2.0

0.10.2.0 has wire protocol changes. By following the recommended rolling upgrade plan below, you guarantee no downtime during the upgrade. However, please review the notable changes in 0.10.2.0 before upgrading.

Starting with version 0.10.2, Java clients (producer and consumer) have acquired the ability to communicate with older brokers. Version 0.10.2 clients can talk to version 0.10.0 or newer brokers. However, if your brokers are older than 0.10.0, you must upgrade all the brokers in the Kafka cluster before upgrading your clients. Version 0.10.2 brokers support 0.8.x and newer clients.

For a rolling upgrade:

1. Update server.properties file on all brokers and add the following properties:
    - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (e.g. 0.8.2, 0.9.0, 0.10.0 or 0.10.1).
    - log.message.format.version=CURRENT_KAFKA_VERSION (See potential performance impact following the upgrade for the details on what this configuration does.)

2. Upgrade the brokers one at a time: shut down the broker, update the code, and restart it.
3. Once the entire cluster is upgraded, bump the protocol version by editing inter.broker.protocol.version and setting it to 0.10.2.
4. If your previous message format is 0.10.0, change log.message.format.version to 0.10.2 (this is a no-op as the message format is the same for 0.10.0, 0.10.1 and 0.10.2). If your previous message format version is lower than 0.10.0, do not change log.message.format.version yet - this parameter should only change once all consumers have been upgraded to 0.10.0.0 or later.
5. Restart the brokers one by one for the new protocol version to take effect.
6. If log.message.format.version is still lower than 0.10.0 at this point, wait until all consumers have been upgraded to 0.10.0 or later, then change log.message.format.version to 0.10.2 on each broker and restart them one by one.

Note: If you are willing to accept downtime, you can simply take all the brokers down, update the code and start all of them. They will start with the new protocol by default.

Note: Bumping the protocol version and restarting can be done any time after the brokers were upgraded. It does not have to be immediately after.

Upgrading a 0.10.1 Kafka Streams Application

- Upgrading your Streams application from 0.10.1 to 0.10.2 does not require a broker upgrade. A Kafka Streams 0.10.2 application can connect to 0.10.2 and 0.10.1 brokers (it is not possible to connect to 0.10.0 brokers though).
- You need to recompile your code. Just swapping the Kafka Streams library jar file will not work and will break your application.
- If you use a custom (i.e., user implemented) timestamp extractor, you will need to update this code, because the `TimestampExtractor` interface was changed.
- If you register custom metrics, you will need to update this code, because the `StreamsMetric` interface was changed.
- See Streams API changes in 0.10.2 for more details.

Upgrading a 0.10.0 Kafka Streams Application

- Upgrading your Streams application from 0.10.0 to 0.10.2 does require a broker upgrade because a Kafka Streams 0.10.2 application can only connect to 0.10.2 or 0.10.1 brokers.
- There are couple of API changes, that are not backward compatible (cf. Streams API changes in 0.10.2 for more details). Thus, you need to update and recompile your code. Just swapping the Kafka Streams library jar file will not work and will break your application.
- Upgrading from 0.10.0.x to 0.10.2.2 requires two rolling bounces with config `upgrade.from="0.10.0"` set for first upgrade phase (cf. KIP-268). As an alternative, an offline upgrade is also possible.
  - prepare your application instances for a rolling bounce and make sure that config `upgrade.from` is set to `"0.10.0"` for new version 0.10.2.2
  - bounce each instance of your application once
  - prepare your newly deployed 0.10.2.2 application instances for a second round of rolling bounces; make sure to remove the value for config `upgrade.mode`
  - bounce each instance of your application once more to complete the upgrade
- Upgrading from 0.10.0.x to 0.10.2.0 or 0.10.2.1 requires an offline upgrade (rolling bounce upgrade is not supported)
  - stop all old (0.10.0.x) application instances
  - update your code and swap old code and jar file with new code and new jar file
  - restart all new (0.10.2.0 or 0.10.2.1) application instances

Notable changes in 0.10.2.2

- New configuration parameter `upgrade.from` added that allows rolling bounce upgrade from version 0.10.0.x

Notable changes in 0.10.2.1

- The default values for two configurations of the StreamsConfig class were changed to improve the resiliency of Kafka Streams applications. The internal Kafka Streams producer `retries` default value was changed from 0 to 10. The internal Kafka Streams consumer `max.poll.interval.ms` default value was changed from 300000 to `Integer.MAX_VALUE`.

Notable changes in 0.10.2.0

- The Java clients (producer and consumer) have acquired the ability to communicate with older brokers. Version 0.10.2 clients can talk to version 0.10.0 or newer brokers. Note that some features are not available or are limited when older brokers are used.
- Several methods on the Java consumer may now throw `InterruptException` if the calling thread is interrupted. Please refer to the `KafkaConsumer` Javadoc for a more in-depth explanation of this change.
- Java consumer now shuts down gracefully. By default, the consumer waits up to 30 seconds to complete pending requests. A new close API with timeout has been added to `KafkaConsumer` to control the maximum wait time.
- Multiple regular expressions separated by commas can be passed to MirrorMaker with the new Java consumer via the --whitelist option. This makes the behaviour consistent with MirrorMaker when used the old Scala consumer.
- Upgrading your Streams application from 0.10.1 to 0.10.2 does not require a broker upgrade. A Kafka Streams 0.10.2 application can connect to 0.10.2 and 0.10.1 brokers (it is not possible to connect to 0.10.0 brokers though).
- The Zookeeper dependency was removed from the Streams API. The Streams API now uses the Kafka protocol to manage internal topics instead of modifying Zookeeper directly. This eliminates the need for privileges to access Zookeeper directly and "StreamsConfig.ZOOKEEPER_CONFIG" should not be set in the Streams app any more. If the Kafka cluster is secured, Streams apps must have the required security privileges to create new topics.
- Several new fields including "security.protocol", "connections.max.idle.ms", "retry.backoff.ms", "reconnect.backoff.ms" and "request.timeout.ms" were added to StreamsConfig class. User should pay attention to the default values and set these if needed. For more details please refer to 3.5 Kafka Streams Configs.

New Protocol Versions

- KIP-88: OffsetFetchRequest v2 supports retrieval of offsets for all topics if the `topics` array is set to `null`.
- KIP-88: OffsetFetchResponse v2 introduces a top-level `error_code` field.
- KIP-103: UpdateMetadataRequest v3 introduces a `listener_name` field to the elements of the `end_points` array.
- KIP-108: CreateTopicsRequest v1 introduces a `validate_only` field.
- KIP-108: CreateTopicsResponse v1 introduces an `error_message` field to the elements of the `topic_errors` array.

Upgrading from 0.8.x, 0.9.x or 0.10.0.X to 0.10.1.0

0.10.1.0 has wire protocol changes. By following the recommended rolling upgrade plan below, you guarantee no downtime during the upgrade. However, please notice the Potential breaking changes in 0.10.1.0 before upgrade.
Note: Because new protocols are introduced, it is important to upgrade your Kafka clusters before upgrading your clients (i.e. 0.10.1.x clients only support 0.10.1.x or later brokers while 0.10.1.x brokers also support older clients).

For a rolling upgrade:

1. Update server.properties file on all brokers and add the following properties:
    - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (e.g. 0.8.2.0, 0.9.0.0 or 0.10.0.0).
    - log.message.format.version=CURRENT_KAFKA_VERSION (See potential performance impact following the upgrade for the details on what this configuration does.)
2. Upgrade the brokers one at a time: shut down the broker, update the code, and restart it.
3. Once the entire cluster is upgraded, bump the protocol version by editing inter.broker.protocol.version and setting it to 0.10.1.0.
4. If your previous message format is 0.10.0, change log.message.format.version to 0.10.1 (this is a no-op as the message format is the same for both 0.10.0 and 0.10.1). If your previous message format version is lower than 0.10.0, do not change log.message.format.version yet - this parameter should only change once all consumers have been upgraded to 0.10.0.0 or later.
5. Restart the brokers one by one for the new protocol version to take effect.
6. If log.message.format.version is still lower than 0.10.0 at this point, wait until all consumers have been upgraded to 0.10.0 or later, then change log.message.format.version to 0.10.1 on each broker and restart them one by one.

Note: If you are willing to accept downtime, you can simply take all the brokers down, update the code and start all of them. They will start with the new protocol by default.

Note: Bumping the protocol version and restarting can be done any time after the brokers were upgraded. It does not have to be immediately after.

Potential breaking changes in 0.10.1.0

- The log retention time is no longer based on last modified time of the log segments. Instead it will be based on the largest timestamp of the messages in a log segment.
- The log rolling time is no longer depending on log segment create time. Instead it is now based on the timestamp in the messages. More specifically. if the timestamp of the first message in the segment is T, the log will be rolled out when a new message has a timestamp greater than or equal to T + log.roll.ms
- The open file handlers of 0.10.0 will increase by ~33% because of the addition of time index files for each segment.
- The time index and offset index share the same index size configuration. Since each time index entry is 1.5x the size of offset index entry. User may need to increase log.index.size.max.bytes to avoid potential frequent log rolling.
- Due to the increased number of index files, on some brokers with large amount the log segments (e.g. >15K), the log loading process during the broker startup could be longer. Based on our experiment, setting the num.recovery.threads.per.data.dir to one may reduce the log loading time.

Upgrading a 0.10.0 Kafka Streams Application

- Upgrading your Streams application from 0.10.0 to 0.10.1 does require a broker upgrade because a Kafka Streams 0.10.1 application can only connect to 0.10.1 brokers.
- There are couple of API changes, that are not backward compatible (cf. Streams API changes in 0.10.1 for more details). Thus, you need to update and recompile your code. Just swapping the Kafka Streams library jar file will not work and will break your application.
- Upgrading from 0.10.0.x to 0.10.1.2 requires two rolling bounces with config `upgrade.from="0.10.0"` set for first upgrade phase (cf. KIP-268). As an alternative, an offline upgrade is also possible.
  - prepare your application instances for a rolling bounce and make sure that config `upgrade.from` is set to `"0.10.0"` for new version 0.10.1.2
  - bounce each instance of your application once
  - prepare your newly deployed 0.10.1.2 application instances for a second round of rolling bounces; make sure to remove the value for config `upgrade.mode`
  - bounce each instance of your application once more to complete the upgrade
- Upgrading from 0.10.0.x to 0.10.1.0 or 0.10.1.1 requires an offline upgrade (rolling bounce upgrade is not supported)
  - stop all old (0.10.0.x) application instances
  - update your code and swap old code and jar file with new code and new jar file
  - restart all new (0.10.1.0 or 0.10.1.1) application instances

Notable changes in 0.10.1.0

- The new Java consumer is no longer in beta and we recommend it for all new development. The old Scala consumers are still supported, but they will be deprecated in the next release and will be removed in a future major release.
- The `--new-consumer` / `--new.consumer` switch is no longer required to use tools like MirrorMaker and the Console Consumer with the new consumer; one simply needs to pass a Kafka broker to connect to instead of the ZooKeeper ensemble. In addition, usage of the Console Consumer with the old consumer has been deprecated and it will be removed in a future major release.
- Kafka clusters can now be uniquely identified by a cluster id. It will be automatically generated when a broker is upgraded to 0.10.1.0. The cluster id is available via the kafka.server:type=KafkaServer,name=ClusterId metric and it is part of the Metadata response. Serializers, client interceptors and metric reporters can receive the cluster id by implementing the ClusterResourceListener interface.
- The BrokerState "RunningAsController" (value 4) has been removed. Due to a bug, a broker would only be in this state briefly before transitioning out of it and hence the impact of the removal should be minimal. The recommended way to detect if a given broker is the controller is via the kafka.controller:type=KafkaController,name=ActiveControllerCount metric.
- The new Java Consumer now allows users to search offsets by timestamp on partitions.
- The new Java Consumer now supports heartbeating from a background thread. There is a new configuration `max.poll.interval.ms` which controls the maximum time between poll invocations before the consumer will proactively leave the group (5 minutes by default). The

value of the configuration `request.timeout.ms` must always be larger than `max.poll.interval.ms` because this is the maximum time that a JoinGroup request can block on the server while the consumer is rebalancing, so we have changed its default value to just above 5 minutes. Finally, the default value of `session.timeout.ms` has been adjusted down to 10 seconds, and the default value of `max.poll.records` has been changed to 500.
- When using an Authorizer and a user doesn't have **Describe** authorization on a topic, the broker will no longer return TOPIC_AUTHORIZATION_FAILED errors to requests since this leaks topic names. Instead, the UNKNOWN_TOPIC_OR_PARTITION error code will be returned. This may cause unexpected timeouts or delays when using the producer and consumer since Kafka clients will typically retry automatically on unknown topic errors. You should consult the client logs if you suspect this could be happening.
- Fetch responses have a size limit by default (50 MB for consumers and 10 MB for replication). The existing per partition limits also apply (1 MB for consumers and replication). Note that neither of these limits is an absolute maximum as explained in the next point.
- Consumers and replicas can make progress if a message larger than the response/partition size limit is found. More concretely, if the first message in the first non-empty partition of the fetch is larger than either or both limits, the message will still be returned.
- Overloaded constructors were added to `kafka.api.FetchRequest` and `kafka.javaapi.FetchRequest` to allow the caller to specify the order of the partitions (since order is significant in v3). The previously existing constructors were deprecated and the partitions are shuffled before the request is sent to avoid starvation issues.

New Protocol Versions

- ListOffsetRequest v1 supports accurate offset search based on timestamps.
- MetadataResponse v2 introduces a new field: "cluster_id".
- FetchRequest v3 supports limiting the response size (in addition to the existing per partition limit), it returns messages bigger than the limits if required to make progress and the order of partitions in the request is now significant.
- JoinGroup v1 introduces a new field: "rebalance_timeout".

Upgrading from 0.8.x or 0.9.x to 0.10.0.0

0.10.0.0 has potential breaking changes (please review before upgrading) and possible performance impact following the upgrade. By following the recommended rolling upgrade plan below, you guarantee no downtime and no performance impact during and following the upgrade.
Note: Because new protocols are introduced, it is important to upgrade your Kafka clusters before upgrading your clients.

Notes to clients with version 0.9.0.0: Due to a bug introduced in 0.9.0.0, clients that depend on ZooKeeper (old Scala high-level Consumer and MirrorMaker if used with the old consumer) will not work with 0.10.0.x brokers. Therefore, 0.9.0.0 clients should be upgraded to 0.9.0.1 **before** brokers are upgraded to 0.10.0.x. This step is not necessary for 0.8.X or 0.9.0.1 clients.

For a rolling upgrade:

1. Update server.properties file on all brokers and add the following properties:
   - inter.broker.protocol.version=CURRENT_KAFKA_VERSION (e.g. 0.8.2 or 0.9.0.0).
   - log.message.format.version=CURRENT_KAFKA_VERSION (See potential performance impact following the upgrade for the details on what this configuration does.)
2. Upgrade the brokers. This can be done a broker at a time by simply bringing it down, updating the code, and restarting it.
3. Once the entire cluster is upgraded, bump the protocol version by editing inter.broker.protocol.version and setting it to 0.10.0.0. NOTE: You shouldn't touch log.message.format.version yet - this parameter should only change once all consumers have been upgraded to 0.10.0.0
4. Restart the brokers one by one for the new protocol version to take effect.
5. Once all consumers have been upgraded to 0.10.0, change log.message.format.version to 0.10.0 on each broker and restart them one by one.

Note: If you are willing to accept downtime, you can simply take all the brokers down, update the code and start all of them. They will start with the new protocol by default.

Note: Bumping the protocol version and restarting can be done any time after the brokers were upgraded. It does not have to be immediately after.

Potential performance impact following upgrade to 0.10.0.0

The message format in 0.10.0 includes a new timestamp field and uses relative offsets for compressed messages. The on disk message format can be configured through log.message.format.version in the server.properties file. The default on-disk message format is 0.10.0. If a consumer client is on a version before 0.10.0.0, it only understands message formats before 0.10.0. In this case, the broker is able to convert messages from the 0.10.0 format to an earlier format before sending the response to the consumer on an older version. However, the broker can't use zero-copy transfer in this case. Reports from the Kafka community on the performance impact have shown CPU utilization going from 20% before to 100% after an upgrade, which forced an immediate upgrade of all clients to bring performance back to normal. To avoid such message conversion before consumers are upgraded to 0.10.0.0, one can set log.message.format.version to 0.8.2 or 0.9.0 when upgrading the broker to 0.10.0.0. This way, the broker can still use zero-copy transfer to send the data to the old consumers. Once consumers are upgraded, one can change the message format to 0.10.0 on the broker and enjoy the new message format that includes new timestamp and improved compression. The conversion is supported to ensure compatibility and can be useful to support a few apps that have not updated to newer clients yet, but is impractical to support all consumer traffic on even an overprovisioned cluster. Therefore, it is critical to avoid the message conversion as much as possible when brokers have been upgraded but the majority of clients have not.

For clients that are upgraded to 0.10.0.0, there is no performance impact.

Note: By setting the message format version, one certifies that all existing messages are on or below that message format version. Otherwise consumers before 0.10.0.0 might break. In particular, after the message format is set to 0.10.0, one should not change it back to an earlier format as it may break consumers on versions before 0.10.0.0.

Note: Due to the additional timestamp introduced in each message, producers sending small messages may see a message throughput degradation because of the increased overhead. Likewise, replication now transmits an additional 8 bytes per message. If you're running close to the network capacity of your cluster, it's possible that you'll overwhelm the network cards and see failures and performance issues due to the overload.

Note: If you have enabled compression on producers, you may notice reduced producer throughput and/or lower compression rate on the broker in some cases. When receiving compressed messages, 0.10.0 brokers avoid recompressing the messages, which in general reduces the latency and improves the throughput. In certain cases, however, this may reduce the batching size on the producer, which could lead to worse throughput. If this happens, users can tune linger.ms and batch.size of the producer for better throughput. In addition, the producer buffer used for compressing messages with snappy is smaller than the one used by the broker, which may have a negative impact on the compression ratio for the messages on disk. We intend to make this configurable in a future Kafka release.

Potential breaking changes in 0.10.0.0

- Starting from Kafka 0.10.0.0, the message format version in Kafka is represented as the Kafka version. For example, message format 0.9.0 refers to the highest message version supported by Kafka 0.9.0.
- Message format 0.10.0 has been introduced and it is used by default. It includes a timestamp field in the messages and relative offsets are used for compressed messages.
- ProduceRequest/Response v2 has been introduced and it is used by default to support message format 0.10.0
- FetchRequest/Response v2 has been introduced and it is used by default to support message format 0.10.0
- MessageFormatter interface was changed from `def writeTo(key: Array[Byte], value: Array[Byte], output: PrintStream)` to `def writeTo(consumerRecord: ConsumerRecord[Array[Byte], Array[Byte]], output: PrintStream)`
- MessageReader interface was changed from `def readMessage(): KeyedMessage[Array[Byte], Array[Byte]]` to `def readMessage(): ProducerRecord[Array[Byte], Array[Byte]]`
- MessageFormatter's package was changed from `kafka.tools` to `kafka.common`
- MessageReader's package was changed from `kafka.tools` to `kafka.common`
- MirrorMakerMessageHandler no longer exposes the `handle(record: MessageAndMetadata[Array[Byte], Array[Byte]])` method as it was never called.
- The 0.7 KafkaMigrationTool is no longer packaged with Kafka. If you need to migrate from 0.7 to 0.10.0, please migrate to 0.8 first and then follow the documented upgrade process to upgrade from 0.8 to 0.10.0.
- The new consumer has standardized its APIs to accept `java.util.Collection` as the sequence type for method parameters. Existing code may have to be updated to work with the 0.10.0 client library.
- LZ4-compressed message handling was changed to use an interoperable framing specification (LZ4f v1.5.1). To maintain compatibility with old clients, this change only applies to Message format 0.10.0 and later. Clients that Produce/Fetch LZ4-compressed messages using v0/v1

(Message format 0.9.0) should continue to use the 0.9.0 framing implementation. Clients that use Produce/Fetch protocols v2 or later should use interoperable LZ4f framing. A list of interoperable LZ4 libraries is available at http://www.lz4.org/

Notable changes in 0.10.0.0

- Starting from Kafka 0.10.0.0, a new client library named **Kafka Streams** is available for stream processing on data stored in Kafka topics. This new client library only works with 0.10.x and upward versioned brokers due to message format changes mentioned above. For more information please read Streams documentation.
- The default value of the configuration parameter `receive.buffer.bytes` is now 64K for the new consumer.
- The new consumer now exposes the configuration parameter `exclude.internal.topics` to restrict internal topics (such as the consumer offsets topic) from accidentally being included in regular expression subscriptions. By default, it is enabled.
- The old Scala producer has been deprecated. Users should migrate their code to the Java producer included in the kafka-clients JAR as soon as possible.
- The new consumer API has been marked stable.

Upgrading from 0.8.0, 0.8.1.X, or 0.8.2.X to 0.9.0.0

0.9.0.0 has potential breaking changes (please review before upgrading) and an inter-broker protocol change from previous versions. This means that upgraded brokers and clients may not be compatible with older versions. It is important that you upgrade your Kafka cluster before upgrading your clients. If you are using MirrorMaker downstream clusters should be upgraded first as well.

For a rolling upgrade:

1. Update server.properties file on all brokers and add the following property: inter.broker.protocol.version=0.8.2.X
2. Upgrade the brokers. This can be done a broker at a time by simply bringing it down, updating the code, and restarting it.
3. Once the entire cluster is upgraded, bump the protocol version by editing inter.broker.protocol.version and setting it to 0.9.0.0.
4. Restart the brokers one by one for the new protocol version to take effect

Note: If you are willing to accept downtime, you can simply take all the brokers down, update the code and start all of them. They will start with the new protocol by default.

Note: Bumping the protocol version and restarting can be done any time after the brokers were upgraded. It does not have to be immediately after.

Potential breaking changes in 0.9.0.0

- Java 1.6 is no longer supported.
- Scala 2.9 is no longer supported.
- Broker IDs above 1000 are now reserved by default to automatically assigned broker IDs. If your cluster has existing broker IDs above that threshold make sure to increase the reserved.broker.max.id broker configuration property accordingly.
- Configuration parameter replica.lag.max.messages was removed. Partition leaders will no longer consider the number of lagging messages when deciding which replicas are in sync.
- Configuration parameter replica.lag.time.max.ms now refers not just to the time passed since last fetch request from replica, but also to time since the replica last caught up. Replicas that are still fetching messages from leaders but did not catch up to the latest messages in replica.lag.time.max.ms will be considered out of sync.
- Compacted topics no longer accept messages without key and an exception is thrown by the producer if this is attempted. In 0.8.x, a message without key would cause the log compaction thread to subsequently complain and quit (and stop compacting all compacted topics).
- MirrorMaker no longer supports multiple target clusters. As a result it will only accept a single --consumer.config parameter. To mirror multiple source clusters, you will need at least one MirrorMaker instance per source cluster, each with its own consumer configuration.
- Tools packaged under *org.apache.kafka.clients.tools.** have been moved to *org.apache.kafka.tools.**. All included scripts will still function as usual, only custom code directly importing these classes will be affected.
- The default Kafka JVM performance options (KAFKA_JVM_PERFORMANCE_OPTS) have been changed in kafka-run-class.sh.
- The kafka-topics.sh script (kafka.admin.TopicCommand) now exits with non-zero exit code on failure.

- The kafka-topics.sh script (kafka.admin.TopicCommand) will now print a warning when topic names risk metric collisions due to the use of a '.' or '_' in the topic name, and error in the case of an actual collision.
- The kafka-console-producer.sh script (kafka.tools.ConsoleProducer) will use the Java producer instead of the old Scala producer be default, and users have to specify 'old-producer' to use the old producer.
- By default, all command line tools will print all logging messages to stderr instead of stdout.

Notable changes in 0.9.0.1

- The new broker id generation feature can be disabled by setting broker.id.generation.enable to false.
- Configuration parameter log.cleaner.enable is now true by default. This means topics with a cleanup.policy=compact will now be compacted by default, and 128 MB of heap will be allocated to the cleaner process via log.cleaner.dedupe.buffer.size. You may want to review log.cleaner.dedupe.buffer.size and the other log.cleaner configuration values based on your usage of compacted topics.
- Default value of configuration parameter fetch.min.bytes for the new consumer is now 1 by default.

Deprecations in 0.9.0.0

- Altering topic configuration from the kafka-topics.sh script (kafka.admin.TopicCommand) has been deprecated. Going forward, please use the kafka-configs.sh script (kafka.admin.ConfigCommand) for this functionality.
- The kafka-consumer-offset-checker.sh (kafka.tools.ConsumerOffsetChecker) has been deprecated. Going forward, please use kafka-consumer-groups.sh (kafka.admin.ConsumerGroupCommand) for this functionality.
- The kafka.tools.ProducerPerformance class has been deprecated. Going forward, please use org.apache.kafka.tools.ProducerPerformance for this functionality (kafka-producer-perf-test.sh will also be changed to use the new class).
- The producer config block.on.buffer.full has been deprecated and will be removed in future release. Currently its default value has been changed to false. The KafkaProducer will no longer throw BufferExhaustedException but instead will use max.block.ms value to block, after which it will throw a TimeoutException. If block.on.buffer.full property is set to true explicitly, it will set the max.block.ms to Long.MAX_VALUE and metadata.fetch.timeout.ms will not be honoured

Upgrading from 0.8.1 to 0.8.2

0.8.2 is fully compatible with 0.8.1. The upgrade can be done one broker at a time by simply bringing it down, updating the code, and restarting it.

Upgrading from 0.8.0 to 0.8.1

0.8.1 is fully compatible with 0.8. The upgrade can be done one broker at a time by simply bringing it down, updating the code, and restarting it.

Upgrading from 0.7

Release 0.7 is incompatible with newer releases. Major changes were made to the API, ZooKeeper data structures, and protocol, and configuration in order to add replication (Which was missing in 0.7). The upgrade from 0.7 to later versions requires a special tool for migration. This migration can be done without downtime.

2. APIS

Kafka includes five core apis:

1. The Producer API allows applications to send streams of data to topics in the Kafka cluster.
2. The Consumer API allows applications to read streams of data from topics in the Kafka cluster.
3. The Streams API allows transforming streams of data from input topics to output topics.
4. The Connect API allows implementing connectors that continually pull from some source system or application into Kafka or push from Kafka into some sink system or application.
5. The Admin API allows managing and inspecting topics, brokers, and other Kafka objects.

Kafka exposes all its functionality over a language independent protocol which has clients available in many programming languages. However only the Java clients are maintained as part of the main Kafka project, the others are available as independent open source projects. A list of non-Java clients is available here.

2.1 Producer API

The Producer API allows applications to send streams of data to topics in the Kafka cluster.

Examples showing how to use the producer are given in the javadocs.

To use the producer, you can use the following maven dependency:

```
<dependency>
    <groupId>org.apache.kafka</groupId>
    <artifactId>kafka-clients</artifactId>
    <version>2.4.0</version>
</dependency>
```

2.2 Consumer API

The Consumer API allows applications to read streams of data from topics in the Kafka cluster.

Examples showing how to use the consumer are given in the javadocs.

To use the consumer, you can use the following maven dependency:

```
<dependency>
    <groupId>org.apache.kafka</groupId>
    <artifactId>kafka-clients</artifactId>
    <version>2.4.0</version>
</dependency>
```

2.3 Streams API

The Streams API allows transforming streams of data from input topics to output topics.

Examples showing how to use this library are given in the javadocs

Additional documentation on using the Streams API is available here.

To use Kafka Streams you can use the following maven dependency:

```
<dependency>
    <groupId>org.apache.kafka</groupId>
    <artifactId>kafka-streams</artifactId>
    <version>2.4.0</version>
</dependency>
```

When using Scala you may optionally include the `kafka-streams-scala` library. Additional documentation on using the Kafka Streams DSL for Scala is available in the developer guide.

To use Kafka Streams DSL for Scala for Scala 2.12 you can use the following maven dependency:

```
<dependency>
    <groupId>org.apache.kafka</groupId>
    <artifactId>kafka-streams-scala_2.12</artifactId>
    <version>2.4.0</version>
</dependency>
```

2.4 Connect API

The Connect API allows implementing connectors that continually pull from some source data system into Kafka or push from Kafka into some sink data system.

Many users of Connect won't need to use this API directly, though, they can use pre-built connectors without needing to write any code. Additional information on using Connect is available here.

Those who want to implement custom connectors can see the javadoc.

2.5 Admin API

The Admin API supports managing and inspecting topics, brokers, acls, and other Kafka objects.

To use the Admin API, add the following Maven dependency:

```
<dependency>
    <groupId>org.apache.kafka</groupId>
    <artifactId>kafka-clients</artifactId>
    <version>2.4.0</version>
</dependency>

```

For more information about the Admin APIs, see the javadoc.

3. CONFIGURATION

Kafka uses key-value pairs in the property file format for configuration. These values can be supplied either from a file or programmatically.

3.1 Broker Configs

The essential configurations are the following:

- `broker.id`
- `log.dirs`
- `zookeeper.connect`

Topic-level configurations and defaults are discussed in more detail below.

zookeeper.connect: Specifies the ZooKeeper connection string in the form `hostname:port` where host and port are the host and port of a ZooKeeper server. To allow connecting through other ZooKeeper nodes when that ZooKeeper machine is down you can also specify multiple hosts in the form `hostname1:port1,hostname2:port2,hostname3:port3` . The server can also have a ZooKeeper chroot path as part of its ZooKeeper connection string which puts its data under some path in the global ZooKeeper namespace. For example to give a chroot path of `/chroot/path` you would give the connection string as `hostname1:port1,hostname2:port2,hostname3:port3/chroot/path` .

Type: string — **Default**: — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

advertised.host.name: DEPRECATED: only used when `advertised.listeners` or `listeners` are not set. Use `advertised.listeners` instead. Hostname to publish to ZooKeeper for clients to use. In IaaS environments, this may need to be different from the interface to which the broker binds. If this is not set, it will use the value for `host.name` if configured. Otherwise it will use the value returned from java.net.InetAddress.getCanonicalHostName().

Type: string — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

advertised.listeners: Listeners to publish to ZooKeeper for clients to use, if different than the `listeners` config property. In IaaS environments, this may need to be different from the interface to which the broker binds. If this is not set, the value for `listeners` will be used. Unlike `listeners` it is not valid to advertise the 0.0.0.0 meta-address.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: per-broker

---

advertised.port: DEPRECATED: only used when `advertised.listeners` or `listeners` are not set. Use `advertised.listeners` instead. The port to publish to ZooKeeper for clients to use. In IaaS environments, this may need to be different from the port to which the broker binds. If this is not set, it will publish the same port that the broker binds to.

Type: int — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

auto.create.topics.enable: Enable auto creation of topic on the server

Type: boolean — **Default**: true — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

auto.leader.rebalance.enable: Enables auto leader balancing. A background thread checks the distribution of partition leaders at regular intervals, configurable by `leader.imbalance.check.interval.seconds`. If the leader imbalance exceeds `leader.imbalance.per.broker.percentage`, leader rebalance to the preferred leader for partitions is triggered.

Type: boolean — **Default**: true — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

background.threads: The number of threads to use for various background processing tasks

Type: int — **Default**: 10 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: cluster-wide

---

broker.id: The broker id for this server. If unset, a unique broker id will be generated.To avoid conflicts between zookeeper generated broker id's and user configured broker id's, generated broker ids start from reserved.broker.max.id + 1.

Type: int — **Default**: -1 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

compression.type: Specify the final compression type for a given topic. This configuration accepts the standard compression codecs ('gzip', 'snappy', 'lz4', 'zstd'). It additionally accepts 'uncompressed' which is equivalent to no compression; and 'producer' which means retain the original compression codec set by the producer.

Type: string — **Default**: producer — **Valid Values**: — **Importance**: high — **Update Mode**: cluster-wide

---

control.plane.listener.name: Name of listener used for communication between controller and brokers. Broker will use the control.plane.listener.name to locate the endpoint in listeners list, to listen for connections from the controller. For example, if a broker's config is : listeners = INTERNAL://192.1.1.8:9092, EXTERNAL://10.1.1.5:9093, CONTROLLER://192.1.1.8:9094 listener.security.protocol.map = INTERNAL:PLAINTEXT, EXTERNAL:SSL, CONTROLLER:SSL control.plane.listener.name = CONTROLLER On startup, the broker will start listening on "192.1.1.8:9094" with security protocol "SSL". On controller side, when it discovers a broker's published endpoints through zookeeper, it will use the control.plane.listener.name to find the endpoint, which it will use to establish connection to the broker. For example, if the broker's published endpoints on zookeeper are : "endpoints" : ["INTERNAL://broker1.example.com:9092","EXTERNAL://broker1.example.com:9093","CONTROLLER://broker1.example.com:9094"] and the controller's config is : listener.security.protocol.map = INTERNAL:PLAINTEXT, EXTERNAL:SSL, CONTROLLER:SSL control.plane.listener.name = CONTROLLER then controller will use "broker1.example.com:9094" with security protocol "SSL" to connect to the broker. If not explicitly configured, the default value will be null and there will be no dedicated endpoints for controller connections.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

delete.topic.enable: Enables delete topic. Delete topic through the admin tool will have no effect if this config is turned off

Type: boolean — **Default**: true — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

host.name: DEPRECATED: only used when `listeners` is not set. Use `listeners` instead. hostname of broker. If this is set, it will only bind to this address. If this is not set, it will bind to all interfaces

Type: string — **Default**: "" — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

leader.imbalance.check.interval.seconds: The frequency with which the partition rebalance check is triggered by the controller

Type: long — **Default**: 300 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

leader.imbalance.per.broker.percentage: The ratio of leader imbalance allowed per broker. The controller would trigger a leader balance if it goes above this value per broker. The value is specified in percentage.

Type: int — **Default**: 10 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

listeners: Listener List - Comma-separated list of URIs we will listen on and the listener names. If the listener name is not a security protocol, listener.security.protocol.map must also be set. Specify hostname as 0.0.0.0 to bind to all interfaces. Leave hostname empty to bind to default interface. Examples of legal listener lists: PLAINTEXT://myhost:9092,SSL://:9091 CLIENT://0.0.0.0:9092,REPLICATION://localhost:9093

Type: string — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: per-broker

---

log.dir: The directory in which the log data is kept (supplemental for log.dirs property)

Type: string — **Default**: /tmp/kafka-logs — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

log.dirs: The directories in which the log data is kept. If not set, the value in log.dir is used

Type: string — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

log.flush.interval.messages: The number of messages accumulated on a log partition before messages are flushed to disk

Type: long — **Default**: 9223372036854775807 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: cluster-wide

---

log.flush.interval.ms: The maximum time in ms that a message in any topic is kept in memory before flushed to disk. If not set, the value in log.flush.scheduler.interval.ms is used

Type: long — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: cluster-wide

---

log.flush.offset.checkpoint.interval.ms: The frequency with which we update the persistent record of the last flush which acts as the log recovery point

Type: int — **Default**: 60000 — **Valid Values**: [0,...] — **Importance**: high — **Update Mode**: read-only

---

log.flush.scheduler.interval.ms: The frequency in ms that the log flusher checks whether any log needs to be flushed to disk

Type: long — **Default**: 9223372036854775807 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

log.flush.start.offset.checkpoint.interval.ms: The frequency with which we update the persistent record of log start offset

Type: int — **Default**: 60000 — **Valid Values**: [0,...] — **Importance**: high — **Update Mode**: read-only

---

log.retention.bytes: The maximum size of the log before deleting it

Type: long — **Default**: -1 — **Valid Values**: — **Importance**: high — **Update Mode**: cluster-wide

---

log.retention.hours: The number of hours to keep a log file before deleting it (in hours), tertiary to log.retention.ms property

Type: int — **Default**: 168 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

log.retention.minutes: The number of minutes to keep a log file before deleting it (in minutes), secondary to log.retention.ms property. If not set, the value in log.retention.hours is used

Type: int — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

log.retention.ms: The number of milliseconds to keep a log file before deleting it (in milliseconds), If not set, the value in log.retention.minutes is used. If set to -1, no time limit is applied.

Type: long — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: cluster-wide

---

log.roll.hours: The maximum time before a new log segment is rolled out (in hours), secondary to log.roll.ms property

Type: int — **Default**: 168 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

log.roll.jitter.hours: The maximum jitter to subtract from logRollTimeMillis (in hours), secondary to log.roll.jitter.ms property

Type: int — **Default**: 0 — **Valid Values**: [0,...] — **Importance**: high — **Update Mode**: read-only

---

log.roll.jitter.ms: The maximum jitter to subtract from logRollTimeMillis (in milliseconds). If not set, the value in log.roll.jitter.hours is used

Type: long — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: cluster-wide

---

log.roll.ms: The maximum time before a new log segment is rolled out (in milliseconds). If not set, the value in log.roll.hours is used

Type: long — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: cluster-wide

---

log.segment.bytes: The maximum size of a single log file

Type: int — **Default**: 1073741824 — **Valid Values**: [14,...] — **Importance**: high — **Update Mode**: cluster-wide

---

log.segment.delete.delay.ms: The amount of time to wait before deleting a file from the filesystem

Type: long — **Default**: 60000 — **Valid Values**: [0,...] — **Importance**: high — **Update Mode**: cluster-wide

---

message.max.bytes: The largest record batch size allowed by Kafka. If this is increased and there are consumers older than 0.10.2, the consumers' fetch size must also be increased so that the they can fetch record batches this large. In the latest message format version, records are always grouped into batches for efficiency. In previous message format versions, uncompressed records are not grouped into batches and this limit only applies to a single record in that case.This can be set per topic with the topic level `max.message.bytes` config.

Type: int — **Default**: 1000012 — **Valid Values**: [0,...] — **Importance**: high — **Update Mode**: cluster-wide

---

min.insync.replicas: When a producer sets acks to "all" (or "-1"), 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 (either NotEnoughReplicas or NotEnoughReplicasAfterAppend).
When used together, min.insync.replicas and acks allow you to enforce greater durability guarantees. A typical scenario would be to create a topic with a replication factor of 3, set min.insync.replicas to 2, and produce with acks of "all". This will ensure that the producer raises an exception if a majority of replicas do not receive a write.

Type: int — **Default**: 1 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: cluster-wide

---

num.io.threads: The number of threads that the server uses for processing requests, which may include disk I/O

Type: int — **Default**: 8 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: cluster-wide

---

num.network.threads: The number of threads that the server uses for receiving requests from the network and sending responses to the network

Type: int — **Default**: 3 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: cluster-wide

---

num.recovery.threads.per.data.dir: The number of threads per data directory to be used for log recovery at startup and flushing at shutdown

Type: int — **Default**: 1 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: cluster-wide

---

num.replica.alter.log.dirs.threads: The number of threads that can move replicas between log directories, which may include disk I/O

Type: int — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

num.replica.fetchers: Number of fetcher threads used to replicate messages from a source broker. Increasing this value can increase the degree of I/O parallelism in the follower broker.

Type: int — **Default**: 1 — **Valid Values**: — **Importance**: high — **Update Mode**: cluster-wide

---

offset.metadata.max.bytes: The maximum size for a metadata entry associated with an offset commit

Type: int — **Default**: 4096 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

offsets.commit.required.acks: The required acks before the commit can be accepted. In general, the default (-1) should not be overridden

Type: short — **Default**: -1 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

offsets.commit.timeout.ms: Offset commit will be delayed until all replicas for the offsets topic receive the commit or this timeout is reached. This is similar to the producer request timeout.

Type: int — **Default**: 5000 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

offsets.load.buffer.size: Batch size for reading from the offsets segments when loading offsets into the cache (soft-limit, overridden if records are too large).

Type: int — **Default**: 5242880 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

offsets.retention.check.interval.ms: Frequency at which to check for stale offsets

Type: long — **Default**: 600000 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

offsets.retention.minutes: After a consumer group loses all its consumers (i.e. becomes empty) its offsets will be kept for this retention period before getting discarded. For standalone consumers (using manual assignment), offsets will be expired after the time of last commit plus this retention period.

Type: int — **Default**: 10080 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

offsets.topic.compression.codec: Compression codec for the offsets topic - compression may be used to achieve "atomic" commits

Type: int — **Default**: 0 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

offsets.topic.num.partitions: The number of partitions for the offset commit topic (should not change after deployment)

Type: int — **Default**: 50 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

offsets.topic.replication.factor: The replication factor for the offsets topic (set higher to ensure availability). Internal topic creation will fail until the cluster size meets this replication factor requirement.

Type: short — **Default**: 3 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

offsets.topic.segment.bytes: The offsets topic segment bytes should be kept relatively small in order to facilitate faster log compaction and cache loads

Type: int — **Default**: 104857600 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

port: DEPRECATED: only used when `listeners` is not set. Use `listeners` instead. the port to listen and accept connections on

Type: int — **Default**: 9092 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

queued.max.requests: The number of queued requests allowed for data-plane, before blocking the network threads

Type: int — **Default**: 500 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

quota.consumer.default: DEPRECATED: Used only when dynamic default quotas are not configured for or in Zookeeper. Any consumer distinguished by clientId/consumer group will get throttled if it fetches more bytes than this value per-second

Type: long — **Default**: 9223372036854775807 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

quota.producer.default: DEPRECATED: Used only when dynamic default quotas are not configured for , or in Zookeeper. Any producer distinguished by clientId will get throttled if it produces more bytes than this value per-second

Type: long — **Default**: 9223372036854775807 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

replica.fetch.min.bytes: Minimum bytes expected for each fetch response. If not enough bytes, wait up to replicaMaxWaitTimeMs

Type: int — **Default**: 1 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

replica.fetch.wait.max.ms: max wait time for each fetcher request issued by follower replicas. This value should always be less than the replica.lag.time.max.ms at all times to prevent frequent shrinking of ISR for low throughput topics

Type: int — **Default**: 500 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

replica.high.watermark.checkpoint.interval.ms: The frequency with which the high watermark is saved out to disk

Type: long — **Default**: 5000 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

replica.lag.time.max.ms: If a follower hasn't sent any fetch requests or hasn't consumed up to the leaders log end offset for at least this time, the leader will remove the follower from isr

Type: long — **Default**: 10000 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

replica.socket.receive.buffer.bytes: The socket receive buffer for network requests

Type: int — **Default**: 65536 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

replica.socket.timeout.ms: The socket timeout for network requests. Its value should be at least replica.fetch.wait.max.ms

Type: int — **Default**: 30000 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

request.timeout.ms: The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted.

Type: int — **Default**: 30000 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

socket.receive.buffer.bytes: The SO_RCVBUF buffer of the socket server sockets. If the value is -1, the OS default will be used.

Type: int — **Default**: 102400 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

socket.request.max.bytes: The maximum number of bytes in a socket request

Type: int — **Default**: 104857600 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

socket.send.buffer.bytes: The SO_SNDBUF buffer of the socket server sockets. If the value is -1, the OS default will be used.

Type: int — **Default**: 102400 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

transaction.max.timeout.ms: The maximum allowed timeout for transactions. If a client's requested transaction time exceed this, then the broker will return an error in InitProducerIdRequest. This prevents a client from too large of a timeout, which can stall consumers reading from topics included in the transaction.

Type: int — **Default**: 900000 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

transaction.state.log.load.buffer.size: Batch size for reading from the transaction log segments when loading producer ids and transactions into the cache (soft-limit, overridden if records are too large).

Type: int — **Default**: 5242880 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

transaction.state.log.min.isr: Overridden min.insync.replicas config for the transaction topic.

Type: int — **Default**: 2 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

transaction.state.log.num.partitions: The number of partitions for the transaction topic (should not change after deployment).

Type: int — **Default**: 50 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

transaction.state.log.replication.factor: The replication factor for the transaction topic (set higher to ensure availability). Internal topic creation will fail until the cluster size meets this replication factor requirement.

Type: short — **Default**: 3 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

transaction.state.log.segment.bytes: The transaction topic segment bytes should be kept relatively small in order to facilitate faster log compaction and cache loads

Type: int — **Default**: 104857600 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

transactional.id.expiration.ms: The time in ms that the transaction coordinator will wait without receiving any transaction status updates for the current transaction before expiring its transactional id. This setting also influences producer id expiration - producer ids are expired once this time has elapsed after the last write with the given producer id. Note that producer ids may expire sooner if the last write from the producer id is deleted due to the topic's retention settings.

Type: int — **Default**: 604800000 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

unclean.leader.election.enable: Indicates whether to enable replicas not in the ISR set to be elected as leader as a last resort, even though doing so may result in data loss

Type: boolean — **Default**: false — **Valid Values**: — **Importance**: high — **Update Mode**: cluster-wide

---

zookeeper.connection.timeout.ms: The max time that the client waits to establish a connection to zookeeper. If not set, the value in zookeeper.session.timeout.ms is used

Type: int — **Default**: null — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

zookeeper.max.in.flight.requests: The maximum number of unacknowledged requests the client will send to Zookeeper before blocking.

Type: int — **Default**: 10 — **Valid Values**: [1,...] — **Importance**: high — **Update Mode**: read-only

---

zookeeper.session.timeout.ms: Zookeeper session timeout

Type: int — **Default**: 6000 — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

zookeeper.set.acl: Set client to use secure ACLs

Type: boolean — **Default**: false — **Valid Values**: — **Importance**: high — **Update Mode**: read-only

---

broker.id.generation.enable: Enable automatic broker id generation on the server. When enabled the value configured for reserved.broker.max.id should be reviewed.

Type: boolean — **Default**: true — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

broker.rack: Rack of the broker. This will be used in rack aware replication assignment for fault tolerance. Examples: `RACK1`, `us-east-1d`

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

connections.max.idle.ms: Idle connections timeout: the server socket processor threads close the connections that idle more than this

Type: long — **Default**: 600000 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

connections.max.reauth.ms: When explicitly set to a positive number (the default is 0, not a positive number), a session lifetime that will not exceed the configured value will be communicated to v2.2.0 or later clients when they authenticate. The broker will disconnect any such connection that is not re-authenticated within the session lifetime and that is then subsequently used for any purpose other than re-authentication. Configuration names can optionally be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.oauthbearer.connections.max.reauth.ms=3600000

Type: long — **Default**: 0 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

controlled.shutdown.enable: Enable controlled shutdown of the server

Type: boolean — **Default**: true — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

controlled.shutdown.max.retries: Controlled shutdown can fail for multiple reasons. This determines the number of retries when such failure happens

Type: int — **Default**: 3 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

controlled.shutdown.retry.backoff.ms: Before each retry, the system needs time to recover from the state that caused the previous failure (Controller fail over, replica lag etc). This config determines the amount of time to wait before retrying.

Type: long — **Default**: 5000 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

controller.socket.timeout.ms: The socket timeout for controller-to-broker channels

Type: int — **Default**: 30000 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

default.replication.factor: default replication factors for automatically created topics

Type: int — **Default**: 1 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

delegation.token.expiry.time.ms: The token validity time in miliseconds before the token needs to be renewed. Default value 1 day.

Type: long — **Default**: 86400000 — **Valid Values**: [1,...] — **Importance**: medium — **Update Mode**: read-only

---

delegation.token.master.key: Master/secret key to generate and verify delegation tokens. Same key must be configured across all the brokers. If the key is not set or set to empty string, brokers will disable the delegation token support.

Type: password — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

delegation.token.max.lifetime.ms: The token has a maximum lifetime beyond which it cannot be renewed anymore. Default value 7 days.

Type: long — **Default**: 604800000 — **Valid Values**: [1,...] — **Importance**: medium — **Update Mode**: read-only

---

delete.records.purgatory.purge.interval.requests: The purge interval (in number of requests) of the delete records request purgatory

Type: int — **Default**: 1 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

fetch.purgatory.purge.interval.requests: The purge interval (in number of requests) of the fetch request purgatory

Type: int — **Default**: 1000 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

group.initial.rebalance.delay.ms: The amount of time the group coordinator will wait for more consumers to join a new group before performing the first rebalance. A longer delay means potentially fewer rebalances, but increases the time until processing begins.

Type: int — **Default**: 3000 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

group.max.session.timeout.ms: The maximum allowed session timeout for registered consumers. Longer timeouts give consumers more time to process messages in between heartbeats at the cost of a longer time to detect failures.

Type: int — **Default**: 1800000 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

group.max.size: The maximum number of consumers that a single consumer group can accommodate.

Type: int — **Default**: 2147483647 — **Valid Values**: [1,...] — **Importance**: medium — **Update Mode**: read-only

---

group.min.session.timeout.ms: The minimum allowed session timeout for registered consumers. Shorter timeouts result in quicker failure detection at the cost of more frequent consumer heartbeating, which can overwhelm broker resources.

Type: int — **Default**: 6000 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

inter.broker.listener.name: Name of listener used for communication between brokers. If this is unset, the listener name is defined by security.inter.broker.protocol. It is an error to set this and security.inter.broker.protocol properties at the same time.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

inter.broker.protocol.version: Specify which version of the inter-broker protocol will be used. This is typically bumped after all brokers were upgraded to a new version. Example of some valid values are: 0.8.0, 0.8.1, 0.8.1.1, 0.8.2, 0.8.2.0, 0.8.2.1, 0.9.0.0, 0.9.0.1 Check ApiVersion for the full list.

Type: string — **Default**: 2.4-IV1
— **Valid Values**: [0.8.0, 0.8.1, 0.8.2, 0.9.0, 0.10.0-IV0, 0.10.0-IV1, 0.10.1-IV0, 0.10.1-IV1, 0.10.1-IV2, 0.10.2-IV0, 0.11.0-IV0, 0.11.0-IV1, 0.11.0-IV2, 1.0-IV0, 1.1-IV0, 2.0-IV0, 2.0-IV1, 2.1-IV0, 2.1-IV1, 2.1-IV2, 2.2-IV0, 2.2-IV1, 2.3-IV0, 2.3-IV1, 2.4-IV0, 2.4-IV1]
— **Importance**: medium — **Update Mode**: read-only

---

log.cleaner.backoff.ms: The amount of time to sleep when there are no logs to clean

Type: long — **Default**: 15000 — **Valid Values**: [0,...] — **Importance**: medium — **Update Mode**: cluster-wide

---

log.cleaner.dedupe.buffer.size: The total memory used for log deduplication across all cleaner threads

Type: long — **Default**: 134217728 — **Valid Values**: — **Importance**: medium — **Update Mode**: cluster-wide

---

log.cleaner.delete.retention.ms: How long are delete records retained?

Type: long — **Default**: 86400000 — **Valid Values**: — **Importance**: medium — **Update Mode**: cluster-wide

---

log.cleaner.enable: Enable the log cleaner process to run on the server. Should be enabled if using any topics with a cleanup.policy=compact including the internal offsets topic. If disabled those topics will not be compacted and continually grow in size.

Type: boolean — **Default**: true — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

log.cleaner.io.buffer.load.factor: Log cleaner dedupe buffer load factor. The percentage full the dedupe buffer can become. A higher value will allow more log to be cleaned at once but will lead to more hash collisions

Type: double — **Default**: 0.9 — **Valid Values**: — **Importance**: medium — **Update Mode**: cluster-wide

---

log.cleaner.io.buffer.size: The total memory used for log cleaner I/O buffers across all cleaner threads

Type: int — **Default**: 524288 — **Valid Values**: [0,...] — **Importance**: medium — **Update Mode**: cluster-wide

---

log.cleaner.io.max.bytes.per.second: The log cleaner will be throttled so that the sum of its read and write i/o will be less than this value on average

Type: double — **Default**: 1.7976931348623157E308 — **Valid Values**: — **Importance**: medium — **Update Mode**: cluster-wide

---

log.cleaner.max.compaction.lag.ms: The maximum time a message will remain ineligible for compaction in the log. Only applicable for logs that are being compacted.

Type: long — **Default**: 9223372036854775807 — **Valid Values**: — **Importance**: medium — **Update Mode**: cluster-wide

---

log.cleaner.min.cleanable.ratio: The minimum ratio of dirty log to total log for a log to eligible for cleaning. If the log.cleaner.max.compaction.lag.ms or the log.cleaner.min.compaction.lag.ms configurations are also specified, then the log compactor considers the log eligible for compaction as soon as either: (i) the dirty ratio threshold has been met and the log has had dirty (uncompacted) records for at least the log.cleaner.min.compaction.lag.ms duration, or (ii) if the log has had dirty (uncompacted) records for at most the log.cleaner.max.compaction.lag.ms period.

Type: double — **Default**: 0.5 — **Valid Values**: — **Importance**: medium — **Update Mode**: cluster-wide

---

log.cleaner.min.compaction.lag.ms: The minimum time a message will remain uncompacted in the log. Only applicable for logs that are being compacted.

Type: long — **Default**: 0 — **Valid Values**: — **Importance**: medium — **Update Mode**: cluster-wide

---

log.cleaner.threads: The number of background threads to use for log cleaning

Type: int — **Default**: 1 — **Valid Values**: [0,...] — **Importance**: medium — **Update Mode**: cluster-wide

---

log.cleanup.policy: The default cleanup policy for segments beyond the retention window. A comma separated list of valid policies. Valid policies are: "delete" and "compact"

Type: list — **Default**: delete — **Valid Values**: [compact, delete] — **Importance**: medium — **Update Mode**: cluster-wide

---

log.index.interval.bytes: The interval with which we add an entry to the offset index

Type: int — **Default**: 4096 — **Valid Values**: [0,...] — **Importance**: medium — **Update Mode**: cluster-wide

---

log.index.size.max.bytes: The maximum size in bytes of the offset index

Type: int — **Default**: 10485760 — **Valid Values**: [4,...] — **Importance**: medium — **Update Mode**: cluster-wide

---

log.message.format.version: Specify the message format version the broker will use to append messages to the logs. The value should be a valid ApiVersion. Some examples are: 0.8.2, 0.9.0.0, 0.10.0, check ApiVersion for more details. By setting a particular message format version, the user is certifying that all the existing messages on disk are smaller or equal than the specified version. Setting this value incorrectly will cause consumers with older versions to break as they will receive messages with a format that they don't understand.

Type: string — **Default**: 2.4-IV1
— **Valid Values**: [0.8.0, 0.8.1, 0.8.2, 0.9.0, 0.10.0-IV0, 0.10.0-IV1, 0.10.1-IV0, 0.10.1-IV1, 0.10.1-IV2, 0.10.2-IV0, 0.11.0-IV0, 0.11.0-IV1, 0.11.0-IV2, 1.0-IV0, 1.1-IV0, 2.0-IV0, 2.0-IV1, 2.1-IV0, 2.1-IV1, 2.1-IV2, 2.2-IV0, 2.2-IV1, 2.3-IV0, 2.3-IV1, 2.4-IV0, 2.4-IV1]
— **Importance**: medium — **Update Mode**: read-only

---

log.message.timestamp.difference.max.ms: The maximum difference allowed between the timestamp when a broker receives a message and the timestamp specified in the message. If log.message.timestamp.type=CreateTime, a message will be rejected if the difference in timestamp exceeds this threshold. This configuration is ignored if log.message.timestamp.type=LogAppendTime.The maximum timestamp difference allowed should be no greater than log.retention.ms to avoid unnecessarily frequent log rolling.

Type: long — **Default**: 9223372036854775807 — **Valid Values**: — **Importance**: medium — **Update Mode**: cluster-wide

---

log.message.timestamp.type: Define whether the timestamp in the message is message create time or log append time. The value should be either `CreateTime` or `LogAppendTime`

Type: string — **Default**: CreateTime — **Valid Values**: [CreateTime, LogAppendTime] — **Importance**: medium
— **Update Mode**: cluster-wide

---

log.preallocate: Should pre allocate file when create new segment? If you are using Kafka on Windows, you probably need to set it to true.

Type: boolean — **Default**: false — **Valid Values**: — **Importance**: medium — **Update Mode**: cluster-wide

---

log.retention.check.interval.ms: The frequency in milliseconds that the log cleaner checks whether any log is eligible for deletion

Type: long — **Default**: 300000 — **Valid Values**: [1,...] — **Importance**: medium — **Update Mode**: read-only

---

max.connections: The maximum number of connections we allow in the broker at any time. This limit is applied in addition to any per-ip limits configured using max.connections.per.ip. Listener-level limits may also be configured by prefixing the config name with the listener prefix, for example, `listener.name.internal.max.connections`. Broker-wide limit should be configured based on broker capacity while listener limits should be configured based on application requirements. New connections are blocked if either the listener or broker limit is reached. Connections on the inter-broker listener are permitted even if broker-wide limit is reached. The least recently used connection on another listener will be closed in this case.

Type: int — **Default**: 2147483647 — **Valid Values**: [0,...] — **Importance**: medium — **Update Mode**: cluster-wide

---

max.connections.per.ip: The maximum number of connections we allow from each ip address. This can be set to 0 if there are overrides configured using max.connections.per.ip.overrides property. New connections from the ip address are dropped if the limit is reached.

Type: int — **Default**: 2147483647 — **Valid Values**: [0,...] — **Importance**: medium — **Update Mode**: cluster-wide

---

max.connections.per.ip.overrides: A comma-separated list of per-ip or hostname overrides to the default maximum number of connections. An example value is "hostName:100,127.0.0.1:200"

Type: string — **Default**: "" — **Valid Values**: — **Importance**: medium — **Update Mode**: cluster-wide

---

max.incremental.fetch.session.cache.slots: The maximum number of incremental fetch sessions that we will maintain.

Type: int — **Default**: 1000 — **Valid Values**: [0,...] — **Importance**: medium — **Update Mode**: read-only

---

num.partitions: The default number of log partitions per topic

Type: int — **Default**: 1 — **Valid Values**: [1,...] — **Importance**: medium — **Update Mode**: read-only

---

password.encoder.old.secret: The old secret that was used for encoding dynamically configured passwords. This is required only when the secret is updated. If specified, all dynamically encoded passwords are decoded using this old secret and re-encoded using password.encoder.secret when broker starts up.

Type: password — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

password.encoder.secret: The secret used for encoding dynamically configured passwords for this broker.

Type: password — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

principal.builder.class: The fully qualified name of a class that implements the KafkaPrincipalBuilder interface, which is used to build the KafkaPrincipal object used during authorization. This config also supports the deprecated PrincipalBuilder interface which was previously used for client authentication over SSL. If no principal builder is defined, the default behavior depends on the security protocol in use. For SSL authentication, the principal will be derived using the rules defined by `ssl.principal.mapping.rules` applied on the distinguished name from the client certificate if one is provided; otherwise, if client authentication is not required, the principal name will be ANONYMOUS. For SASL authentication, the principal will be derived using the rules defined by `sasl.kerberos.principal.to.local.rules` if GSSAPI is in use, and the SASL authentication ID for other mechanisms. For PLAINTEXT, the principal will be ANONYMOUS.

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

producer.purgatory.purge.interval.requests: The purge interval (in number of requests) of the producer request purgatory

Type: int — **Default**: 1000 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

queued.max.request.bytes: The number of queued bytes allowed before no more requests are read

Type: long — **Default**: -1 — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

replica.fetch.backoff.ms: The amount of time to sleep when fetch partition error occurs.

Type: int — **Default**: 1000 — **Valid Values**: [0,...] — **Importance**: medium — **Update Mode**: read-only

---

replica.fetch.max.bytes: The number of bytes of messages to attempt to fetch for each partition. This is not an absolute maximum, if the first record batch in the first non-empty partition of the fetch is larger than this value, the record batch will still be returned to ensure that progress can be made. The maximum record batch size accepted by the broker is defined via `message.max.bytes` (broker config) or `max.message.bytes` (topic config).

Type: int — **Default**: 1048576 — **Valid Values**: [0,...] — **Importance**: medium — **Update Mode**: read-only

---

replica.fetch.response.max.bytes: Maximum bytes expected for the entire fetch response. Records are fetched in batches, and if the first record batch in the first non-empty partition of the fetch is larger than this value, the record batch will still be returned to ensure that progress can be made. As such, this is not an absolute maximum. The maximum record batch size accepted by the broker is defined via `message.max.bytes` (broker config) or `max.message.bytes` (topic config).

Type: int — **Default**: 10485760 — **Valid Values**: [0,...] — **Importance**: medium — **Update Mode**: read-only

---

replica.selector.class: The fully qualified class name that implements ReplicaSelector. This is used by the broker to find the preferred read replica. By default, we use an implementation that returns the leader.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

reserved.broker.max.id: Max number that can be used for a broker.id

Type: int — **Default**: 1000 — **Valid Values**: [0,...] — **Importance**: medium — **Update Mode**: read-only

---

sasl.client.callback.handler.class: The fully qualified name of a SASL client callback handler class that implements the AuthenticateCallbackHandler interface.

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

sasl.enabled.mechanisms: The list of SASL mechanisms enabled in the Kafka server. The list may contain any mechanism for which a security provider is available. Only GSSAPI is enabled by default.

Type: list — **Default**: GSSAPI — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.jaas.config: JAAS login context parameters for SASL connections in the format used by JAAS configuration files. JAAS configuration file format is described [here](). The format for the value is: '`loginModuleClass controlFlag (optionName=optionValue)*;`'. For brokers, the config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.jaas.config=com.example.ScramLoginModule required;

Type: password — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.kerberos.kinit.cmd: Kerberos kinit command path.

Type: string — **Default**: /usr/bin/kinit — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.kerberos.min.time.before.relogin: Login thread sleep time between refresh attempts.

Type: long — **Default**: 60000 — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.kerberos.principal.to.local.rules: A list of rules for mapping from principal names to short names (typically operating system usernames). The rules are evaluated in order and the first rule that matches a principal name is used to map it to a short name. Any later rules in the list are ignored. By default, principal names of the form {username}/{hostname}@{REALM} are mapped to {username}. For more details on the format please see [security authorization and acls](). Note that this configuration is ignored if an extension of KafkaPrincipalBuilder is provided by the `principal.builder.class` configuration.

Type: list — **Default**: DEFAULT — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.kerberos.service.name: The Kerberos principal name that Kafka runs as. This can be defined either in Kafka's JAAS config or in Kafka's config.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.kerberos.ticket.renew.jitter: Percentage of random jitter added to the renewal time.

Type: double — **Default**: 0.05 — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.kerberos.ticket.renew.window.factor: Login thread will sleep until the specified window factor of time from last refresh to ticket's expiry has been reached, at which time it will try to renew the ticket.

Type: double — **Default**: 0.8 — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.login.callback.handler.class: The fully qualified name of a SASL login callback handler class that implements the AuthenticateCallbackHandler interface. For brokers, login callback handler config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.callback.handler.class=com.example.CustomScramLoginCallbackHandler

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

sasl.login.class: The fully qualified name of a class that implements the Login interface. For brokers, login config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.class=com.example.CustomScramLogin

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

sasl.login.refresh.buffer.seconds: The amount of buffer time before credential expiration to maintain when refreshing a credential, in seconds. If a refresh would otherwise occur closer to expiration than the number of buffer seconds then the refresh will be moved up to maintain as much of the buffer time as possible. Legal values are between 0 and 3600 (1 hour); a default value of 300 (5 minutes) is used if no value is specified. This value and sasl.login.refresh.min.period.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

Type: short — **Default**: 300 — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.login.refresh.min.period.seconds: The desired minimum time for the login refresh thread to wait before refreshing a credential, in seconds. Legal values are between 0 and 900 (15 minutes); a default value of 60 (1 minute) is used if no value is specified. This value and sasl.login.refresh.buffer.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

Type: short — **Default**: 60 — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.login.refresh.window.factor: Login refresh thread will sleep until the specified window factor relative to the credential's lifetime has been reached, at which time it will try to refresh the credential. Legal values are between 0.5 (50%) and 1.0 (100%) inclusive; a default value of 0.8 (80%) is used if no value is specified. Currently applies only to OAUTHBEARER.

Type: double — **Default**: 0.8 — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.login.refresh.window.jitter: The maximum amount of random jitter relative to the credential's lifetime that is added to the login refresh thread's sleep time. Legal values are between 0 and 0.25 (25%) inclusive; a default value of 0.05 (5%) is used if no value is specified. Currently applies only to OAUTHBEARER.

Type: double — **Default**: 0.05 — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.mechanism.inter.broker.protocol: SASL mechanism used for inter-broker communication. Default is GSSAPI.

Type: string — **Default**: GSSAPI — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

sasl.server.callback.handler.class: The fully qualified name of a SASL server callback handler class that implements the AuthenticateCallbackHandler interface. Server callback handlers must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.plain.sasl.server.callback.handler.class=com.example.CustomPlainCallbackHandler.

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

security.inter.broker.protocol: Security protocol used to communicate between brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL. It is an error to set this and inter.broker.listener.name properties at the same time.

Type: string — **Default**: PLAINTEXT — **Valid Values**: — **Importance**: medium — **Update Mode**: read-only

---

ssl.cipher.suites: A list of cipher suites. This is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol. By default all the available cipher suites are supported.

Type: list — **Default**: "" — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.client.auth: Configures kafka broker to request client authentication. The following settings are common:

- `ssl.client.auth=required` If set to required client authentication is required.
- `ssl.client.auth=requested` This means client authentication is optional. unlike requested , if this option is set client can choose not to provide authentication information about itself
- `ssl.client.auth=none` This means client authentication is not needed.

Type: string — **Default**: none — **Valid Values**: [required, requested, none] — **Importance**: medium — **Update Mode**: per-broker

---

ssl.enabled.protocols: The list of protocols enabled for SSL connections.

Type: list — **Default**: TLSv1.2,TLSv1.1,TLSv1 — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.key.password: The password of the private key in the key store file. This is optional for client.

Type: password — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.keymanager.algorithm: The algorithm used by key manager factory for SSL connections. Default value is the key manager factory algorithm configured for the Java Virtual Machine.

Type: string — **Default**: SunX509 — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.keystore.location: The location of the key store file. This is optional for client and can be used for two-way authentication for client.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.keystore.password: The store password for the key store file. This is optional for client and only needed if ssl.keystore.location is configured.

Type: password — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.keystore.type: The file format of the key store file. This is optional for client.

Type: string — **Default**: JKS — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.protocol: The SSL protocol used to generate the SSLContext. Default setting is TLS, which is fine for most cases. Allowed values in recent JVMs are TLS, TLSv1.1 and TLSv1.2. SSL, SSLv2 and SSLv3 may be supported in older JVMs, but their usage is discouraged due to known security vulnerabilities.

Type: string — **Default**: TLS — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.provider: The name of the security provider used for SSL connections. Default value is the default security provider of the JVM.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.trustmanager.algorithm: The algorithm used by trust manager factory for SSL connections. Default value is the trust manager factory algorithm configured for the Java Virtual Machine.

Type: string — **Default**: PKIX — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.truststore.location: The location of the trust store file.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.truststore.password: The password for the trust store file. If a password is not set access to the truststore is still available, but integrity checking is disabled.

Type: password — **Default**: null — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

ssl.truststore.type: The file format of the trust store file.

Type: string — **Default**: JKS — **Valid Values**: — **Importance**: medium — **Update Mode**: per-broker

---

alter.config.policy.class.name: The alter configs policy class that should be used for validation. The class should implement the `org.apache.kafka.server.policy.AlterConfigPolicy` interface.

Type: class — **Default**: null — **Valid Values**: — **Importance**: low — **Update Mode**: read-only

---

alter.log.dirs.replication.quota.window.num: The number of samples to retain in memory for alter log dirs replication quotas

Type: int — **Default**: 11 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

alter.log.dirs.replication.quota.window.size.seconds: The time span of each sample for alter log dirs replication quotas

Type: int — **Default**: 1 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

authorizer.class.name: The fully qualified name of a class that implements sorg.apache.kafka.server.authorizer.Authorizer interface, which is used by the broker for authorization. This config also supports authorizers that implement the deprecated kafka.security.auth.Authorizer trait which was previously used for authorization.

Type: string — **Default**: "" — **Valid Values**: — **Importance**: low — **Update Mode**: read-only

---

client.quota.callback.class: The fully qualified name of a class that implements the ClientQuotaCallback interface, which is used to determine quota limits applied to client requests. By default, , or quotas stored in ZooKeeper are applied. For any given request, the most specific quota that matches the user principal of the session and the client-id of the request is applied.

Type: class — **Default**: null — **Valid Values**: — **Importance**: low — **Update Mode**: read-only

---

connection.failed.authentication.delay.ms: Connection close delay on failed authentication: this is the time (in milliseconds) by which connection close will be delayed on authentication failure. This must be configured to be less than connections.max.idle.ms to prevent connection timeout.

Type: int — **Default**: 100 — **Valid Values**: [0,...] — **Importance**: low — **Update Mode**: read-only

---

create.topic.policy.class.name: The create topic policy class that should be used for validation. The class should implement the `org.apache.kafka.server.policy.CreateTopicPolicy` interface.

Type: class — **Default**: null — **Valid Values**: — **Importance**: low — **Update Mode**: read-only

---

delegation.token.expiry.check.interval.ms: Scan interval to remove expired delegation tokens.

Type: long — **Default**: 3600000 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

kafka.metrics.polling.interval.secs: The metrics polling interval (in seconds) which can be used in kafka.metrics.reporters implementations.

Type: int — **Default**: 10 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

kafka.metrics.reporters: A list of classes to use as Yammer metrics custom reporters. The reporters should implement `kafka.metrics.KafkaMetricsReporter` trait. If a client wants to expose JMX operations on a custom reporter, the custom reporter needs to additionally implement an MBean trait that extends `kafka.metrics.KafkaMetricsReporterMBean` trait so that the registered MBean is compliant with the standard MBean convention.

Type: list — **Default**: "" — **Valid Values**: — **Importance**: low — **Update Mode**: read-only

---

listener.security.protocol.map: Map between listener names and security protocols. This must be defined for the same security protocol to be usable in more than one port or IP. For example, internal and external traffic can be separated even if SSL is required for both. Concretely, the user could define listeners with names INTERNAL and EXTERNAL and this property as: `INTERNAL:SSL,EXTERNAL:SSL`. As shown, key and value are separated by a colon and map entries are separated by commas. Each listener name should only appear once in the map. Different security (SSL and SASL) settings can be configured for each listener by adding a normalised prefix (the listener name is lowercased) to the config name. For example, to set a different keystore for the INTERNAL listener, a config with name `listener.name.internal.ssl.keystore.location` would be set. If the config for the listener name is not set, the config will fallback to the generic config (i.e. `ssl.keystore.location`).

Type: string — **Default**: PLAINTEXT:PLAINTEXT,SSL:SSL,SASL_PLAINTEXT:SASL_PLAINTEXT,SASL_SSL:SASL_SSL — **Valid Values**: — **Importance**: low — **Update Mode**: per-broker

---

log.message.downconversion.enable: This configuration controls whether down-conversion of message formats is enabled to satisfy consume requests. When set to `false`, broker will not perform down-conversion for consumers expecting an older message format. The broker responds with `UNSUPPORTED_VERSION` error for consume requests from such older clients. This configurationdoes not apply to any message format conversion that might be required for replication to followers.

Type: boolean — **Default**: true — **Valid Values**: — **Importance**: low — **Update Mode**: cluster-wide

---

metric.reporters: A list of classes to use as metrics reporters. Implementing the `org.apache.kafka.common.metrics.MetricsReporter` interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

Type: list — **Default**: "" — **Valid Values**: — **Importance**: low — **Update Mode**: cluster-wide

---

metrics.num.samples: The number of samples maintained to compute metrics.

Type: int — **Default**: 2 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

metrics.recording.level: The highest recording level for metrics.

Type: string — **Default**: INFO — **Valid Values**: — **Importance**: low — **Update Mode**: read-only

---

metrics.sample.window.ms: The window of time a metrics sample is computed over.

Type: long — **Default**: 30000 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

password.encoder.cipher.algorithm: The Cipher algorithm used for encoding dynamically configured passwords.

Type: string — **Default**: AES/CBC/PKCS5Padding — **Valid Values**: — **Importance**: low — **Update Mode**: read-only

---

password.encoder.iterations: The iteration count used for encoding dynamically configured passwords.

Type: int — **Default**: 4096 — **Valid Values**: [1024,...] — **Importance**: low — **Update Mode**: read-only

---

password.encoder.key.length: The key length used for encoding dynamically configured passwords.

Type: int — **Default**: 128 — **Valid Values**: [8,...] — **Importance**: low — **Update Mode**: read-only

---

password.encoder.keyfactory.algorithm: The SecretKeyFactory algorithm used for encoding dynamically configured passwords. Default is PBKDF2WithHmacSHA512 if available and PBKDF2WithHmacSHA1 otherwise.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low — **Update Mode**: read-only

---

quota.window.num: The number of samples to retain in memory for client quotas

Type: int — **Default**: 11 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

quota.window.size.seconds: The time span of each sample for client quotas

Type: int — **Default**: 1 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

replication.quota.window.num: The number of samples to retain in memory for replication quotas

Type: int — **Default**: 11 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

replication.quota.window.size.seconds: The time span of each sample for replication quotas

Type: int — **Default**: 1 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

security.providers: A list of configurable creator classes each returning a provider implementing security algorithms. These classes should implement the `org.apache.kafka.common.security.auth.SecurityProviderCreator` interface.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low — **Update Mode**: read-only

---

ssl.endpoint.identification.algorithm: The endpoint identification algorithm to validate server hostname using server certificate.

Type: string — **Default**: https — **Valid Values**: — **Importance**: low — **Update Mode**: per-broker

---

ssl.principal.mapping.rules: A list of rules for mapping from distinguished name from the client certificate to short name. The rules are evaluated in order and the first rule that matches a principal name is used to map it to a short name. Any later rules in the list are ignored.

By default, distinguished name of the X.500 certificate will be the principal. For more details on the format please see security authorization and acls. Note that this configuration is ignored if an extension of KafkaPrincipalBuilder is provided by the `principal.builder.class` configuration.

Type: string — **Default**: DEFAULT — **Valid Values**: — **Importance**: low — **Update Mode**: read-only

---

ssl.secure.random.implementation: The SecureRandom PRNG implementation to use for SSL cryptography operations.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low — **Update Mode**: per-broker

---

transaction.abort.timed.out.transaction.cleanup.interval.ms: The interval at which to rollback transactions that have timed out

Type: int — **Default**: 60000 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

transaction.remove.expired.transaction.cleanup.interval.ms: The interval at which to remove transactions that have expired due to `transactional.id.expiration.ms` passing

Type: int — **Default**: 3600000 — **Valid Values**: [1,...] — **Importance**: low — **Update Mode**: read-only

---

zookeeper.sync.time.ms: How far a ZK follower can be behind a ZK leader

Type: int — **Default**: 2000 — **Valid Values**: — **Importance**: low — **Update Mode**: read-only

---

More details about broker configuration can be found in the scala class `kafka.server.KafkaConfig`.

3.1.1 Updating Broker Configs

From Kafka version 1.1 onwards, some of the broker configs can be updated without restarting the broker. See the `Dynamic Update Mode` column in Broker Configs for the update mode of each broker config.

- `read-only` : Requires a broker restart for update
- `per-broker` : May be updated dynamically for each broker
- `cluster-wide` : May be updated dynamically as a cluster-wide default. May also be updated as a per-broker value for testing.

To alter the current broker configs for broker id 0 (for example, the number of log cleaner threads):

```
> bin/kafka-configs.sh --bootstrap-server localhost:9092 --entity-type brokers --entity-name 0 --alter --add-c
```

To describe the current dynamic broker configs for broker id 0:

```
> bin/kafka-configs.sh --bootstrap-server localhost:9092 --entity-type brokers --entity-name 0 --describe
```

To delete a config override and revert to the statically configured or default value for broker id 0 (for example, the number of log cleaner threads):

```
> bin/kafka-configs.sh --bootstrap-server localhost:9092 --entity-type brokers --entity-name 0 --alter --delet
```

Some configs may be configured as a cluster-wide default to maintain consistent values across the whole cluster. All brokers in the cluster will process the cluster default update. For example, to update log cleaner threads on all brokers:

```
> bin/kafka-configs.sh --bootstrap-server localhost:9092 --entity-type brokers --entity-default --alter --add-
```

To describe the currently configured dynamic cluster-wide default configs:

```
> bin/kafka-configs.sh --bootstrap-server localhost:9092 --entity-type brokers --entity-default --describe
```

All configs that are configurable at cluster level may also be configured at per-broker level (e.g. for testing). If a config value is defined at different levels, the following order of precedence is used:

- Dynamic per-broker config stored in ZooKeeper
- Dynamic cluster-wide default config stored in ZooKeeper
- Static broker config from `server.properties`
- Kafka default, see broker configs

Updating Password Configs Dynamically

Password config values that are dynamically updated are encrypted before storing in ZooKeeper. The broker config `password.encoder.secret` must be configured in `server.properties` to enable dynamic update of password configs. The secret may be different on different brokers.

The secret used for password encoding may be rotated with a rolling restart of brokers. The old secret used for encoding passwords currently in ZooKeeper must be provided in the static broker config `password.encoder.old.secret` and the new secret must be provided in `password.encoder.secret`. All dynamic password configs stored in ZooKeeper will be re-encoded with the new secret when the broker starts up.

In Kafka 1.1.x, all dynamically updated password configs must be provided in every alter request when updating configs using `kafka-configs.sh` even if the password config is not being altered. This constraint will be removed in a future release.

Updating Password Configs in ZooKeeper Before Starting Brokers

From Kafka 2.0.0 onwards, `kafka-configs.sh` enables dynamic broker configs to be updated using ZooKeeper before starting brokers for bootstrapping. This enables all password configs to be stored in encrypted form, avoiding the need for clear passwords in `server.properties`. The broker config `password.encoder.secret` must also be specified if any password configs are included in the alter command. Additional encryption parameters may also be specified. Password encoder configs will not be persisted in ZooKeeper. For example, to store SSL key password for listener `INTERNAL` on broker 0:

```
> bin/kafka-configs.sh --zookeeper localhost:2181 --entity-type brokers --entity-name 0 --alter --add-config
  'listener.name.internal.ssl.key.password=key-password,password.encoder.secret=secret,password.encoder.iterat
```

The configuration `listener.name.internal.ssl.key.password` will be persisted in ZooKeeper in encrypted form using the provided encoder configs. The encoder secret and iterations are not persisted in ZooKeeper.

Updating SSL Keystore of an Existing Listener

Brokers may be configured with SSL keystores with short validity periods to reduce the risk of compromised certificates. Keystores may be updated dynamically without restarting the broker. The config name must be prefixed with the listener prefix `listener.name.{listenerName}.` so that only the keystore config of a specific listener is updated. The following configs may be updated in a single alter request at per-broker level:

- `ssl.keystore.type`
- `ssl.keystore.location`
- `ssl.keystore.password`
- `ssl.key.password`

If the listener is the inter-broker listener, the update is allowed only if the new keystore is trusted by the truststore configured for that listener. For other listeners, no trust validation is performed on the keystore by the broker. Certificates must be signed by the same certificate authority that signed the old certificate to avoid any client authentication failures.

Updating SSL Truststore of an Existing Listener

Broker truststores may be updated dynamically without restarting the broker to add or remove certificates. Updated truststore will be used to authenticate new client connections. The config name must be prefixed with the listener prefix `listener.name.{listenerName}.` so that only the truststore config of a specific listener is updated. The following configs may be updated in a single alter request at per-broker level:

- `ssl.truststore.type`
- `ssl.truststore.location`
- `ssl.truststore.password`

If the listener is the inter-broker listener, the update is allowed only if the existing keystore for that listener is trusted by the new truststore. For other listeners, no trust validation is performed by the broker before the update. Removal of CA certificates used to sign client certificates from the new truststore can lead to client authentication failures.

Updating Default Topic Configuration

Default topic configuration options used by brokers may be updated without broker restart. The configs are applied to topics without a topic config override for the equivalent per-topic config. One or more of these configs may be overridden at cluster-default level used by all brokers.

- `log.segment.bytes`
- `log.roll.ms`
- `log.roll.hours`
- `log.roll.jitter.ms`
- `log.roll.jitter.hours`
- `log.index.size.max.bytes`
- `log.flush.interval.messages`
- `log.flush.interval.ms`
- `log.retention.bytes`
- `log.retention.ms`
- `log.retention.minutes`
- `log.retention.hours`
- `log.index.interval.bytes`
- `log.cleaner.delete.retention.ms`
- `log.cleaner.min.compaction.lag.ms`
- `log.cleaner.max.compaction.lag.ms`
- `log.cleaner.min.cleanable.ratio`
- `log.cleanup.policy`
- `log.segment.delete.delay.ms`
- `unclean.leader.election.enable`
- `min.insync.replicas`
- `max.message.bytes`
- `compression.type`
- `log.preallocate`
- `log.message.timestamp.type`
- `log.message.timestamp.difference.max.ms`

From Kafka version 2.0.0 onwards, unclean leader election is automatically enabled by the controller when the config `unclean.leader.election.enable` is dynamically updated. In Kafka version 1.1.x, changes to `unclean.leader.election.enable` take effect only when a new controller is elected. Controller re-election may be forced by running:

```
> bin/zookeeper-shell.sh localhost
rmr /controller
```

Updating Log Cleaner Configs

Log cleaner configs may be updated dynamically at cluster-default level used by all brokers. The changes take effect on the next iteration of log cleaning. One or more of these configs may be updated:

- `log.cleaner.threads`
- `log.cleaner.io.max.bytes.per.second`
- `log.cleaner.dedupe.buffer.size`
- `log.cleaner.io.buffer.size`
- `log.cleaner.io.buffer.load.factor`
- `log.cleaner.backoff.ms`

Updating Thread Configs

The size of various thread pools used by the broker may be updated dynamically at cluster-default level used by all brokers. Updates are restricted to the range `currentSize / 2` to `currentSize * 2` to ensure that config updates are handled gracefully.

- `num.network.threads`

- `num.io.threads`
- `num.replica.fetchers`
- `num.recovery.threads.per.data.dir`
- `log.cleaner.threads`
- `background.threads`

Updating ConnectionQuota Configs

The maximum number of connections allowed for a given IP/host by the broker may be updated dynamically at cluster-default level used by all brokers. The changes will apply for new connection creations and the existing connections count will be taken into account by the new limits.

- `max.connections.per.ip`
- `max.connections.per.ip.overrides`

Adding and Removing Listeners

Listeners may be added or removed dynamically. When a new listener is added, security configs of the listener must be provided as listener configs with the listener prefix `listener.name.{listenerName}.` . If the new listener uses SASL, the JAAS configuration of the listener must be provided using the JAAS configuration property `sasl.jaas.config` with the listener and mechanism prefix. See JAAS configuration for Kafka brokers for details.

In Kafka version 1.1.x, the listener used by the inter-broker listener may not be updated dynamically. To update the inter-broker listener to a new listener, the new listener may be added on all brokers without restarting the broker. A rolling restart is then required to update `inter.broker.listener.name` .

In addition to all the security configs of new listeners, the following configs may be updated dynamically at per-broker level:

- `listeners`
- `advertised.listeners`
- `listener.security.protocol.map`

Inter-broker listener must be configured using the static broker configuration `inter.broker.listener.name` or `inter.broker.security.protocol` .

3.2 Topic-Level Configs

Configurations pertinent to topics have both a server default as well an optional per-topic override. If no per-topic configuration is given the server default is used. The override can be set at topic creation time by giving one or more `--config` options. This example creates a topic named *my-topic* with a custom max message size and flush rate:

```
> bin/kafka-topics.sh --bootstrap-server localhost:9092 --create --topic my-topic --partitions 1 \
    --replication-factor 1 --config max.message.bytes=64000 --config flush.messages=1
```

Overrides can also be changed or set later using the alter configs command. This example updates the max message size for *my-topic*:

```
> bin/kafka-configs.sh --zookeeper localhost:2181 --entity-type topics --entity-name my-topic
    --alter --add-config max.message.bytes=128000
```

To check overrides set on the topic you can do

```
> bin/kafka-configs.sh --zookeeper localhost:2181 --entity-type topics --entity-name my-topic --describe
```

To remove an override you can do

```
> bin/kafka-configs.sh --zookeeper localhost:2181  --entity-type topics --entity-name my-topic
    --alter --delete-config max.message.bytes
```

The following are the topic-level configurations. The server's default configuration for this property is given under the Server Default Property heading. A given server default config value only applies to a topic if it does not have an explicit topic config override.

> **cleanup.policy**: A string that is either "delete" or "compact" or both. This string designates the retention policy to use on old log segments. The default policy ("delete") will discard old segments when their retention time or size limit has been reached. The "compact" setting will enable log compaction on the topic.

Type: list — **Default**: delete — **Valid Values**: [compact, delete] — **Server Default Property**: log.cleanup.policy — **Importance**: medium

---

compression.type: Specify the final compression type for a given topic. This configuration accepts the standard compression codecs ('gzip', 'snappy', 'lz4', 'zstd'). It additionally accepts 'uncompressed' which is equivalent to no compression; and 'producer' which means retain the original compression codec set by the producer.

Type: string — **Default**: producer — **Valid Values**: [uncompressed, zstd, lz4, snappy, gzip, producer] — **Server Default Property**: compression.type — **Importance**: medium

---

delete.retention.ms: The amount of time to retain delete tombstone markers for log compacted topics. This setting also gives a bound on the time in which a consumer must complete a read if they begin from offset 0 to ensure that they get a valid snapshot of the final stage (otherwise delete tombstones may be collected before they complete their scan).

Type: long — **Default**: 86400000 — **Valid Values**: [0,...] — **Server Default Property**: log.cleaner.delete.retention.ms — **Importance**: medium

---

file.delete.delay.ms: The time to wait before deleting a file from the filesystem

Type: long — **Default**: 60000 — **Valid Values**: [0,...] — **Server Default Property**: log.segment.delete.delay.ms — **Importance**: medium

---

flush.messages: This setting allows specifying an interval at which we will force an fsync of data written to the log. For example if this was set to 1 we would fsync after every message; if it were 5 we would fsync after every five messages. In general we recommend you not set this and use replication for durability and allow the operating system's background flush capabilities as it is more efficient. This setting can be overridden on a per-topic basis (see the per-topic configuration section).

Type: long — **Default**: 9223372036854775807 — **Valid Values**: [0,...] — **Server Default Property**: log.flush.interval.messages — **Importance**: medium

---

flush.ms: This setting allows specifying a time interval at which we will force an fsync of data written to the log. For example if this was set to 1000 we would fsync after 1000 ms had passed. In general we recommend you not set this and use replication for durability and allow the operating system's background flush capabilities as it is more efficient.

Type: long — **Default**: 9223372036854775807 — **Valid Values**: [0,...] — **Server Default Property**: log.flush.interval.ms — **Importance**: medium

---

follower.replication.throttled.replicas: A list of replicas for which log replication should be throttled on the follower side. The list should describe a set of replicas in the form [PartitionId]:[BrokerId],[PartitionId]:[BrokerId]:... or alternatively the wildcard '*' can be used to throttle all replicas for this topic.

Type: list — **Default**: "" — **Valid Values**: [partitionId]:[brokerId],[partitionId]:[brokerId],... — **Server Default Property**: follower.replication.throttled.replicas — **Importance**: medium

---

index.interval.bytes: This setting controls how frequently Kafka adds an index entry to its offset index. The default setting ensures that we index a message roughly every 4096 bytes. More indexing allows reads to jump closer to the exact position in the log but makes the index larger. You probably don't need to change this.

Type: int — **Default**: 4096 — **Valid Values**: [0,...] — **Server Default Property**: log.index.interval.bytes — **Importance**: medium

---

leader.replication.throttled.replicas: A list of replicas for which log replication should be throttled on the leader side. The list should describe a set of replicas in the form [PartitionId]:[BrokerId],[PartitionId]:[BrokerId]:... or alternatively the wildcard '*' can be used to throttle all replicas for this topic.

Type: list — **Default**: "" — **Valid Values**: [partitionId]:[brokerId],[partitionId]:[brokerId],... — **Server Default Property**: leader.replication.throttled.replicas — **Importance**: medium

max.compaction.lag.ms: The maximum time a message will remain ineligible for compaction in the log. Only applicable for logs that are being compacted.

Type: long — **Default**: 9223372036854775807 — **Valid Values**: [1,...] — **Server Default Property**: log.cleaner.max.compaction.lag.ms — **Importance**: medium

---

max.message.bytes: The largest record batch size allowed by Kafka. If this is increased and there are consumers older than 0.10.2, the consumers' fetch size must also be increased so that the they can fetch record batches this large. In the latest message format version, records are always grouped into batches for efficiency. In previous message format versions, uncompressed records are not grouped into batches and this limit only applies to a single record in that case.

Type: int — **Default**: 1000012 — **Valid Values**: [0,...] — **Server Default Property**: message.max.bytes — **Importance**: medium

---

message.format.version: Specify the message format version the broker will use to append messages to the logs. The value should be a valid ApiVersion. Some examples are: 0.8.2, 0.9.0.0, 0.10.0, check ApiVersion for more details. By setting a particular message format version, the user is certifying that all the existing messages on disk are smaller or equal than the specified version. Setting this value incorrectly will cause consumers with older versions to break as they will receive messages with a format that they don't understand.

Type: string — **Default**: 2.4-IV1 — **Valid Values**: [0.8.0, 0.8.1, 0.8.2, 0.9.0, 0.10.0-IV0, 0.10.0-IV1, 0.10.1-IV0, 0.10.1-IV1, 0.10.1-IV2, 0.10.2-IV0, 0.11.0-IV0, 0.11.0-IV1, 0.11.0-IV2, 1.0-IV0, 1.1-IV0, 2.0-IV0, 2.0-IV1, 2.1-IV0, 2.1-IV1, 2.1-IV2, 2.2-IV0, 2.2-IV1, 2.3-IV0, 2.3-IV1, 2.4-IV0, 2.4-IV1] — **Server Default Property**: log.message.format.version — **Importance**: medium

---

message.timestamp.difference.max.ms: The maximum difference allowed between the timestamp when a broker receives a message and the timestamp specified in the message. If message.timestamp.type=CreateTime, a message will be rejected if the difference in timestamp exceeds this threshold. This configuration is ignored if message.timestamp.type=LogAppendTime.

Type: long — **Default**: 9223372036854775807 — **Valid Values**: [0,...] — **Server Default Property**: log.message.timestamp.difference.max.ms — **Importance**: medium

---

message.timestamp.type: Define whether the timestamp in the message is message create time or log append time. The value should be either `CreateTime` or `LogAppendTime`

Type: string — **Default**: CreateTime — **Valid Values**: [CreateTime, LogAppendTime] — **Server Default Property**: log.message.timestamp.type — **Importance**: medium

---

min.cleanable.dirty.ratio: This configuration controls how frequently the log compactor will attempt to clean the log (assuming [log compaction]() is enabled). By default we will avoid cleaning a log where more than 50% of the log has been compacted. This ratio bounds the maximum space wasted in the log by duplicates (at 50% at most 50% of the log could be duplicates). A higher ratio will mean fewer, more efficient cleanings but will mean more wasted space in the log. If the max.compaction.lag.ms or the min.compaction.lag.ms configurations are also specified, then the log compactor considers the log to be eligible for compaction as soon as either: (i) the dirty ratio threshold has been met and the log has had dirty (uncompacted) records for at least the min.compaction.lag.ms duration, or (ii) if the log has had dirty (uncompacted) records for at most the max.compaction.lag.ms period.

Type: double — **Default**: 0.5 — **Valid Values**: [0,...,1] — **Server Default Property**: log.cleaner.min.cleanable.ratio — **Importance**: medium

---

min.compaction.lag.ms: The minimum time a message will remain uncompacted in the log. Only applicable for logs that are being compacted.

Type: long — **Default**: 0 — **Valid Values**: [0,...] — **Server Default Property**: log.cleaner.min.compaction.lag.ms — **Importance**: medium

---

min.insync.replicas: When a producer sets acks to "all" (or "-1"), this configuration 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 (either NotEnoughReplicas or NotEnoughReplicasAfterAppend).
When used together, `min.insync.replicas` and `acks` allow you to enforce greater durability guarantees. A typical scenario would be to create a topic with a replication factor of 3, set `min.insync.replicas` to 2, and produce with `acks` of "all". This will ensure that the producer raises an exception if a majority of replicas do not receive a write.

Type: int — **Default**: 1 — **Valid Values**: [1,...] — **Server Default Property**: min.insync.replicas — **Importance**: medium

---

preallocate: True if we should preallocate the file on disk when creating a new log segment.

Type: boolean — **Default**: false — **Valid Values**: — **Server Default Property**: log.preallocate — **Importance**: medium

---

retention.bytes: This configuration controls the maximum size a partition (which consists of log segments) can grow to before we will discard old log segments to free up space if we are using the "delete" retention policy. By default there is no size limit only a time limit. Since this limit is enforced at the partition level, multiply it by the number of partitions to compute the topic retention in bytes.

Type: long — **Default**: -1 — **Valid Values**: — **Server Default Property**: log.retention.bytes — **Importance**: medium

---

retention.ms: This configuration controls the maximum time we will retain a log before we will discard old log segments to free up space if we are using the "delete" retention policy. This represents an SLA on how soon consumers must read their data. If set to -1, no time limit is applied.

Type: long — **Default**: 604800000 — **Valid Values**: [-1,...] — **Server Default Property**: log.retention.ms — **Importance**: medium

---

segment.bytes: This configuration controls the segment file size for the log. Retention and cleaning is always done a file at a time so a larger segment size means fewer files but less granular control over retention.

Type: int — **Default**: 1073741824 — **Valid Values**: [14,...] — **Server Default Property**: log.segment.bytes — **Importance**: medium

---

segment.index.bytes: This configuration controls the size of the index that maps offsets to file positions. We preallocate this index file and shrink it only after log rolls. You generally should not need to change this setting.

Type: int — **Default**: 10485760 — **Valid Values**: [0,...] — **Server Default Property**: log.index.size.max.bytes — **Importance**: medium

---

segment.jitter.ms: The maximum random jitter subtracted from the scheduled segment roll time to avoid thundering herds of segment rolling

Type: long — **Default**: 0 — **Valid Values**: [0,...] — **Server Default Property**: log.roll.jitter.ms — **Importance**: medium

---

segment.ms: This configuration controls the period of time after which Kafka will force the log to roll even if the segment file isn't full to ensure that retention can delete or compact old data.

Type: long — **Default**: 604800000 — **Valid Values**: [1,...] — **Server Default Property**: log.roll.ms — **Importance**: medium

---

unclean.leader.election.enable: Indicates whether to enable replicas not in the ISR set to be elected as leader as a last resort, even though doing so may result in data loss.

Type: boolean — **Default**: false — **Valid Values**: — **Server Default Property**: unclean.leader.election.enable — **Importance**: medium

---

message.downconversion.enable: This configuration controls whether down-conversion of message formats is enabled to satisfy consume requests. When set to `false`, broker will not perform down-conversion for consumers expecting an older message format. The broker responds with `UNSUPPORTED_VERSION` error for consume requests from such older clients. This configurationdoes not apply to any message format conversion that might be required for replication to followers.

Type: boolean — **Default**: true — **Valid Values**: — **Server Default Property**: log.message.downconversion.enable — **Importance**: low

---

3.3 Producer Configs

Below is the configuration of the producer:

key.serializer: Serializer class for key that implements the `org.apache.kafka.common.serialization.Serializer` interface.

Type: class — **Default**: — **Valid Values**: — **Importance**: high

---

value.serializer: Serializer class for value that implements the `org.apache.kafka.common.serialization.Serializer` interface.

Type: class — **Default**: — **Valid Values**: — **Importance**: high

---

acks: The number of acknowledgments the producer requires the leader to have received before considering a request complete. This controls the durability of records that are sent. The following settings are allowed:

- `acks=0` If set to zero then the producer will not wait for any acknowledgment from the server at all. The record will be immediately added to the socket buffer and considered sent. No guarantee can be made that the server has received the record in this case, and the `retries` configuration will not take effect (as the client won't generally know of any failures). The offset given back for each record will always be set to `-1`.
- `acks=1` This will mean the leader will write the record to its local log but will respond without awaiting full acknowledgement from all followers. In this case should the leader fail immediately after acknowledging the record but before the followers have replicated it then the record will be lost.
- `acks=all` This means the leader will wait for the full set of in-sync replicas to acknowledge the record. This guarantees that the record will not be lost as long as at least one in-sync replica remains alive. This is the strongest available guarantee. This is equivalent to the acks=-1 setting.

Type: string — **Default**: 1 — **Valid Values**: [all, -1, 0, 1] — **Importance**: high

---

bootstrap.servers: A list of host/port pairs to use for establishing the initial connection to the Kafka cluster. The client will make use of all servers irrespective of which servers are specified here for bootstrapping—this list only impacts the initial hosts used to discover the full set of servers. This list should be in the form `host1:port1,host2:port2,...`. Since these servers are just used for the initial connection to discover the full cluster membership (which may change dynamically), this list need not contain the full set of servers (you may want more than one, though, in case a server is down).

Type: list — **Default**: "" — **Valid Values**: non-null string — **Importance**: high

---

buffer.memory: The total bytes of memory the producer can use to buffer records waiting to be sent to the server. If records are sent faster than they can be delivered to the server the producer will block for `max.block.ms` after which it will throw an exception.

This setting should correspond roughly to the total memory the producer will use, but is not a hard bound since not all memory the producer uses is used for buffering. Some additional memory will be used for compression (if compression is enabled) as well as for maintaining in-flight requests.

Type: long — **Default**: 33554432 — **Valid Values**: [0,...] — **Importance**: high

---

compression.type: The compression type for all data generated by the producer. The default is none (i.e. no compression). Valid values are `none`, `gzip`, `snappy`, `lz4`, or `zstd`. Compression is of full batches of data, so the efficacy of batching will also impact the compression ratio (more batching means better compression).

Type: string — **Default**: none — **Valid Values**: — **Importance**: high

---

retries: Setting a value greater than zero will cause the client to resend any record whose send fails with a potentially transient error. Note that this retry is no different than if the client resent the record upon receiving the error. Allowing retries without setting `max.in.flight.requests.per.connection` to 1 will potentially change the ordering of records because if two batches are sent to a single partition, and the first fails and is retried but the second succeeds, then the records in the second batch may appear first. Note additionally that produce requests will be failed before the number of retries has been exhausted if the timeout configured by `delivery.timeout.ms` expires first before successful acknowledgement. Users should generally prefer to leave this config unset and instead use `delivery.timeout.ms` to control retry behavior.

Type: int — **Default**: 2147483647 — **Valid Values**: [0,...,2147483647] — **Importance**: high

---

ssl.key.password: The password of the private key in the key store file. This is optional for client.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.keystore.location: The location of the key store file. This is optional for client and can be used for two-way authentication for client.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.keystore.password: The store password for the key store file. This is optional for client and only needed if ssl.keystore.location is configured.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.truststore.location: The location of the trust store file.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.truststore.password: The password for the trust store file. If a password is not set access to the truststore is still available, but integrity checking is disabled.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

batch.size: The producer will attempt to batch records together into fewer requests whenever multiple records are being sent to the same partition. This helps performance on both the client and the server. This configuration controls the default batch size in bytes.

No attempt will be made to batch records larger than this size.

Requests sent to brokers will contain multiple batches, one for each partition with data available to be sent.

A small batch size will make batching less common and may reduce throughput (a batch size of zero will disable batching entirely). A very large batch size may use memory a bit more wastefully as we will always allocate a buffer of the specified batch size in anticipation of additional records.

Type: int — **Default**: 16384 — **Valid Values**: [0,...] — **Importance**: medium

---

client.dns.lookup: Controls how the client uses DNS lookups. If set to `use_all_dns_ips` then, when the lookup returns multiple IP addresses for a hostname, they will all be attempted to connect to before failing the connection. Applies to both bootstrap and advertised servers. If the value is `resolve_canonical_bootstrap_servers_only` each entry will be resolved and expanded into a list of canonical names.

Type: string — **Default**: default — **Valid Values**: [default, use_all_dns_ips, resolve_canonical_bootstrap_servers_only] — **Importance**: medium

---

client.id: An id string to pass to the server when making requests. The purpose of this is to be able to track the source of requests beyond just ip/port by allowing a logical application name to be included in server-side request logging.

Type: string — **Default**: "" — **Valid Values**: — **Importance**: medium

---

connections.max.idle.ms: Close idle connections after the number of milliseconds specified by this config.

Type: long — **Default**: 540000 — **Valid Values**: — **Importance**: medium

---

delivery.timeout.ms: An upper bound on the time to report success or failure after a call to `send()` returns. This limits the total time that a record will be delayed prior to sending, the time to await acknowledgement from the broker (if expected), and the time allowed for retriable send failures. The producer may report failure to send a record earlier than this config if either an unrecoverable error is encountered, the retries have been exhausted, or the record is added to a batch which reached an earlier delivery expiration deadline. The value of this config should be greater than or equal to the sum of `request.timeout.ms` and `linger.ms`.

Type: int — **Default**: 120000 — **Valid Values**: [0,...] — **Importance**: medium

---

linger.ms: The producer groups together any records that arrive in between request transmissions into a single batched request. Normally this occurs only under load when records arrive faster than they can be sent out. However in some circumstances the client may want to reduce the number of requests even under moderate load. This setting accomplishes this by adding a small amount of artificial delay—that is, rather than immediately sending out a record the producer will wait for up to the given delay to allow other records to be sent so that the sends can be batched together. This can be thought of as analogous to Nagle's algorithm in TCP. This setting gives the upper bound on the delay for batching: once we get `batch.size` worth of records for a partition it will be sent immediately regardless of this setting, however if we have fewer than this many bytes accumulated for this partition we will 'linger' for the specified time waiting for more records to show up. This setting defaults to 0 (i.e. no delay). Setting `linger.ms=5`, for example, would have the effect of reducing the number of requests sent but would add up to 5ms of latency to records sent in the absence of load.

Type: long — **Default**: 0 — **Valid Values**: [0,...] — **Importance**: medium

---

max.block.ms: The configuration controls how long `KafkaProducer.send()` and `KafkaProducer.partitionsFor()` will block.These methods can be blocked either because the buffer is full or metadata unavailable.Blocking in the user-supplied serializers or partitioner will not be counted against this timeout.

Type: long — **Default**: 60000 — **Valid Values**: [0,...] — **Importance**: medium

---

max.request.size: The maximum size of a request in bytes. This setting will limit the number of record batches the producer will send in a single request to avoid sending huge requests. This is also effectively a cap on the maximum record batch size. Note that the server has its own cap on record batch size which may be different from this.

Type: int — **Default**: 1048576 — **Valid Values**: [0,...] — **Importance**: medium

---

partitioner.class: Partitioner class that implements the `org.apache.kafka.clients.producer.Partitioner` interface.

Type: class — **Default**: org.apache.kafka.clients.producer.internals.DefaultPartitioner — **Valid Values**: — **Importance**: medium

---

receive.buffer.bytes: The size of the TCP receive buffer (SO_RCVBUF) to use when reading data. If the value is -1, the OS default will be used.

Type: int — **Default**: 32768 — **Valid Values**: [-1,...] — **Importance**: medium

---

request.timeout.ms: The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted. This should be larger than `replica.lag.time.max.ms` (a broker configuration) to reduce the possibility of message duplication due to unnecessary producer retries.

Type: int — **Default**: 30000 — **Valid Values**: [0,...] — **Importance**: medium

---

sasl.client.callback.handler.class: The fully qualified name of a SASL client callback handler class that implements the AuthenticateCallbackHandler interface.

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.jaas.config: JAAS login context parameters for SASL connections in the format used by JAAS configuration files. JAAS configuration file format is described here. The format for the value is: '`loginModuleClass controlFlag (optionName=optionValue)*;`'. For brokers, the config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.jaas.config=com.example.ScramLoginModule required;

Type: password — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.kerberos.service.name: The Kerberos principal name that Kafka runs as. This can be defined either in Kafka's JAAS config or in Kafka's config.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.login.callback.handler.class: The fully qualified name of a SASL login callback handler class that implements the AuthenticateCallbackHandler interface. For brokers, login callback handler config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.callback.handler.class=com.example.CustomScramLoginCallbackHandler

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.login.class: The fully qualified name of a class that implements the Login interface. For brokers, login config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.class=com.example.CustomScramLogin

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.mechanism: SASL mechanism used for client connections. This may be any mechanism for which a security provider is available. GSSAPI is the default mechanism.

Type: string — **Default**: GSSAPI — **Valid Values**: — **Importance**: medium

---

security.protocol: Protocol used to communicate with brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL.

Type: string — **Default**: PLAINTEXT — **Valid Values**: — **Importance**: medium

---

send.buffer.bytes: The size of the TCP send buffer (SO_SNDBUF) to use when sending data. If the value is -1, the OS default will be used.

Type: int — **Default**: 131072 — **Valid Values**: [-1,...] — **Importance**: medium

---

ssl.enabled.protocols: The list of protocols enabled for SSL connections.

Type: list — **Default**: TLSv1.2,TLSv1.1,TLSv1 — **Valid Values**: — **Importance**: medium

---

ssl.keystore.type: The file format of the key store file. This is optional for client.

Type: string — **Default**: JKS — **Valid Values**: — **Importance**: medium

---

ssl.protocol: The SSL protocol used to generate the SSLContext. Default setting is TLS, which is fine for most cases. Allowed values in recent JVMs are TLS, TLSv1.1 and TLSv1.2. SSL, SSLv2 and SSLv3 may be supported in older JVMs, but their usage is discouraged due to known security vulnerabilities.

Type: string — **Default**: TLS — **Valid Values**: — **Importance**: medium

---

ssl.provider: The name of the security provider used for SSL connections. Default value is the default security provider of the JVM.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

ssl.truststore.type: The file format of the trust store file.

Type: string — **Default**: JKS — **Valid Values**: — **Importance**: medium

---

enable.idempotence: When set to 'true', the producer will ensure that exactly one copy of each message is written in the stream. If 'false', producer retries due to broker failures, etc., may write duplicates of the retried message in the stream. Note that enabling idempotence requires `max.in.flight.requests.per.connection` to be less than or equal to 5, `retries` to be greater than 0 and `acks` must be 'all'. If these values are not explicitly set by the user, suitable values will be chosen. If incompatible values are set, a `ConfigException` will be thrown.

Type: boolean — **Default**: false — **Valid Values**: — **Importance**: low

---

interceptor.classes: A list of classes to use as interceptors. Implementing the `org.apache.kafka.clients.producer.ProducerInterceptor` interface allows you to intercept (and possibly mutate) the records received by the producer before they are published to the Kafka cluster. By default, there are no interceptors.

Type: list — **Default**: "" — **Valid Values**: non-null string — **Importance**: low

---

max.in.flight.requests.per.connection: The maximum number of unacknowledged requests the client will send on a single connection before blocking. Note that if this setting is set to be greater than 1 and there are failed sends, there is a risk of message re-ordering due to retries (i.e., if retries are enabled).

Type: int — **Default**: 5 — **Valid Values**: [1,...] — **Importance**: low

---

metadata.max.age.ms: The period of time in milliseconds after which we force a refresh of metadata even if we haven't seen any partition leadership changes to proactively discover any new brokers or partitions.

Type: long — **Default**: 300000 — **Valid Values**: [0,...] — **Importance**: low

---

metric.reporters: A list of classes to use as metrics reporters. Implementing the `org.apache.kafka.common.metrics.MetricsReporter` interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

Type: list — **Default**: "" — **Valid Values**: non-null string — **Importance**: low

---

metrics.num.samples: The number of samples maintained to compute metrics.

Type: int — **Default**: 2 — **Valid Values**: [1,...] — **Importance**: low

---

metrics.recording.level: The highest recording level for metrics.

Type: string — **Default**: INFO — **Valid Values**: [INFO, DEBUG] — **Importance**: low

---

metrics.sample.window.ms: The window of time a metrics sample is computed over.

Type: long — **Default**: 30000 — **Valid Values**: [0,...] — **Importance**: low

---

reconnect.backoff.max.ms: The maximum amount of time in milliseconds to wait when reconnecting to a broker that has repeatedly failed to connect. If provided, the backoff per host will increase exponentially for each consecutive connection failure, up to this maximum. After calculating the backoff increase, 20% random jitter is added to avoid connection storms.

Type: long — **Default**: 1000 — **Valid Values**: [0,...] — **Importance**: low

---

reconnect.backoff.ms: The base amount of time to wait before attempting to reconnect to a given host. This avoids repeatedly connecting to a host in a tight loop. This backoff applies to all connection attempts by the client to a broker.

Type: long — **Default**: 50 — **Valid Values**: [0,...] — **Importance**: low

---

retry.backoff.ms: The amount of time to wait before attempting to retry a failed request to a given topic partition. This avoids repeatedly sending requests in a tight loop under some failure scenarios.

Type: long — **Default**: 100 — **Valid Values**: [0,...] — **Importance**: low

---

sasl.kerberos.kinit.cmd: Kerberos kinit command path.

Type: string — **Default**: /usr/bin/kinit — **Valid Values**: — **Importance**: low

---

sasl.kerberos.min.time.before.relogin: Login thread sleep time between refresh attempts.

Type: long — **Default**: 60000 — **Valid Values**: — **Importance**: low

---

sasl.kerberos.ticket.renew.jitter: Percentage of random jitter added to the renewal time.

Type: double — **Default**: 0.05 — **Valid Values**: — **Importance**: low

---

sasl.kerberos.ticket.renew.window.factor: Login thread will sleep until the specified window factor of time from last refresh to ticket's expiry has been reached, at which time it will try to renew the ticket.

Type: double — **Default**: 0.8 — **Valid Values**: — **Importance**: low

---

sasl.login.refresh.buffer.seconds: The amount of buffer time before credential expiration to maintain when refreshing a credential, in seconds. If a refresh would otherwise occur closer to expiration than the number of buffer seconds then the refresh will be moved up to maintain as much of the buffer time as possible. Legal values are between 0 and 3600 (1 hour); a default value of 300 (5 minutes) is used if no value is specified. This value and sasl.login.refresh.min.period.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

Type: short — **Default**: 300 — **Valid Values**: [0,...,3600] — **Importance**: low

---

sasl.login.refresh.min.period.seconds: The desired minimum time for the login refresh thread to wait before refreshing a credential, in seconds. Legal values are between 0 and 900 (15 minutes); a default value of 60 (1 minute) is used if no value is specified. This value and sasl.login.refresh.buffer.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

Type: short — **Default**: 60 — **Valid Values**: [0,...,900] — **Importance**: low

---

sasl.login.refresh.window.factor: Login refresh thread will sleep until the specified window factor relative to the credential's lifetime has been reached, at which time it will try to refresh the credential. Legal values are between 0.5 (50%) and 1.0 (100%) inclusive; a default value of 0.8 (80%) is used if no value is specified. Currently applies only to OAUTHBEARER.

Type: double — **Default**: 0.8 — **Valid Values**: [0.5,...,1.0] — **Importance**: low

---

sasl.login.refresh.window.jitter: The maximum amount of random jitter relative to the credential's lifetime that is added to the login refresh thread's sleep time. Legal values are between 0 and 0.25 (25%) inclusive; a default value of 0.05 (5%) is used if no value is specified. Currently applies only to OAUTHBEARER.

Type: double — **Default**: 0.05 — **Valid Values**: [0.0,...,0.25] — **Importance**: low

---

security.providers: A list of configurable creator classes each returning a provider implementing security algorithms. These classes should implement the `org.apache.kafka.common.security.auth.SecurityProviderCreator` interface.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low

---

ssl.cipher.suites: A list of cipher suites. This is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol. By default all the available cipher suites are supported.

Type: list — **Default**: null — **Valid Values**: — **Importance**: low

---

ssl.endpoint.identification.algorithm: The endpoint identification algorithm to validate server hostname using server certificate.

Type: string — **Default**: https — **Valid Values**: — **Importance**: low

---

ssl.keymanager.algorithm: The algorithm used by key manager factory for SSL connections. Default value is the key manager factory algorithm configured for the Java Virtual Machine.

Type: string — **Default**: SunX509 — **Valid Values**: — **Importance**: low

---

ssl.secure.random.implementation: The SecureRandom PRNG implementation to use for SSL cryptography operations.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low

---

ssl.trustmanager.algorithm: The algorithm used by trust manager factory for SSL connections. Default value is the trust manager factory algorithm configured for the Java Virtual Machine.

Type: string — **Default**: PKIX — **Valid Values**: — **Importance**: low

---

transaction.timeout.ms: The maximum amount of time in ms that the transaction coordinator will wait for a transaction status update from the producer before proactively aborting the ongoing transaction.If this value is larger than the transaction.max.timeout.ms setting in the broker, the request will fail with a `InvalidTransactionTimeout` error.

Type: int — **Default**: 60000 — **Valid Values**: — **Importance**: low

---

transactional.id: The TransactionalId to use for transactional delivery. This enables reliability semantics which span multiple producer sessions since it allows the client to guarantee that transactions using the same TransactionalId have been completed prior to starting any new transactions. If no TransactionalId is provided, then the producer is limited to idempotent delivery. Note that `enable.idempotence` must be enabled if a TransactionalId is configured. The default is `null`, which means transactions cannot be used. Note that, by default, transactions require a cluster of at least three brokers which is the recommended setting for production; for development you can change this, by adjusting broker setting `transaction.state.log.replication.factor`.

Type: string — **Default**: null — **Valid Values**: non-empty string — **Importance**: low

---

3.4 Consumer Configs

Below is the configuration for the consumer:

key.deserializer: Deserializer class for key that implements the `org.apache.kafka.common.serialization.Deserializer` interface.

Type: class — **Default**: — **Valid Values**: — **Importance**: high

---

value.deserializer: Deserializer class for value that implements the `org.apache.kafka.common.serialization.Deserializer` interface.

Type: class — **Default**: — **Valid Values**: — **Importance**: high

---

bootstrap.servers: A list of host/port pairs to use for establishing the initial connection to the Kafka cluster. The client will make use of all servers irrespective of which servers are specified here for bootstrapping—this list only impacts the initial hosts used to discover the full set of servers. This list should be in the form `host1:port1,host2:port2,...` . Since these servers are just used for the initial connection to discover the full cluster membership (which may change dynamically), this list need not contain the full set of servers (you may want more than one, though, in case a server is down).

Type: list — **Default**: "" — **Valid Values**: non-null string — **Importance**: high

---

fetch.min.bytes: The minimum amount of data the server should return for a fetch request. If insufficient data is available the request will wait for that much data to accumulate before answering the request. The default setting of 1 byte means that fetch requests are answered as soon as a single byte of data is available or the fetch request times out waiting for data to arrive. Setting this to something greater than 1 will cause the server to wait for larger amounts of data to accumulate which can improve server throughput a bit at the cost of some additional latency.

Type: int — **Default**: 1 — **Valid Values**: [0,...] — **Importance**: high

---

group.id: A unique string that identifies the consumer group this consumer belongs to. This property is required if the consumer uses either the group management functionality by using `subscribe(topic)` or the Kafka-based offset management strategy.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high

---

heartbeat.interval.ms: The expected time between heartbeats to the consumer coordinator when using Kafka's group management facilities. Heartbeats are used to ensure that the consumer's session stays active and to facilitate rebalancing when new consumers join or leave the group. The value must be set lower than `session.timeout.ms` , but typically should be set no higher than 1/3 of that value. It can be adjusted even lower to control the expected time for normal rebalances.

Type: int — **Default**: 3000 — **Valid Values**: — **Importance**: high

---

max.partition.fetch.bytes: The maximum amount of data per-partition the server will return. Records are fetched in batches by the consumer. If the first record batch in the first non-empty partition of the fetch is larger than this limit, the batch will still be returned to ensure that the consumer can make progress. The maximum record batch size accepted by the broker is defined via `message.max.bytes` (broker config) or `max.message.bytes` (topic config). See fetch.max.bytes for limiting the consumer request size.

Type: int — **Default**: 1048576 — **Valid Values**: [0,...] — **Importance**: high

---

session.timeout.ms: The timeout used to detect client failures when using Kafka's group management facility. The client sends periodic heartbeats to indicate its liveness to the broker. If no heartbeats are received by the broker before the expiration of this session timeout, then the broker will remove this client from the group and initiate a rebalance. Note that the value must be in the allowable range as configured in the broker configuration by `group.min.session.timeout.ms` and `group.max.session.timeout.ms` .

Type: int — **Default**: 10000 — **Valid Values**: — **Importance**: high

---

ssl.key.password: The password of the private key in the key store file. This is optional for client.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.keystore.location: The location of the key store file. This is optional for client and can be used for two-way authentication for client.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.keystore.password: The store password for the key store file. This is optional for client and only needed if ssl.keystore.location is configured.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.truststore.location: The location of the trust store file.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.truststore.password: The password for the trust store file. If a password is not set access to the truststore is still available, but integrity checking is disabled.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

allow.auto.create.topics: Allow automatic topic creation on the broker when subscribing to or assigning a topic. A topic being subscribed to will be automatically created only if the broker allows for it using `auto.create.topics.enable` broker configuration. This configuration must be set to `false` when using brokers older than 0.11.0

Type: boolean — **Default**: true — **Valid Values**: — **Importance**: medium

---

auto.offset.reset: What to do when there is no initial offset in Kafka or if the current offset does not exist any more on the server (e.g. because that data has been deleted):

- earliest: automatically reset the offset to the earliest offset
- latest: automatically reset the offset to the latest offset
- none: throw exception to the consumer if no previous offset is found for the consumer's group
- anything else: throw exception to the consumer.

Type: string — **Default**: latest — **Valid Values**: [latest, earliest, none] — **Importance**: medium

---

client.dns.lookup: Controls how the client uses DNS lookups. If set to `use_all_dns_ips` then, when the lookup returns multiple IP addresses for a hostname, they will all be attempted to connect to before failing the connection. Applies to both bootstrap and advertised servers. If the value is `resolve_canonical_bootstrap_servers_only` each entry will be resolved and expanded into a list of canonical names.

Type: string — **Default**: default — **Valid Values**: [default, use_all_dns_ips, resolve_canonical_bootstrap_servers_only] — **Importance**: medium

---

connections.max.idle.ms: Close idle connections after the number of milliseconds specified by this config.

Type: long — **Default**: 540000 — **Valid Values**: — **Importance**: medium

---

default.api.timeout.ms: Specifies the timeout (in milliseconds) for consumer APIs that could block. This configuration is used as the default timeout for all consumer operations that do not explicitly accept a `timeout` parameter.

Type: int — **Default**: 60000 — **Valid Values**: [0,...] — **Importance**: medium

---

enable.auto.commit: If true the consumer's offset will be periodically committed in the background.

Type: boolean — **Default**: true — **Valid Values**: — **Importance**: medium

---

exclude.internal.topics: Whether internal topics matching a subscribed pattern should be excluded from the subscription. It is always possible to explicitly subscribe to an internal topic.

Type: boolean — **Default**: true — **Valid Values**: — **Importance**: medium

---

fetch.max.bytes: The maximum amount of data the server should return for a fetch request. Records are fetched in batches by the consumer, and if the first record batch in the first non-empty partition of the fetch is larger than this value, the record batch will still be returned to ensure that the consumer can make progress. As such, this is not a absolute maximum. The maximum record batch size accepted by the broker is defined via `message.max.bytes` (broker config) or `max.message.bytes` (topic config). Note that the consumer performs multiple fetches in parallel.

Type: int — **Default**: 52428800 — **Valid Values**: [0,...] — **Importance**: medium

---

group.instance.id: A unique identifier of the consumer instance provided by the end user. Only non-empty strings are permitted. If set, the consumer is treated as a static member, which means that only one instance with this ID is allowed in the consumer group at any time. This can be used in combination with a larger session timeout to avoid group rebalances caused by transient unavailability (e.g. process restarts). If not set, the consumer will join the group as a dynamic member, which is the traditional behavior.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

isolation.level: Controls how to read messages written transactionally. If set to `read_committed`, consumer.poll() will only return transactional messages which have been committed. If set to `read_uncommitted`' (the default), consumer.poll() will return all messages, even transactional messages which have been aborted. Non-transactional messages will be returned unconditionally in either mode.

Messages will always be returned in offset order. Hence, in `read_committed` mode, consumer.poll() will only return messages up to the last stable offset (LSO), which is the one less than the offset of the first open transaction. In particular any messages appearing after messages belonging to ongoing transactions will be withheld until the relevant transaction has been completed. As a result, `read_committed` consumers will not be able to read up to the high watermark when there are in flight transactions.

Further, when in `read_committed` the seekToEnd method will return the LSO

Type: string — **Default**: read_uncommitted — **Valid Values**: [read_committed, read_uncommitted] — **Importance**: medium

---

max.poll.interval.ms: The maximum delay between invocations of poll() when using consumer group management. This places an upper bound on the amount of time that the consumer can be idle before fetching more records. If poll() is not called before expiration of this timeout, then the consumer is considered failed and the group will rebalance in order to reassign the partitions to another member. For consumers using a non-null `group.instance.id` which reach this timeout, partitions will not be immediately reassigned. Instead, the consumer will stop sending heartbeats and partitions will be reassigned after expiration of `session.timeout.ms`. This mirrors the behavior of a static consumer which has shutdown.

Type: int — **Default**: 300000 — **Valid Values**: [1,...] — **Importance**: medium

---

max.poll.records: The maximum number of records returned in a single call to poll().

Type: int — **Default**: 500 — **Valid Values**: [1,...] — **Importance**: medium

---

partition.assignment.strategy: A list of class names or class types, ordered by preference, of supported assignors responsible for the partition assignment strategy that the client will use to distribute partition ownership amongst consumer instances when group management is used. Implementing the `org.apache.kafka.clients.consumer.ConsumerPartitionAssignor` interface allows you to plug in a custom assignment strategy.

Type: list — **Default**: class org.apache.kafka.clients.consumer.RangeAssignor — **Valid Values**: non-null string — **Importance**: medium

---

receive.buffer.bytes: The size of the TCP receive buffer (SO_RCVBUF) to use when reading data. If the value is -1, the OS default will be used.

Type: int — **Default**: 65536 — **Valid Values**: [-1,...] — **Importance**: medium

---

request.timeout.ms: The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted.

Type: int — **Default**: 30000 — **Valid Values**: [0,...] — **Importance**: medium

---

sasl.client.callback.handler.class: The fully qualified name of a SASL client callback handler class that implements the AuthenticateCallbackHandler interface.

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.jaas.config: JAAS login context parameters for SASL connections in the format used by JAAS configuration files. JAAS configuration file format is described here. The format for the value is: '`loginModuleClass controlFlag (optionName=optionValue)*;`'. For brokers, the config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.jaas.config=com.example.ScramLoginModule required;

Type: password — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.kerberos.service.name: The Kerberos principal name that Kafka runs as. This can be defined either in Kafka's JAAS config or in Kafka's config.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.login.callback.handler.class: The fully qualified name of a SASL login callback handler class that implements the AuthenticateCallbackHandler interface. For brokers, login callback handler config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.callback.handler.class=com.example.CustomScramLoginCallbackHandler

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.login.class: The fully qualified name of a class that implements the Login interface. For brokers, login config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.class=com.example.CustomScramLogin

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.mechanism: SASL mechanism used for client connections. This may be any mechanism for which a security provider is available. GSSAPI is the default mechanism.

Type: string — **Default**: GSSAPI — **Valid Values**: — **Importance**: medium

---

security.protocol: Protocol used to communicate with brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL.

Type: string — **Default**: PLAINTEXT — **Valid Values**: — **Importance**: medium

---

send.buffer.bytes: The size of the TCP send buffer (SO_SNDBUF) to use when sending data. If the value is -1, the OS default will be used.

Type: int — **Default**: 131072 — **Valid Values**: [-1,...] — **Importance**: medium

---

ssl.enabled.protocols: The list of protocols enabled for SSL connections.

Type: list — **Default**: TLSv1.2,TLSv1.1,TLSv1 — **Valid Values**: — **Importance**: medium

---

ssl.keystore.type: The file format of the key store file. This is optional for client.

Type: string — **Default**: JKS — **Valid Values**: — **Importance**: medium

---

ssl.protocol: The SSL protocol used to generate the SSLContext. Default setting is TLS, which is fine for most cases. Allowed values in recent JVMs are TLS, TLSv1.1 and TLSv1.2. SSL, SSLv2 and SSLv3 may be supported in older JVMs, but their usage is discouraged due to known security vulnerabilities.

Type: string — **Default**: TLS — **Valid Values**: — **Importance**: medium

---

ssl.provider: The name of the security provider used for SSL connections. Default value is the default security provider of the JVM.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

ssl.truststore.type: The file format of the trust store file.

Type: string — **Default**: JKS — **Valid Values**: — **Importance**: medium

---

auto.commit.interval.ms: The frequency in milliseconds that the consumer offsets are auto-committed to Kafka if `enable.auto.commit` is set to `true` .

Type: int — **Default**: 5000 — **Valid Values**: [0,...] — **Importance**: low

---

check.crcs: Automatically check the CRC32 of the records consumed. This ensures no on-the-wire or on-disk corruption to the messages occurred. This check adds some overhead, so it may be disabled in cases seeking extreme performance.

Type: boolean — **Default**: true — **Valid Values**: — **Importance**: low

---

client.id: An id string to pass to the server when making requests. The purpose of this is to be able to track the source of requests beyond just ip/port by allowing a logical application name to be included in server-side request logging.

Type: string — **Default**: "" — **Valid Values**: — **Importance**: low

---

client.rack: A rack identifier for this client. This can be any string value which indicates where this client is physically located. It corresponds with the broker config 'broker.rack'

Type: string — **Default**: "" — **Valid Values**: — **Importance**: low

---

fetch.max.wait.ms: The maximum amount of time the server will block before answering the fetch request if there isn't sufficient data to immediately satisfy the requirement given by fetch.min.bytes.

Type: int — **Default**: 500 — **Valid Values**: [0,...] — **Importance**: low

---

interceptor.classes: A list of classes to use as interceptors. Implementing the `org.apache.kafka.clients.consumer.ConsumerInterceptor` interface allows you to intercept (and possibly mutate) records received by the consumer. By default, there are no interceptors.

Type: list — **Default**: "" — **Valid Values**: non-null string — **Importance**: low

---

metadata.max.age.ms: The period of time in milliseconds after which we force a refresh of metadata even if we haven't seen any partition leadership changes to proactively discover any new brokers or partitions.

Type: long — **Default**: 300000 — **Valid Values**: [0,...] — **Importance**: low

---

metric.reporters: A list of classes to use as metrics reporters. Implementing the `org.apache.kafka.common.metrics.MetricsReporter` interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

Type: list — **Default**: "" — **Valid Values**: non-null string — **Importance**: low

---

metrics.num.samples: The number of samples maintained to compute metrics.

Type: int — **Default**: 2 — **Valid Values**: [1,...] — **Importance**: low

---

metrics.recording.level: The highest recording level for metrics.

Type: string — **Default**: INFO — **Valid Values**: [INFO, DEBUG] — **Importance**: low

---

metrics.sample.window.ms: The window of time a metrics sample is computed over.

Type: long — **Default**: 30000 — **Valid Values**: [0,...] — **Importance**: low

---

reconnect.backoff.max.ms: The maximum amount of time in milliseconds to wait when reconnecting to a broker that has repeatedly failed to connect. If provided, the backoff per host will increase exponentially for each consecutive connection failure, up to this maximum. After calculating the backoff increase, 20% random jitter is added to avoid connection storms.

Type: long — **Default**: 1000 — **Valid Values**: [0,...] — **Importance**: low

---

reconnect.backoff.ms: The base amount of time to wait before attempting to reconnect to a given host. This avoids repeatedly connecting to a host in a tight loop. This backoff applies to all connection attempts by the client to a broker.

Type: long — **Default**: 50 — **Valid Values**: [0,...] — **Importance**: low

---

retry.backoff.ms: The amount of time to wait before attempting to retry a failed request to a given topic partition. This avoids repeatedly sending requests in a tight loop under some failure scenarios.

Type: long — **Default**: 100 — **Valid Values**: [0,...] — **Importance**: low

---

sasl.kerberos.kinit.cmd: Kerberos kinit command path.

Type: string — **Default**: /usr/bin/kinit — **Valid Values**: — **Importance**: low

---

sasl.kerberos.min.time.before.relogin: Login thread sleep time between refresh attempts.

Type: long — **Default**: 60000 — **Valid Values**: — **Importance**: low

---

sasl.kerberos.ticket.renew.jitter: Percentage of random jitter added to the renewal time.

Type: double — **Default**: 0.05 — **Valid Values**: — **Importance**: low

---

sasl.kerberos.ticket.renew.window.factor: Login thread will sleep until the specified window factor of time from last refresh to ticket's expiry has been reached, at which time it will try to renew the ticket.

Type: double — **Default**: 0.8 — **Valid Values**: — **Importance**: low

---

sasl.login.refresh.buffer.seconds: The amount of buffer time before credential expiration to maintain when refreshing a credential, in seconds. If a refresh would otherwise occur closer to expiration than the number of buffer seconds then the refresh will be moved up to maintain as much of the buffer time as possible. Legal values are between 0 and 3600 (1 hour); a default value of 300 (5 minutes) is used if no value is specified. This value and sasl.login.refresh.min.period.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

Type: short — **Default**: 300 — **Valid Values**: [0,...,3600] — **Importance**: low

---

sasl.login.refresh.min.period.seconds: The desired minimum time for the login refresh thread to wait before refreshing a credential, in seconds. Legal values are between 0 and 900 (15 minutes); a default value of 60 (1 minute) is used if no value is specified. This value and sasl.login.refresh.buffer.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

Type: short — **Default**: 60 — **Valid Values**: [0,...,900] — **Importance**: low

---

sasl.login.refresh.window.factor: Login refresh thread will sleep until the specified window factor relative to the credential's lifetime has been reached, at which time it will try to refresh the credential. Legal values are between 0.5 (50%) and 1.0 (100%) inclusive; a default value of 0.8 (80%) is used if no value is specified. Currently applies only to OAUTHBEARER.

Type: double — **Default**: 0.8 — **Valid Values**: [0.5,...,1.0] — **Importance**: low

---

sasl.login.refresh.window.jitter: The maximum amount of random jitter relative to the credential's lifetime that is added to the login refresh thread's sleep time. Legal values are between 0 and 0.25 (25%) inclusive; a default value of 0.05 (5%) is used if no value is specified. Currently applies only to OAUTHBEARER.

Type: double — **Default**: 0.05 — **Valid Values**: [0.0,...,0.25] — **Importance**: low

---

security.providers: A list of configurable creator classes each returning a provider implementing security algorithms. These classes should implement the `org.apache.kafka.common.security.auth.SecurityProviderCreator` interface.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low

---

ssl.cipher.suites: A list of cipher suites. This is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol. By default all the available cipher suites are supported.

Type: list — **Default**: null — **Valid Values**: — **Importance**: low

---

ssl.endpoint.identification.algorithm: The endpoint identification algorithm to validate server hostname using server certificate.

Type: string — **Default**: https — **Valid Values**: — **Importance**: low

---

ssl.keymanager.algorithm: The algorithm used by key manager factory for SSL connections. Default value is the key manager factory algorithm configured for the Java Virtual Machine.

Type: string — **Default**: SunX509 — **Valid Values**: — **Importance**: low

---

ssl.secure.random.implementation: The SecureRandom PRNG implementation to use for SSL cryptography operations.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low

---

ssl.trustmanager.algorithm: The algorithm used by trust manager factory for SSL connections. Default value is the trust manager factory algorithm configured for the Java Virtual Machine.

Type: string — **Default**: PKIX — **Valid Values**: — **Importance**: low

---

3.5 Kafka Connect Configs

Below is the configuration of the Kafka Connect framework.

config.storage.topic: The name of the Kafka topic where connector configurations are stored

Type: string — **Default**: — **Valid Values**: — **Importance**: high

---

group.id: A unique string that identifies the Connect cluster group this worker belongs to.

Type: string — **Default**: — **Valid Values**: — **Importance**: high

---

key.converter: Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the keys in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro.

Type: class — **Default**: — **Valid Values**: — **Importance**: high

---

offset.storage.topic: The name of the Kafka topic where connector offsets are stored

Type: string — **Default**: — **Valid Values**: — **Importance**: high

---

status.storage.topic: The name of the Kafka topic where connector and task status are stored

Type: string — **Default**: — **Valid Values**: — **Importance**: high

---

value.converter: Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the values in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro.

Type: class — **Default**: — **Valid Values**: — **Importance**: high

---

bootstrap.servers: A list of host/port pairs to use for establishing the initial connection to the Kafka cluster. The client will make use of all servers irrespective of which servers are specified here for bootstrapping—this list only impacts the initial hosts used to discover the full set of servers. This list should be in the form `host1:port1,host2:port2,...` . Since these servers are just used for the initial connection to discover the full cluster membership (which may change dynamically), this list need not contain the full set of servers (you may want more than one, though, in case a server is down).

Type: list — **Default**: localhost:9092 — **Valid Values**: — **Importance**: high

---

heartbeat.interval.ms: The expected time between heartbeats to the group coordinator when using Kafka's group management facilities. Heartbeats are used to ensure that the worker's session stays active and to facilitate rebalancing when new members join or leave the group. The value must be set lower than `session.timeout.ms` , but typically should be set no higher than 1/3 of that value. It can be adjusted even lower to control the expected time for normal rebalances.

Type: int — **Default**: 3000 — **Valid Values**: — **Importance**: high

---

rebalance.timeout.ms: The maximum allowed time for each worker to join the group once a rebalance has begun. This is basically a limit on the amount of time needed for all tasks to flush any pending data and commit offsets. If the timeout is exceeded, then the worker will be removed from the group, which will cause offset commit failures.

Type: int — **Default**: 60000 — **Valid Values**: — **Importance**: high

---

session.timeout.ms: The timeout used to detect worker failures. The worker sends periodic heartbeats to indicate its liveness to the broker. If no heartbeats are received by the broker before the expiration of this session timeout, then the broker will remove the worker from the group and initiate a rebalance. Note that the value must be in the allowable range as configured in the broker configuration by `group.min.session.timeout.ms` and `group.max.session.timeout.ms`.

Type: int — **Default**: 10000 — **Valid Values**: — **Importance**: high

---

ssl.key.password: The password of the private key in the key store file. This is optional for client.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.keystore.location: The location of the key store file. This is optional for client and can be used for two-way authentication for client.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.keystore.password: The store password for the key store file. This is optional for client and only needed if ssl.keystore.location is configured.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.truststore.location: The location of the trust store file.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.truststore.password: The password for the trust store file. If a password is not set access to the truststore is still available, but integrity checking is disabled.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

client.dns.lookup: Controls how the client uses DNS lookups. If set to `use_all_dns_ips` then, when the lookup returns multiple IP addresses for a hostname, they will all be attempted to connect to before failing the connection. Applies to both bootstrap and advertised servers. If the value is `resolve_canonical_bootstrap_servers_only` each entry will be resolved and expanded into a list of canonical names.

Type: string — **Default**: default — **Valid Values**: [default, use_all_dns_ips, resolve_canonical_bootstrap_servers_only] — **Importance**: medium

---

connections.max.idle.ms: Close idle connections after the number of milliseconds specified by this config.

Type: long — **Default**: 540000 — **Valid Values**: — **Importance**: medium

---

connector.client.config.override.policy: Class name or alias of implementation of `ConnectorClientConfigOverridePolicy`. Defines what client configurations can be overriden by the connector. The default implementation is `None`. The other possible policies in the framework include `All` and `Principal`.

Type: string — **Default**: None — **Valid Values**: — **Importance**: medium

---

receive.buffer.bytes: The size of the TCP receive buffer (SO_RCVBUF) to use when reading data. If the value is -1, the OS default will be used.

Type: int — **Default**: 32768 — **Valid Values**: [0,...] — **Importance**: medium

---

request.timeout.ms: The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted.

Type: int — **Default**: 40000 — **Valid Values**: [0,...] — **Importance**: medium

---

sasl.client.callback.handler.class: The fully qualified name of a SASL client callback handler class that implements the AuthenticateCallbackHandler interface.

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.jaas.config: JAAS login context parameters for SASL connections in the format used by JAAS configuration files. JAAS configuration file format is described [here](). The format for the value is: '`loginModuleClass controlFlag (optionName=optionValue)*;`'. For brokers, the config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.jaas.config=com.example.ScramLoginModule required;

Type: password — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.kerberos.service.name: The Kerberos principal name that Kafka runs as. This can be defined either in Kafka's JAAS config or in Kafka's config.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.login.callback.handler.class: The fully qualified name of a SASL login callback handler class that implements the AuthenticateCallbackHandler interface. For brokers, login callback handler config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.callback.handler.class=com.example.CustomScramLoginCallbackHandler

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.login.class: The fully qualified name of a class that implements the Login interface. For brokers, login config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.class=com.example.CustomScramLogin

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.mechanism: SASL mechanism used for client connections. This may be any mechanism for which a security provider is available. GSSAPI is the default mechanism.

Type: string — **Default**: GSSAPI — **Valid Values**: — **Importance**: medium

---

security.protocol: Protocol used to communicate with brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL.

Type: string — **Default**: PLAINTEXT — **Valid Values**: — **Importance**: medium

---

send.buffer.bytes: The size of the TCP send buffer (SO_SNDBUF) to use when sending data. If the value is -1, the OS default will be used.

Type: int — **Default**: 131072 — **Valid Values**: [0,...] — **Importance**: medium

---

ssl.enabled.protocols: The list of protocols enabled for SSL connections.

Type: list — **Default**: TLSv1.2,TLSv1.1,TLSv1 — **Valid Values**: — **Importance**: medium

---

ssl.keystore.type: The file format of the key store file. This is optional for client.

Type: string — **Default**: JKS — **Valid Values**: — **Importance**: medium

---

ssl.protocol: The SSL protocol used to generate the SSLContext. Default setting is TLS, which is fine for most cases. Allowed values in recent JVMs are TLS, TLSv1.1 and TLSv1.2. SSL, SSLv2 and SSLv3 may be supported in older JVMs, but their usage is discouraged due to known security vulnerabilities.

Type: string — **Default**: TLS — **Valid Values**: — **Importance**: medium

---

ssl.provider: The name of the security provider used for SSL connections. Default value is the default security provider of the JVM.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

ssl.truststore.type: The file format of the trust store file.

Type: string — **Default**: JKS — **Valid Values**: — **Importance**: medium

---

worker.sync.timeout.ms: When the worker is out of sync with other workers and needs to resynchronize configurations, wait up to this amount of time before giving up, leaving the group, and waiting a backoff period before rejoining.

Type: int — **Default**: 3000 — **Valid Values**: — **Importance**: medium

---

worker.unsync.backoff.ms: When the worker is out of sync with other workers and fails to catch up within worker.sync.timeout.ms, leave the Connect cluster for this long before rejoining.

Type: int — **Default**: 300000 — **Valid Values**: — **Importance**: medium

---

access.control.allow.methods: Sets the methods supported for cross origin requests by setting the Access-Control-Allow-Methods header. The default value of the Access-Control-Allow-Methods header allows cross origin requests for GET, POST and HEAD.

Type: string — **Default**: "" — **Valid Values**: — **Importance**: low

---

access.control.allow.origin: Value to set the Access-Control-Allow-Origin header to for REST API requests.To enable cross origin access, set this to the domain of the application that should be permitted to access the API, or '*' to allow access from any domain. The default value only allows access from the domain of the REST API.

Type: string — **Default**: "" — **Valid Values**: — **Importance**: low

---

admin.listeners: List of comma-separated URIs the Admin REST API will listen on. The supported protocols are HTTP and HTTPS. An empty or blank string will disable this feature. The default behavior is to use the regular listener (specified by the 'listeners' property).

Type: list — **Default**: null — **Valid Values**: org.apache.kafka.connect.runtime.WorkerConfig$AdminListenersValidator@51efea79 — **Importance**: low

---

client.id: An id string to pass to the server when making requests. The purpose of this is to be able to track the source of requests beyond just ip/port by allowing a logical application name to be included in server-side request logging.

Type: string — **Default**: "" — **Valid Values**: — **Importance**: low

---

config.providers: Comma-separated names of `ConfigProvider` classes, loaded and used in the order specified. Implementing the interface `ConfigProvider` allows you to replace variable references in connector configurations, such as for externalized secrets.

Type: list — **Default**: "" — **Valid Values**: — **Importance**: low

---

config.storage.replication.factor: Replication factor used when creating the configuration storage topic

Type: short — **Default**: 3 — **Valid Values**: [1,...] — **Importance**: low

---

connect.protocol: Compatibility mode for Kafka Connect Protocol

Type: string — **Default**: sessioned — **Valid Values**: [eager, compatible, sessioned] — **Importance**: low

---

header.converter: HeaderConverter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the header values in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro. By default, the SimpleHeaderConverter is used to serialize header values to strings and deserialize them by inferring the schemas.

Type: class — **Default**: org.apache.kafka.connect.storage.SimpleHeaderConverter — **Valid Values**: — **Importance**: low

---

inter.worker.key.generation.algorithm: The algorithm to use for generating internal request keys

Type: string — **Default**: HmacSHA256 — **Valid Values**: Any KeyGenerator algorithm supported by the worker JVM — **Importance**: low

---

inter.worker.key.size: The size of the key to use for signing internal requests, in bits. If null, the default key size for the key generation algorithm will be used.

Type: int — **Default**: null — **Valid Values**: — **Importance**: low

---

inter.worker.key.ttl.ms: The TTL of generated session keys used for internal request validation (in milliseconds)

Type: int — **Default**: 3600000 — **Valid Values**: [0,...,2147483647] — **Importance**: low

---

inter.worker.signature.algorithm: The algorithm used to sign internal requests

Type: string — **Default**: HmacSHA256 — **Valid Values**: Any MAC algorithm supported by the worker JVM — **Importance**: low

---

inter.worker.verification.algorithms: A list of permitted algorithms for verifying internal requests

Type: list — **Default**: HmacSHA256 — **Valid Values**: A list of one or more MAC algorithms, each supported by the worker JVM — **Importance**: low

---

internal.key.converter: Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the keys in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro. This setting controls the format used for internal bookkeeping data used by the framework, such as configs and offsets, so users can typically use any functioning Converter implementation. Deprecated; will be removed in an upcoming version.

Type: class — **Default**: org.apache.kafka.connect.json.JsonConverter — **Valid Values**: — **Importance**: low

---

internal.value.converter: Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the values in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro. This setting controls the format used for internal bookkeeping data used by the framework, such as configs and offsets, so users can typically use any functioning Converter implementation. Deprecated; will be removed in an upcoming version.

Type: class — **Default**: org.apache.kafka.connect.json.JsonConverter — **Valid Values**: — **Importance**: low

---

listeners: List of comma-separated URIs the REST API will listen on. The supported protocols are HTTP and HTTPS. Specify hostname as 0.0.0.0 to bind to all interfaces. Leave hostname empty to bind to default interface. Examples of legal listener lists: HTTP://myhost:8083,HTTPS://myhost:8084

Type: list — **Default**: null — **Valid Values**: — **Importance**: low

---

metadata.max.age.ms: The period of time in milliseconds after which we force a refresh of metadata even if we haven't seen any partition leadership changes to proactively discover any new brokers or partitions.

Type: long — **Default**: 300000 — **Valid Values**: [0,...] — **Importance**: low

---

metric.reporters: A list of classes to use as metrics reporters. Implementing the `org.apache.kafka.common.metrics.MetricsReporter` interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

Type: list — **Default**: "" — **Valid Values**: — **Importance**: low

---

metrics.num.samples: The number of samples maintained to compute metrics.

Type: int — **Default**: 2 — **Valid Values**: [1,...] — **Importance**: low

---

metrics.recording.level: The highest recording level for metrics.

Type: string — **Default**: INFO — **Valid Values**: [INFO, DEBUG] — **Importance**: low

---

metrics.sample.window.ms: The window of time a metrics sample is computed over.

Type: long — **Default**: 30000 — **Valid Values**: [0,...] — **Importance**: low

---

offset.flush.interval.ms: Interval at which to try committing offsets for tasks.

Type: long — **Default**: 60000 — **Valid Values**: — **Importance**: low

---

offset.flush.timeout.ms: Maximum number of milliseconds to wait for records to flush and partition offset data to be committed to offset storage before cancelling the process and restoring the offset data to be committed in a future attempt.

Type: long — **Default**: 5000 — **Valid Values**: — **Importance**: low

---

offset.storage.partitions: The number of partitions used when creating the offset storage topic

Type: int — **Default**: 25 — **Valid Values**: [1,...] — **Importance**: low

---

offset.storage.replication.factor: Replication factor used when creating the offset storage topic

Type: short — **Default**: 3 — **Valid Values**: [1,...] — **Importance**: low

---

plugin.path: List of paths separated by commas (,) that contain plugins (connectors, converters, transformations). The list should consist of top level directories that include any combination of: a) directories immediately containing jars with plugins and their dependencies b) uber-jars with plugins and their dependencies c) directories immediately containing the package directory structure of classes of plugins and their dependencies Note: symlinks will be followed to discover dependencies or plugins. Examples: plugin.path=/usr/local/share/java,/usr/local/share/kafka/plugins,/opt/connectors

Type: list — **Default**: null — **Valid Values**: — **Importance**: low

---

reconnect.backoff.max.ms: The maximum amount of time in milliseconds to wait when reconnecting to a broker that has repeatedly failed to connect. If provided, the backoff per host will increase exponentially for each consecutive connection failure, up to this maximum. After calculating the backoff increase, 20% random jitter is added to avoid connection storms.

Type: long — **Default**: 1000 — **Valid Values**: [0,...] — **Importance**: low

---

reconnect.backoff.ms: The base amount of time to wait before attempting to reconnect to a given host. This avoids repeatedly connecting to a host in a tight loop. This backoff applies to all connection attempts by the client to a broker.

Type: long — **Default**: 50 — **Valid Values**: [0,...] — **Importance**: low

---

rest.advertised.host.name: If this is set, this is the hostname that will be given out to other workers to connect to.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low

---

rest.advertised.listener: Sets the advertised listener (HTTP or HTTPS) which will be given to other workers to use.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low

---

rest.advertised.port: If this is set, this is the port that will be given out to other workers to connect to.

Type: int — **Default**: null — **Valid Values**: — **Importance**: low

---

rest.extension.classes: Comma-separated names of `ConnectRestExtension` classes, loaded and called in the order specified. Implementing the interface `ConnectRestExtension` allows you to inject into Connect's REST API user defined resources like filters. Typically used to add custom capability like logging, security, etc.

Type: list — **Default**: "" — **Valid Values**: — **Importance**: low

---

rest.host.name: Hostname for the REST API. If this is set, it will only bind to this interface.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low

---

rest.port: Port for the REST API to listen on.

Type: int — **Default**: 8083 — **Valid Values**: — **Importance**: low

---

retry.backoff.ms: The amount of time to wait before attempting to retry a failed request to a given topic partition. This avoids repeatedly sending requests in a tight loop under some failure scenarios.

Type: long — **Default**: 100 — **Valid Values**: [0,...] — **Importance**: low

---

sasl.kerberos.kinit.cmd: Kerberos kinit command path.

Type: string — **Default**: /usr/bin/kinit — **Valid Values**: — **Importance**: low

---

sasl.kerberos.min.time.before.relogin: Login thread sleep time between refresh attempts.

Type: long — **Default**: 60000 — **Valid Values**: — **Importance**: low

---

sasl.kerberos.ticket.renew.jitter: Percentage of random jitter added to the renewal time.

Type: double — **Default**: 0.05 — **Valid Values**: — **Importance**: low

---

sasl.kerberos.ticket.renew.window.factor: Login thread will sleep until the specified window factor of time from last refresh to ticket's expiry has been reached, at which time it will try to renew the ticket.

Type: double — **Default**: 0.8 — **Valid Values**: — **Importance**: low

---

sasl.login.refresh.buffer.seconds: The amount of buffer time before credential expiration to maintain when refreshing a credential, in seconds. If a refresh would otherwise occur closer to expiration than the number of buffer seconds then the refresh will be moved up to maintain as much of the buffer time as possible. Legal values are between 0 and 3600 (1 hour); a default value of 300 (5 minutes) is used if no value is specified. This value and sasl.login.refresh.min.period.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

Type: short — **Default**: 300 — **Valid Values**: [0,...,3600] — **Importance**: low

---

sasl.login.refresh.min.period.seconds: The desired minimum time for the login refresh thread to wait before refreshing a credential, in seconds. Legal values are between 0 and 900 (15 minutes); a default value of 60 (1 minute) is used if no value is specified. This value and sasl.login.refresh.buffer.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

Type: short — **Default**: 60 — **Valid Values**: [0,...,900] — **Importance**: low

---

sasl.login.refresh.window.factor: Login refresh thread will sleep until the specified window factor relative to the credential's lifetime has been reached, at which time it will try to refresh the credential. Legal values are between 0.5 (50%) and 1.0 (100%) inclusive; a default value of 0.8 (80%) is used if no value is specified. Currently applies only to OAUTHBEARER.

Type: double — **Default**: 0.8 — **Valid Values**: [0.5,...,1.0] — **Importance**: low

---

sasl.login.refresh.window.jitter: The maximum amount of random jitter relative to the credential's lifetime that is added to the login refresh thread's sleep time. Legal values are between 0 and 0.25 (25%) inclusive; a default value of 0.05 (5%) is used if no value is specified. Currently applies only to OAUTHBEARER.

Type: double — **Default**: 0.05 — **Valid Values**: [0.0,...,0.25] — **Importance**: low

---

scheduled.rebalance.max.delay.ms: The maximum delay that is scheduled in order to wait for the return of one or more departed workers before rebalancing and reassigning their connectors and tasks to the group. During this period the connectors and tasks of the departed workers remain unassigned

Type: int — **Default**: 300000 — **Valid Values**: [0,...,2147483647] — **Importance**: low

---

ssl.cipher.suites: A list of cipher suites. This is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol. By default all the available cipher suites are supported.

Type: list — **Default**: null — **Valid Values**: — **Importance**: low

---

ssl.client.auth: Configures kafka broker to request client authentication. The following settings are common:

- `ssl.client.auth=required` If set to required client authentication is required.
- `ssl.client.auth=requested` This means client authentication is optional. unlike requested , if this option is set client can choose not to provide authentication information about itself
- `ssl.client.auth=none` This means client authentication is not needed.

Type: string — **Default**: none — **Valid Values**: — **Importance**: low

---

ssl.endpoint.identification.algorithm: The endpoint identification algorithm to validate server hostname using server certificate.

Type: string — **Default**: https — **Valid Values**: — **Importance**: low

---

ssl.keymanager.algorithm: The algorithm used by key manager factory for SSL connections. Default value is the key manager factory algorithm configured for the Java Virtual Machine.

Type: string — **Default**: SunX509 — **Valid Values**: — **Importance**: low

---

ssl.secure.random.implementation: The SecureRandom PRNG implementation to use for SSL cryptography operations.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low

---

ssl.trustmanager.algorithm: The algorithm used by trust manager factory for SSL connections. Default value is the trust manager factory algorithm configured for the Java Virtual Machine.

Type: string — **Default**: PKIX — **Valid Values**: — **Importance**: low

---

status.storage.partitions: The number of partitions used when creating the status storage topic

Type: int — **Default**: 5 — **Valid Values**: [1,...] — **Importance**: low

---

status.storage.replication.factor: Replication factor used when creating the status storage topic

Type: short — **Default**: 3 — **Valid Values**: [1,...] — **Importance**: low

---

task.shutdown.graceful.timeout.ms: Amount of time to wait for tasks to shutdown gracefully. This is the total amount of time, not per task. All task have shutdown triggered, then they are waited on sequentially.

Type: long — **Default**: 5000 — **Valid Values**: — **Importance**: low

---

3.5.1 Source Connector Configs

Below is the configuration of a source connector.

name: Globally unique name to use for this connector.

Type: string — **Default**: — **Valid Values**: non-empty string without ISO control characters — **Importance**: high

---

connector.class: Name or alias of the class for this connector. Must be a subclass of org.apache.kafka.connect.connector.Connector. If the connector is org.apache.kafka.connect.file.FileStreamSinkConnector, you can either specify this full name, or use "FileStreamSink" or "FileStreamSinkConnector" to make the configuration a bit shorter

Type: string — **Default**: — **Valid Values**: — **Importance**: high

---

tasks.max: Maximum number of tasks to use for this connector.

Type: int — **Default**: 1 — **Valid Values**: [1,...] — **Importance**: high

---

key.converter: Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the keys in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro.

Type: class — **Default**: null — **Valid Values**: — **Importance**: low

---

value.converter: Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the values in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro.

Type: class — **Default**: null — **Valid Values**: — **Importance**: low

---

header.converter: HeaderConverter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the header values in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro. By default, the SimpleHeaderConverter is used to serialize header values to strings and deserialize them by inferring the schemas.

Type: class — **Default**: null — **Valid Values**: — **Importance**: low

---

config.action.reload: The action that Connect should take on the connector when changes in external configuration providers result in a change in the connector's configuration properties. A value of 'none' indicates that Connect will do nothing. A value of 'restart' indicates that Connect should restart/reload the connector with the updated configuration properties.The restart may actually be scheduled in the future if the external configuration provider indicates that a configuration value will expire in the future.

Type: string — **Default**: restart — **Valid Values**: [none, restart] — **Importance**: low

---

transforms: Aliases for the transformations to be applied to records.

Type: list — **Default**: "" — **Valid Values**: non-null string, unique transformation aliases — **Importance**: low

---

errors.retry.timeout: The maximum duration in milliseconds that a failed operation will be reattempted. The default is 0, which means no retries will be attempted. Use -1 for infinite retries.

Type: long — **Default**: 0 — **Valid Values**: — **Importance**: medium

---

errors.retry.delay.max.ms: The maximum duration in milliseconds between consecutive retry attempts. Jitter will be added to the delay once this limit is reached to prevent thundering herd issues.

Type: long — **Default**: 60000 — **Valid Values**: — **Importance**: medium

---

errors.tolerance: Behavior for tolerating errors during connector operation. 'none' is the default value and signals that any error will result in an immediate connector task failure; 'all' changes the behavior to skip over problematic records.

Type: string — **Default**: none — **Valid Values**: [none, all] — **Importance**: medium

---

errors.log.enable: If true, write each error and the details of the failed operation and problematic record to the Connect application log. This is 'false' by default, so that only errors that are not tolerated are reported.

Type: boolean — **Default**: false — **Valid Values**: — **Importance**: medium

---

errors.log.include.messages: Whether to the include in the log the Connect record that resulted in a failure. This is 'false' by default, which will prevent record keys, values, and headers from being written to log files, although some information such as topic and partition number will still be logged.

Type: boolean — **Default**: false — **Valid Values**: — **Importance**: medium

---

3.5.2 Sink Connector Configs

Below is the configuration of a sink connector.

name: Globally unique name to use for this connector.

Type: string — **Default**: — **Valid Values**: non-empty string without ISO control characters — **Importance**: high

---

connector.class: Name or alias of the class for this connector. Must be a subclass of org.apache.kafka.connect.connector.Connector. If the connector is org.apache.kafka.connect.file.FileStreamSinkConnector, you can either specify this full name, or use "FileStreamSink" or "FileStreamSinkConnector" to make the configuration a bit shorter

Type: string — **Default**: — **Valid Values**: — **Importance**: high

---

tasks.max: Maximum number of tasks to use for this connector.

Type: int — **Default**: 1 — **Valid Values**: [1,...] — **Importance**: high

---

topics: List of topics to consume, separated by commas

Type: list — **Default**: "" — **Valid Values**: — **Importance**: high

---

topics.regex: Regular expression giving topics to consume. Under the hood, the regex is compiled to a `java.util.regex.Pattern`. Only one of topics or topics.regex should be specified.

Type: string — **Default**: "" — **Valid Values**: valid regex — **Importance**: high

---

key.converter: Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the keys in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro.

Type: class — **Default**: null — **Valid Values**: — **Importance**: low

---

value.converter: Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the values in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro.

Type: class — **Default**: null — **Valid Values**: — **Importance**: low

---

header.converter: HeaderConverter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the header values in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro. By default, the SimpleHeaderConverter is used to serialize header values to strings and deserialize them by inferring the schemas.

Type: class — **Default**: null — **Valid Values**: — **Importance**: low

---

config.action.reload: The action that Connect should take on the connector when changes in external configuration providers result in a change in the connector's configuration properties. A value of 'none' indicates that Connect will do nothing. A value of 'restart' indicates that Connect should restart/reload the connector with the updated configuration properties.The restart may actually be scheduled in the future if the external configuration provider indicates that a configuration value will expire in the future.

Type: string — **Default**: restart — **Valid Values**: [none, restart] — **Importance**: low

---

transforms: Aliases for the transformations to be applied to records.

Type: list — **Default**: "" — **Valid Values**: non-null string, unique transformation aliases — **Importance**: low

---

errors.retry.timeout: The maximum duration in milliseconds that a failed operation will be reattempted. The default is 0, which means no retries will be attempted. Use -1 for infinite retries.

Type: long — **Default**: 0 — **Valid Values**: — **Importance**: medium

---

errors.retry.delay.max.ms: The maximum duration in milliseconds between consecutive retry attempts. Jitter will be added to the delay once this limit is reached to prevent thundering herd issues.

Type: long — **Default**: 60000 — **Valid Values**: — **Importance**: medium

---

errors.tolerance: Behavior for tolerating errors during connector operation. 'none' is the default value and signals that any error will result in an immediate connector task failure; 'all' changes the behavior to skip over problematic records.

Type: string — **Default**: none — **Valid Values**: [none, all] — **Importance**: medium

---

errors.log.enable: If true, write each error and the details of the failed operation and problematic record to the Connect application log. This is 'false' by default, so that only errors that are not tolerated are reported.

Type: boolean — **Default**: false — **Valid Values**: — **Importance**: medium

---

errors.log.include.messages: Whether to the include in the log the Connect record that resulted in a failure. This is 'false' by default, which will prevent record keys, values, and headers from being written to log files, although some information such as topic and partition number will still be logged.

Type: boolean — **Default**: false — **Valid Values**: — **Importance**: medium

---

errors.deadletterqueue.topic.name: The name of the topic to be used as the dead letter queue (DLQ) for messages that result in an error when processed by this sink connector, or its transformations or converters. The topic name is blank by default, which means that no messages are to be recorded in the DLQ.

Type: string — **Default**: "" — **Valid Values**: — **Importance**: medium

---

errors.deadletterqueue.topic.replication.factor: Replication factor used to create the dead letter queue topic when it doesn't already exist.

Type: short — **Default**: 3 — **Valid Values**: — **Importance**: medium

---

errors.deadletterqueue.context.headers.enable: If true, add headers containing error context to the messages written to the dead letter queue. To avoid clashing with headers from the original record, all error context header keys, all error context header keys will start with `__connect.errors.`

Type: boolean — **Default**: false — **Valid Values**: — **Importance**: medium

---

3.6 Kafka Streams Configs

Below is the configuration of the Kafka Streams client library.

application.id: An identifier for the stream processing application. Must be unique within the Kafka cluster. It is used as 1) the default client-id prefix, 2) the group-id for membership management, 3) the changelog topic prefix.

Type: string — **Default**: — **Valid Values**: — **Importance**: high

---

bootstrap.servers: A list of host/port pairs to use for establishing the initial connection to the Kafka cluster. The client will make use of all servers irrespective of which servers are specified here for bootstrapping—this list only impacts the initial hosts used to discover the full set of servers. This list should be in the form `host1:port1,host2:port2,...`. Since these servers are just used for the initial connection to discover the full cluster membership (which may change dynamically), this list need not contain the full set of servers (you may want more than one, though, in case a server is down).

Type: list — **Default**: — **Valid Values**: — **Importance**: high

---

replication.factor: The replication factor for change log topics and repartition topics created by the stream processing application.

Type: int — **Default**: 1 — **Valid Values**: — **Importance**: high

---

state.dir: Directory location for state store. This path must be unique for each streams instance sharing the same underlying filesystem.

Type: string — **Default**: /tmp/kafka-streams — **Valid Values**: — **Importance**: high

---

cache.max.bytes.buffering: Maximum number of memory bytes to be used for buffering across all threads

Type: long — **Default**: 10485760 — **Valid Values**: [0,...] — **Importance**: medium

---

client.id: An ID prefix string used for the client IDs of internal consumer, producer and restore-consumer, with pattern '-StreamThread--'.

Type: string — **Default**: "" — **Valid Values**: — **Importance**: medium

---

default.deserialization.exception.handler: Exception handling class that implements the `org.apache.kafka.streams.errors.DeserializationExceptionHandler` interface.

Type: class — **Default**: org.apache.kafka.streams.errors.LogAndFailExceptionHandler — **Valid Values**: — **Importance**: medium

---

default.key.serde: Default serializer / deserializer class for key that implements the `org.apache.kafka.common.serialization.Serde` interface. Note when windowed serde class is used, one needs to set the inner serde class that implements the `org.apache.kafka.common.serialization.Serde` interface via 'default.windowed.key.serde.inner' or 'default.windowed.value.serde.inner' as well

Type: class — **Default**: org.apache.kafka.common.serialization.Serdes$ByteArraySerde — **Valid Values**: — **Importance**: medium

---

default.production.exception.handler: Exception handling class that implements the `org.apache.kafka.streams.errors.ProductionExceptionHandler` interface.

Type: class — **Default**: org.apache.kafka.streams.errors.DefaultProductionExceptionHandler — **Valid Values**: — **Importance**: medium

---

default.timestamp.extractor: Default timestamp extractor class that implements the `org.apache.kafka.streams.processor.TimestampExtractor` interface.

Type: class — **Default**: org.apache.kafka.streams.processor.FailOnInvalidTimestamp — **Valid Values**: — **Importance**: medium

---

default.value.serde: Default serializer / deserializer class for value that implements the `org.apache.kafka.common.serialization.Serde` interface. Note when windowed serde class is used, one needs to set the inner serde class that implements the `org.apache.kafka.common.serialization.Serde` interface via 'default.windowed.key.serde.inner' or 'default.windowed.value.serde.inner' as well

Type: class — **Default**: org.apache.kafka.common.serialization.Serdes$ByteArraySerde — **Valid Values**: — **Importance**: medium

---

max.task.idle.ms: Maximum amount of time a stream task will stay idle when not all of its partition buffers contain records, to avoid potential out-of-order record processing across multiple input streams.

Type: long — **Default**: 0 — **Valid Values**: — **Importance**: medium

---

num.standby.replicas: The number of standby replicas for each task.

Type: int — **Default**: 0 — **Valid Values**: — **Importance**: medium

---

num.stream.threads: The number of threads to execute stream processing.

Type: int — **Default**: 1 — **Valid Values**: — **Importance**: medium

---

processing.guarantee: The processing guarantee that should be used. Possible values are `at_least_once` (default) and `exactly_once` . Note that exactly-once processing requires a cluster of at least three brokers by default what is the recommended setting for production; for development you can change this, by adjusting broker setting `transaction.state.log.replication.factor` and `transaction.state.log.min.isr` .

Type: string — **Default**: at_least_once — **Valid Values**: [at_least_once, exactly_once] — **Importance**: medium

---

security.protocol: Protocol used to communicate with brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL.

Type: string — **Default**: PLAINTEXT — **Valid Values**: — **Importance**: medium

---

topology.optimization: A configuration telling Kafka Streams if it should optimize the topology, disabled by default

Type: string — **Default**: none — **Valid Values**: [none, all] — **Importance**: medium

---

application.server: A host:port pair pointing to an embedded user defined endpoint that can be used for discovering the locations of state stores within a single KafkaStreams application

Type: string — **Default**: "" — **Valid Values**: — **Importance**: low

---

buffered.records.per.partition: Maximum number of records to buffer per partition.

Type: int — **Default**: 1000 — **Valid Values**: — **Importance**: low

---

commit.interval.ms: The frequency with which to save the position of the processor. (Note, if `processing.guarantee` is set to `exactly_once` , the default value is `100` , otherwise the default value is `30000` .

Type: long — **Default**: 30000 — **Valid Values**: [0,...] — **Importance**: low

---

connections.max.idle.ms: Close idle connections after the number of milliseconds specified by this config.

Type: long — **Default**: 540000 — **Valid Values**: — **Importance**: low

---

metadata.max.age.ms: The period of time in milliseconds after which we force a refresh of metadata even if we haven't seen any partition leadership changes to proactively discover any new brokers or partitions.

Type: long — **Default**: 300000 — **Valid Values**: [0,...] — **Importance**: low

---

metric.reporters: A list of classes to use as metrics reporters. Implementing the `org.apache.kafka.common.metrics.MetricsReporter` interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

Type: list — **Default**: "" — **Valid Values**: — **Importance**: low

---

metrics.num.samples: The number of samples maintained to compute metrics.

Type: int — **Default**: 2 — **Valid Values**: [1,...] — **Importance**: low

---

metrics.recording.level: The highest recording level for metrics.

Type: string — **Default**: INFO — **Valid Values**: [INFO, DEBUG] — **Importance**: low

---

metrics.sample.window.ms: The window of time a metrics sample is computed over.

Type: long — **Default**: 30000 — **Valid Values**: [0,...] — **Importance**: low

---

partition.grouper: Partition grouper class that implements the `org.apache.kafka.streams.processor.PartitionGrouper` interface. WARNING: This config is deprecated and will be removed in 3.0.0 release.

Type: class — **Default**: org.apache.kafka.streams.processor.DefaultPartitionGrouper — **Valid Values**: — **Importance**: low

---

poll.ms: The amount of time in milliseconds to block waiting for input.

Type: long — **Default**: 100 — **Valid Values**: — **Importance**: low

---

receive.buffer.bytes: The size of the TCP receive buffer (SO_RCVBUF) to use when reading data. If the value is -1, the OS default will be used.

Type: int — **Default**: 32768 — **Valid Values**: [-1,...] — **Importance**: low

---

reconnect.backoff.max.ms: The maximum amount of time in milliseconds to wait when reconnecting to a broker that has repeatedly failed to connect. If provided, the backoff per host will increase exponentially for each consecutive connection failure, up to this maximum. After calculating the backoff increase, 20% random jitter is added to avoid connection storms.

Type: long — **Default**: 1000 — **Valid Values**: [0,...] — **Importance**: low

---

reconnect.backoff.ms: The base amount of time to wait before attempting to reconnect to a given host. This avoids repeatedly connecting to a host in a tight loop. This backoff applies to all connection attempts by the client to a broker.

Type: long — **Default**: 50 — **Valid Values**: [0,...] — **Importance**: low

---

request.timeout.ms: The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted.

Type: int — **Default**: 40000 — **Valid Values**: [0,...] — **Importance**: low

---

retries: Setting a value greater than zero will cause the client to resend any request that fails with a potentially transient error.

Type: int — **Default**: 0 — **Valid Values**: [0,...,2147483647] — **Importance**: low

---

retry.backoff.ms: The amount of time to wait before attempting to retry a failed request to a given topic partition. This avoids repeatedly sending requests in a tight loop under some failure scenarios.

Type: long — **Default**: 100 — **Valid Values**: [0,...] — **Importance**: low

---

rocksdb.config.setter: A Rocks DB config setter class or class name that implements the `org.apache.kafka.streams.state.RocksDBConfigSetter` interface

Type: class — **Default**: null — **Valid Values**: — **Importance**: low

---

send.buffer.bytes: The size of the TCP send buffer (SO_SNDBUF) to use when sending data. If the value is -1, the OS default will be used.

Type: int — **Default**: 131072 — **Valid Values**: [-1,...] — **Importance**: low

---

state.cleanup.delay.ms: The amount of time in milliseconds to wait before deleting state when a partition has migrated. Only state directories that have not been modified for at least `state.cleanup.delay.ms` will be removed

Type: long — **Default**: 600000 — **Valid Values**: — **Importance**: low

---

upgrade.from: Allows upgrading in a backward compatible way. This is needed when upgrading from [0.10.0, 1.1] to 2.0+, or when upgrading from [2.0, 2.3] to 2.4+. When upgrading from 2.4 to a newer version it is not required to specify this config. Default is null. Accepted values are "0.10.0", "0.10.1", "0.10.2", "0.11.0", "1.0", "1.1", "2.0", "2.1", "2.2", "2.3" (for upgrading from the corresponding old version).

Type: string — **Default**: null — **Valid Values**: [null, 0.10.0, 0.10.1, 0.10.2, 0.11.0, 1.0, 1.1, 2.0, 2.1, 2.2, 2.3] — **Importance**: low

---

windowstore.changelog.additional.retention.ms: Added to a windows maintainMs to ensure data is not deleted from the log prematurely. Allows for clock drift. Default is 1 day

Type: long — **Default**: 86400000 — **Valid Values**: — **Importance**: low

---

3.7 Admin Configs

Below is the configuration of the Kafka Admin client library.

bootstrap.servers: A list of host/port pairs to use for establishing the initial connection to the Kafka cluster. The client will make use of all servers irrespective of which servers are specified here for bootstrapping—this list only impacts the initial hosts used to discover the full set of servers. This list should be in the form `host1:port1,host2:port2,...` . Since these servers are just used for the initial connection to discover the full cluster membership (which may change dynamically), this list need not contain the full set of servers (you may want more than one, though, in case a server is down).

Type: list — **Default**: — **Valid Values**: — **Importance**: high

---

ssl.key.password: The password of the private key in the key store file. This is optional for client.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.keystore.location: The location of the key store file. This is optional for client and can be used for two-way authentication for client.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.keystore.password: The store password for the key store file. This is optional for client and only needed if ssl.keystore.location is configured.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.truststore.location: The location of the trust store file.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high

---

ssl.truststore.password: The password for the trust store file. If a password is not set access to the truststore is still available, but integrity checking is disabled.

Type: password — **Default**: null — **Valid Values**: — **Importance**: high

---

client.dns.lookup: Controls how the client uses DNS lookups. If set to `use_all_dns_ips` then, when the lookup returns multiple IP addresses for a hostname, they will all be attempted to connect to before failing the connection. Applies to both bootstrap and advertised servers. If the value is `resolve_canonical_bootstrap_servers_only` each entry will be resolved and expanded into a list of canonical names.

Type: string — **Default**: default — **Valid Values**: [default, use_all_dns_ips, resolve_canonical_bootstrap_servers_only] — **Importance**: medium

---

client.id: An id string to pass to the server when making requests. The purpose of this is to be able to track the source of requests beyond just ip/port by allowing a logical application name to be included in server-side request logging.

Type: string — **Default**: "" — **Valid Values**: — **Importance**: medium

---

connections.max.idle.ms: Close idle connections after the number of milliseconds specified by this config.

Type: long — **Default**: 300000 — **Valid Values**: — **Importance**: medium

---

receive.buffer.bytes: The size of the TCP receive buffer (SO_RCVBUF) to use when reading data. If the value is -1, the OS default will be used.

Type: int — **Default**: 65536 — **Valid Values**: [-1,...] — **Importance**: medium

---

request.timeout.ms: The configuration controls the maximum amount of time the client will wait for the response of a request. If the response is not received before the timeout elapses the client will resend the request if necessary or fail the request if retries are exhausted.

Type: int — **Default**: 120000 — **Valid Values**: [0,...] — **Importance**: medium

---

sasl.client.callback.handler.class: The fully qualified name of a SASL client callback handler class that implements the AuthenticateCallbackHandler interface.

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.jaas.config: JAAS login context parameters for SASL connections in the format used by JAAS configuration files. JAAS configuration file format is described here. The format for the value is: '`loginModuleClass controlFlag (optionName=optionValue)*;`'. For brokers, the config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.jaas.config=com.example.ScramLoginModule required;

Type: password — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.kerberos.service.name: The Kerberos principal name that Kafka runs as. This can be defined either in Kafka's JAAS config or in Kafka's config.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.login.callback.handler.class: The fully qualified name of a SASL login callback handler class that implements the AuthenticateCallbackHandler interface. For brokers, login callback handler config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.callback.handler.class=com.example.CustomScramLoginCallbackHandler

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.login.class: The fully qualified name of a class that implements the Login interface. For brokers, login config must be prefixed with listener prefix and SASL mechanism name in lower-case. For example, listener.name.sasl_ssl.scram-sha-256.sasl.login.class=com.example.CustomScramLogin

Type: class — **Default**: null — **Valid Values**: — **Importance**: medium

---

sasl.mechanism: SASL mechanism used for client connections. This may be any mechanism for which a security provider is available. GSSAPI is the default mechanism.

Type: string — **Default**: GSSAPI — **Valid Values**: — **Importance**: medium

---

security.protocol: Protocol used to communicate with brokers. Valid values are: PLAINTEXT, SSL, SASL_PLAINTEXT, SASL_SSL.

Type: string — **Default**: PLAINTEXT — **Valid Values**: — **Importance**: medium

---

send.buffer.bytes: The size of the TCP send buffer (SO_SNDBUF) to use when sending data. If the value is -1, the OS default will be used.

Type: int — **Default**: 131072 — **Valid Values**: [-1,...] — **Importance**: medium

---

ssl.enabled.protocols: The list of protocols enabled for SSL connections.

Type: list — **Default**: TLSv1.2,TLSv1.1,TLSv1 — **Valid Values**: — **Importance**: medium

---

ssl.keystore.type: The file format of the key store file. This is optional for client.

Type: string — **Default**: JKS — **Valid Values**: — **Importance**: medium

---

ssl.protocol: The SSL protocol used to generate the SSLContext. Default setting is TLS, which is fine for most cases. Allowed values in recent JVMs are TLS, TLSv1.1 and TLSv1.2. SSL, SSLv2 and SSLv3 may be supported in older JVMs, but their usage is discouraged due to known security vulnerabilities.

Type: string — **Default**: TLS — **Valid Values**: — **Importance**: medium

---

ssl.provider: The name of the security provider used for SSL connections. Default value is the default security provider of the JVM.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

ssl.truststore.type: The file format of the trust store file.

Type: string — **Default**: JKS — **Valid Values**: — **Importance**: medium

---

metadata.max.age.ms: The period of time in milliseconds after which we force a refresh of metadata even if we haven't seen any partition leadership changes to proactively discover any new brokers or partitions.

Type: long — **Default**: 300000 — **Valid Values**: [0,...] — **Importance**: low

---

metric.reporters: A list of classes to use as metrics reporters. Implementing the `org.apache.kafka.common.metrics.MetricsReporter` interface allows plugging in classes that will be notified of new metric creation. The JmxReporter is always included to register JMX statistics.

Type: list — **Default**: "" — **Valid Values**: — **Importance**: low

---

metrics.num.samples: The number of samples maintained to compute metrics.

Type: int — **Default**: 2 — **Valid Values**: [1,...] — **Importance**: low

---

metrics.recording.level: The highest recording level for metrics.

Type: string — **Default**: INFO — **Valid Values**: [INFO, DEBUG] — **Importance**: low

---

metrics.sample.window.ms: The window of time a metrics sample is computed over.

Type: long — **Default**: 30000 — **Valid Values**: [0,...] — **Importance**: low

---

reconnect.backoff.max.ms: The maximum amount of time in milliseconds to wait when reconnecting to a broker that has repeatedly failed to connect. If provided, the backoff per host will increase exponentially for each consecutive connection failure, up to this maximum. After calculating the backoff increase, 20% random jitter is added to avoid connection storms.

Type: long — **Default**: 1000 — **Valid Values**: [0,...] — **Importance**: low

---

reconnect.backoff.ms: The base amount of time to wait before attempting to reconnect to a given host. This avoids repeatedly connecting to a host in a tight loop. This backoff applies to all connection attempts by the client to a broker.

Type: long — **Default**: 50 — **Valid Values**: [0,...] — **Importance**: low

---

retries: Setting a value greater than zero will cause the client to resend any request that fails with a potentially transient error.

Type: int — **Default**: 5 — **Valid Values**: [0,...] — **Importance**: low

---

retry.backoff.ms: The amount of time to wait before attempting to retry a failed request. This avoids repeatedly sending requests in a tight loop under some failure scenarios.

Type: long — **Default**: 100 — **Valid Values**: [0,...] — **Importance**: low

---

sasl.kerberos.kinit.cmd: Kerberos kinit command path.

Type: string — **Default**: /usr/bin/kinit — **Valid Values**: — **Importance**: low

---

sasl.kerberos.min.time.before.relogin: Login thread sleep time between refresh attempts.

Type: long — **Default**: 60000 — **Valid Values**: — **Importance**: low

---

sasl.kerberos.ticket.renew.jitter: Percentage of random jitter added to the renewal time.

Type: double — **Default**: 0.05 — **Valid Values**: — **Importance**: low

---

sasl.kerberos.ticket.renew.window.factor: Login thread will sleep until the specified window factor of time from last refresh to ticket's expiry has been reached, at which time it will try to renew the ticket.

Type: double — **Default**: 0.8 — **Valid Values**: — **Importance**: low

---

sasl.login.refresh.buffer.seconds: The amount of buffer time before credential expiration to maintain when refreshing a credential, in seconds. If a refresh would otherwise occur closer to expiration than the number of buffer seconds then the refresh will be moved up to maintain as much of the buffer time as possible. Legal values are between 0 and 3600 (1 hour); a default value of 300 (5 minutes) is used if no value is specified. This value and sasl.login.refresh.min.period.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

Type: short — **Default**: 300 — **Valid Values**: [0,...,3600] — **Importance**: low

---

sasl.login.refresh.min.period.seconds: The desired minimum time for the login refresh thread to wait before refreshing a credential, in seconds. Legal values are between 0 and 900 (15 minutes); a default value of 60 (1 minute) is used if no value is specified. This value and sasl.login.refresh.buffer.seconds are both ignored if their sum exceeds the remaining lifetime of a credential. Currently applies only to OAUTHBEARER.

Type: short — **Default**: 60 — **Valid Values**: [0,...,900] — **Importance**: low

---

sasl.login.refresh.window.factor: Login refresh thread will sleep until the specified window factor relative to the credential's lifetime has been reached, at which time it will try to refresh the credential. Legal values are between 0.5 (50%) and 1.0 (100%) inclusive; a default value of 0.8 (80%) is used if no value is specified. Currently applies only to OAUTHBEARER.

Type: double — **Default**: 0.8 — **Valid Values**: [0.5,...,1.0] — **Importance**: low

---

sasl.login.refresh.window.jitter: The maximum amount of random jitter relative to the credential's lifetime that is added to the login refresh thread's sleep time. Legal values are between 0 and 0.25 (25%) inclusive; a default value of 0.05 (5%) is used if no value is specified. Currently applies only to OAUTHBEARER.

Type: double — **Default**: 0.05 — **Valid Values**: [0.0,...,0.25] — **Importance**: low

---

security.providers: A list of configurable creator classes each returning a provider implementing security algorithms. These classes should implement the `org.apache.kafka.common.security.auth.SecurityProviderCreator` interface.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low

---

ssl.cipher.suites: A list of cipher suites. This is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol. By default all the available cipher suites are supported.

Type: list — **Default**: null — **Valid Values**: — **Importance**: low

---

ssl.endpoint.identification.algorithm: The endpoint identification algorithm to validate server hostname using server certificate.

Type: string — **Default**: https — **Valid Values**: — **Importance**: low

---

ssl.keymanager.algorithm: The algorithm used by key manager factory for SSL connections. Default value is the key manager factory algorithm configured for the Java Virtual Machine.

Type: string — **Default**: SunX509 — **Valid Values**: — **Importance**: low

---

ssl.secure.random.implementation: The SecureRandom PRNG implementation to use for SSL cryptography operations.

Type: string — **Default**: null — **Valid Values**: — **Importance**: low

---

ssl.trustmanager.algorithm: The algorithm used by trust manager factory for SSL connections. Default value is the trust manager factory algorithm configured for the Java Virtual Machine.

Type: string — **Default**: PKIX — **Valid Values**: — **Importance**: low

---

4. DESIGN

4.1 Motivation

We designed Kafka to be able to act as a unified platform for handling all the real-time data feeds a large company might have. To do this we had to think through a fairly broad set of use cases.

It would have to have high-throughput to support high volume event streams such as real-time log aggregation.

It would need to deal gracefully with large data backlogs to be able to support periodic data loads from offline systems.

It also meant the system would have to handle low-latency delivery to handle more traditional messaging use-cases.

We wanted to support partitioned, distributed, real-time processing of these feeds to create new, derived feeds. This motivated our partitioning and consumer model.

Finally in cases where the stream is fed into other data systems for serving, we knew the system would have to be able to guarantee fault-tolerance in the presence of machine failures.

Supporting these uses led us to a design with a number of unique elements, more akin to a database log than a traditional messaging system. We will outline some elements of the design in the following sections.

4.2 Persistence

Don't fear the filesystem!

Kafka relies heavily on the filesystem for storing and caching messages. There is a general perception that "disks are slow" which makes people skeptical that a persistent structure can offer competitive performance. In fact disks are both much slower and much faster than people expect depending on how they are used; and a properly designed disk structure can often be as fast as the network.

The key fact about disk performance is that the throughput of hard drives has been diverging from the latency of a disk seek for the last decade. As a result the performance of linear writes on a JBOD configuration with six 7200rpm SATA RAID-5 array is about 600MB/sec but the performance of random writes is only about 100k/sec—a difference of over 6000X. These linear reads and writes are the most predictable of all usage patterns, and are heavily optimized by the operating system. A modern operating system provides read-ahead and write-behind techniques that prefetch data in large block multiples and group smaller logical writes into large physical writes. A further discussion of this issue can be found in this ACM Queue article; they actually find that sequential disk access can in some cases be faster than random memory access!

To compensate for this performance divergence, modern operating systems have become increasingly aggressive in their use of main memory for disk caching. A modern OS will happily divert *all* free memory to disk caching with little performance penalty when the memory is reclaimed. All disk reads and writes will go through this unified cache. This feature cannot easily be turned off without using direct I/O, so even if a process maintains an in-process cache of the data, this data will likely be duplicated in OS pagecache, effectively storing everything twice.

Furthermore, we are building on top of the JVM, and anyone who has spent any time with Java memory usage knows two things:

1. The memory overhead of objects is very high, often doubling the size of the data stored (or worse).
2. Java garbage collection becomes increasingly fiddly and slow as the in-heap data increases.

As a result of these factors using the filesystem and relying on pagecache is superior to maintaining an in-memory cache or other structure—we at least double the available cache by having automatic access to all free memory, and likely double again by storing a compact byte structure rather than individual objects. Doing so will result in a cache of up to 28-30GB on a 32GB machine without GC penalties. Furthermore, this cache will stay warm even if the service is restarted, whereas the in-process cache will need to be rebuilt in memory (which for a 10GB cache may take 10 minutes) or else it will need to start with a completely cold cache (which likely means terrible initial performance). This also greatly simplifies the code as all logic for maintaining coherency between the cache and filesystem is now in the OS, which tends to do so more efficiently and more correctly than one-off in-process attempts. If your disk usage favors linear reads then read-ahead is effectively pre-populating this cache with useful data on each disk read.

This suggests a design which is very simple: rather than maintain as much as possible in-memory and flush it all out to the filesystem in a panic when we run out of space, we invert that. All data is immediately written to a persistent log on the filesystem without necessarily flushing to disk. In effect this just means that it is transferred into the kernel's pagecache.

This style of pagecache-centric design is described in an article on the design of Varnish here (along with a healthy dose of arrogance).

Constant Time Suffices

The persistent data structure used in messaging systems are often a per-consumer queue with an associated BTree or other general-purpose random access data structures to maintain metadata about messages. BTrees are the most versatile data structure available, and make it possible to support a wide variety of transactional and non-transactional semantics in the messaging system. They do come with a fairly high cost, though: Btree operations are O(log N). Normally O(log N) is considered essentially equivalent to constant time, but this is not true for disk operations. Disk seeks come at 10 ms a pop, and each disk can do only one seek at a time so parallelism is limited. Hence even a handful of disk seeks leads to very high overhead. Since storage systems mix very fast cached operations with very slow physical disk operations, the observed performance of tree structures is often superlinear as data increases with fixed cache--i.e. doubling your data makes things much worse than twice as slow.

Intuitively a persistent queue could be built on simple reads and appends to files as is commonly the case with logging solutions. This structure has the advantage that all operations are O(1) and reads do not block writes or each other. This has obvious performance advantages since the performance is completely decoupled from the data size—one server can now take full advantage of a number of cheap, low-rotational speed 1+TB SATA drives. Though they have poor seek performance, these drives have acceptable performance for large reads and writes and come at 1/3 the price and 3x the capacity.

Having access to virtually unlimited disk space without any performance penalty means that we can provide some features not usually found in a messaging system. For example, in Kafka, instead of attempting to delete messages as soon as they are consumed, we can retain messages for a relatively long period (say a week). This leads to a great deal of flexibility for consumers, as we will describe.

4.3 Efficiency

We have put significant effort into efficiency. One of our primary use cases is handling web activity data, which is very high volume: each page view may generate dozens of writes. Furthermore, we assume each message published is read by at least one consumer (often many), hence we strive to make consumption as cheap as possible.

We have also found, from experience building and running a number of similar systems, that efficiency is a key to effective multi-tenant operations. If the downstream infrastructure service can easily become a bottleneck due to a small bump in usage by the application, such small changes will often create problems. By being very fast we help ensure that the application will tip-over under load before the infrastructure. This is particularly important when trying to run a centralized service that supports dozens or hundreds of applications on a centralized cluster as changes in usage patterns are a near-daily occurrence.

We discussed disk efficiency in the previous section. Once poor disk access patterns have been eliminated, there are two common causes of inefficiency in this type of system: too many small I/O operations, and excessive byte copying.

The small I/O problem happens both between the client and the server and in the server's own persistent operations.

To avoid this, our protocol is built around a "message set" abstraction that naturally groups messages together. This allows network requests to group messages together and amortize the overhead of the network roundtrip rather than sending a single message at a time. The server in turn appends chunks of messages to its log in one go, and the consumer fetches large linear chunks at a time.

This simple optimization produces orders of magnitude speed up. Batching leads to larger network packets, larger sequential disk operations, contiguous memory blocks, and so on, all of which allows Kafka to turn a bursty stream of random message writes into linear writes that flow to the consumers.

The other inefficiency is in byte copying. At low message rates this is not an issue, but under load the impact is significant. To avoid this we employ a standardized binary message format that is shared by the producer, the broker, and the consumer (so data chunks can be transferred without modification between them).

The message log maintained by the broker is itself just a directory of files, each populated by a sequence of message sets that have been written to disk in the same format used by the producer and consumer. Maintaining this common format allows optimization of the most important operation: network transfer of persistent log chunks. Modern unix operating systems offer a highly optimized code path for transferring data out of pagecache to a socket; in Linux this is done with the sendfile system call.

To understand the impact of sendfile, it is important to understand the common data path for transfer of data from file to socket:

1. The operating system reads data from the disk into pagecache in kernel space
2. The application reads the data from kernel space into a user-space buffer

3. The application writes the data back into kernel space into a socket buffer
4. The operating system copies the data from the socket buffer to the NIC buffer where it is sent over the network

This is clearly inefficient, there are four copies and two system calls. Using sendfile, this re-copying is avoided by allowing the OS to send the data from pagecache to the network directly. So in this optimized path, only the final copy to the NIC buffer is needed.

We expect a common use case to be multiple consumers on a topic. Using the zero-copy optimization above, data is copied into pagecache exactly once and reused on each consumption instead of being stored in memory and copied out to user-space every time it is read. This allows messages to be consumed at a rate that approaches the limit of the network connection.

This combination of pagecache and sendfile means that on a Kafka cluster where the consumers are mostly caught up you will see no read activity on the disks whatsoever as they will be serving data entirely from cache.

For more background on the sendfile and zero-copy support in Java, see this article.

End-to-end Batch Compression

In some cases the bottleneck is actually not CPU or disk but network bandwidth. This is particularly true for a data pipeline that needs to send messages between data centers over a wide-area network. Of course, the user can always compress its messages one at a time without any support needed from Kafka, but this can lead to very poor compression ratios as much of the redundancy is due to repetition between messages of the same type (e.g. field names in JSON or user agents in web logs or common string values). Efficient compression requires compressing multiple messages together rather than compressing each message individually.

Kafka supports this with an efficient batching format. A batch of messages can be clumped together compressed and sent to the server in this form. This batch of messages will be written in compressed form and will remain compressed in the log and will only be decompressed by the consumer.

Kafka supports GZIP, Snappy, LZ4 and ZStandard compression protocols. More details on compression can be found here.

4.4 The Producer

Load balancing

The producer sends data directly to the broker that is the leader for the partition without any intervening routing tier. To help the producer do this all Kafka nodes can answer a request for metadata about which servers are alive and where the leaders for the partitions of a topic are at any given time to allow the producer to appropriately direct its requests.

The client controls which partition it publishes messages to. This can be done at random, implementing a kind of random load balancing, or it can be done by some semantic partitioning function. We expose the interface for semantic partitioning by allowing the user to specify a key to partition by and using this to hash to a partition (there is also an option to override the partition function if need be). For example if the key chosen was a user id then all data for a given user would be sent to the same partition. This in turn will allow consumers to make locality assumptions about their consumption. This style of partitioning is explicitly designed to allow locality-sensitive processing in consumers.

Asynchronous send

Batching is one of the big drivers of efficiency, and to enable batching the Kafka producer will attempt to accumulate data in memory and to send out larger batches in a single request. The batching can be configured to accumulate no more than a fixed number of messages and to wait no longer than some fixed latency bound (say 64k or 10 ms). This allows the accumulation of more bytes to send, and few larger I/O operations on the servers. This buffering is configurable and gives a mechanism to trade off a small amount of additional latency for better throughput.

Details on configuration and the api for the producer can be found elsewhere in the documentation.

4.5 The Consumer

The Kafka consumer works by issuing "fetch" requests to the brokers leading the partitions it wants to consume. The consumer specifies its offset in the log with each request and receives back a chunk of log beginning from that position. The consumer thus has significant control over this position and can rewind it to re-consume data if need be.

Push vs. pull

An initial question we considered is whether consumers should pull data from brokers or brokers should push data to the consumer. In this respect Kafka follows a more traditional design, shared by most messaging systems, where data is pushed to the broker from the producer and pulled from the broker by the consumer. Some logging-centric systems, such as [Scribe] and [Apache Flume], follow a very different push-based path where data is pushed downstream. There are pros and cons to both approaches. However, a push-based system has difficulty dealing with diverse consumers as the broker controls the rate at which data is transferred. The goal is generally for the consumer to be able to consume at the maximum possible rate; unfortunately, in a push system this means the consumer tends to be overwhelmed when its rate of consumption falls below the rate of production (a denial of service attack, in essence). A pull-based system has the nicer property that the consumer simply falls behind and catches up when it can. This can be mitigated with some kind of backoff protocol by which the consumer can indicate it is overwhelmed, but getting the rate of transfer to fully utilize (but never over-utilize) the consumer is trickier than it seems. Previous attempts at building systems in this fashion led us to go with a more traditional pull model.

Another advantage of a pull-based system is that it lends itself to aggressive batching of data sent to the consumer. A push-based system must choose to either send a request immediately or accumulate more data and then send it later without knowledge of whether the downstream consumer will be able to immediately process it. If tuned for low latency, this will result in sending a single message at a time only for the transfer to end up being buffered anyway, which is wasteful. A pull-based design fixes this as the consumer always pulls all available messages after its current position in the log (or up to some configurable max size). So one gets optimal batching without introducing unnecessary latency.

The deficiency of a naive pull-based system is that if the broker has no data the consumer may end up polling in a tight loop, effectively busy-waiting for data to arrive. To avoid this we have parameters in our pull request that allow the consumer request to block in a "long poll" waiting until data arrives (and optionally waiting until a given number of bytes is available to ensure large transfer sizes).

You could imagine other possible designs which would be only pull, end-to-end. The producer would locally write to a local log, and brokers would pull from that with consumers pulling from them. A similar type of "store-and-forward" producer is often proposed. This is intriguing but we felt not very suitable for our target use cases which have thousands of producers. Our experience running persistent data systems at scale led us to feel that involving thousands of disks in the system across many applications would not actually make things more reliable and would be a nightmare to operate. And in practice we have found that we can run a pipeline with strong SLAs at large scale without a need for producer persistence.

Consumer Position

Keeping track of *what* has been consumed is, surprisingly, one of the key performance points of a messaging system.

Most messaging systems keep metadata about what messages have been consumed on the broker. That is, as a message is handed out to a consumer, the broker either records that fact locally immediately or it may wait for acknowledgement from the consumer. This is a fairly intuitive choice, and indeed for a single machine server it is not clear where else this state could go. Since the data structures used for storage in many messaging systems scale poorly, this is also a pragmatic choice--since the broker knows what is consumed it can immediately delete it, keeping the data size small.

What is perhaps not obvious is that getting the broker and consumer to come into agreement about what has been consumed is not a trivial problem. If the broker records a message as **consumed** immediately every time it is handed out over the network, then if the consumer fails to process the message (say because it crashes or the request times out or whatever) that message will be lost. To solve this problem, many messaging systems add an acknowledgement feature which means that messages are only marked as **sent** not **consumed** when they are sent; the broker waits for a specific acknowledgement from the consumer to record the message as **consumed**. This strategy fixes the problem of losing messages, but creates new problems. First of all, if the consumer processes the message but fails before it can send an acknowledgement then the message will be consumed twice. The second problem is around performance, now the broker must keep multiple states about every single message (first to lock it so it is not given out a second time, and then to mark it as permanently consumed so that it can be removed). Tricky problems must be dealt with, like what to do with messages that are sent but never acknowledged.

Kafka handles this differently. Our topic is divided into a set of totally ordered partitions, each of which is consumed by exactly one consumer within each subscribing consumer group at any given time. This means that the position of a consumer in each partition is just a single integer, the offset of the next message to consume. This makes the state about what has been consumed very small, just one number for each partition. This state can be periodically checkpointed. This makes the equivalent of message acknowledgements very cheap.

There is a side benefit of this decision. A consumer can deliberately *rewind* back to an old offset and re-consume data. This violates the common contract of a queue, but turns out to be an essential feature for many consumers. For example, if the consumer code has a bug and is discovered after some messages are consumed, the consumer can re-consume those messages once the bug is fixed.

Offline Data Load

Scalable persistence allows for the possibility of consumers that only periodically consume such as batch data loads that periodically bulk-load data into an offline system such as Hadoop or a relational data warehouse.

In the case of Hadoop we parallelize the data load by splitting the load over individual map tasks, one for each node/topic/partition combination, allowing full parallelism in the loading. Hadoop provides the task management, and tasks which fail can restart without danger of duplicate data —they simply restart from their original position.

Static Membership

Static membership aims to improve the availability of stream applications, consumer groups and other applications built on top of the group rebalance protocol. The rebalance protocol relies on the group coordinator to allocate entity ids to group members. These generated ids are ephemeral and will change when members restart and rejoin. For consumer based apps, this "dynamic membership" can cause a large percentage of tasks re-assigned to different instances during administrative operations such as code deploys, configuration updates and periodic restarts. For large state applications, shuffled tasks need a long time to recover their local states before processing and cause applications to be partially or entirely unavailable. Motivated by this observation, Kafka's group management protocol allows group members to provide persistent entity ids. Group membership remains unchanged based on those ids, thus no rebalance will be triggered.

If you want to use static membership,

- Upgrade both broker cluster and client apps to 2.3 or beyond, and also make sure the upgraded brokers are using `inter.broker.protocol.version` of 2.3 or beyond as well.
- Set the config `ConsumerConfig#GROUP_INSTANCE_ID_CONFIG` to a unique value for each consumer instance under one group.
- For Kafka Streams applications, it is sufficient to set a unique `ConsumerConfig#GROUP_INSTANCE_ID_CONFIG` per KafkaStreams instance, independent of the number of used threads for an instance.

If your broker is on an older version than 2.3, but you choose to set `ConsumerConfig#GROUP_INSTANCE_ID_CONFIG` on the client side, the application will detect the broker version and then throws an UnsupportedException. If you accidentally configure duplicate ids for different instances, a fencing mechanism on broker side will inform your duplicate client to shutdown immediately by triggering a `org.apache.kafka.common.errors.FencedInstanceIdException`. For more details, see [KIP-345](https://cwiki.apache.org/confluence/display/KAFKA/KIP-345)

4.6 Message Delivery Semantics

Now that we understand a little about how producers and consumers work, let's discuss the semantic guarantees Kafka provides between producer and consumer. Clearly there are multiple possible message delivery guarantees that could be provided:

- *At most once*—Messages may be lost but are never redelivered.
- *At least once*—Messages are never lost but may be redelivered.
- *Exactly once*—this is what people actually want, each message is delivered once and only once.

It's worth noting that this breaks down into two problems: the durability guarantees for publishing a message and the guarantees when consuming a message.

Many systems claim to provide "exactly once" delivery semantics, but it is important to read the fine print, most of these claims are misleading (i.e. they don't translate to the case where consumers or producers can fail, cases where there are multiple consumer processes, or cases where data written to disk can be lost).

Kafka's semantics are straight-forward. When publishing a message we have a notion of the message being "committed" to the log. Once a published message is committed it will not be lost as long as one broker that replicates the partition to which this message was written remains "alive". The definition of committed message, alive partition as well as a description of which types of failures we attempt to handle will be described in more detail in the next section. For now let's assume a perfect, lossless broker and try to understand the guarantees to the producer and consumer. If a producer attempts to publish a message and experiences a network error it cannot be sure if this error happened before or after the message was committed. This is similar to the semantics of inserting into a database table with an autogenerated key.

Prior to 0.11.0.0, if a producer failed to receive a response indicating that a message was committed, it had little choice but to resend the message. This provides at-least-once delivery semantics since the message may be written to the log again during resending if the original request had in fact succeeded. Since 0.11.0.0, the Kafka producer also supports an idempotent delivery option which guarantees that resending will not result in duplicate entries in the log. To achieve this, the broker assigns each producer an ID and deduplicates messages using a sequence number that is sent by the producer along with every message. Also beginning with 0.11.0.0, the producer supports the ability to send messages to multiple topic partitions using transaction-like semantics: i.e. either all messages are successfully written or none of them are. The main use case for this is exactly-once processing between Kafka topics (described below).

Not all use cases require such strong guarantees. For uses which are latency sensitive we allow the producer to specify the durability level it desires. If the producer specifies that it wants to wait on the message being committed this can take on the order of 10 ms. However the producer can also specify that it wants to perform the send completely asynchronously or that it wants to wait only until the leader (but not necessarily the followers) have the message.

Now let's describe the semantics from the point-of-view of the consumer. All replicas have the exact same log with the same offsets. The consumer controls its position in this log. If the consumer never crashed it could just store this position in memory, but if the consumer fails and we want this topic partition to be taken over by another process the new process will need to choose an appropriate position from which to start processing. Let's say the consumer reads some messages -- it has several options for processing the messages and updating its position.

1. It can read the messages, then save its position in the log, and finally process the messages. In this case there is a possibility that the consumer process crashes after saving its position but before saving the output of its message processing. In this case the process that took over processing would start at the saved position even though a few messages prior to that position had not been processed. This corresponds to "at-most-once" semantics as in the case of a consumer failure messages may not be processed.
2. It can read the messages, process the messages, and finally save its position. In this case there is a possibility that the consumer process crashes after processing messages but before saving its position. In this case when the new process takes over the first few messages it receives will already have been processed. This corresponds to the "at-least-once" semantics in the case of consumer failure. In many cases messages have a primary key and so the updates are idempotent (receiving the same message twice just overwrites a record with another copy of itself).

So what about exactly once semantics (i.e. the thing you actually want)? When consuming from a Kafka topic and producing to another topic (as in a Kafka Streams application), we can leverage the new transactional producer capabilities in 0.11.0.0 that were mentioned above. The consumer's position is stored as a message in a topic, so we can write the offset to Kafka in the same transaction as the output topics receiving the processed data. If the transaction is aborted, the consumer's position will revert to its old value and the produced data on the output topics will not be visible to other consumers, depending on their "isolation level." In the default "read_uncommitted" isolation level, all messages are visible to consumers even if they were part of an aborted transaction, but in "read_committed," the consumer will only return messages from transactions which were committed (and any messages which were not part of a transaction).

When writing to an external system, the limitation is in the need to coordinate the consumer's position with what is actually stored as output. The classic way of achieving this would be to introduce a two-phase commit between the storage of the consumer position and the storage of the consumers output. But this can be handled more simply and generally by letting the consumer store its offset in the same place as its output. This is better because many of the output systems a consumer might want to write to will not support a two-phase commit. As an example of this, consider a Kafka Connect connector which populates data in HDFS along with the offsets of the data it reads so that it is guaranteed that either data and offsets are both updated or neither is. We follow similar patterns for many other data systems which require these stronger semantics and for which the messages do not have a primary key to allow for deduplication.

So effectively Kafka supports exactly-once delivery in Kafka Streams, and the transactional producer/consumer can be used generally to provide exactly-once delivery when transferring and processing data between Kafka topics. Exactly-once delivery for other destination systems generally requires cooperation with such systems, but Kafka provides the offset which makes implementing this feasible (see also Kafka Connect). Otherwise, Kafka guarantees at-least-once delivery by default, and allows the user to implement at-most-once delivery by disabling retries on the producer and committing offsets in the consumer prior to processing a batch of messages.

4.7 Replication

Kafka replicates the log for each topic's partitions across a configurable number of servers (you can set this replication factor on a topic-by-topic basis). This allows automatic failover to these replicas when a server in the cluster fails so messages remain available in the presence of failures.

Other messaging systems provide some replication-related features, but, in our (totally biased) opinion, this appears to be a tacked-on thing, not heavily used, and with large downsides: replicas are inactive, throughput is heavily impacted, it requires fiddly manual configuration, etc. Kafka is meant to be used with replication by default—in fact we implement un-replicated topics as replicated topics where the replication factor is one.

The unit of replication is the topic partition. Under non-failure conditions, each partition in Kafka has a single leader and zero or more followers. The total number of replicas including the leader constitute the replication factor. All reads and writes go to the leader of the partition. Typically, there are many more partitions than brokers and the leaders are evenly distributed among brokers. The logs on the followers are identical to the leader's log—all have the same offsets and messages in the same order (though, of course, at any given time the leader may have a few as-yet unreplicated messages at the end of its log).

Followers consume messages from the leader just as a normal Kafka consumer would and apply them to their own log. Having the followers pull from the leader has the nice property of allowing the follower to naturally batch together log entries they are applying to their log.

As with most distributed systems automatically handling failures requires having a precise definition of what it means for a node to be "alive". For Kafka node liveness has two conditions

1. A node must be able to maintain its session with ZooKeeper (via ZooKeeper's heartbeat mechanism)
2. If it is a follower it must replicate the writes happening on the leader and not fall "too far" behind

We refer to nodes satisfying these two conditions as being "in sync" to avoid the vagueness of "alive" or "failed". The leader keeps track of the set of "in sync" nodes. If a follower dies, gets stuck, or falls behind, the leader will remove it from the list of in sync replicas. The determination of stuck and lagging replicas is controlled by the replica.lag.time.max.ms configuration.

In distributed systems terminology we only attempt to handle a "fail/recover" model of failures where nodes suddenly cease working and then later recover (perhaps without knowing that they have died). Kafka does not handle so-called "Byzantine" failures in which nodes produce arbitrary or malicious responses (perhaps due to bugs or foul play).

We can now more precisely define that a message is considered committed when all in sync replicas for that partition have applied it to their log. Only committed messages are ever given out to the consumer. This means that the consumer need not worry about potentially seeing a message that could be lost if the leader fails. Producers, on the other hand, have the option of either waiting for the message to be committed or not, depending on their preference for tradeoff between latency and durability. This preference is controlled by the acks setting that the producer uses. Note that topics have a setting for the "minimum number" of in-sync replicas that is checked when the producer requests acknowledgment that a message has been written to the full set of in-sync replicas. If a less stringent acknowledgement is requested by the producer, then the message can be committed, and consumed, even if the number of in-sync replicas is lower than the minimum (e.g. it can be as low as just the leader).

The guarantee that Kafka offers is that a committed message will not be lost, as long as there is at least one in sync replica alive, at all times.

Kafka will remain available in the presence of node failures after a short fail-over period, but may not remain available in the presence of network partitions.

Replicated Logs: Quorums, ISRs, and State Machines (Oh my!)

At its heart a Kafka partition is a replicated log. The replicated log is one of the most basic primitives in distributed data systems, and there are many approaches for implementing one. A replicated log can be used by other systems as a primitive for implementing other distributed systems in the state-machine style.

A replicated log models the process of coming into consensus on the order of a series of values (generally numbering the log entries 0, 1, 2, ...). There are many ways to implement this, but the simplest and fastest is with a leader who chooses the ordering of values provided to it. As long as the leader remains alive, all followers need to only copy the values and ordering the leader chooses.

Of course if leaders didn't fail we wouldn't need followers! When the leader does die we need to choose a new leader from among the followers. But followers themselves may fall behind or crash so we must ensure we choose an up-to-date follower. The fundamental guarantee a log replication algorithm must provide is that if we tell the client a message is committed, and the leader fails, the new leader we elect must also have that message. This yields a tradeoff: if the leader waits for more followers to acknowledge a message before declaring it committed then there will be more potentially electable leaders.

If you choose the number of acknowledgements required and the number of logs that must be compared to elect a leader such that there is guaranteed to be an overlap, then this is called a Quorum.

A common approach to this tradeoff is to use a majority vote for both the commit decision and the leader election. This is not what Kafka does, but let's explore it anyway to understand the tradeoffs. Let's say we have 2*f*+1 replicas. If *f*+1 replicas must receive a message prior to a commit being declared by the leader, and if we elect a new leader by electing the follower with the most complete log from at least *f*+1 replicas, then, with no more than *f* failures, the leader is guaranteed to have all committed messages. This is because among any *f*+1 replicas, there must be at least one replica that contains all committed messages. That replica's log will be the most complete and therefore will be selected as the new leader. There are many remaining details that each algorithm must handle (such as precisely defined what makes a log more complete, ensuring log consistency during leader failure or changing the set of servers in the replica set) but we will ignore these for now.

This majority vote approach has a very nice property: the latency is dependent on only the fastest servers. That is, if the replication factor is three, the latency is determined by the faster follower not the slower one.

There are a rich variety of algorithms in this family including ZooKeeper's [Zab], [Raft], and [Viewstamped Replication]. The most similar academic publication we are aware of to Kafka's actual implementation is [PacificA] from Microsoft.

The downside of majority vote is that it doesn't take many failures to leave you with no electable leaders. To tolerate one failure requires three copies of the data, and to tolerate two failures requires five copies of the data. In our experience having only enough redundancy to tolerate a single failure is not enough for a practical system, but doing every write five times, with 5x the disk space requirements and 1/5th the throughput, is not very practical for large volume data problems. This is likely why quorum algorithms more commonly appear for shared cluster configuration such as ZooKeeper but are less common for primary data storage. For example in HDFS the namenode's high-availability feature is built on a [majority-vote-based journal], but this more expensive approach is not used for the data itself.

Kafka takes a slightly different approach to choosing its quorum set. Instead of majority vote, Kafka dynamically maintains a set of in-sync replicas (ISR) that are caught-up to the leader. Only members of this set are eligible for election as leader. A write to a Kafka partition is not considered committed until *all* in-sync replicas have received the write. This ISR set is persisted to ZooKeeper whenever it changes. Because of this, any replica in the ISR is eligible to be elected leader. This is an important factor for Kafka's usage model where there are many partitions and ensuring leadership balance is important. With this ISR model and *f+1* replicas, a Kafka topic can tolerate *f* failures without losing committed messages.

For most use cases we hope to handle, we think this tradeoff is a reasonable one. In practice, to tolerate *f* failures, both the majority vote and the ISR approach will wait for the same number of replicas to acknowledge before committing a message (e.g. to survive one failure a majority quorum needs three replicas and one acknowledgement and the ISR approach requires two replicas and one acknowledgement). The ability to commit without the slowest servers is an advantage of the majority vote approach. However, we think it is ameliorated by allowing the client to choose whether they block on the message commit or not, and the additional throughput and disk space due to the lower required replication factor is worth it.

Another important design distinction is that Kafka does not require that crashed nodes recover with all their data intact. It is not uncommon for replication algorithms in this space to depend on the existence of "stable storage" that cannot be lost in any failure-recovery scenario without potential consistency violations. There are two primary problems with this assumption. First, disk errors are the most common problem we observe in real operation of persistent data systems and they often do not leave data intact. Secondly, even if this were not a problem, we do not want to require the use of fsync on every write for our consistency guarantees as this can reduce performance by two to three orders of magnitude. Our protocol for allowing a replica to rejoin the ISR ensures that before rejoining, it must fully re-sync again even if it lost unflushed data in its crash.

Unclean leader election: What if they all die?

Note that Kafka's guarantee with respect to data loss is predicated on at least one replica remaining in sync. If all the nodes replicating a partition die, this guarantee no longer holds.

However a practical system needs to do something reasonable when all the replicas die. If you are unlucky enough to have this occur, it is important to consider what will happen. There are two behaviors that could be implemented:

1. Wait for a replica in the ISR to come back to life and choose this replica as the leader (hopefully it still has all its data).
2. Choose the first replica (not necessarily in the ISR) that comes back to life as the leader.

This is a simple tradeoff between availability and consistency. If we wait for replicas in the ISR, then we will remain unavailable as long as those replicas are down. If such replicas were destroyed or their data was lost, then we are permanently down. If, on the other hand, a non-in-sync replica comes back to life and we allow it to become leader, then its log becomes the source of truth even though it is not guaranteed to have every committed message. By default from version 0.11.0.0, Kafka chooses the first strategy and favor waiting for a consistent replica. This behavior can be changed using configuration property unclean.leader.election.enable, to support use cases where uptime is preferable to consistency.

This dilemma is not specific to Kafka. It exists in any quorum-based scheme. For example in a majority voting scheme, if a majority of servers suffer a permanent failure, then you must either choose to lose 100% of your data or violate consistency by taking what remains on an existing server as your new source of truth.

Availability and Durability Guarantees

When writing to Kafka, producers can choose whether they wait for the message to be acknowledged by 0,1 or all (-1) replicas. Note that "acknowledgement by all replicas" does not guarantee that the full set of assigned replicas have received the message. By default, when acks=all, acknowledgement happens as soon as all the current in-sync replicas have received the message. For example, if a topic is configured with only two replicas and one fails (i.e., only one in sync replica remains), then writes that specify acks=all will succeed. However, these writes could be lost if the remaining replica also fails. Although this ensures maximum availability of the partition, this behavior may be undesirable to some users who prefer durability over availability. Therefore, we provide two topic-level configurations that can be used to prefer message durability over availability:

1. Disable unclean leader election - if all replicas become unavailable, then the partition will remain unavailable until the most recent leader becomes available again. This effectively prefers unavailability over the risk of message loss. See the previous section on Unclean Leader Election for clarification.
2. Specify a minimum ISR size - the partition will only accept writes if the size of the ISR is above a certain minimum, in order to prevent the loss of messages that were written to just a single replica, which subsequently becomes unavailable. This setting only takes effect if the producer uses acks=all and guarantees that the message will be acknowledged by at least this many in-sync replicas. This setting offers a trade-off between consistency and availability. A higher setting for minimum ISR size guarantees better consistency since the message is guaranteed to be written to more replicas which reduces the probability that it will be lost. However, it reduces availability since the partition will be unavailable for writes if the number of in-sync replicas drops below the minimum threshold.

Replica Management

The above discussion on replicated logs really covers only a single log, i.e. one topic partition. However a Kafka cluster will manage hundreds or thousands of these partitions. We attempt to balance partitions within a cluster in a round-robin fashion to avoid clustering all partitions for high-volume topics on a small number of nodes. Likewise we try to balance leadership so that each node is the leader for a proportional share of its partitions.

It is also important to optimize the leadership election process as that is the critical window of unavailability. A naive implementation of leader election would end up running an election per partition for all partitions a node hosted when that node failed. Instead, we elect one of the brokers as the "controller". This controller detects failures at the broker level and is responsible for changing the leader of all affected partitions in a failed broker. The result is that we are able to batch together many of the required leadership change notifications which makes the election process far cheaper and faster for a large number of partitions. If the controller fails, one of the surviving brokers will become the new controller.

4.8 Log Compaction

Log compaction ensures that Kafka will always retain at least the last known value for each message key within the log of data for a single topic partition. It addresses use cases and scenarios such as restoring state after application crashes or system failure, or reloading caches after application restarts during operational maintenance. Let's dive into these use cases in more detail and then describe how compaction works.

So far we have described only the simpler approach to data retention where old log data is discarded after a fixed period of time or when the log reaches some predetermined size. This works well for temporal event data such as logging where each record stands alone. However an important class of data streams are the log of changes to keyed, mutable data (for example, the changes to a database table).

Let's discuss a concrete example of such a stream. Say we have a topic containing user email addresses; every time a user updates their email address we send a message to this topic using their user id as the primary key. Now say we send the following messages over some time period for a user with id 123, each message corresponding to a change in email address (messages for other ids are omitted):

```
123 => bill@microsoft.com
        .
```

```
        .
        .
123 => bill@gatesfoundation.org
        .
        .
        .
123 => bill@gmail.com
```

Log compaction gives us a more granular retention mechanism so that we are guaranteed to retain at least the last update for each primary key (e.g. `bill@gmail.com`). By doing this we guarantee that the log contains a full snapshot of the final value for every key not just keys that changed recently. This means downstream consumers can restore their own state off this topic without us having to retain a complete log of all changes.

Let's start by looking at a few use cases where this is useful, then we'll see how it can be used.

1. *Database change subscription*. It is often necessary to have a data set in multiple data systems, and often one of these systems is a database of some kind (either a RDBMS or perhaps a new-fangled key-value store). For example you might have a database, a cache, a search cluster, and a Hadoop cluster. Each change to the database will need to be reflected in the cache, the search cluster, and eventually in Hadoop. In the case that one is only handling the real-time updates you only need recent log. But if you want to be able to reload the cache or restore a failed search node you may need a complete data set.
2. *Event sourcing*. This is a style of application design which co-locates query processing with application design and uses a log of changes as the primary store for the application.
3. *Journaling for high-availability*. A process that does local computation can be made fault-tolerant by logging out changes that it makes to its local state so another process can reload these changes and carry on if it should fail. A concrete example of this is handling counts, aggregations, and other "group by"-like processing in a stream query system. Samza, a real-time stream-processing framework, uses this feature for exactly this purpose.

In each of these cases one needs primarily to handle the real-time feed of changes, but occasionally, when a machine crashes or data needs to be re-loaded or re-processed, one needs to do a full load. Log compaction allows feeding both of these use cases off the same backing topic. This style of usage of a log is described in more detail in this blog post.

The general idea is quite simple. If we had infinite log retention, and we logged each change in the above cases, then we would have captured the state of the system at each time from when it first began. Using this complete log, we could restore to any point in time by replaying the first N records in the log. This hypothetical complete log is not very practical for systems that update a single record many times as the log will grow without bound even for a stable dataset. The simple log retention mechanism which throws away old updates will bound space but the log is no longer a way to restore the current state—now restoring from the beginning of the log no longer recreates the current state as old updates may not be captured at all.

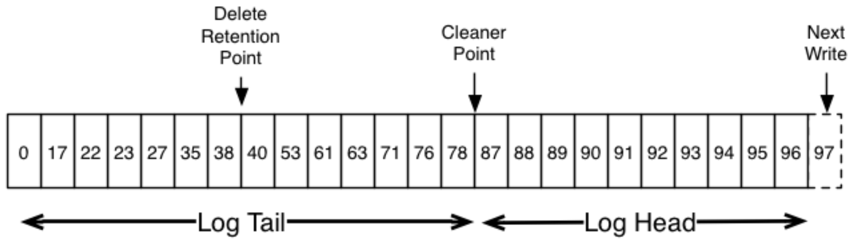
Log compaction is a mechanism to give finer-grained per-record retention, rather than the coarser-grained time-based retention. The idea is to selectively remove records where we have a more recent update with the same primary key. This way the log is guaranteed to have at least the last state for each key.

This retention policy can be set per-topic, so a single cluster can have some topics where retention is enforced by size or time and other topics where retention is enforced by compaction.

This functionality is inspired by one of LinkedIn's oldest and most successful pieces of infrastructure—a database changelog caching service called Databus. Unlike most log-structured storage systems Kafka is built for subscription and organizes data for fast linear reads and writes. Unlike Databus, Kafka acts as a source-of-truth store so it is useful even in situations where the upstream data source would not otherwise be replayable.

Log Compaction Basics

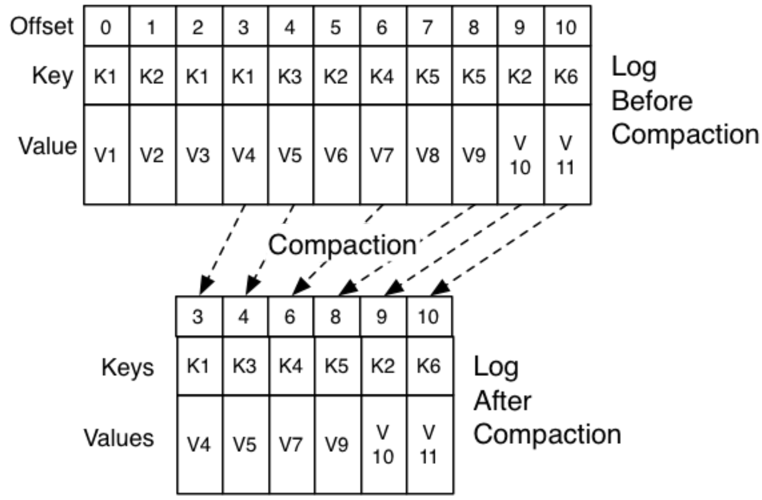
Here is a high-level picture that shows the logical structure of a Kafka log with the offset for each message.



The head of the log is identical to a traditional Kafka log. It has dense, sequential offsets and retains all messages. Log compaction adds an option for handling the tail of the log. The picture above shows a log with a compacted tail. Note that the messages in the tail of the log retain the original offset assigned when they were first written—that never changes. Note also that all offsets remain valid positions in the log, even if the message with that offset has been compacted away; in this case this position is indistinguishable from the next highest offset that does appear in the log. For example, in the picture above the offsets 36, 37, and 38 are all equivalent positions and a read beginning at any of these offsets would return a message set beginning with 38.

Compaction also allows for deletes. A message with a key and a null payload will be treated as a delete from the log. This delete marker will cause any prior message with that key to be removed (as would any new message with that key), but delete markers are special in that they will themselves be cleaned out of the log after a period of time to free up space. The point in time at which deletes are no longer retained is marked as the "delete retention point" in the above diagram.

The compaction is done in the background by periodically recopying log segments. Cleaning does not block reads and can be throttled to use no more than a configurable amount of I/O throughput to avoid impacting producers and consumers. The actual process of compacting a log segment looks something like this:



What guarantees does log compaction provide?

Log compaction guarantees the following:

1. Any consumer that stays caught-up to within the head of the log will see every message that is written; these messages will have sequential offsets. The topic's `min.compaction.lag.ms` can be used to guarantee the minimum length of time must pass after a message is written before it could be compacted. I.e. it provides a lower bound on how long each message will remain in the (uncompacted) head. The topic's `max.compaction.lag.ms` can be used to guarantee the maximum delay between the time a message is written and the time the message becomes eligible for compaction.
2. Ordering of messages is always maintained. Compaction will never re-order messages, just remove some.
3. The offset for a message never changes. It is the permanent identifier for a position in the log.
4. Any consumer progressing from the start of the log will see at least the final state of all records in the order they were written. Additionally, all delete markers for deleted records will be seen, provided the consumer reaches the head of the log in a time period less than the topic's `delete.retention.ms` setting (the default is 24 hours). In other words: since the removal of delete markers happens concurrently with reads, it is possible for a consumer to miss delete markers if it lags by more than `delete.retention.ms` .

Log Compaction Details

Log compaction is handled by the log cleaner, a pool of background threads that recopy log segment files, removing records whose key appears in the head of the log. Each compactor thread works as follows:

1. It chooses the log that has the highest ratio of log head to log tail
2. It creates a succinct summary of the last offset for each key in the head of the log
3. It recopies the log from beginning to end removing keys which have a later occurrence in the log. New, clean segments are swapped into the log immediately so the additional disk space required is just one additional log segment (not a fully copy of the log).
4. The summary of the log head is essentially just a space-compact hash table. It uses exactly 24 bytes per entry. As a result with 8GB of cleaner buffer one cleaner iteration can clean around 366GB of log head (assuming 1k messages).

Configuring The Log Cleaner

The log cleaner is enabled by default. This will start the pool of cleaner threads. To enable log cleaning on a particular topic, add the log-specific property

```
log.cleanup.policy=compact
```

The `log.cleanup.policy` property is a broker configuration setting defined in the broker's `server.properties` file; it affects all of the topics in the cluster that do not have a configuration override in place as documented here. The log cleaner can be configured to retain a minimum amount of the uncompacted "head" of the log. This is enabled by setting the compaction time lag.

```
log.cleaner.min.compaction.lag.ms
```

This can be used to prevent messages newer than a minimum message age from being subject to compaction. If not set, all log segments are eligible for compaction except for the last segment, i.e. the one currently being written to. The active segment will not be compacted even if all of its messages are older than the minimum compaction time lag. The log cleaner can be configured to ensure a maximum delay after which the uncompacted "head" of the log becomes eligible for log compaction.

```
log.cleaner.max.compaction.lag.ms
```

This can be used to prevent log with low produce rate from remaining ineligible for compaction for an unbounded duration. If not set, logs that do not exceed min.cleanable.dirty.ratio are not compacted. Note that this compaction deadline is not a hard guarantee since it is still subjected to the availability of log cleaner threads and the actual compaction time. You will want to monitor the uncleanable-partitions-count, max-clean-time-secs and max-compaction-delay-secs metrics.

Further cleaner configurations are described here.

4.9 Quotas

Kafka cluster has the ability to enforce quotas on requests to control the broker resources used by clients. Two types of client quotas can be enforced by Kafka brokers for each group of clients sharing a quota:

1. Network bandwidth quotas define byte-rate thresholds (since 0.9)
2. Request rate quotas define CPU utilization thresholds as a percentage of network and I/O threads (since 0.11)

Why are quotas necessary?

It is possible for producers and consumers to produce/consume very high volumes of data or generate requests at a very high rate and thus monopolize broker resources, cause network saturation and generally DOS other clients and the brokers themselves. Having quotas protects against these issues and is all the more important in large multi-tenant clusters where a small set of badly behaved clients can degrade user experience for the well behaved ones. In fact, when running Kafka as a service this even makes it possible to enforce API limits according to an agreed upon contract.

Client groups

The identity of Kafka clients is the user principal which represents an authenticated user in a secure cluster. In a cluster that supports unauthenticated clients, user principal is a grouping of unauthenticated users chosen by the broker using a configurable

`PrincipalBuilder`. Client-id is a logical grouping of clients with a meaningful name chosen by the client application. The tuple (user, client-id) defines a secure logical group of clients that share both user principal and client-id.

Quotas can be applied to (user, client-id), user or client-id groups. For a given connection, the most specific quota matching the connection is applied. All connections of a quota group share the quota configured for the group. For example, if (user="test-user", client-id="test-client") has a produce quota of 10MB/sec, this is shared across all producer instances of user "test-user" with the client-id "test-client".

Quota Configuration

Quota configuration may be defined for (user, client-id), user and client-id groups. It is possible to override the default quota at any of the quota levels that needs a higher (or even lower) quota. The mechanism is similar to the per-topic log config overrides. User and (user, client-id) quota overrides are written to ZooKeeper under ***/config/users*** and client-id quota overrides are written under ***/config/clients***. These overrides are read by all brokers and are effective immediately. This lets us change quotas without having to do a rolling restart of the entire cluster. See here for details. Default quotas for each group may also be updated dynamically using the same mechanism.

The order of precedence for quota configuration is:

1. /config/users/<user>/clients/<client-id>
2. /config/users/<user>/clients/<default>
3. /config/users/<user>
4. /config/users/<default>/clients/<client-id>
5. /config/users/<default>/clients/<default>
6. /config/users/<default>
7. /config/clients/<client-id>
8. /config/clients/<default>

Broker properties (quota.producer.default, quota.consumer.default) can also be used to set defaults of network bandwidth quotas for client-id groups. These properties are being deprecated and will be removed in a later release. Default quotas for client-id can be set in Zookeeper similar to the other quota overrides and defaults.

Network Bandwidth Quotas

Network bandwidth quotas are defined as the byte rate threshold for each group of clients sharing a quota. By default, each unique client group receives a fixed quota in bytes/sec as configured by the cluster. This quota is defined on a per-broker basis. Each group of clients can publish/fetch a maximum of X bytes/sec per broker before clients are throttled.

Request Rate Quotas

Request rate quotas are defined as the percentage of time a client can utilize on request handler I/O threads and network threads of each broker within a quota window. A quota of `n%` represents `n%` of one thread, so the quota is out of a total capacity of `((num.io.threads + num.network.threads) * 100)%`. Each group of clients may use a total percentage of upto `n%` across all I/O and network threads in a quota window before being throttled. Since the number of threads allocated for I/O and network threads are typically based on the number of cores available on the broker host, request rate quotas represent the total percentage of CPU that may be used by each group of clients sharing the quota.

Enforcement

By default, each unique client group receives a fixed quota as configured by the cluster. This quota is defined on a per-broker basis. Each client can utilize this quota per broker before it gets throttled. We decided that defining these quotas per broker is much better than having a fixed cluster wide bandwidth per client because that would require a mechanism to share client quota usage among all the brokers. This can be harder to get right than the quota implementation itself!

How does a broker react when it detects a quota violation? In our solution, the broker first computes the amount of delay needed to bring the violating client under its quota and returns a response with the delay immediately. In case of a fetch request, the response will not contain any data. Then, the broker mutes the channel to the client, not to process requests from the client anymore, until the delay is over. Upon receiving a response with a non-zero delay duration, the Kafka client will also refrain from sending further requests to the broker during the delay. Therefore, requests from a throttled client are effectively blocked from both sides. Even with older client implementations that do not respect the delay response from the broker, the back pressure applied by the broker via muting its socket channel can still handle the throttling of badly behaving clients. Those clients who sent further requests to the throttled channel will receive responses only after the delay is over.

Byte-rate and thread utilization are measured over multiple small windows (e.g. 30 windows of 1 second each) in order to detect and correct quota violations quickly. Typically, having large measurement windows (for e.g. 10 windows of 30 seconds each) leads to large bursts of traffic followed by long delays which is not great in terms of user experience.

5. IMPLEMENTATION

5.1 Network Layer

The network layer is a fairly straight-forward NIO server, and will not be described in great detail. The sendfile implementation is done by giving the `MessageSet` interface a `writeTo` method. This allows the file-backed message set to use the more efficient `transferTo` implementation instead of an in-process buffered write. The threading model is a single acceptor thread and *N* processor threads which handle a fixed number of connections each. This design has been pretty thoroughly tested elsewhere and found to be simple to implement and fast. The protocol is kept quite simple to allow for future implementation of clients in other languages.

5.2 Messages

Messages consist of a variable-length header, a variable length opaque key byte array and a variable length opaque value byte array. The format of the header is described in the following section. Leaving the key and value opaque is the right decision: there is a great deal of progress being made on serialization libraries right now, and any particular choice is unlikely to be right for all uses. Needless to say a particular application using Kafka would likely mandate a particular serialization type as part of its usage. The `RecordBatch` interface is simply an iterator over messages with specialized methods for bulk reading and writing to an NIO `Channel` .

5.3 Message Format

Messages (aka Records) are always written in batches. The technical term for a batch of messages is a record batch, and a record batch contains one or more records. In the degenerate case, we could have a record batch containing a single record. Record batches and records have their own headers. The format of each is described below.

5.3.1 Record Batch

The following is the on-disk format of a RecordBatch.

```
baseOffset: int64
batchLength: int32
partitionLeaderEpoch: int32
magic: int8 (current magic value is 2)
crc: int32
attributes: int16
    bit 0~2:
        0: no compression
        1: gzip
        2: snappy
        3: lz4
        4: zstd
    bit 3: timestampType
    bit 4: isTransactional (0 means not transactional)
    bit 5: isControlBatch (0 means not a control batch)
    bit 6~15: unused
lastOffsetDelta: int32
firstTimestamp: int64
maxTimestamp: int64
producerId: int64
producerEpoch: int16
baseSequence: int32
records: [Record]

```

Note that when compression is enabled, the compressed record data is serialized directly following the count of the number of records.

The CRC covers the data from the attributes to the end of the batch (i.e. all the bytes that follow the CRC). It is located after the magic byte, which means that clients must parse the magic byte before deciding how to interpret the bytes between the batch length and the magic byte. The partition leader epoch field is not included in the CRC computation to avoid the need to recompute the CRC when this field is assigned for every batch that is received by the broker. The CRC-32C (Castagnoli) polynomial is used for the computation.

On compaction: unlike the older message formats, magic v2 and above preserves the first and last offset/sequence numbers from the original batch when the log is cleaned. This is required in order to be able to restore the producer's state when the log is reloaded. If we did not retain the last sequence number, for example, then after a partition leader failure, the producer might see an OutOfSequence error. The base sequence number must be preserved for duplicate checking (the broker checks incoming Produce requests for duplicates by verifying that the first and last sequence numbers of the incoming batch match the last from that producer). As a result, it is possible to have empty batches in the log when all the records in the batch are cleaned but batch is still retained in order to preserve a producer's last sequence number. One oddity here is that the baseTimestamp field is not preserved during compaction, so it will change if the first record in the batch is compacted away.

5.3.1.1 Control Batches

A control batch contains a single record called the control record. Control records should not be passed on to applications. Instead, they are used by consumers to filter out aborted transactional messages.

The key of a control record conforms to the following schema:

```
version: int16 (current version is 0)
type: int16 (0 indicates an abort marker, 1 indicates a commit)
```

The schema for the value of a control record is dependent on the type. The value is opaque to clients.

5.3.2 Record

Record level headers were introduced in Kafka 0.11.0. The on-disk format of a record with Headers is delineated below.

```
length: varint
attributes: int8
    bit 0~7: unused
timestampDelta: varint
offsetDelta: varint
keyLength: varint
key: byte[]
valueLen: varint
value: byte[]
Headers => [Header]

```

5.3.2.1 Record Header

```
headerKeyLength: varint
headerKey: String
headerValueLength: varint
Value: byte[]

```

We use the same varint encoding as Protobuf. More information on the latter can be found here. The count of headers in a record is also encoded as a varint.

5.3.3 Old Message Format

Prior to Kafka 0.11, messages were transferred and stored in *message sets*. In a message set, each message has its own metadata. Note that although message sets are represented as an array, they are not preceded by an int32 array size like other array elements in the protocol.

Message Set:

```
MessageSet (Version: 0) => [offset message_size message]
```

```
    offset => INT64
    message_size => INT32
    message => crc magic_byte attributes key value
        crc => INT32
        magic_byte => INT8
        attributes => INT8
            bit 0~2:
                0: no compression
                1: gzip
                2: snappy
            bit 3~7: unused
        key => BYTES
        value => BYTES
```

```
MessageSet (Version: 1) => [offset message_size message]
    offset => INT64
    message_size => INT32
    message => crc magic_byte attributes key value
        crc => INT32
        magic_byte => INT8
        attributes => INT8
            bit 0~2:
                0: no compression
                1: gzip
                2: snappy
                3: lz4
            bit 3: timestampType
                0: create time
                1: log append time
            bit 4~7: unused
        timestamp =>INT64
        key => BYTES
        value => BYTES
```

In versions prior to Kafka 0.10, the only supported message format version (which is indicated in the magic value) was 0. Message format version 1 was introduced with timestamp support in version 0.10.

- Similarly to version 2 above, the lowest bits of attributes represent the compression type.
- In version 1, the producer should always set the timestamp type bit to 0. If the topic is configured to use log append time, (through either broker level config log.message.timestamp.type = LogAppendTime or topic level config message.timestamp.type = LogAppendTime), the broker will overwrite the timestamp type and the timestamp in the message set.
- The highest bits of attributes must be set to 0.

In message format versions 0 and 1 Kafka supports recursive messages to enable compression. In this case the message's attributes must be set to indicate one of the compression types and the value field will contain a message set compressed with that type. We often refer to the nested messages as "inner messages" and the wrapping message as the "outer message." Note that the key should be null for the outer message and its offset will be the offset of the last inner message.

When receiving recursive version 0 messages, the broker decompresses them and each inner message is assigned an offset individually. In version 1, to avoid server side re-compression, only the wrapper message will be assigned an offset. The inner messages will have relative offsets. The absolute offset can be computed using the offset from the outer message, which corresponds to the offset assigned to the last inner message.

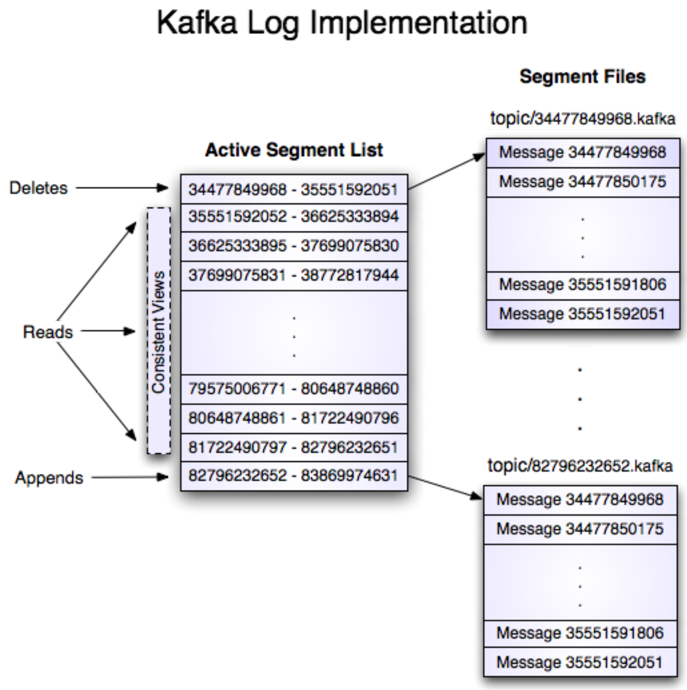
The crc field contains the CRC32 (and not CRC-32C) of the subsequent message bytes (i.e. from magic byte to the value).

5.4 Log

A log for a topic named "my_topic" with two partitions consists of two directories (namely `my_topic_0` and `my_topic_1`) populated with data files containing the messages for that topic. The format of the log files is a sequence of "log entries""; each log entry is a 4 byte integer *N* storing the message length which is followed by the *N* message bytes. Each message is uniquely identified by a 64-bit integer *offset* giving the byte position of the start of this message in the stream of all messages ever sent to that topic on that partition. The on-disk format of each message is given below. Each log file is named with the offset of the first message it contains. So the first file created will be 00000000000.kafka, and each additional file will have an integer name roughly *S* bytes from the previous file where *S* is the max log file size given in the configuration.

The exact binary format for records is versioned and maintained as a standard interface so record batches can be transferred between producer, broker, and client without recopying or conversion when desirable. The previous section included details about the on-disk format of records.

The use of the message offset as the message id is unusual. Our original idea was to use a GUID generated by the producer, and maintain a mapping from GUID to offset on each broker. But since a consumer must maintain an ID for each server, the global uniqueness of the GUID provides no value. Furthermore, the complexity of maintaining the mapping from a random id to an offset requires a heavy weight index structure which must be synchronized with disk, essentially requiring a full persistent random-access data structure. Thus to simplify the lookup structure we decided to use a simple per-partition atomic counter which could be coupled with the partition id and node id to uniquely identify a message; this makes the lookup structure simpler, though multiple seeks per consumer request are still likely. However once we settled on a counter, the jump to directly using the offset seemed natural—both after all are monotonically increasing integers unique to a partition. Since the offset is hidden from the consumer API this decision is ultimately an implementation detail and we went with the more efficient approach.



Writes

The log allows serial appends which always go to the last file. This file is rolled over to a fresh file when it reaches a configurable size (say 1GB). The log takes two configuration parameters: *M*, which gives the number of messages to write before forcing the OS to flush the file to disk, and *S*, which gives a number of seconds after which a flush is forced. This gives a durability guarantee of losing at most *M* messages or *S* seconds of data in the event of a system crash.

Reads

Reads are done by giving the 64-bit logical offset of a message and an *S*-byte max chunk size. This will return an iterator over the messages contained in the *S*-byte buffer. *S* is intended to be larger than any single message, but in the event of an abnormally large message, the read can be retried multiple times, each time doubling the buffer size, until the message is read successfully. A maximum message and buffer size can be specified to make the server reject messages larger than some size, and to give a bound to the client on the maximum it needs to ever read to get a complete message. It is likely that the read buffer ends with a partial message, this is easily detected by the size delimiting.

The actual process of reading from an offset requires first locating the log segment file in which the data is stored, calculating the file-specific offset from the global offset value, and then reading from that file offset. The search is done as a simple binary search variation against an in-memory range maintained for each file.

The log provides the capability of getting the most recently written message to allow clients to start subscribing as of "right now". This is also useful in the case the consumer fails to consume its data within its SLA-specified number of days. In this case when the client attempts to consume a non-existent offset it is given an OutOfRangeException and can either reset itself or fail as appropriate to the use case.

The following is the format of the results sent to the consumer.

```
MessageSetSend (fetch result)

total length     : 4 bytes
error code       : 2 bytes
message 1        : x bytes
...
message n        : x bytes
```

```
MultiMessageSetSend (multiFetch result)

total length       : 4 bytes
error code         : 2 bytes
messageSetSend 1
...
messageSetSend n
```

Deletes

Data is deleted one log segment at a time. The log manager allows pluggable delete policies to choose which files are eligible for deletion. The current policy deletes any log with a modification time of more than *N* days ago, though a policy which retained the last *N* GB could also be useful. To avoid locking reads while still allowing deletes that modify the segment list we use a copy-on-write style segment list implementation that provides consistent views to allow a binary search to proceed on an immutable static snapshot view of the log segments while deletes are progressing.

Guarantees

The log provides a configuration parameter *M* which controls the maximum number of messages that are written before forcing a flush to disk. On startup a log recovery process is run that iterates over all messages in the newest log segment and verifies that each message entry is valid. A message entry is valid if the sum of its size and offset are less than the length of the file AND the CRC32 of the message payload matches the CRC stored with the message. In the event corruption is detected the log is truncated to the last valid offset.

Note that two kinds of corruption must be handled: truncation in which an unwritten block is lost due to a crash, and corruption in which a nonsense block is ADDED to the file. The reason for this is that in general the OS makes no guarantee of the write order between the file inode and the actual block data so in addition to losing written data the file can gain nonsense data if the inode is updated with a new size but a crash occurs before the block containing that data is written. The CRC detects this corner case, and prevents it from corrupting the log (though the unwritten messages are, of course, lost).

5.5 Distribution

Consumer Offset Tracking

Kafka consumer tracks the maximum offset it has consumed in each partition and has the capability to commit offsets so that it can resume from those offsets in the event of a restart. Kafka provides the option to store all the offsets for a given consumer group in a designated broker (for that group) called the group coordinator. i.e., any consumer instance in that consumer group should send its offset commits and fetches to that group coordinator (broker). Consumer groups are assigned to coordinators based on their group names. A consumer can look up its coordinator by issuing a FindCoordinatorRequest to any Kafka broker and reading the FindCoordinatorResponse which will contain the coordinator details. The consumer can then proceed to commit or fetch offsets from the coordinator broker. In case the coordinator moves, the consumer will need to rediscover the coordinator. Offset commits can be done automatically or manually by consumer instance.

When the group coordinator receives an OffsetCommitRequest, it appends the request to a special compacted Kafka topic named *__consumer_offsets*. The broker sends a successful offset commit response to the consumer only after all the replicas of the offsets topic receive the offsets. In case the offsets fail to replicate within a configurable timeout, the offset commit will fail and the consumer may retry the commit after backing off. The brokers periodically compact the offsets topic since it only needs to maintain the most recent offset commit per partition. The coordinator also caches the offsets in an in-memory table in order to serve offset fetches quickly.

When the coordinator receives an offset fetch request, it simply returns the last committed offset vector from the offsets cache. In case coordinator was just started or if it just became the coordinator for a new set of consumer groups (by becoming a leader for a partition of the offsets topic), it may need to load the offsets topic partition into the cache. In this case, the offset fetch will fail with an CoordinatorLoadInProgressException and the consumer may retry the OffsetFetchRequest after backing off.

ZooKeeper Directories

The following gives the ZooKeeper structures and algorithms used for co-ordination between consumers and brokers.

Notation

When an element in a path is denoted [xyz], that means that the value of xyz is not fixed and there is in fact a ZooKeeper znode for each possible value of xyz. For example /topics/[topic] would be a directory named /topics containing a sub-directory for each topic name. Numerical ranges are also given such as [0...5] to indicate the subdirectories 0, 1, 2, 3, 4. An arrow -> is used to indicate the contents of a znode. For example /hello -> world would indicate a znode /hello containing the value "world".

Broker Node Registry

```
/brokers/ids/[0...N] --> {"jmx_port":...,"timestamp":...,"endpoints":[...],"host":...,"version":...,"port":...
```

This is a list of all present broker nodes, each of which provides a unique logical broker id which identifies it to consumers (which must be given as part of its configuration). On startup, a broker node registers itself by creating a znode with the logical broker id under /brokers/ids. The purpose of the logical broker id is to allow a broker to be moved to a different physical machine without affecting consumers. An attempt to register a broker id that is already in use (say because two servers are configured with the same broker id) results in an error.

Since the broker registers itself in ZooKeeper using ephemeral znodes, this registration is dynamic and will disappear if the broker is shutdown or dies (thus notifying consumers it is no longer available).

Broker Topic Registry

```
/brokers/topics/[topic]/partitions/[0...N]/state --> {"controller_epoch":...,"leader":...,"version":...,"leade
```

Each broker registers itself under the topics it maintains and stores the number of partitions for that topic.

Cluster Id

The cluster id is a unique and immutable identifier assigned to a Kafka cluster. The cluster id can have a maximum of 22 characters and the allowed characters are defined by the regular expression [a-zA-Z0-9_\-]+, which corresponds to the characters used by the URL-safe Base64 variant with no padding. Conceptually, it is auto-generated when a cluster is started for the first time.

Implementation-wise, it is generated when a broker with version 0.10.1 or later is successfully started for the first time. The broker tries to get the cluster id from the `/cluster/id` znode during startup. If the znode does not exist, the broker generates a new cluster id and creates the znode with this cluster id.

Broker node registration

The broker nodes are basically independent, so they only publish information about what they have. When a broker joins, it registers itself under the broker node registry directory and writes information about its host name and port. The broker also register the list of existing topics and their logical partitions in the broker topic registry. New topics are registered dynamically when they are created on the broker.

6. OPERATIONS

Here is some information on actually running Kafka as a production system based on usage and experience at LinkedIn. Please send us any additional tips you know of.

6.1 Basic Kafka Operations

This section will review the most common operations you will perform on your Kafka cluster. All of the tools reviewed in this section are available under the `bin/` directory of the Kafka distribution and each tool will print details on all possible commandline options if it is run with no arguments.

Adding and removing topics

You have the option of either adding topics manually or having them be created automatically when data is first published to a non-existent topic. If topics are auto-created then you may want to tune the default topic configurations used for auto-created topics.

Topics are added and modified using the topic tool:

```
> bin/kafka-topics.sh --bootstrap-server broker_host:port --create --topic my_topic_name \
      --partitions 20 --replication-factor 3 --config x=y
```

The replication factor controls how many servers will replicate each message that is written. If you have a replication factor of 3 then up to 2 servers can fail before you will lose access to your data. We recommend you use a replication factor of 2 or 3 so that you can transparently bounce machines without interrupting data consumption.

The partition count controls how many logs the topic will be sharded into. There are several impacts of the partition count. First each partition must fit entirely on a single server. So if you have 20 partitions the full data set (and read and write load) will be handled by no more than 20 servers (not counting replicas). Finally the partition count impacts the maximum parallelism of your consumers. This is discussed in greater detail in the concepts section.

Each sharded partition log is placed into its own folder under the Kafka log directory. The name of such folders consists of the topic name, appended by a dash (-) and the partition id. Since a typical folder name can not be over 255 characters long, there will be a limitation on the length of topic names. We assume the number of partitions will not ever be above 100,000. Therefore, topic names cannot be longer than 249 characters. This leaves just enough room in the folder name for a dash and a potentially 5 digit long partition id.

The configurations added on the command line override the default settings the server has for things like the length of time data should be retained. The complete set of per-topic configurations is documented here.

Modifying topics

You can change the configuration or partitioning of a topic using the same topic tool.

To add partitions you can do

```
> bin/kafka-topics.sh --bootstrap-server broker_host:port --alter --topic my_topic_name \
      --partitions 40
```

Be aware that one use case for partitions is to semantically partition data, and adding partitions doesn't change the partitioning of existing data so this may disturb consumers if they rely on that partition. That is if data is partitioned by `hash(key) % number_of_partitions` then this partitioning will potentially be shuffled by adding partitions but Kafka will not attempt to automatically redistribute data in any way.

To add configs:

```
> bin/kafka-configs.sh --bootstrap-server broker_host:port --entity-type topics --entity-name my_topic_name --
```

To remove a config:

```
> bin/kafka-configs.sh --bootstrap-server broker_host:port --entity-type topics --entity-name my_topic_name --
```

And finally deleting a topic:

```
> bin/kafka-topics.sh --bootstrap-server broker_host:port --delete --topic my_topic_name
```

Kafka does not currently support reducing the number of partitions for a topic.

Instructions for changing the replication factor of a topic can be found here.

Graceful shutdown

The Kafka cluster will automatically detect any broker shutdown or failure and elect new leaders for the partitions on that machine. This will occur whether a server fails or it is brought down intentionally for maintenance or configuration changes. For the latter cases Kafka supports a more graceful mechanism for stopping a server than just killing it. When a server is stopped gracefully it has two optimizations it will take advantage of:

1. It will sync all its logs to disk to avoid needing to do any log recovery when it restarts (i.e. validating the checksum for all messages in the tail of the log). Log recovery takes time so this speeds up intentional restarts.
2. It will migrate any partitions the server is the leader for to other replicas prior to shutting down. This will make the leadership transfer faster and minimize the time each partition is unavailable to a few milliseconds.

Syncing the logs will happen automatically whenever the server is stopped other than by a hard kill, but the controlled leadership migration requires using a special setting:

```
controlled.shutdown.enable=true
```

Note that controlled shutdown will only succeed if *all* the partitions hosted on the broker have replicas (i.e. the replication factor is greater than 1 *and* at least one of these replicas is alive). This is generally what you want since shutting down the last replica would make that topic partition unavailable.

Balancing leadership

Whenever a broker stops or crashes leadership for that broker's partitions transfers to other replicas. This means that by default when the broker is restarted it will only be a follower for all its partitions, meaning it will not be used for client reads and writes.

To avoid this imbalance, Kafka has a notion of preferred replicas. If the list of replicas for a partition is 1,5,9 then node 1 is preferred as the leader to either node 5 or 9 because it is earlier in the replica list. You can have the Kafka cluster try to restore leadership to the restored replicas by running the command:

```
> bin/kafka-preferred-replica-election.sh --zookeeper zk_host:port/chroot
```

Since running this command can be tedious you can also configure Kafka to do this automatically by setting the following configuration:

```
auto.leader.rebalance.enable=true
```

Balancing Replicas Across Racks

The rack awareness feature spreads replicas of the same partition across different racks. This extends the guarantees Kafka provides for broker-failure to cover rack-failure, limiting the risk of data loss should all the brokers on a rack fail at once. The feature can also be applied to other broker groupings such as availability zones in EC2.

You can specify that a broker belongs to a particular rack by adding a property to the broker config:

```
broker.rack=my-rack-id
```

When a topic is created, modified or replicas are redistributed, the rack constraint will be honoured, ensuring replicas span as many racks as they can (a partition will span min(#racks, replication-factor) different racks).

The algorithm used to assign replicas to brokers ensures that the number of leaders per broker will be constant, regardless of how brokers are distributed across racks. This ensures balanced throughput.

However if racks are assigned different numbers of brokers, the assignment of replicas will not be even. Racks with fewer brokers will get more replicas, meaning they will use more storage and put more resources into replication. Hence it is sensible to configure an equal number of brokers per rack.

Mirroring data between clusters

We refer to the process of replicating data *between* Kafka clusters "mirroring" to avoid confusion with the replication that happens amongst the nodes in a single cluster. Kafka comes with a tool for mirroring data between Kafka clusters. The tool consumes from a source cluster and produces to a destination cluster. A common use case for this kind of mirroring is to provide a replica in another datacenter. This scenario will be discussed in more detail in the next section.

You can run many such mirroring processes to increase throughput and for fault-tolerance (if one process dies, the others will take overs the additional load).

Data will be read from topics in the source cluster and written to a topic with the same name in the destination cluster. In fact the mirror maker is little more than a Kafka consumer and producer hooked together.

The source and destination clusters are completely independent entities: they can have different numbers of partitions and the offsets will not be the same. For this reason the mirror cluster is not really intended as a fault-tolerance mechanism (as the consumer position will be different); for that we recommend using normal in-cluster replication. The mirror maker process will, however, retain and use the message key for partitioning so order is preserved on a per-key basis.

Here is an example showing how to mirror a single topic (named *my-topic*) from an input cluster:

```
> bin/kafka-mirror-maker.sh
      --consumer.config consumer.properties
      --producer.config producer.properties --whitelist my-topic
```

Note that we specify the list of topics with the `--whitelist` option. This option allows any regular expression using [Java-style regular expressions](). So you could mirror two topics named *A* and *B* using `--whitelist 'A|B'`. Or you could mirror *all* topics using `--whitelist '*'`. Make sure to quote any regular expression to ensure the shell doesn't try to expand it as a file path. For convenience we allow the use of ',' instead of '|' to specify a list of topics. Combining mirroring with the configuration `auto.create.topics.enable=true` makes it possible to have a replica cluster that will automatically create and replicate all data in a source cluster even as new topics are added.

Checking consumer position

Sometimes it's useful to see the position of your consumers. We have a tool that will show the position of all consumers in a consumer group as well as how far behind the end of the log they are. To run this tool on a consumer group named *my-group* consuming a topic named *my-topic* would look like this:

```
> bin/kafka-consumer-groups.sh --bootstrap-server localhost:9092 --describe --group my-group

TOPIC                          PARTITION  CURRENT-OFFSET  LOG-END-OFFSET  LAG        CONSUMER-ID
my-topic                       0          2               4               2          consumer-1-029af89c-873c-
my-topic                       1          2               3               1          consumer-1-029af89c-873c-
my-topic                       2          2               3               1          consumer-2-42c1abd4-e3b2-
```

Managing Consumer Groups

With the ConsumerGroupCommand tool, we can list, describe, or delete the consumer groups. The consumer group can be deleted manually, or automatically when the last committed offset for that group expires. Manual deletion works only if the group does not have any active members. For example, to list all consumer groups across all topics:

```
> bin/kafka-consumer-groups.sh --bootstrap-server localhost:9092 --list

test-consumer-group
```

To view offsets, as mentioned earlier, we "describe" the consumer group like this:

```
> bin/kafka-consumer-groups.sh --bootstrap-server localhost:9092 --describe --group my-group

TOPIC           PARTITION  CURRENT-OFFSET  LOG-END-OFFSET  LAG             CONSUMER-ID
topic3          0          241019          395308          154289          consumer2-e76ea8c3-5d30-4299-9005-
topic2          1          520678          803288          282610          consumer2-e76ea8c3-5d30-4299-9005-
topic3          1          241018          398817          157799          consumer2-e76ea8c3-5d30-4299-9005-
topic1          0          854144          855809          1665            consumer1-3fc8d6f1-581a-4472-bdf3-
topic2          0          460537          803290          342753          consumer1-3fc8d6f1-581a-4472-bdf3-
topic3          2          243655          398812          155157          consumer4-117fe4d3-c6c1-4178-8ee9-
```

There are a number of additional "describe" options that can be used to provide more detailed information about a consumer group:

- --members: This option provides the list of all active members in the consumer group.

```
> bin/kafka-consumer-groups.sh --bootstrap-server localhost:9092 --describe --group my-group --members

CONSUMER-ID                                     HOST            CLIENT-ID       #PARTITIONS
consumer1-3fc8d6f1-581a-4472-bdf3-3515b4aee8c1 /127.0.0.1      consumer1       2
```

```
consumer4-117fe4d3-c6c1-4178-8ee9-eb4a3954bee0 /127.0.0.1      consumer4       1
consumer2-e76ea8c3-5d30-4299-9005-47eb41f3d3c4 /127.0.0.1      consumer2       3
consumer3-ecea43e4-1f01-479f-8349-f9130b75d8ee /127.0.0.1      consumer3       0
```

- --members --verbose: On top of the information reported by the "--members" options above, this option also provides the partitions assigned to each member.

```
> bin/kafka-consumer-groups.sh --bootstrap-server localhost:9092 --describe --group my-group --members --ve

CONSUMER-ID                                    HOST            CLIENT-ID       #PARTITIONS     ASSIGNMENT
consumer1-3fc8d6f1-581a-4472-bdf3-3515b4aee8c1 /127.0.0.1      consumer1       2               topic1(0), t
consumer4-117fe4d3-c6c1-4178-8ee9-eb4a3954bee0 /127.0.0.1      consumer4       1               topic3(2)
consumer2-e76ea8c3-5d30-4299-9005-47eb41f3d3c4 /127.0.0.1      consumer2       3               topic2(1), t
consumer3-ecea43e4-1f01-479f-8349-f9130b75d8ee /127.0.0.1      consumer3       0               -
```

- --offsets: This is the default describe option and provides the same output as the "--describe" option.
- --state: This option provides useful group-level information.

```
> bin/kafka-consumer-groups.sh --bootstrap-server localhost:9092 --describe --group my-group --state

COORDINATOR (ID)          ASSIGNMENT-STRATEGY       STATE                #MEMBERS
localhost:9092 (0)        range                     Stable               4
```

To manually delete one or multiple consumer groups, the "--delete" option can be used:

```
> bin/kafka-consumer-groups.sh --bootstrap-server localhost:9092 --delete --group my-group --group my-other-gr

Deletion of requested consumer groups ('my-group', 'my-other-group') was successful.
```

To reset offsets of a consumer group, "--reset-offsets" option can be used. This option supports one consumer group at the time. It requires defining following scopes: --all-topics or --topic. One scope must be selected, unless you use '--from-file' scenario. Also, first make sure that the consumer instances are inactive. See KIP-122 for more details.

It has 3 execution options:

- (default) to display which offsets to reset.
- --execute : to execute --reset-offsets process.
- --export : to export the results to a CSV format.

--reset-offsets also has following scenarios to choose from (atleast one scenario must be selected):

- --to-datetime <String: datetime> : Reset offsets to offsets from datetime. Format: 'YYYY-MM-DDTHH:mm:SS.sss'
- --to-earliest : Reset offsets to earliest offset.
- --to-latest : Reset offsets to latest offset.
- --shift-by <Long: number-of-offsets> : Reset offsets shifting current offset by 'n', where 'n' can be positive or negative.
- --from-file : Reset offsets to values defined in CSV file.
- --to-current : Resets offsets to current offset.
- --by-duration <String: duration> : Reset offsets to offset by duration from current timestamp. Format: 'PnDTnHnMnS'
- --to-offset : Reset offsets to a specific offset.

Please note, that out of range offsets will be adjusted to available offset end. For example, if offset end is at 10 and offset shift request is of 15, then, offset at 10 will actually be selected.

For example, to reset offsets of a consumer group to the latest offset:

```
> bin/kafka-consumer-groups.sh --bootstrap-server localhost:9092 --reset-offsets --group consumergroup1 --topi

TOPIC                          PARTITION  NEW-OFFSET
topic1                         0          0
```

If you are using the old high-level consumer and storing the group metadata in ZooKeeper (i.e. `offsets.storage=zookeeper`), pass `--zookeeper` instead of `bootstrap-server`:

```
> bin/kafka-consumer-groups.sh --zookeeper localhost:2181 --list
```

Expanding your cluster

Adding servers to a Kafka cluster is easy, just assign them a unique broker id and start up Kafka on your new servers. However these new servers will not automatically be assigned any data partitions, so unless partitions are moved to them they won't be doing any work until new topics are created. So usually when you add machines to your cluster you will want to migrate some existing data to these machines.

The process of migrating data is manually initiated but fully automated. Under the covers what happens is that Kafka will add the new server as a follower of the partition it is migrating and allow it to fully replicate the existing data in that partition. When the new server has fully replicated the contents of this partition and joined the in-sync replica one of the existing replicas will delete their partition's data.

The partition reassignment tool can be used to move partitions across brokers. An ideal partition distribution would ensure even data load and partition sizes across all brokers. The partition reassignment tool does not have the capability to automatically study the data distribution in a Kafka cluster and move partitions around to attain an even load distribution. As such, the admin has to figure out which topics or partitions should be moved around.

The partition reassignment tool can run in 3 mutually exclusive modes:

- --generate: In this mode, given a list of topics and a list of brokers, the tool generates a candidate reassignment to move all partitions of the specified topics to the new brokers. This option merely provides a convenient way to generate a partition reassignment plan given a list of topics and target brokers.
- --execute: In this mode, the tool kicks off the reassignment of partitions based on the user provided reassignment plan. (using the --reassignment-json-file option). This can either be a custom reassignment plan hand crafted by the admin or provided by using the --generate option
- --verify: In this mode, the tool verifies the status of the reassignment for all partitions listed during the last --execute. The status can be either of successfully completed, failed or in progress

Automatically migrating data to new machines

The partition reassignment tool can be used to move some topics off of the current set of brokers to the newly added brokers. This is typically useful while expanding an existing cluster since it is easier to move entire topics to the new set of brokers, than moving one partition at a time. When used to do this, the user should provide a list of topics that should be moved to the new set of brokers and a target list of new brokers. The tool then evenly distributes all partitions for the given list of topics across the new set of brokers. During this move, the replication factor of the topic is kept constant. Effectively the replicas for all partitions for the input list of topics are moved from the old set of brokers to the newly added brokers.

For instance, the following example will move all partitions for topics foo1,foo2 to the new set of brokers 5,6. At the end of this move, all partitions for topics foo1 and foo2 will *only* exist on brokers 5,6.

Since the tool accepts the input list of topics as a json file, you first need to identify the topics you want to move and create the json file as follows:

```
> cat topics-to-move.json
{"topics": [{"topic": "foo1"},
            {"topic": "foo2"}],
"version":1
}
```

Once the json file is ready, use the partition reassignment tool to generate a candidate assignment:

```
> bin/kafka-reassign-partitions.sh --zookeeper localhost:2181 --topics-to-move-json-file topics-to-move.json
Current partition replica assignment

{"version":1,
"partitions":[{"topic":"foo1","partition":2,"replicas":[1,2]},
              {"topic":"foo1","partition":0,"replicas":[3,4]},
              {"topic":"foo2","partition":2,"replicas":[1,2]},
              {"topic":"foo2","partition":0,"replicas":[3,4]},
              {"topic":"foo1","partition":1,"replicas":[2,3]},
              {"topic":"foo2","partition":1,"replicas":[2,3]}]
}

Proposed partition reassignment configuration

{"version":1,
"partitions":[{"topic":"foo1","partition":2,"replicas":[5,6]},
```

```
              {"topic":"foo1","partition":0,"replicas":[5,6]},
              {"topic":"foo2","partition":2,"replicas":[5,6]},
              {"topic":"foo2","partition":0,"replicas":[5,6]},
              {"topic":"foo1","partition":1,"replicas":[5,6]},
              {"topic":"foo2","partition":1,"replicas":[5,6]}]
}
```

The tool generates a candidate assignment that will move all partitions from topics foo1,foo2 to brokers 5,6. Note, however, that at this point, the partition movement has not started, it merely tells you the current assignment and the proposed new assignment. The current assignment should be saved in case you want to rollback to it. The new assignment should be saved in a json file (e.g. expand-cluster-reassignment.json) to be input to the tool with the --execute option as follows:

```
> bin/kafka-reassign-partitions.sh --zookeeper localhost:2181 --reassignment-json-file expand-cluster-reassig
Current partition replica assignment

{"version":1,
"partitions":[{"topic":"foo1","partition":2,"replicas":[1,2]},
              {"topic":"foo1","partition":0,"replicas":[3,4]},
              {"topic":"foo2","partition":2,"replicas":[1,2]},
              {"topic":"foo2","partition":0,"replicas":[3,4]},
              {"topic":"foo1","partition":1,"replicas":[2,3]},
              {"topic":"foo2","partition":1,"replicas":[2,3]}]
}

Save this to use as the --reassignment-json-file option during rollback
Successfully started reassignment of partitions
{"version":1,
"partitions":[{"topic":"foo1","partition":2,"replicas":[5,6]},
              {"topic":"foo1","partition":0,"replicas":[5,6]},
              {"topic":"foo2","partition":2,"replicas":[5,6]},
              {"topic":"foo2","partition":0,"replicas":[5,6]},
              {"topic":"foo1","partition":1,"replicas":[5,6]},
              {"topic":"foo2","partition":1,"replicas":[5,6]}]
}
```

Finally, the --verify option can be used with the tool to check the status of the partition reassignment. Note that the same expand-cluster-reassignment.json (used with the --execute option) should be used with the --verify option:

```
> bin/kafka-reassign-partitions.sh --zookeeper localhost:2181 --reassignment-json-file expand-cluster-reassigr
Status of partition reassignment:
Reassignment of partition [foo1,0] completed successfully
Reassignment of partition [foo1,1] is in progress
Reassignment of partition [foo1,2] is in progress
Reassignment of partition [foo2,0] completed successfully
Reassignment of partition [foo2,1] completed successfully
Reassignment of partition [foo2,2] completed successfully
```

Custom partition assignment and migration

The partition reassignment tool can also be used to selectively move replicas of a partition to a specific set of brokers. When used in this manner, it is assumed that the user knows the reassignment plan and does not require the tool to generate a candidate reassignment, effectively skipping the --generate step and moving straight to the --execute step

For instance, the following example moves partition 0 of topic foo1 to brokers 5,6 and partition 1 of topic foo2 to brokers 2,3:

The first step is to hand craft the custom reassignment plan in a json file:

```
> cat custom-reassignment.json
{"version":1,"partitions":[{"topic":"foo1","partition":0,"replicas":[5,6]},{"topic":"foo2","partition":1,"repl
```

Then, use the json file with the --execute option to start the reassignment process:

```
> bin/kafka-reassign-partitions.sh --zookeeper localhost:2181 --reassignment-json-file custom-reassignment.js
Current partition replica assignment

{"version":1,
"partitions":[{"topic":"foo1","partition":0,"replicas":[1,2]},
              {"topic":"foo2","partition":1,"replicas":[3,4]}]
```

```
}

Save this to use as the --reassignment-json-file option during rollback
Successfully started reassignment of partitions
{"version":1,
"partitions":[{"topic":"foo1","partition":0,"replicas":[5,6]},
              {"topic":"foo2","partition":1,"replicas":[2,3]}]
}
```

The --verify option can be used with the tool to check the status of the partition reassignment. Note that the same custom-reassignment.json (used with the --execute option) should be used with the --verify option:

```
> bin/kafka-reassign-partitions.sh --zookeeper localhost:2181 --reassignment-json-file custom-reassignment.jsc
Status of partition reassignment:
Reassignment of partition [foo1,0] completed successfully
Reassignment of partition [foo2,1] completed successfully
```

Decommissioning brokers

The partition reassignment tool does not have the ability to automatically generate a reassignment plan for decommissioning brokers yet. As such, the admin has to come up with a reassignment plan to move the replica for all partitions hosted on the broker to be decommissioned, to the rest of the brokers. This can be relatively tedious as the reassignment needs to ensure that all the replicas are not moved from the decommissioned broker to only one other broker. To make this process effortless, we plan to add tooling support for decommissioning brokers in the future.

Increasing replication factor

Increasing the replication factor of an existing partition is easy. Just specify the extra replicas in the custom reassignment json file and use it with the --execute option to increase the replication factor of the specified partitions.

For instance, the following example increases the replication factor of partition 0 of topic foo from 1 to 3. Before increasing the replication factor, the partition's only replica existed on broker 5. As part of increasing the replication factor, we will add more replicas on brokers 6 and 7.

The first step is to hand craft the custom reassignment plan in a json file:

```
> cat increase-replication-factor.json
{"version":1,
"partitions":[{"topic":"foo","partition":0,"replicas":[5,6,7]}]}
```

Then, use the json file with the --execute option to start the reassignment process:

```
> bin/kafka-reassign-partitions.sh --zookeeper localhost:2181 --reassignment-json-file increase-replication-f
Current partition replica assignment

{"version":1,
"partitions":[{"topic":"foo","partition":0,"replicas":[5]}]}

Save this to use as the --reassignment-json-file option during rollback
Successfully started reassignment of partitions
{"version":1,
"partitions":[{"topic":"foo","partition":0,"replicas":[5,6,7]}]}
```

The --verify option can be used with the tool to check the status of the partition reassignment. Note that the same increase-replication-factor.json (used with the --execute option) should be used with the --verify option:

```
> bin/kafka-reassign-partitions.sh --zookeeper localhost:2181 --reassignment-json-file increase-replication-fa
Status of partition reassignment:
Reassignment of partition [foo,0] completed successfully
```

You can also verify the increase in replication factor with the kafka-topics tool:

```
> bin/kafka-topics.sh --bootstrap-server localhost:9092 --topic foo --describe
Topic:foo	PartitionCount:1	ReplicationFactor:3	Configs:
  Topic: foo	Partition: 0	Leader: 5	Replicas: 5,6,7	Isr: 5,6,7
```

Limiting Bandwidth Usage during Data Migration

Kafka lets you apply a throttle to replication traffic, setting an upper bound on the bandwidth used to move replicas from machine to machine. This is useful when rebalancing a cluster, bootstrapping a new broker or adding or removing brokers, as it limits the impact these data-intensive operations will have on users.

There are two interfaces that can be used to engage a throttle. The simplest, and safest, is to apply a throttle when invoking the kafka-reassign-partitions.sh, but kafka-configs.sh can also be used to view and alter the throttle values directly.

So for example, if you were to execute a rebalance, with the below command, it would move partitions at no more than 50MB/s.

```
$ bin/kafka-reassign-partitions.sh --zookeeper localhost:2181 --execute --reassignment-json-file bigger-cluste
```

When you execute this script you will see the throttle engage:

```
The throttle limit was set to 50000000 B/s
Successfully started reassignment of partitions.
```

Should you wish to alter the throttle, during a rebalance, say to increase the throughput so it completes quicker, you can do this by re-running the execute command passing the same reassignment-json-file:

```
$ bin/kafka-reassign-partitions.sh --zookeeper localhost:2181  --execute --reassignment-json-file bigger-clust
  There is an existing assignment running.
  The throttle limit was set to 700000000 B/s
```

Once the rebalance completes the administrator can check the status of the rebalance using the --verify option. If the rebalance has completed, the throttle will be removed via the --verify command. It is important that administrators remove the throttle in a timely manner once rebalancing completes by running the command with the --verify option. Failure to do so could cause regular replication traffic to be throttled.

When the --verify option is executed, and the reassignment has completed, the script will confirm that the throttle was removed:

```
> bin/kafka-reassign-partitions.sh --zookeeper localhost:2181  --verify --reassignment-json-file bigger-cluste
Status of partition reassignment:
Reassignment of partition [my-topic,1] completed successfully
Reassignment of partition [mytopic,0] completed successfully
Throttle was removed.
```

The administrator can also validate the assigned configs using the kafka-configs.sh. There are two pairs of throttle configuration used to manage the throttling process. The throttle value itself. This is configured, at a broker level, using the dynamic properties:

```
leader.replication.throttled.rate
  follower.replication.throttled.rate
```

There is also an enumerated set of throttled replicas:

```
leader.replication.throttled.replicas
  follower.replication.throttled.replicas
```

Which are configured per topic. All four config values are automatically assigned by kafka-reassign-partitions.sh (discussed below).

To view the throttle limit configuration:

```
> bin/kafka-configs.sh --describe --zookeeper localhost:2181 --entity-type brokers
Configs for brokers '2' are leader.replication.throttled.rate=700000000,follower.replication.throttled.rate=70
Configs for brokers '1' are leader.replication.throttled.rate=700000000,follower.replication.throttled.rate=70
```

This shows the throttle applied to both leader and follower side of the replication protocol. By default both sides are assigned the same throttled throughput value.

To view the list of throttled replicas:

```
> bin/kafka-configs.sh --describe --zookeeper localhost:2181 --entity-type topics
Configs for topic 'my-topic' are leader.replication.throttled.replicas=1:102,0:101,
    follower.replication.throttled.replicas=1:101,0:102
```

Here we see the leader throttle is applied to partition 1 on broker 102 and partition 0 on broker 101. Likewise the follower throttle is applied to partition 1 on broker 101 and partition 0 on broker 102.

By default kafka-reassign-partitions.sh will apply the leader throttle to all replicas that exist before the rebalance, any one of which might be leader. It will apply the follower throttle to all move destinations. So if there is a partition with replicas on brokers 101,102, being reassigned to

102,103, a leader throttle, for that partition, would be applied to 101,102 and a follower throttle would be applied to 103 only.

If required, you can also use the --alter switch on kafka-configs.sh to alter the throttle configurations manually.

Safe usage of throttled replication

Some care should be taken when using throttled replication. In particular:

(1) Throttle Removal:

The throttle should be removed in a timely manner once reassignment completes (by running kafka-reassign-partitions —verify).

(2) Ensuring Progress:

If the throttle is set too low, in comparison to the incoming write rate, it is possible for replication to not make progress. This occurs when:

```
max(BytesInPerSec) > throttle
```

Where BytesInPerSec is the metric that monitors the write throughput of producers into each broker.

The administrator can monitor whether replication is making progress, during the rebalance, using the metric:

```
kafka.server:type=FetcherLagMetrics,name=ConsumerLag,clientId=([-.\w]+),topic=([-.\w]+),partition=([0-9
```

The lag should constantly decrease during replication. If the metric does not decrease the administrator should increase the throttle throughput as described above.

Setting quotas

Quotas overrides and defaults may be configured at (user, client-id), user or client-id levels as described here. By default, clients receive an unlimited quota. It is possible to set custom quotas for each (user, client-id), user or client-id group.

Configure custom quota for (user=user1, client-id=clientA):

```
> bin/kafka-configs.sh  --zookeeper localhost:2181 --alter --add-config 'producer_byte_rate=1024,consumer_byte
Updated config for entity: user-principal 'user1', client-id 'clientA'.
```

Configure custom quota for user=user1:

```
> bin/kafka-configs.sh  --zookeeper localhost:2181 --alter --add-config 'producer_byte_rate=1024,consumer_byte
Updated config for entity: user-principal 'user1'.
```

Configure custom quota for client-id=clientA:

```
> bin/kafka-configs.sh  --zookeeper localhost:2181 --alter --add-config 'producer_byte_rate=1024,consumer_byte
Updated config for entity: client-id 'clientA'.
```

It is possible to set default quotas for each (user, client-id), user or client-id group by specifying *--entity-default* option instead of *--entity-name*.

Configure default client-id quota for user=userA:

```
> bin/kafka-configs.sh  --zookeeper localhost:2181 --alter --add-config 'producer_byte_rate=1024,consumer_byte
Updated config for entity: user-principal 'user1', default client-id.
```

Configure default quota for user:

```
> bin/kafka-configs.sh  --zookeeper localhost:2181 --alter --add-config 'producer_byte_rate=1024,consumer_byte
Updated config for entity: default user-principal.
```

Configure default quota for client-id:

```
> bin/kafka-configs.sh  --zookeeper localhost:2181 --alter --add-config 'producer_byte_rate=1024,consumer_byte
Updated config for entity: default client-id.
```

Here's how to describe the quota for a given (user, client-id):

```
> bin/kafka-configs.sh  --zookeeper localhost:2181 --describe --entity-type users --entity-name user1 --entity
Configs for user-principal 'user1', client-id 'clientA' are producer_byte_rate=1024,consumer_byte_rate=2048,re
```

Describe quota for a given user:

```
> bin/kafka-configs.sh  --zookeeper localhost:2181 --describe --entity-type users --entity-name user1
Configs for user-principal 'user1' are producer_byte_rate=1024,consumer_byte_rate=2048,request_percentage=200
```

Describe quota for a given client-id:

```
> bin/kafka-configs.sh  --zookeeper localhost:2181 --describe --entity-type clients --entity-name clientA
Configs for client-id 'clientA' are producer_byte_rate=1024,consumer_byte_rate=2048,request_percentage=200
```

If entity name is not specified, all entities of the specified type are described. For example, describe all users:

```
> bin/kafka-configs.sh  --zookeeper localhost:2181 --describe --entity-type users
Configs for user-principal 'user1' are producer_byte_rate=1024,consumer_byte_rate=2048,request_percentage=200
Configs for default user-principal are producer_byte_rate=1024,consumer_byte_rate=2048,request_percentage=200
```

Similarly for (user, client):

```
> bin/kafka-configs.sh  --zookeeper localhost:2181 --describe --entity-type users --entity-type clients
Configs for user-principal 'user1', default client-id are producer_byte_rate=1024,consumer_byte_rate=2048,requ
Configs for user-principal 'user1', client-id 'clientA' are producer_byte_rate=1024,consumer_byte_rate=2048,re
```

It is possible to set default quotas that apply to all client-ids by setting these configs on the brokers. These properties are applied only if quota overrides or defaults are not configured in Zookeeper. By default, each client-id receives an unlimited quota. The following sets the default quota per producer and consumer client-id to 10MB/sec.

```
quota.producer.default=10485760
quota.consumer.default=10485760
```

Note that these properties are being deprecated and may be removed in a future release. Defaults configured using kafka-configs.sh take precedence over these properties.

6.2 Datacenters

Some deployments will need to manage a data pipeline that spans multiple datacenters. Our recommended approach to this is to deploy a local Kafka cluster in each datacenter with application instances in each datacenter interacting only with their local cluster and mirroring between clusters (see the documentation on the mirror maker tool for how to do this).

This deployment pattern allows datacenters to act as independent entities and allows us to manage and tune inter-datacenter replication centrally. This allows each facility to stand alone and operate even if the inter-datacenter links are unavailable: when this occurs the mirroring falls behind until the link is restored at which time it catches up.

For applications that need a global view of all data you can use mirroring to provide clusters which have aggregate data mirrored from the local clusters in *all* datacenters. These aggregate clusters are used for reads by applications that require the full data set.

This is not the only possible deployment pattern. It is possible to read from or write to a remote Kafka cluster over the WAN, though obviously this will add whatever latency is required to get the cluster.

Kafka naturally batches data in both the producer and consumer so it can achieve high-throughput even over a high-latency connection. To allow this though it may be necessary to increase the TCP socket buffer sizes for the producer, consumer, and broker using the `socket.send.buffer.bytes` and `socket.receive.buffer.bytes` configurations. The appropriate way to set this is documented here.

It is generally *not* advisable to run a *single* Kafka cluster that spans multiple datacenters over a high-latency link. This will incur very high replication latency both for Kafka writes and ZooKeeper writes, and neither Kafka nor ZooKeeper will remain available in all locations if the network between locations is unavailable.

6.3 Kafka Configuration

Important Client Configurations

The most important producer configurations are:

- acks
- compression
- batch size

The most important consumer configuration is the fetch size.

All configurations are documented in the configuration section.

A Production Server Config

Here is an example production server configuration:

```
# ZooKeeper
zookeeper.connect=[list of ZooKeeper servers]

# Log configuration
num.partitions=8
default.replication.factor=3
log.dir=[List of directories. Kafka should have its own dedicated disk(s) or SSD(s).]

# Other configurations
broker.id=[An integer. Start with 0 and increment by 1 for each new broker.]
listeners=[list of listeners]
auto.create.topics.enable=false
min.insync.replicas=2
queued.max.requests=[number of concurrent requests]
```

Our client configuration varies a fair amount between different use cases.

6.4 Java Version

From a security perspective, we recommend you use the latest released version of JDK 1.8 as older freely available versions have disclosed security vulnerabilities. LinkedIn is currently running JDK 1.8 u5 (looking to upgrade to a newer version) with the G1 collector. LinkedIn's tuning looks like this:

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

For reference, here are the stats on one of LinkedIn's busiest clusters (at peak):

- 60 brokers
- 50k partitions (replication factor 2)
- 800k messages/sec in
- 300 MB/sec inbound, 1 GB/sec+ outbound

The tuning looks fairly aggressive, but all of the brokers in that cluster have a 90% GC pause time of about 21ms, and they're doing less than 1 young GC per second.

6.5 Hardware and OS

We are using dual quad-core Intel Xeon machines with 24GB of memory.

You need sufficient memory to buffer active readers and writers. You can do a back-of-the-envelope estimate of memory needs by assuming you want to be able to buffer for 30 seconds and compute your memory need as write_throughput*30.

The disk throughput is important. We have 8x7200 rpm SATA drives. In general disk throughput is the performance bottleneck, and more disks is better. Depending on how you configure flush behavior you may or may not benefit from more expensive disks (if you force flush often then higher RPM SAS drives may be better).

OS

Kafka should run well on any unix system and has been tested on Linux and Solaris.

We have seen a few issues running on Windows and Windows is not currently a well supported platform though we would be happy to change that.

It is unlikely to require much OS-level tuning, but there are three potentially important OS-level configurations:

- File descriptor limits: Kafka uses file descriptors for log segments and open connections. If a broker hosts many partitions, consider that the broker needs at least (number_of_partitions)*(partition_size/segment_size) to track all log segments in addition to the number of connections the broker makes. We recommend at least 100000 allowed file descriptors for the broker processes as a starting point. Note: The mmap() function adds an extra reference to the file associated with the file descriptor fildes which is not removed by a subsequent close() on that file descriptor. This reference is removed when there are no more mappings to the file.
- Max socket buffer size: can be increased to enable high-performance data transfer between data centers as described here.
- Maximum number of memory map areas a process may have (aka vm.max_map_count). See the Linux kernel documentation. You should keep an eye at this OS-level property when considering the maximum number of partitions a broker may have. By default, on a number of Linux systems, the value of vm.max_map_count is somewhere around 65535. Each log segment, allocated per partition, requires a pair of index/timeindex files, and each of these files consumes 1 map area. In other words, each log segment uses 2 map areas. Thus, each partition requires minimum 2 map areas, as long as it hosts a single log segment. That is to say, creating 50000 partitions on a broker will result allocation of 100000 map areas and likely cause broker crash with OutOfMemoryError (Map failed) on a system with default vm.max_map_count. Keep in mind that the number of log segments per partition varies depending on the segment size, load intensity, retention policy and, generally, tends to be more than one.

Disks and Filesystem

We recommend using multiple drives to get good throughput and not sharing the same drives used for Kafka data with application logs or other OS filesystem activity to ensure good latency. You can either RAID these drives together into a single volume or format and mount each drive as its own directory. Since Kafka has replication the redundancy provided by RAID can also be provided at the application level. This choice has several tradeoffs.

If you configure multiple data directories partitions will be assigned round-robin to data directories. Each partition will be entirely in one of the data directories. If data is not well balanced among partitions this can lead to load imbalance between disks.

RAID can potentially do better at balancing load between disks (although it doesn't always seem to) because it balances load at a lower level. The primary downside of RAID is that it is usually a big performance hit for write throughput and reduces the available disk space.

Another potential benefit of RAID is the ability to tolerate disk failures. However our experience has been that rebuilding the RAID array is so I/O intensive that it effectively disables the server, so this does not provide much real availability improvement.

Application vs. OS Flush Management

Kafka always immediately writes all data to the filesystem and supports the ability to configure the flush policy that controls when data is forced out of the OS cache and onto disk using the flush. This flush policy can be controlled to force data to disk after a period of time or after a certain number of messages has been written. There are several choices in this configuration.

Kafka must eventually call fsync to know that data was flushed. When recovering from a crash for any log segment not known to be fsync'd Kafka will check the integrity of each message by checking its CRC and also rebuild the accompanying offset index file as part of the recovery process executed on startup.

Note that durability in Kafka does not require syncing data to disk, as a failed node will always recover from its replicas.

We recommend using the default flush settings which disable application fsync entirely. This means relying on the background flush done by the OS and Kafka's own background flush. This provides the best of all worlds for most uses: no knobs to tune, great throughput and latency, and full recovery guarantees. We generally feel that the guarantees provided by replication are stronger than sync to local disk, however the paranoid still may prefer having both and application level fsync policies are still supported.

The drawback of using application level flush settings is that it is less efficient in its disk usage pattern (it gives the OS less leeway to re-order writes) and it can introduce latency as fsync in most Linux filesystems blocks writes to the file whereas the background flushing does much more granular page-level locking.

In general you don't need to do any low-level tuning of the filesystem, but in the next few sections we will go over some of this in case it is useful.

Understanding Linux OS Flush Behavior

In Linux, data written to the filesystem is maintained in pagecache until it must be written out to disk (due to an application-level fsync or the OS's own flush policy). The flushing of data is done by a set of background threads called pdflush (or in post 2.6.32 kernels "flusher threads").

Pdflush has a configurable policy that controls how much dirty data can be maintained in cache and for how long before it must be written back to disk. This policy is described here. When Pdflush cannot keep up with the rate of data being written it will eventually cause the writing process to block incurring latency in the writes to slow down the accumulation of data.

You can see the current state of OS memory usage by doing

```
> cat /proc/meminfo
```

The meaning of these values are described in the link above.

Using pagecache has several advantages over an in-process cache for storing data that will be written out to disk:

- The I/O scheduler will batch together consecutive small writes into bigger physical writes which improves throughput.
- The I/O scheduler will attempt to re-sequence writes to minimize movement of the disk head which improves throughput.
- It automatically uses all the free memory on the machine

Filesystem Selection

Kafka uses regular files on disk, and as such it has no hard dependency on a specific filesystem. The two filesystems which have the most usage, however, are EXT4 and XFS. Historically, EXT4 has had more usage, but recent improvements to the XFS filesystem have shown it to have better performance characteristics for Kafka's workload with no compromise in stability.

Comparison testing was performed on a cluster with significant message loads, using a variety of filesystem creation and mount options. The primary metric in Kafka that was monitored was the "Request Local Time", indicating the amount of time append operations were taking. XFS resulted in much better local times (160ms vs. 250ms+ for the best EXT4 configuration), as well as lower average wait times. The XFS performance also showed less variability in disk performance.

General Filesystem Notes

For any filesystem used for data directories, on Linux systems, the following options are recommended to be used at mount time:

- noatime: This option disables updating of a file's atime (last access time) attribute when the file is read. This can eliminate a significant number of filesystem writes, especially in the case of bootstrapping consumers. Kafka does not rely on the atime attributes at all, so it is safe to disable this.

XFS Notes

The XFS filesystem has a significant amount of auto-tuning in place, so it does not require any change in the default settings, either at filesystem creation time or at mount. The only tuning parameters worth considering are:

- largeio: This affects the preferred I/O size reported by the stat call. While this can allow for higher performance on larger disk writes, in practice it had minimal or no effect on performance.
- nobarrier: For underlying devices that have battery-backed cache, this option can provide a little more performance by disabling periodic write flushes. However, if the underlying device is well-behaved, it will report to the filesystem that it does not require flushes, and this option will have no effect.

EXT4 Notes

EXT4 is a serviceable choice of filesystem for the Kafka data directories, however getting the most performance out of it will require adjusting several mount options. In addition, these options are generally unsafe in a failure scenario, and will result in much more data loss and corruption. For a single broker failure, this is not much of a concern as the disk can be wiped and the replicas rebuilt from the cluster. In a multiple-failure scenario, such as a power outage, this can mean underlying filesystem (and therefore data) corruption that is not easily recoverable. The following options can be adjusted:

- data=writeback: Ext4 defaults to data=ordered which puts a strong order on some writes. Kafka does not require this ordering as it does very paranoid data recovery on all unflushed log. This setting removes the ordering constraint and seems to significantly reduce latency.
- Disabling journaling: Journaling is a tradeoff: it makes reboots faster after server crashes but it introduces a great deal of additional locking which adds variance to write performance. Those who don't care about reboot time and want to reduce a major source of write latency spikes can turn off journaling entirely.
- commit=num_secs: This tunes the frequency with which ext4 commits to its metadata journal. Setting this to a lower value reduces the loss of unflushed data during a crash. Setting this to a higher value will improve throughput.
- nobh: This setting controls additional ordering guarantees when using data=writeback mode. This should be safe with Kafka as we do not depend on write ordering and improves throughput and latency.
- delalloc: Delayed allocation means that the filesystem avoid allocating any blocks until the physical write occurs. This allows ext4 to allocate a large extent instead of smaller pages and helps ensure the data is written sequentially. This feature is great for throughput. It does seem to involve some locking in the filesystem which adds a bit of latency variance.

6.6 Monitoring

Kafka uses Yammer Metrics for metrics reporting in the server. The Java clients use Kafka Metrics, a built-in metrics registry that minimizes transitive dependencies pulled into client applications. Both expose metrics via JMX and can be configured to report stats using pluggable stats reporters to hook up to your monitoring system.

All Kafka rate metrics have a corresponding cumulative count metric with suffix `-total`. For example, `records-consumed-rate` has a corresponding metric named `records-consumed-total`.

The easiest way to see the available metrics is to fire up jconsole and point it at a running kafka client or server; this will allow browsing all metrics with JMX.

Security Considerations for Remote Monitoring using JMX

Apache Kafka disables remote JMX by default. You can enable remote monitoring using JMX by setting the environment variable `JMX_PORT` for processes started using the CLI or standard Java system properties to enable remote JMX programmatically. You must enable security when enabling remote JMX in production scenarios to ensure that unauthorized users cannot monitor or control your broker or application as well as the platform on which these are running. Note that authentication is disabled for JMX by default in Kafka and security configs must be overridden for production deployments by setting the environment variable `KAFKA_JMX_OPTS` for processes started using the CLI or by setting appropriate Java system properties. See Monitoring and Management Using JMX Technology for details on securing JMX.

We do graphing and alerting on the following metrics:

DESCRIPTION	MBEAN NAME	NORMAL VALUE
Message in rate	kafka.server:type=BrokerTopicMetrics,name=MessagesInPerSec	
Byte in rate from clients	kafka.server:type=BrokerTopicMetrics,name=BytesInPerSec	
Byte in rate from other brokers	kafka.server:type=BrokerTopicMetrics,name=ReplicationBytesInPerSec	
Request rate	kafka.network:type=RequestMetrics,name=RequestsPerSec,request={Produce|FetchConsumer|FetchFollower}	
Error rate	kafka.network:type=RequestMetrics,name=ErrorsPerSec,request=([-.\w]+),error=([-.\w]+)	Number of errors in responses counted per-request-type, per-error-code. If a response contains multiple errors, all are counted. error=NONE indicates successful responses.
Request size in bytes	kafka.network:type=Re-	Size of requests for each

	questMetrics,name=RequestBytes,request=([-.\w]+)	request type.
Temporary memory size in bytes	kafka.network:type=RequestMetrics,name=TemporaryMemoryBytes,request={Produce|Fetch}	Temporary memory used for message format conversions and decompression.
Message conversion time	kafka.network:type=RequestMetrics,name=MessageConversionsTimeMs,request={Produce|Fetch}	Time in milliseconds spent on message format conversions.
Message conversion rate	kafka.server:type=BrokerTopicMetrics,name={Produce|Fetch}MessageConversionsPerSec,topic=([-.\w]+)	Number of records which required message format conversion.
Byte out rate to clients	kafka.server:type=BrokerTopicMetrics,name=BytesOutPerSec	
Byte out rate to other brokers	kafka.server:type=BrokerTopicMetrics,name=ReplicationBytesOutPerSec	
Message validation failure rate due to no key specified for compacted topic	kafka.server:type=BrokerTopicMetrics,name=NoKeyCompactedTopicRecordsPerSec	
Message validation failure rate due to invalid magic number	kafka.server:type=BrokerTopicMetrics,name=InvalidMagicNumberRecordsPerSec	
Message validation failure rate due to incorrect crc checksum	kafka.server:type=BrokerTopicMetrics,name=InvalidMessageCrcRecordsPerSec	
Message validation failure rate due to non-continuous offset or sequence number in batch	kafka.server:type=BrokerTopicMetrics,name=InvalidOffsetOrSequenceRecordsPerSec	
Log flush rate and time	kafka.log:type=LogFlushStats,name=LogFlushRateAndTimeMs	
# of under replicated partitions (|ISR| < |all replicas|)	kafka.server:type=ReplicaManager,name=UnderReplicatedPartitions	0
# of under minIsr partitions (|ISR| < min.insync.replicas)	kafka.server:type=ReplicaManager,name=UnderMinIsrPartitionCount	0
# of at minIsr partitions (|ISR| = min.insync.replicas)	kafka.server:type=ReplicaManager,name=AtMinIsrPartitionCount	0
# of offline log directories	kafka.log:type=LogManager,name=OfflineLogDirectoryCount	0
Is controller active on broker	kafka.controller:type=KafkaController,name=ActiveControllerCount	only one broker in the cluster should have 1
Leader election rate	kafka.controller:type=ControllerStats,name=LeaderElectionRateAndTimeMs	non-zero when there are broker failures
Unclean leader election rate	kafka.controller:type=ControllerStats,name=UncleanLeaderElectionsPerSec	0
Pending topic deletes	kafka.controller:type=KafkaController,name=TopicsToDeleteCount	
Pending replica deletes	kafka.controller:type=Kafka-	

	Controller,name=ReplicasToDeleteCount	
Ineligible pending topic deletes	kafka.controller:type=KafkaController,name=TopicsIneligibleToDeleteCount	
Ineligible pending replica deletes	kafka.controller:type=KafkaController,name=ReplicasIneligibleToDeleteCount	
Partition counts	kafka.server:type=ReplicaManager,name=PartitionCount	mostly even across brokers
Leader replica counts	kafka.server:type=ReplicaManager,name=LeaderCount	mostly even across brokers
ISR shrink rate	kafka.server:type=ReplicaManager,name=IsrShrinksPerSec	If a broker goes down, ISR for some of the partitions will shrink. When that broker is up again, ISR will be expanded once the replicas are fully caught up. Other than that, the expected value for both ISR shrink rate and expansion rate is 0.
ISR expansion rate	kafka.server:type=ReplicaManager,name=IsrExpandsPerSec	See above
Max lag in messages btw follower and leader replicas	kafka.server:type=ReplicaFetcherManager,name=MaxLag,clientId=Replica	lag should be proportional to the maximum batch size of a produce request.
Lag in messages per follower replica	kafka.server:type=FetcherLagMetrics,name=ConsumerLag,clientId=([-.\w]+),topic=([-.\w]+),partition=([0-9]+)	lag should be proportional to the maximum batch size of a produce request.
Requests waiting in the producer purgatory	kafka.server:type=DelayedOperationPurgatory,name=PurgatorySize,delayedOperation=Produce	non-zero if ack=-1 is used
Requests waiting in the fetch purgatory	kafka.server:type=DelayedOperationPurgatory,name=PurgatorySize,delayedOperation=Fetch	size depends on fetch.wait.max.ms in the consumer
Request total time	kafka.network:type=RequestMetrics,name=TotalTimeMs,request={Produce|FetchConsumer|FetchFollower}	broken into queue, local, remote and response send time
Time the request waits in the request queue	kafka.network:type=RequestMetrics,name=RequestQueueTimeMs,request={Produce|FetchConsumer|FetchFollower}	
Time the request is processed at the leader	kafka.network:type=RequestMetrics,name=LocalTimeMs,request={Produce|FetchConsumer|FetchFollower}	
Time the request waits for the follower	kafka.network:type=RequestMetrics,name=RemoteTimeMs,request={Produce|FetchConsumer|FetchFollower}	non-zero for produce requests when ack=-1
Time the request waits in the response queue	kafka.network:type=RequestMetrics,name=ResponseQueueTimeMs,request=	

	{Produce|FetchConsumer|FetchFollower}	
Time to send the response	kafka.network:type=RequestMetrics,name=ResponseSendTimeMs,request={Produce|FetchConsumer|FetchFollower}	
Number of messages the consumer lags behind the producer by. Published by the consumer, not broker.	kafka.consumer:type=consumer-fetch-manager-metrics,client-id={client-id} Attribute: records-lag-max	
The average fraction of time the network processors are idle	kafka.network:type=SocketServer,name=NetworkProcessorAvgIdlePercent	between 0 and 1, ideally > 0.3
The number of connections disconnected on a processor due to a client not re-authenticating and then using the connection beyond its expiration time for anything other than re-authentication	kafka.server:type=socket-server-metrics,listener=[SASL_PLAINTEXT|SASL_SSL],networkProcessor=<#>,name=expired-connections-killed-count	ideally 0 when re-authentication is enabled, implying there are no longer any older, pre-2.2.0 clients connecting to this (listener, processor) combination
The total number of connections disconnected, across all processors, due to a client not re-authenticating and then using the connection beyond its expiration time for anything other than re-authentication	kafka.network:type=SocketServer,name=ExpiredConnectionsKilledCount	ideally 0 when re-authentication is enabled, implying there are no longer any older, pre-2.2.0 clients connecting to this broker
The average fraction of time the request handler threads are idle	kafka.server:type=KafkaRequestHandlerPool,name=RequestHandlerAvgIdlePercent	between 0 and 1, ideally > 0.3
Bandwidth quota metrics per (user, client-id), user or client-id	kafka.server:type={Produce|Fetch},user=([-.\w]+),client-id=([-.\w]+)	Two attributes. throttle-time indicates the amount of time in ms the client was throttled. Ideally = 0. byte-rate indicates the data produce/consume rate of the client in bytes/sec. For (user, client-id) quotas, both user and client-id are specified. If per-client-id quota is applied to the client, user is not specified. If per-user quota is applied, client-id is not specified.
Request quota metrics per (user, client-id), user or client-id	kafka.server:type=Request,user=([-.\w]+),client-id=([-.\w]+)	Two attributes. throttle-time indicates the amount of time in ms the client was throttled. Ideally = 0. request-time indicates the percentage of time spent in broker network and I/O threads to process requests from client group. For (user, client-id) quotas, both user and client-id are specified. If per-client-id quota is applied to the client, user is not specified. If per-user quota is applied, client-id is not specified.
Requests exempt from throttling	kafka.server:type=Request	exempt-throttle-time indicates the percentage of time spent in broker network and I/O threads to

		process requests that are exempt from throttling.
ZooKeeper client request latency	kafka.server:type=ZooKeeperClientMetrics,name=ZooKeeperRequestLatencyMs	Latency in millseconds for ZooKeeper requests from broker.
ZooKeeper connection status	kafka.server:type=SessionExpireListener,name=SessionState	Connection status of broker's ZooKeeper session which may be one of Disconnected|SyncConnected|AuthFailed|ConnectedReadOnly|SaslAuthenticated|Expired.
Max time to load group metadata	kafka.server:type=group-coordinator-metrics,name=partition-load-time-max	maximum time, in milliseconds, it took to load offsets and group metadata from the consumer offset partitions loaded in the last 30 seconds
Avg time to load group metadata	kafka.server:type=group-coordinator-metrics,name=partition-load-time-avg	average time, in milliseconds, it took to load offsets and group metadata from the consumer offset partitions loaded in the last 30 seconds
Max time to load transaction metadata	kafka.server:type=transaction-coordinator-metrics,name=partition-load-time-max	maximum time, in milliseconds, it took to load transaction metadata from the consumer offset partitions loaded in the last 30 seconds
Avg time to load transaction metadata	kafka.server:type=transaction-coordinator-metrics,name=partition-load-time-avg	average time, in milliseconds, it took to load transaction metadata from the consumer offset partitions loaded in the last 30 seconds

Common monitoring metrics for producer/consumer/connect/streams

The following metrics are available on producer/consumer/connector/streams instances. For specific metrics, please see following sections.

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
connection-close-rate	Connections closed per second in the window.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
connection-close-total	Total connections closed in the window.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
connection-creation-rate	New connections established per second in the window.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
connection-creation-total	Total new connections established in the window.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
network-io-rate	The average number of network operations (reads or writes) on all connections per second.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)

network-io-total	The total number of network operations (reads or writes) on all connections.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
outgoing-byte-rate	The average number of outgoing bytes sent per second to all servers.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
outgoing-byte-total	The total number of outgoing bytes sent to all servers.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
request-rate	The average number of requests sent per second.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
request-total	The total number of requests sent.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
request-size-avg	The average size of all requests in the window.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
request-size-max	The maximum size of any request sent in the window.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
incoming-byte-rate	Bytes/second read off all sockets.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
incoming-byte-total	Total bytes read off all sockets.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
response-rate	Responses received per second.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
response-total	Total responses received.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
select-rate	Number of times the I/O layer checked for new I/O to perform per second.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
select-total	Total number of times the I/O layer checked for new I/O to perform.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
io-wait-time-ns-avg	The average length of time the I/O thread spent waiting	kafka.[producer|consumer|connect]:type=[producer|consumer|con-

	for a socket ready for reads or writes in nanoseconds.	sumer|connect]-metrics,client-id=([-.\w]+)
io-wait-ratio	The fraction of time the I/O thread spent waiting.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
io-time-ns-avg	The average length of time for I/O per select call in nanoseconds.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
io-ratio	The fraction of time the I/O thread spent doing I/O.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
connection-count	The current number of active connections.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
successful-authentication-rate	Connections per second that were successfully authenticated using SASL or SSL.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
successful-authentication-total	Total connections that were successfully authenticated using SASL or SSL.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
failed-authentication-rate	Connections per second that failed authentication.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
failed-authentication-total	Total connections that failed authentication.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
successful-reauthentication-rate	Connections per second that were successfully re-authenticated using SASL.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
successful-reauthentication-total	Total connections that were successfully re-authenticated using SASL.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
reauthentication-latency-max	The maximum latency in ms observed due to re-authentication.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
reauthentication-latency-avg	The average latency in ms observed due to re-authentication.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
failed-reauthentication-rate	Connections per second that failed re-authentication.	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
failed-reauthentication-total	Total connections that	kafka.

	failed re-authentication.	[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)
successful-authentication-no-reauth-total	Total connections that were successfully authenticated by older, pre-2.2.0 SASL clients that do not support re-authentication. May only be non-zero	kafka.[producer|consumer|connect]:type=[producer|consumer|connect]-metrics,client-id=([-.\w]+)

Common Per-broker metrics for producer/consumer/connect/streams

The following metrics are available on producer/consumer/connector/streams instances. For specific metrics, please see following sections.

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
outgoing-byte-rate	The average number of outgoing bytes sent per second for a node.	kafka.[producer|consumer|connect]:type=[consumer|producer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)
outgoing-byte-total	The total number of outgoing bytes sent for a node.	kafka.[producer|consumer|connect]:type=[consumer|producer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)
request-rate	The average number of requests sent per second for a node.	kafka.[producer|consumer|connect]:type=[consumer|producer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)
request-total	The total number of requests sent for a node.	kafka.[producer|consumer|connect]:type=[consumer|producer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)
request-size-avg	The average size of all requests in the window for a node.	kafka.[producer|consumer|connect]:type=[consumer|producer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)
request-size-max	The maximum size of any request sent in the window for a node.	kafka.[producer|consumer|connect]:type=[consumer|producer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)
incoming-byte-rate	The average number of bytes received per second for a node.	kafka.[producer|consumer|connect]:type=[consumer|producer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)
incoming-byte-total	The total number of bytes received for a node.	kafka.[producer|consumer|connect]:type=[consumer|producer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)
request-latency-avg	The average request latency in ms for a node.	kafka.[producer|consumer|connect]:type=[consumer|pro-

		ducer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)
request-latency-max	The maximum request latency in ms for a node.	kafka.[producer|consumer|connect]:type=[consumer|producer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)
response-rate	Responses received per second for a node.	kafka.[producer|consumer|connect]:type=[consumer|producer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)
response-total	Total responses received for a node.	kafka.[producer|consumer|connect]:type=[consumer|producer|connect]-node-metrics,client-id=([-.\w]+),node-id=([0-9]+)

Producer monitoring

The following metrics are available on producer instances.

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
waiting-threads	The number of user threads blocked waiting for buffer memory to enqueue their records.	kafka.producer:type=producer-metrics,client-id=([-.\w]+)
buffer-total-bytes	The maximum amount of buffer memory the client can use (whether or not it is currently used).	kafka.producer:type=producer-metrics,client-id=([-.\w]+)
buffer-available-bytes	The total amount of buffer memory that is not being used (either unallocated or in the free list).	kafka.producer:type=producer-metrics,client-id=([-.\w]+)
bufferpool-wait-time	The fraction of time an appender waits for space allocation.	kafka.producer:type=producer-metrics,client-id=([-.\w]+)

Producer Sender Metrics

kafka.producer:type=producer-metrics,client-id="{client-id}"		
	ATTRIBUTE NAME	DESCRIPTION
	batch-size-avg	The average number of bytes sent per partition per-request.
	batch-size-max	The max number of bytes sent per partition per-request.
	batch-split-rate	The average number of batch splits per second
	batch-split-total	The total number of batch splits
	compression-rate-avg	The average compression rate of record batches.
	metadata-age	The age in seconds of the current producer metadata being used.

	produce-throttle-time-avg	The average time in ms a request was throttled by a broker
	produce-throttle-time-max	The maximum time in ms a request was throttled by a broker
	record-error-rate	The average per-second number of record sends that resulted in errors
	record-error-total	The total number of record sends that resulted in errors
	record-queue-time-avg	The average time in ms record batches spent in the send buffer.
	record-queue-time-max	The maximum time in ms record batches spent in the send buffer.
	record-retry-rate	The average per-second number of retried record sends
	record-retry-total	The total number of retried record sends
	record-send-rate	The average number of records sent per second.
	record-send-total	The total number of records sent.
	record-size-avg	The average record size
	record-size-max	The maximum record size
	records-per-request-avg	The average number of records per request.
	request-latency-avg	The average request latency in ms
	request-latency-max	The maximum request latency in ms
	requests-in-flight	The current number of in-flight requests awaiting a response.
kafka.producer:type=producer-topic-metrics,client-id="{client-id}",topic="{topic}"		
	ATTRIBUTE NAME	DESCRIPTION
	byte-rate	The average number of bytes sent per second for a topic.
	byte-total	The total number of bytes sent for a topic.
	compression-rate	The average compression rate of record batches for a topic.
	record-error-rate	The average per-second number of record sends that resulted in errors for a topic
	record-error-total	The total number of record sends that resulted in errors for a topic
	record-retry-rate	The average per-second number of retried record sends for a topic
	record-retry-total	The total number of retried record sends for a topic
	record-send-rate	The average number of records sent per second for

		a topic.
	record-send-total	The total number of records sent for a topic.

consumer monitoring

The following metrics are available on consumer instances.

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
time-between-poll-avg	The average delay between invocations of poll().	kafka.consumer:type=consumer-metrics,client-id=([-.\w]+)
time-between-poll-max	The max delay between invocations of poll().	kafka.consumer:type=consumer-metrics,client-id=([-.\w]+)
last-poll-seconds-ago	The number of seconds since the last poll() invocation.	kafka.consumer:type=consumer-metrics,client-id=([-.\w]+)
poll-idle-ratio-avg	The average fraction of time the consumer's poll() is idle as opposed to waiting for the user code to process records.	kafka.consumer:type=consumer-metrics,client-id=([-.\w]+)

Consumer Group Metrics

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
commit-latency-avg	The average time taken for a commit request	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
commit-latency-max	The max time taken for a commit request	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
commit-rate	The number of commit calls per second	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
commit-total	The total number of commit calls	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
assigned-partitions	The number of partitions currently assigned to this consumer	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
heartbeat-response-time-max	The max time taken to receive a response to a heartbeat request	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
heartbeat-rate	The average number of heartbeats per second	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
heartbeat-total	The total number of heartbeats	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
join-time-avg	The average time taken for a group rejoin	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
join-time-max	The max time taken for a group rejoin	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
join-rate	The number of group joins per second	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
join-total	The total number of group	kafka.consumer:type=con-

	joins	sumer-coordinator-metrics,client-id=([-.\w]+)
sync-time-avg	The average time taken for a group sync	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
sync-time-max	The max time taken for a group sync	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
sync-rate	The number of group syncs per second	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
sync-total	The total number of group syncs	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
rebalance-latency-avg	The average time taken for a group rebalance	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
rebalance-latency-max	The max time taken for a group rebalance	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
rebalance-latency-total	The total time taken for group rebalances so far	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
rebalance-total	The total number of group rebalances participated	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
rebalance-rate-per-hour	The number of group rebalance participated per hour	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
failed-rebalance-total	The total number of failed group rebalances	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
failed-rebalance-rate-per-hour	The number of failed group rebalance event per hour	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
last-rebalance-seconds-ago	The number of seconds since the last rebalance event	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
last-heartbeat-seconds-ago	The number of seconds since the last controller heartbeat	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
partitions-revoked-latency-avg	The average time taken by the on-partitions-revoked rebalance listener callback	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
partitions-revoked-latency-max	The max time taken by the on-partitions-revoked rebalance listener callback	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
partitions-assigned-latency-avg	The average time taken by the on-partitions-assigned rebalance listener callback	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
partitions-assigned-latency-max	The max time taken by the on-partitions-assigned rebalance listener callback	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
partitions-lost-latency-avg	The average time taken by the on-partitions-lost rebalance listener callback	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)
partitions-lost-latency-max	The max time taken by the on-partitions-lost rebalance listener callback	kafka.consumer:type=consumer-coordinator-metrics,client-id=([-.\w]+)

Consumer Fetch Metrics

kafka.consumer:type=consumer-fetch-manager-metrics,client-id="{client-id}"

	ATTRIBUTE NAME	DESCRIPTION
	bytes-consumed-rate	The average number of bytes consumed per second
	bytes-consumed-total	The total number of bytes consumed
	fetch-latency-avg	The average time taken for a fetch request.
	fetch-latency-max	The max time taken for any fetch request.
	fetch-rate	The number of fetch requests per second.
	fetch-size-avg	The average number of bytes fetched per request
	fetch-size-max	The maximum number of bytes fetched per request
	fetch-throttle-time-avg	The average throttle time in ms
	fetch-throttle-time-max	The maximum throttle time in ms
	fetch-total	The total number of fetch requests.
	records-consumed-rate	The average number of records consumed per second
	records-consumed-total	The total number of records consumed
	records-lag-max	The maximum lag in terms of number of records for any partition in this window
	records-lead-min	The minimum lead in terms of number of records for any partition in this window
	records-per-request-avg	The average number of records in each request
kafka.consumer:type=consumer-fetch-manager-metrics,client-id="{client-id}",topic="{topic}"		
	ATTRIBUTE NAME	DESCRIPTION
	bytes-consumed-rate	The average number of bytes consumed per second for a topic
	bytes-consumed-total	The total number of bytes consumed for a topic
	fetch-size-avg	The average number of bytes fetched per request for a topic
	fetch-size-max	The maximum number of bytes fetched per request for a topic
	records-consumed-rate	The average number of records consumed per second for a topic
	records-consumed-total	The total number of records consumed for a topic
	records-per-request-avg	The average number of records in each request for a topic
kafka.consumer:type=consumer-fetch-manager-metrics,partition="{partition}",topic="{topic}",client-id="{client-id}"		

	ATTRIBUTE NAME	DESCRIPTION
	preferred-read-replica	The current read replica for the partition, or -1 if reading from leader
	records-lag	The latest lag of the partition
	records-lag-avg	The average lag of the partition
	records-lag-max	The max lag of the partition
	records-lead	The latest lead of the partition
	records-lead-avg	The average lead of the partition
	records-lead-min	The min lead of the partition

Connect Monitoring

A Connect worker process contains all the producer and consumer metrics as well as metrics specific to Connect. The worker process itself has a number of metrics, while each connector and task have additional metrics.

kafka.connect:type=connect-worker-metrics		
	ATTRIBUTE NAME	DESCRIPTION
	connector-count	The number of connectors run in this worker.
	connector-startup-attempts-total	The total number of connector startups that this worker has attempted.
	connector-startup-failure-percentage	The average percentage of this worker's connectors starts that failed.
	connector-startup-failure-total	The total number of connector starts that failed.
	connector-startup-success-percentage	The average percentage of this worker's connectors starts that succeeded.
	connector-startup-success-total	The total number of connector starts that succeeded.
	task-count	The number of tasks run in this worker.
	task-startup-attempts-total	The total number of task startups that this worker has attempted.
	task-startup-failure-percentage	The average percentage of this worker's tasks starts that failed.
	task-startup-failure-total	The total number of task starts that failed.
	task-startup-success-percentage	The average percentage of this worker's tasks starts that succeeded.
	task-startup-success-total	The total number of task starts that succeeded.
kafka.connect:type=connect-worker-metrics,connector="{connector}"		
	ATTRIBUTE NAME	DESCRIPTION
	connector-destroyed-task-count	The number of destroyed tasks of the connector on

		the worker.
	connector-failed-task-count	The number of failed tasks of the connector on the worker.
	connector-paused-task-count	The number of paused tasks of the connector on the worker.
	connector-running-task-count	The number of running tasks of the connector on the worker.
	connector-total-task-count	The number of tasks of the connector on the worker.
	connector-unassigned-task-count	The number of unassigned tasks of the connector on the worker.
kafka.connect:type=connect-worker-rebalance-metrics		
	ATTRIBUTE NAME	DESCRIPTION
	completed-rebalances-total	The total number of rebalances completed by this worker.
	connect-protocol	The Connect protocol used by this cluster
	epoch	The epoch or generation number of this worker.
	leader-name	The name of the group leader.
	rebalance-avg-time-ms	The average time in milliseconds spent by this worker to rebalance.
	rebalance-max-time-ms	The maximum time in milliseconds spent by this worker to rebalance.
	rebalancing	Whether this worker is currently rebalancing.
	time-since-last-rebalance-ms	The time in milliseconds since this worker completed the most recent rebalance.
kafka.connect:type=connector-metrics,connector="{connector}"		
	ATTRIBUTE NAME	DESCRIPTION
	connector-class	The name of the connector class.
	connector-type	The type of the connector. One of 'source' or 'sink'.
	connector-version	The version of the connector class, as reported by the connector.
	status	The status of the connector. One of 'unassigned', 'running', 'paused', 'failed', or 'destroyed'.
kafka.connect:type=connector-task-metrics,connector="{connector}",task="{task}"		
	ATTRIBUTE NAME	DESCRIPTION
	batch-size-avg	The average size of the batches processed by the connector.
	batch-size-max	The maximum size of the batches processed by the connector.
	offset-commit-avg-time-ms	The average time in mil-

		liseconds taken by this task to commit offsets.
	offset-commit-failure-percentage	The average percentage of this task's offset commit attempts that failed.
	offset-commit-max-time-ms	The maximum time in milliseconds taken by this task to commit offsets.
	offset-commit-success-percentage	The average percentage of this task's offset commit attempts that succeeded.
	pause-ratio	The fraction of time this task has spent in the pause state.
	running-ratio	The fraction of time this task has spent in the running state.
	status	The status of the connector task. One of 'unassigned', 'running', 'paused', 'failed', or 'destroyed'.
kafka.connect:type=sink-task-metrics,connector="{connector}",task="{task}"		
	ATTRIBUTE NAME	DESCRIPTION
	offset-commit-completion-rate	The average per-second number of offset commit completions that were completed successfully.
	offset-commit-completion-total	The total number of offset commit completions that were completed successfully.
	offset-commit-seq-no	The current sequence number for offset commits.
	offset-commit-skip-rate	The average per-second number of offset commit completions that were received too late and skipped/ignored.
	offset-commit-skip-total	The total number of offset commit completions that were received too late and skipped/ignored.
	partition-count	The number of topic partitions assigned to this task belonging to the named sink connector in this worker.
	put-batch-avg-time-ms	The average time taken by this task to put a batch of sinks records.
	put-batch-max-time-ms	The maximum time taken by this task to put a batch of sinks records.
	sink-record-active-count	The number of records that have been read from Kafka but not yet completely committed/flushed/acknowledged by the sink task.
	sink-record-active-count-avg	The average number of records that have been read from Kafka but not yet completely committed/flushed/acknowledged by the sink task.

	sink-record-active-count-max	The maximum number of records that have been read from Kafka but not yet completely committed/flushed/acknowledged by the sink task.
	sink-record-lag-max	The maximum lag in terms of number of records that the sink task is behind the consumer's position for any topic partitions.
	sink-record-read-rate	The average per-second number of records read from Kafka for this task belonging to the named sink connector in this worker. This is before transformations are applied.
	sink-record-read-total	The total number of records read from Kafka by this task belonging to the named sink connector in this worker, since the task was last restarted.
	sink-record-send-rate	The average per-second number of records output from the transformations and sent/put to this task belonging to the named sink connector in this worker. This is after transformations are applied and excludes any records filtered out by the transformations.
	sink-record-send-total	The total number of records output from the transformations and sent/put to this task belonging to the named sink connector in this worker, since the task was last restarted.
kafka.connect:type=source-task-metrics,connector="{connector}",task="{task}"		
	ATTRIBUTE NAME	DESCRIPTION
	poll-batch-avg-time-ms	The average time in milliseconds taken by this task to poll for a batch of source records.
	poll-batch-max-time-ms	The maximum time in milliseconds taken by this task to poll for a batch of source records.
	source-record-active-count	The number of records that have been produced by this task but not yet completely written to Kafka.
	source-record-active-count-avg	The average number of records that have been produced by this task but not yet completely written to Kafka.
	source-record-active-count-max	The maximum number of records that have been produced by this task but not yet completely written to Kafka.
	source-record-poll-rate	The average per-second number of records pro-

		duced/polled (before transformation) by this task belonging to the named source connector in this worker.
	source-record-poll-total	The total number of records produced/polled (before transformation) by this task belonging to the named source connector in this worker.
	source-record-write-rate	The average per-second number of records output from the transformations and written to Kafka for this task belonging to the named source connector in this worker. This is after transformations are applied and excludes any records filtered out by the transformations.
	source-record-write-total	The number of records output from the transformations and written to Kafka for this task belonging to the named source connector in this worker, since the task was last restarted.
kafka.connect:type=task-error-metrics,connector="{connector}",task="{task}"		
	ATTRIBUTE NAME	DESCRIPTION
	deadletterqueue-produce-failures	The number of failed writes to the dead letter queue.
	deadletterqueue-produce-requests	The number of attempted writes to the dead letter queue.
	last-error-timestamp	The epoch timestamp when this task last encountered an error.
	total-errors-logged	The number of errors that were logged.
	total-record-errors	The number of record processing errors in this task.
	total-record-failures	The number of record processing failures in this task.
	total-records-skipped	The number of records skipped due to errors.
	total-retries	The number of operations retried.

Streams Monitoring

A Kafka Streams instance contains all the producer and consumer metrics as well as additional metrics specific to streams. By default Kafka Streams has metrics with two recording levels: debug and info. The debug level records all metrics, while the info level records only the thread-level metrics.

Note that the metrics have a 4-layer hierarchy. At the top level there are client-level metrics for each started Kafka Streams client. Each client has stream threads, with their own metrics. Each stream thread has tasks, with their own metrics. Each task has a number of processor nodes, with their own metrics. Each task also has a number of state stores and record caches, all with their own metrics.

Use the following configuration option to specify which metrics you want collected:

```
metrics.recording.level="info"
```

Client Metrics

All the following metrics have a recording level of `info` :

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
version	The version of the Kafka Streams client.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
commit-id	The version control commit ID of the Kafka Streams client.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
application-id	The application ID of the Kafka Streams client.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
topology-description	The description of the topology executed in the Kafka Streams client.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
state	The state of the Kafka Streams client.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)

Thread Metrics

All the following metrics have a recording level of `info` :

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
commit-latency-avg	The average execution time in ms for committing, across all running tasks of this thread.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
commit-latency-max	The maximum execution time in ms for committing across all running tasks of this thread.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
poll-latency-avg	The average execution time in ms for polling, across all running tasks of this thread.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
poll-latency-max	The maximum execution time in ms for polling across all running tasks of this thread.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
process-latency-avg	The average execution time in ms for processing, across all running tasks of this thread.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
process-latency-max	The maximum execution time in ms for processing across all running tasks of this thread.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
punctuate-latency-avg	The average execution time in ms for punctuating, across all running tasks of this thread.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
punctuate-latency-max	The maximum execution time in ms for punctuating across all running tasks of this thread.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
commit-rate	The average number of commits per second.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
commit-total	The total number of commit calls across all tasks.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
poll-rate	The average number of	kafka.streams:type=stream-

	polls per second.	metrics,client-id=([-.\w]+)
poll-total	The total number of poll calls across all tasks.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
process-rate	The average number of process calls per second.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
process-total	The total number of process calls across all tasks.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
punctuate-rate	The average number of punctuates per second.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
punctuate-total	The total number of punctuate calls across all tasks.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
task-created-rate	The average number of newly created tasks per second.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
task-created-total	The total number of tasks created.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
task-closed-rate	The average number of tasks closed per second.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
task-closed-total	The total number of tasks closed.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
skipped-records-rate	The average number of skipped records per second.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)
skipped-records-total	The total number of skipped records.	kafka.streams:type=stream-metrics,client-id=([-.\w]+)

Task Metrics

All the following metrics have a recording level of `debug` :

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
commit-latency-avg	The average commit time in ns for this task.	kafka.streams:type=stream-task-metrics,client-id=([-.\w]+),task-id=([-.\w]+)
commit-latency-max	The maximum commit time in ns for this task.	kafka.streams:type=stream-task-metrics,client-id=([-.\w]+),task-id=([-.\w]+)
commit-rate	The average number of commit calls per second.	kafka.streams:type=stream-task-metrics,client-id=([-.\w]+),task-id=([-.\w]+)
commit-total	The total number of commit calls.	kafka.streams:type=stream-task-metrics,client-id=([-.\w]+),task-id=([-.\w]+)
record-lateness-avg	The average observed lateness of records.	kafka.streams:type=stream-task-metrics,client-id=([-.\w]+),task-id=([-.\w]+)
record-lateness-max	The max observed lateness of records.	kafka.streams:type=stream-task-metrics,client-id=([-.\w]+),task-id=([-.\w]+)

Processor Node Metrics

All the following metrics have a recording level of `debug` :

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
process-latency-avg	The average process execution time in ns.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=

		([-.\w]+),processor-node-id=([-.\w]+)
process-latency-max	The maximum process execution time in ns.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
punctuate-latency-avg	The average punctuate execution time in ns.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
punctuate-latency-max	The maximum punctuate execution time in ns.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
create-latency-avg	The average create execution time in ns.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
create-latency-max	The maximum create execution time in ns.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
destroy-latency-avg	The average destroy execution time in ns.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
destroy-latency-max	The maximum destroy execution time in ns.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
process-rate	The average number of process operations per second.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
process-total	The total number of process operations called.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
punctuate-rate	The average number of punctuate operations per second.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
punctuate-total	The total number of punctuate operations called.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
create-rate	The average number of cre-	kafka.streams:type=stream-

	ate operations per second.	processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
create-total	The total number of create operations called.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
destroy-rate	The average number of destroy operations per second.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
destroy-total	The total number of destroy operations called.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
forward-rate	The average rate of records being forwarded downstream, from source nodes only, per second.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
forward-total	The total number of of records being forwarded downstream, from source nodes only.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
suppression-emit-rate	The rate at which records that have been emitted downstream from suppression operation nodes. Compare with the `process-rate` metric to determine how many updates are being suppressed.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)
suppression-emit-total	The total number of records that have been emitted downstream from suppression operation nodes. Compare with the `process-total` metric to determine how many updates are being suppressed.	kafka.streams:type=stream-processor-node-metrics,client-id=([-.\w]+),task-id=([-.\w]+),processor-node-id=([-.\w]+)

State Store Metrics

All the following metrics have a recording level of `debug` . Note that the `store-scope` value is specified in `StoreSupplier#metricsScope()` for user's customized state stores; for built-in state stores, currently we have:

- `in-memory-state`
- `in-memory-lru-state`
- `in-memory-window-state`
- `rocksdb-state` (for RocksDB backed key-value store)
- `rocksdb-window-state` (for RocksDB backed window store)
- `rocksdb-session-state` (for RocksDB backed session store)

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
put-latency-avg	The average put execution	kafka.streams:type=stream-

	time in ns.	[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
put-latency-max	The maximum put execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
put-if-absent-latency-avg	The average put-if-absent execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
put-if-absent-latency-max	The maximum put-if-absent execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
get-latency-avg	The average get execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
get-latency-max	The maximum get execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
delete-latency-avg	The average delete execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
delete-latency-max	The maximum delete execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
put-all-latency-avg	The average put-all execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
put-all-latency-max	The maximum put-all execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
all-latency-avg	The average all operation execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
all-latency-max	The maximum all operation execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
range-latency-avg	The average range execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
range-latency-max	The maximum range execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
flush-latency-avg	The average flush execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
flush-latency-max	The maximum flush execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
restore-latency-avg	The average restore execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)

restore-latency-max	The maximum restore execution time in ns.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
put-rate	The average put rate for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
put-total	The total number of put calls for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
put-if-absent-rate	The average put-if-absent rate for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
put-if-absent-total	The total number of put-if-absent calls for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
get-rate	The average get rate for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
get-total	The total number of get calls for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
delete-rate	The average delete rate for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
delete-total	The total number of delete calls for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
put-all-rate	The average put-all rate for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
put-all-total	The total number of put-all calls for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
all-rate	The average all operation rate for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
all-total	The total number of all operation calls for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
range-rate	The average range rate for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
range-total	The total number of range calls for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
flush-rate	The average flush rate for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
flush-total	The total number of flush calls for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-

		id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
restore-rate	The average restore rate for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
restore-total	The total number of restore calls for this store.	kafka.streams:type=stream-[store-scope]-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)

RocksDB Metrics

All the following metrics have a recording level of `debug`. The metrics are collected every minute from the RocksDB state stores. If a state store consists of multiple RocksDB instances as it is the case for aggregations over time and session windows, each metric reports an aggregation over the RocksDB instances of the state store. Note that the `store-scope` for built-in RocksDB state stores are currently the following:

- `rocksdb-state` (for RocksDB backed key-value store)
- `rocksdb-window-state` (for RocksDB backed window store)
- `rocksdb-session-state` (for RocksDB backed session store)

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
bytes-written-rate	The average number of bytes written per second to the RocksDB state store.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
bytes-written-total	The total number of bytes written to the RocksDB state store.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
bytes-read-rate	The average number of bytes read per second from the RocksDB state store.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
bytes-read-total	The total number of bytes read from the RocksDB state store.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
memtable-bytes-flushed-rate	The average number of bytes flushed per second from the memtable to disk.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
memtable-bytes-flushed-total	The total number of bytes flushed from the memtable to disk.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
memtable-hit-ratio	The ratio of memtable hits relative to all lookups to the memtable.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
block-cache-data-hit-ratio	The ratio of block cache hits for data blocks relative to all lookups for data blocks to the block cache.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
block-cache-index-hit-ratio	The ratio of block cache hits for index blocks relative to all lookups for index blocks to the block cache.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
block-cache-filter-hit-ratio	The ratio of block cache hits for filter blocks relative to all lookups for filter blocks to the block cache.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)

write-stall-duration-avg	The average duration of write stalls in ms.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
write-stall-duration-total	The total duration of write stalls in ms.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
bytes-read-compaction-rate	The average number of bytes read per second during compaction.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
bytes-written-compaction-rate	The average number of bytes written per second during compaction.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
number-open-files	The number of current open files.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)
number-file-errors-total	The total number of file errors occurred.	kafka.streams:type=stream-state-metrics,client-id=([-.\w]+),task-id=([-.\w]+),[store-scope]-id=([-.\w]+)

Record Cache Metrics

All the following metrics have a recording level of `debug` :

METRIC/ATTRIBUTE NAME	DESCRIPTION	MBEAN NAME
hitRatio-avg	The average cache hit ratio defined as the ratio of cache read hits over the total cache read requests.	kafka.streams:type=stream-record-cache-metrics,client-id=([-.\w]+),task-id=([-.\w]+),record-cache-id=([-.\w]+)
hitRatio-min	The mininum cache hit ratio.	kafka.streams:type=stream-record-cache-metrics,client-id=([-.\w]+),task-id=([-.\w]+),record-cache-id=([-.\w]+)
hitRatio-max	The maximum cache hit ratio.	kafka.streams:type=stream-record-cache-metrics,client-id=([-.\w]+),task-id=([-.\w]+),record-cache-id=([-.\w]+)

Suppression Buffer Metrics

All the following metrics have a recording level of `debug` :

suppression-buffer-size-current	The current total size, in bytes, of the buffered data.	kafka.streams:type=stream-buffer-metrics,client-id=([-.\w]+),task-id=([-.\w]+),buffer-id=([-.\w]+)
suppression-buffer-size-avg	The average total size, in bytes, of the buffered data over the sampling window.	kafka.streams:type=stream-buffer-metrics,client-id=([-.\w]+),task-id=([-.\w]+),buffer-id=([-.\w]+)
suppression-buffer-size-max	The maximum total size, in bytes, of the buffered data over the sampling window.	kafka.streams:type=stream-buffer-metrics,client-id=([-.\w]+),task-id=([-.\w]+),buffer-id=([-.\w]+)
suppression-buffer-count-current	The current number of records buffered.	kafka.streams:type=stream-buffer-metrics,client-id=

		([-.\w]+),task-id=([-.\w]+),buffer-id=([-.\w]+)
suppression-buffer-size-avg	The average number of records buffered over the sampling window.	kafka.streams:type=stream-buffer-metrics,client-id=([-.\w]+),task-id=([-.\w]+),buffer-id=([-.\w]+)
suppression-buffer-size-max	The maximum number of records buffered over the sampling window.	kafka.streams:type=stream-buffer-metrics,client-id=([-.\w]+),task-id=([-.\w]+),buffer-id=([-.\w]+)

Others

We recommend monitoring GC time and other stats and various server stats such as CPU utilization, I/O service time, etc. On the client side, we recommend monitoring the message/byte rate (global and per topic), request rate/size/time, and on the consumer side, max lag in messages among all partitions and min fetch request rate. For a consumer to keep up, max lag needs to be less than a threshold and min fetch rate needs to be larger than 0.

6.7 ZooKeeper

Stable version

The current stable branch is 3.5. Kafka is regularly updated to include the latest release in the 3.5 series.

Operationalizing ZooKeeper

Operationally, we do the following for a healthy ZooKeeper installation:

- Redundancy in the physical/hardware/network layout: try not to put them all in the same rack, decent (but don't go nuts) hardware, try to keep redundant power and network paths, etc. A typical ZooKeeper ensemble has 5 or 7 servers, which tolerates 2 and 3 servers down, respectively. If you have a small deployment, then using 3 servers is acceptable, but keep in mind that you'll only be able to tolerate 1 server down in this case.
- I/O segregation: if you do a lot of write type traffic you'll almost definitely want the transaction logs on a dedicated disk group. Writes to the transaction log are synchronous (but batched for performance), and consequently, concurrent writes can significantly affect performance. ZooKeeper snapshots can be one such a source of concurrent writes, and ideally should be written on a disk group separate from the transaction log. Snapshots are written to disk asynchronously, so it is typically ok to share with the operating system and message log files. You can configure a server to use a separate disk group with the dataLogDir parameter.
- Application segregation: Unless you really understand the application patterns of other apps that you want to install on the same box, it can be a good idea to run ZooKeeper in isolation (though this can be a balancing act with the capabilities of the hardware).
- Use care with virtualization: It can work, depending on your cluster layout and read/write patterns and SLAs, but the tiny overheads introduced by the virtualization layer can add up and throw off ZooKeeper, as it can be very time sensitive
- ZooKeeper configuration: It's java, make sure you give it 'enough' heap space (We usually run them with 3-5G, but that's mostly due to the data set size we have here). Unfortunately we don't have a good formula for it, but keep in mind that allowing for more ZooKeeper state means that snapshots can become large, and large snapshots affect recovery time. In fact, if the snapshot becomes too large (a few gigabytes), then you may need to increase the initLimit parameter to give enough time for servers to recover and join the ensemble.
- Monitoring: Both JMX and the 4 letter words (4lw) commands are very useful, they do overlap in some cases (and in those cases we prefer the 4 letter commands, they seem more predictable, or at the very least, they work better with the LI monitoring infrastructure)
- Don't overbuild the cluster: large clusters, especially in a write heavy usage pattern, means a lot of intracluster communication (quorums on the writes and subsequent cluster member updates), but don't underbuild it (and risk swamping the cluster). Having more servers adds to your read capacity.

Overall, we try to keep the ZooKeeper system as small as will handle the load (plus standard growth capacity planning) and as simple as possible. We try not to do anything fancy with the configuration or application layout as compared to the official release as well as keep it as self contained as possible. For these reasons, we tend to skip the OS packaged versions, since it has a tendency to try to put things in the OS standard hierarchy, which can be 'messy', for want of a better way to word it.

7. SECURITY

7.1 Security Overview

In release 0.9.0.0, the Kafka community added a number of features that, used either separately or together, increases security in a Kafka cluster. The following security measures are currently supported:

1. Authentication of connections to brokers from clients (producers and consumers), other brokers and tools, using either SSL or SASL. Kafka supports the following SASL mechanisms:
   - SASL/GSSAPI (Kerberos) - starting at version 0.9.0.0
   - SASL/PLAIN - starting at version 0.10.0.0
   - SASL/SCRAM-SHA-256 and SASL/SCRAM-SHA-512 - starting at version 0.10.2.0
   - SASL/OAUTHBEARER - starting at version 2.0
2. Authentication of connections from brokers to ZooKeeper
3. Encryption of data transferred between brokers and clients, between brokers, or between brokers and tools using SSL (Note that there is a performance degradation when SSL is enabled, the magnitude of which depends on the CPU type and the JVM implementation.)
4. Authorization of read / write operations by clients
5. Authorization is pluggable and integration with external authorization services is supported

It's worth noting that security is optional - non-secured clusters are supported, as well as a mix of authenticated, unauthenticated, encrypted and non-encrypted clients. The guides below explain how to configure and use the security features in both clients and brokers.

7.2 Encryption and Authentication using SSL

Apache Kafka allows clients to connect over SSL. By default, SSL is disabled but can be turned on as needed.

1. **Generate SSL key and certificate for each Kafka broker**

   The first step of deploying one or more brokers with the SSL support is to generate the key and the certificate for each machine in the cluster. You can use Java's keytool utility to accomplish this task. We will generate the key into a temporary keystore initially so that we can export and sign it later with CA.

   ```
   keytool -keystore server.keystore.jks -alias localhost -validity {validity} -genkey -keyalg RSA
   ```

   You need to specify two parameters in the above command:
   1. keystore: the keystore file that stores the certificate. The keystore file contains the private key of the certificate; therefore, it needs to be kept safely.
   2. validity: the valid time of the certificate in days.

   Configuring Host Name Verification

   From Kafka version 2.0.0 onwards, host name verification of servers is enabled by default for client connections as well as inter-broker connections to prevent man-in-the-middle attacks. Server host name verification may be disabled by setting `ssl.endpoint.identification.algorithm` to an empty string. For example,

   ```
   ssl.endpoint.identification.algorithm=
   ```

   For dynamically configured broker listeners, hostname verification may be disabled using `kafka-configs.sh`. For example,

   ```
   bin/kafka-configs.sh --bootstrap-server localhost:9093 --entity-type brokers --entity-name 0 --alter --ad
   ```

   For older versions of Kafka, `ssl.endpoint.identification.algorithm` is not defined by default, so host name verification is not performed. The property should be set to `HTTPS` to enable host name verification.

   ```
   ssl.endpoint.identification.algorithm=HTTPS
   ```

   Host name verification must be enabled to prevent man-in-the-middle attacks if server endpoints are not validated externally.

   Configuring Host Name In Certificates

If host name verification is enabled, clients will verify the server's fully qualified domain name (FQDN) against one of the following two fields:

1. Common Name (CN)
2. Subject Alternative Name (SAN)

Both fields are valid, RFC-2818 recommends the use of SAN however. SAN is also more flexible, allowing for multiple DNS entries to be declared. Another advantage is that the CN can be set to a more meaningful value for authorization purposes. To add a SAN field append the following argument `-ext SAN=DNS:{FQDN}` to the keytool command:

```
keytool -keystore server.keystore.jks -alias localhost -validity {validity} -genkey -keyalg RSA -ext SAN=
```

The following command can be run afterwards to verify the contents of the generated certificate:

```
keytool -list -v -keystore server.keystore.jks
```

2. **Creating your own CA**

After the first step, each machine in the cluster has a public-private key pair, and a certificate to identify the machine. The certificate, however, is unsigned, which means that an attacker can create such a certificate to pretend to be any machine.

Therefore, it is important to prevent forged certificates by signing them for each machine in the cluster. A certificate authority (CA) is responsible for signing certificates. CA works likes a government that issues passports—the government stamps (signs) each passport so that the passport becomes difficult to forge. Other governments verify the stamps to ensure the passport is authentic. Similarly, the CA signs the certificates, and the cryptography guarantees that a signed certificate is computationally difficult to forge. Thus, as long as the CA is a genuine and trusted authority, the clients have high assurance that they are connecting to the authentic machines.

```
openssl req -new -x509 -keyout ca-key -out ca-cert -days 365
```

The generated CA is simply a public-private key pair and certificate, and it is intended to sign other certificates.
The next step is to add the generated CA to the **clients' truststore** so that the clients can trust this CA:

```
keytool -keystore client.truststore.jks -alias CARoot -import -file ca-cert
```

Note: If you configure the Kafka brokers to require client authentication by setting ssl.client.auth to be "requested" or "required" on the Kafka brokers config then you must provide a truststore for the Kafka brokers as well and it should have all the CA certificates that clients' keys were signed by.

```
keytool -keystore server.truststore.jks -alias CARoot -import -file ca-cert
```

In contrast to the keystore in step 1 that stores each machine's own identity, the truststore of a client stores all the certificates that the client should trust. Importing a certificate into one's truststore also means trusting all certificates that are signed by that certificate. As the analogy above, trusting the government (CA) also means trusting all passports (certificates) that it has issued. This attribute is called the chain of trust, and it is particularly useful when deploying SSL on a large Kafka cluster. You can sign all certificates in the cluster with a single CA, and have all machines share the same truststore that trusts the CA. That way all machines can authenticate all other machines.

3. **Signing the certificate**

The next step is to sign all certificates generated by step 1 with the CA generated in step 2. First, you need to export the certificate from the keystore:

```
keytool -keystore server.keystore.jks -alias localhost -certreq -file cert-file
```

Then sign it with the CA:

```
openssl x509 -req -CA ca-cert -CAkey ca-key -in cert-file -out cert-signed -days {validity} -CAcreateseri
```

Finally, you need to import both the certificate of the CA and the signed certificate into the keystore:

```
keytool -keystore server.keystore.jks -alias CARoot -import -file ca-cert
keytool -keystore server.keystore.jks -alias localhost -import -file cert-signed
```

The definitions of the parameters are the following:

1. keystore: the location of the keystore
2. ca-cert: the certificate of the CA

3. ca-key: the private key of the CA
4. ca-password: the passphrase of the CA
5. cert-file: the exported, unsigned certificate of the server
6. cert-signed: the signed certificate of the server

Here is an example of a bash script with all above steps. Note that one of the commands assumes a password of `test1234`, so either use that password or edit the command before running it.

```
#!/bin/bash
#Step 1
keytool -keystore server.keystore.jks -alias localhost -validity 365 -keyalg RSA -genke
#Step 2
openssl req -new -x509 -keyout ca-key -out ca-cert -days 365
keytool -keystore server.truststore.jks -alias CARoot -import -file ca-cert
keytool -keystore client.truststore.jks -alias CARoot -import -file ca-cert
#Step 3
keytool -keystore server.keystore.jks -alias localhost -certreq -file cert-file
openssl x509 -req -CA ca-cert -CAkey ca-key -in cert-file -out cert-signed -days 365 -C
keytool -keystore server.keystore.jks -alias CARoot -import -file ca-cert
keytool -keystore server.keystore.jks -alias localhost -import -file cert-signed
```

4. **Configuring Kafka Brokers**

Kafka Brokers support listening for connections on multiple ports. We need to configure the following property in server.properties, which must have one or more comma-separated values:

```
listeners
```

If SSL is not enabled for inter-broker communication (see below for how to enable it), both PLAINTEXT and SSL ports will be necessary.

```
listeners=PLAINTEXT://host.name:port,SSL://host.name:port
```

Following SSL configs are needed on the broker side

```
ssl.keystore.location=/var/private/ssl/server.keystore.jks
ssl.keystore.password=test1234
ssl.key.password=test1234
ssl.truststore.location=/var/private/ssl/server.truststore.jks
ssl.truststore.password=test1234
```

Note: ssl.truststore.password is technically optional but highly recommended. If a password is not set access to the truststore is still available, but integrity checking is disabled. Optional settings that are worth considering:

1. ssl.client.auth=none ("required" => client authentication is required, "requested" => client authentication is requested and client without certs can still connect. The usage of "requested" is discouraged as it provides a false sense of security and misconfigured clients will still connect successfully.)
2. ssl.cipher.suites (Optional). A cipher suite is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol. (Default is an empty list)
3. ssl.enabled.protocols=TLSv1.2,TLSv1.1,TLSv1 (list out the SSL protocols that you are going to accept from clients. Do note that SSL is deprecated in favor of TLS and using SSL in production is not recommended)
4. ssl.keystore.type=JKS
5. ssl.truststore.type=JKS
6. ssl.secure.random.implementation=SHA1PRNG

If you want to enable SSL for inter-broker communication, add the following to the server.properties file (it defaults to PLAINTEXT)

```
security.inter.broker.protocol=SSL
```

Due to import regulations in some countries, the Oracle implementation limits the strength of cryptographic algorithms available by default. If stronger algorithms are needed (for example, AES with 256-bit keys), the JCE Unlimited Strength Jurisdiction Policy Files must be obtained and installed in the JDK/JRE. See the JCA Providers Documentation for more information.

The JRE/JDK will have a default pseudo-random number generator (PRNG) that is used for cryptography operations, so it is not required to configure the implementation used with the

```
ssl.secure.random.implementation
```

. However, there are performance issues with some implementations (notably, the default chosen on Linux systems,

```
NativePRNG
```

, utilizes a global lock). In cases where performance of SSL connections becomes an issue, consider explicitly setting the implementation to be used. The

```
SHA1PRNG
```

implementation is non-blocking, and has shown very good performance characteristics under heavy load (50 MB/sec of produced messages, plus replication traffic, per-broker).

Once you start the broker you should be able to see in the server.log

```
            with addresses: PLAINTEXT -> EndPoint(192.168.64.1,9092,PLAINTEXT),SSL -> EndPoint(192.
```

To check quickly if the server keystore and truststore are setup properly you can run the following command

```
openssl s_client -debug -connect localhost:9093 -tls1
```

(Note: TLSv1 should be listed under ssl.enabled.protocols)
In the output of this command you should see server's certificate:

```
            -----BEGIN CERTIFICATE-----
            {variable sized random bytes}
            -----END CERTIFICATE-----
            subject=/C=US/ST=CA/L=Santa Clara/O=org/OU=org/CN=Sriharsha Chintalapani
            issuer=/C=US/ST=CA/L=Santa Clara/O=org/OU=org/CN=kafka/emailAddress=test@test.com
```

If the certificate does not show up or if there are any other error messages then your keystore is not setup properly.

5. **Configuring Kafka Clients**

SSL is supported only for the new Kafka Producer and Consumer, the older API is not supported. The configs for SSL will be the same for both producer and consumer.
If client authentication is not required in the broker, then the following is a minimal configuration example:

```
security.protocol=SSL
ssl.truststore.location=/var/private/ssl/client.truststore.jks
ssl.truststore.password=test1234
```

Note: ssl.truststore.password is technically optional but highly recommended. If a password is not set access to the truststore is still available, but integrity checking is disabled. If client authentication is required, then a keystore must be created like in step 1 and the following must also be configured:

```
ssl.keystore.location=/var/private/ssl/client.keystore.jks
ssl.keystore.password=test1234
ssl.key.password=test1234
```

Other configuration settings that may also be needed depending on our requirements and the broker configuration:

1. ssl.provider (Optional). The name of the security provider used for SSL connections. Default value is the default security provider of the JVM.
2. ssl.cipher.suites (Optional). A cipher suite is a named combination of authentication, encryption, MAC and key exchange algorithm used to negotiate the security settings for a network connection using TLS or SSL network protocol.
3. ssl.enabled.protocols=TLSv1.2,TLSv1.1,TLSv1. It should list at least one of the protocols configured on the broker side
4. ssl.truststore.type=JKS
5. ssl.keystore.type=JKS

Examples using console-producer and console-consumer:

```
kafka-console-producer.sh --broker-list localhost:9093 --topic test --producer.config client-ssl.properti
kafka-console-consumer.sh --bootstrap-server localhost:9093 --topic test --consumer.config client-ssl.pro
```

7.3 Authentication using SASL

1. JAAS configuration

Kafka uses the Java Authentication and Authorization Service (JAAS) for SASL configuration.

1. JAAS configuration for Kafka brokers

`KafkaServer` is the section name in the JAAS file used by each KafkaServer/Broker. This section provides SASL configuration options for the broker including any SASL client connections made by the broker for inter-broker communication. If multiple listeners are configured to use SASL, the section name may be prefixed with the listener name in lower-case followed by a period, e.g. `sasl_ssl.KafkaServer`.

`Client` section is used to authenticate a SASL connection with zookeeper. It also allows the brokers to set SASL ACL on zookeeper nodes which locks these nodes down so that only the brokers can modify it. It is necessary to have the same principal name across all brokers. If you want to use a section name other than Client, set the system property `zookeeper.sasl.clientconfig` to the appropriate name (*e.g.*, `-Dzookeeper.sasl.clientconfig=ZkClient`).

ZooKeeper uses "zookeeper" as the service name by default. If you want to change this, set the system property `zookeeper.sasl.client.username` to the appropriate name (*e.g.*, `-Dzookeeper.sasl.client.username=zk`).

Brokers may also configure JAAS using the broker configuration property `sasl.jaas.config`. The property name must be prefixed with the listener prefix including the SASL mechanism, i.e. `listener.name.{listenerName}.{saslMechanism}.sasl.jaas.config`. Only one login module may be specified in the config value. If multiple mechanisms are configured on a listener, configs must be provided for each mechanism using the listener and mechanism prefix. For example,

```
listener.name.sasl_ssl.scram-sha-256.sasl.jaas.config=org.apache.kafka.common.security.scram.ScramLo
    username="admin" \
    password="admin-secret";
listener.name.sasl_ssl.plain.sasl.jaas.config=org.apache.kafka.common.security.plain.PlainLoginModul
    username="admin" \
    password="admin-secret" \
    user_admin="admin-secret" \
    user_alice="alice-secret";
```

If JAAS configuration is defined at different levels, the order of precedence used is:

- Broker configuration property `listener.name.{listenerName}.{saslMechanism}.sasl.jaas.config`
- `{listenerName}.KafkaServer` section of static JAAS configuration
- `KafkaServer` section of static JAAS configuration

Note that ZooKeeper JAAS config may only be configured using static JAAS configuration.

See GSSAPI (Kerberos), PLAIN, SCRAM or OAUTHBEARER for example broker configurations.

2. **JAAS configuration for Kafka clients**

   Clients may configure JAAS using the client configuration property sasl.jaas.config or using the static JAAS config file similar to brokers.

   1. **JAAS configuration using client configuration property**

      Clients may specify JAAS configuration as a producer or consumer property without creating a physical configuration file. This mode also enables different producers and consumers within the same JVM to use different credentials by specifying different properties for each client. If both static JAAS configuration system property `java.security.auth.login.config` and client property `sasl.jaas.config` are specified, the client property will be used.

      See GSSAPI (Kerberos), PLAIN, SCRAM or OAUTHBEARER for example configurations.

   2. **JAAS configuration using static config file**

      To configure SASL authentication on the clients using static JAAS config file:

      1. Add a JAAS config file with a client login section named `KafkaClient`. Configure a login module in `KafkaClient` for the selected mechanism as described in the examples for setting up GSSAPI (Kerberos), PLAIN, SCRAM or OAUTHBEARER. For example, GSSAPI credentials may be configured as:

```
    KafkaClient {
    com.sun.security.auth.module.Krb5LoginModule required
    useKeyTab=true
    storeKey=true
    keyTab="/etc/security/keytabs/kafka_client.keytab"
    principal="kafka-client-1@EXAMPLE.COM";
};
```

      2. Pass the JAAS config file location as JVM parameter to each client JVM. For example:

```
-Djava.security.auth.login.config=/etc/kafka/kafka_client_jaas.conf
```

2. SASL configuration

SASL may be used with PLAINTEXT or SSL as the transport layer using the security protocol SASL_PLAINTEXT or SASL_SSL respectively. If SASL_SSL is used, then SSL must also be configured.

1. **SASL mechanisms**

   Kafka supports the following SASL mechanisms:

   - GSSAPI (Kerberos)
   - PLAIN
   - SCRAM-SHA-256
   - SCRAM-SHA-512
   - OAUTHBEARER

2. **SASL configuration for Kafka brokers**

   1. Configure a SASL port in server.properties, by adding at least one of SASL_PLAINTEXT or SASL_SSL to the *listeners* parameter, which contains one or more comma-separated values:

```
listeners=SASL_PLAINTEXT://host.name:port
```

      If you are only configuring a SASL port (or if you want the Kafka brokers to authenticate each other using SASL) then make sure you set the same SASL protocol for inter-broker communication:

```
security.inter.broker.protocol=SASL_PLAINTEXT (or SASL_SSL)
```

2. Select one or more supported mechanisms to enable in the broker and follow the steps to configure SASL for the mechanism. To enable multiple mechanisms in the broker, follow the steps here.

3. **SASL configuration for Kafka clients**

SASL authentication is only supported for the new Java Kafka producer and consumer, the older API is not supported.

To configure SASL authentication on the clients, select a SASL mechanism that is enabled in the broker for client authentication and follow the steps to configure SASL for the selected mechanism.

3. Authentication using SASL/Kerberos

1. Prerequisites

1. **Kerberos**
   If your organization is already using a Kerberos server (for example, by using Active Directory), there is no need to install a new server just for Kafka. Otherwise you will need to install one, your Linux vendor likely has packages for Kerberos and a short guide on how to install and configure it (Ubuntu, Redhat). Note that if you are using Oracle Java, you will need to download JCE policy files for your Java version and copy them to $JAVA_HOME/jre/lib/security.
2. **Create Kerberos Principals**
   If you are using the organization's Kerberos or Active Directory server, ask your Kerberos administrator for a principal for each Kafka broker in your cluster and for every operating system user that will access Kafka with Kerberos authentication (via clients and tools).
   If you have installed your own Kerberos, you will need to create these principals yourself using the following commands:

```
sudo /usr/sbin/kadmin.local -q 'addprinc -randkey kafka/{hostname}@{REALM}'
sudo /usr/sbin/kadmin.local -q "ktadd -k /etc/security/keytabs/{keytabname}.keytab kafka/{hostna
```

3. **Make sure all hosts can be reachable using hostnames** - it is a Kerberos requirement that all your hosts can be resolved with their FQDNs.

2. Configuring Kafka Brokers

1. Add a suitably modified JAAS file similar to the one below to each Kafka broker's config directory, let's call it kafka_server_jaas.conf for this example (note that each broker should have its own keytab):

```
KafkaServer {
    com.sun.security.auth.module.Krb5LoginModule required
    useKeyTab=true
    storeKey=true
    keyTab="/etc/security/keytabs/kafka_server.keytab"
    principal="kafka/kafka1.hostname.com@EXAMPLE.COM";
};

// Zookeeper client authentication
Client {
com.sun.security.auth.module.Krb5LoginModule required
useKeyTab=true
storeKey=true
keyTab="/etc/security/keytabs/kafka_server.keytab"
principal="kafka/kafka1.hostname.com@EXAMPLE.COM";
};
```

   `KafkaServer` section in the JAAS file tells the broker which principal to use and the location of the keytab where this principal is stored. It allows the broker to login using the keytab specified in this section. See notes for more details on Zookeeper SASL configuration.
2. Pass the JAAS and optionally the krb5 file locations as JVM parameters to each Kafka broker (see here for more details):

```
-Djava.security.krb5.conf=/etc/kafka/krb5.conf
    -Djava.security.auth.login.config=/etc/kafka/kafka_server_jaas.conf
```

3. Make sure the keytabs configured in the JAAS file are readable by the operating system user who is starting kafka broker.
4. Configure SASL port and SASL mechanisms in server.properties as described here. For example:

```
listeners=SASL_PLAINTEXT://host.name:port
    security.inter.broker.protocol=SASL_PLAINTEXT
    sasl.mechanism.inter.broker.protocol=GSSAPI
    sasl.enabled.mechanisms=GSSAPI
```

We must also configure the service name in server.properties, which should match the principal name of the kafka brokers. In the above example, principal is "kafka/kafka1.hostname.com@EXAMPLE.com", so:

```
sasl.kerberos.service.name=kafka
```

3. **Configuring Kafka Clients**

To configure SASL authentication on the clients:

1. Clients (producers, consumers, connect workers, etc) will authenticate to the cluster with their own principal (usually with the same name as the user running the client), so obtain or create these principals as needed. Then configure the JAAS configuration property for each client. Different clients within a JVM may run as different users by specifying different principals. The property `sasl.jaas.config` in producer.properties or consumer.properties describes how clients like producer and consumer can connect to the Kafka Broker. The following is an example configuration for a client using a keytab (recommended for long-running processes):

```
sasl.jaas.config=com.sun.security.auth.module.Krb5LoginModule required \
    useKeyTab=true \
    storeKey=true  \
    keyTab="/etc/security/keytabs/kafka_client.keytab" \
    principal="kafka-client-1@EXAMPLE.COM";
```

For command-line utilities like kafka-console-consumer or kafka-console-producer, kinit can be used along with "useTicketCache=true" as in:

```
sasl.jaas.config=com.sun.security.auth.module.Krb5LoginModule required \
    useTicketCache=true;
```

JAAS configuration for clients may alternatively be specified as a JVM parameter similar to brokers as described here. Clients use the login section named `KafkaClient`. This option allows only one user for all client connections from a JVM.
2. Make sure the keytabs configured in the JAAS configuration are readable by the operating system user who is starting kafka client.
3. Optionally pass the krb5 file locations as JVM parameters to each client JVM (see here for more details):

```
-Djava.security.krb5.conf=/etc/kafka/krb5.conf
```

4. Configure the following properties in producer.properties or consumer.properties:

```
security.protocol=SASL_PLAINTEXT (or SASL_SSL)
sasl.mechanism=GSSAPI
sasl.kerberos.service.name=kafka
```

4. **Authentication using SASL/PLAIN**

   SASL/PLAIN is a simple username/password authentication mechanism that is typically used with TLS for encryption to implement secure authentication. Kafka supports a default implementation for SASL/PLAIN which can be extended for production use as described here.

   The username is used as the authenticated `Principal` for configuration of ACLs etc.

   1. **Configuring Kafka Brokers**

      1. Add a suitably modified JAAS file similar to the one below to each Kafka broker's config directory, let's call it kafka_server_jaas.conf for this example:

         ```
         KafkaServer {
             org.apache.kafka.common.security.plain.PlainLoginModule required
             username="admin"
             password="admin-secret"
             user_admin="admin-secret"
             user_alice="alice-secret";
         };
         ```

         This configuration defines two users (*admin* and *alice*). The properties `username` and `password` in the `KafkaServer` section are used by the broker to initiate connections to other brokers. In this example, *admin* is the user for inter-broker communication. The set of properties `user_userName` defines the passwords for all users that connect to the broker and the broker validates all client connections including those from other brokers using these properties.
      2. Pass the JAAS config file location as JVM parameter to each Kafka broker:

         ```
         -Djava.security.auth.login.config=/etc/kafka/kafka_server_jaas.conf
         ```

      3. Configure SASL port and SASL mechanisms in server.properties as described here. For example:

         ```
         listeners=SASL_SSL://host.name:port
             security.inter.broker.protocol=SASL_SSL
             sasl.mechanism.inter.broker.protocol=PLAIN
             sasl.enabled.mechanisms=PLAIN
         ```

   2. **Configuring Kafka Clients**

      To configure SASL authentication on the clients:

      1. Configure the JAAS configuration property for each client in producer.properties or consumer.properties. The login module describes how the clients like producer and consumer can connect to the Kafka Broker. The following is an example configuration for a client for the PLAIN mechanism:

         ```
         sasl.jaas.config=org.apache.kafka.common.security.plain.PlainLoginModule required \
             username="alice" \
             password="alice-secret";
         ```

         The options `username` and `password` are used by clients to configure the user for client connections. In this example, clients connect to the broker as user *alice*. Different clients within a JVM may connect as different users by specifying different user names and passwords in `sasl.jaas.config`.

         JAAS configuration for clients may alternatively be specified as a JVM parameter similar to brokers as described here. Clients use the login section named `KafkaClient`. This option allows only one user for all client connections from a JVM.

2. Configure the following properties in producer.properties or consumer.properties:

```
security.protocol=SASL_SSL
sasl.mechanism=PLAIN
```

3. **Use of SASL/PLAIN in production**

- SASL/PLAIN should be used only with SSL as transport layer to ensure that clear passwords are not transmitted on the wire without encryption.
- The default implementation of SASL/PLAIN in Kafka specifies usernames and passwords in the JAAS configuration file as shown here. From Kafka version 2.0 onwards, you can avoid storing clear passwords on disk by configuring your own callback handlers that obtain username and password from an external source using the configuration options `sasl.server.callback.handler.class` and `sasl.client.callback.handler.class`.
- In production systems, external authentication servers may implement password authentication. From Kafka version 2.0 onwards, you can plug in your own callback handlers that use external authentication servers for password verification by configuring `sasl.server.callback.handler.class`.

5. Authentication using SASL/SCRAM

Salted Challenge Response Authentication Mechanism (SCRAM) is a family of SASL mechanisms that addresses the security concerns with traditional mechanisms that perform username/password authentication like PLAIN and DIGEST-MD5. The mechanism is defined in RFC 5802. Kafka supports SCRAM-SHA-256 and SCRAM-SHA-512 which can be used with TLS to perform secure authentication. The username is used as the authenticated `Principal` for configuration of ACLs etc. The default SCRAM implementation in Kafka stores SCRAM credentials in Zookeeper and is suitable for use in Kafka installations where Zookeeper is on a private network. Refer to Security Considerations for more details.

1. **Creating SCRAM Credentials**

The SCRAM implementation in Kafka uses Zookeeper as credential store. Credentials can be created in Zookeeper using `kafka-configs.sh`. For each SCRAM mechanism enabled, credentials must be created by adding a config with the mechanism name. Credentials for inter-broker communication must be created before Kafka brokers are started. Client credentials may be created and updated dynamically and updated credentials will be used to authenticate new connections.

Create SCRAM credentials for user *alice* with password *alice-secret*:

```
> bin/kafka-configs.sh --zookeeper localhost:2181 --alter --add-config 'SCRAM-SHA-256=[iterations=81
```

The default iteration count of 4096 is used if iterations are not specified. A random salt is created and the SCRAM identity consisting of salt, iterations, StoredKey and ServerKey are stored in Zookeeper. See RFC 5802 for details on SCRAM identity and the individual fields.

The following examples also require a user *admin* for inter-broker communication which can be created using:

```
> bin/kafka-configs.sh --zookeeper localhost:2181 --alter --add-config 'SCRAM-SHA-256=[password=admi
```

Existing credentials may be listed using the *--describe* option:

```
> bin/kafka-configs.sh --zookeeper localhost:2181 --describe --entity-type users --entity-name alice
```

Credentials may be deleted for one or more SCRAM mechanisms using the *--delete* option:

```
> bin/kafka-configs.sh --zookeeper localhost:2181 --alter --delete-config 'SCRAM-SHA-512' --entity-t
```

2. **Configuring Kafka Brokers**

1. Add a suitably modified JAAS file similar to the one below to each Kafka broker's config directory, let's call it kafka_server_jaas.conf for this example:

```
KafkaServer {
    org.apache.kafka.common.security.scram.ScramLoginModule required
    username="admin"
    password="admin-secret";
};
```

The properties `username` and `password` in the `KafkaServer` section are used by the broker to initiate connections to other brokers. In this example, *admin* is the user for inter-broker communication.

2. Pass the JAAS config file location as JVM parameter to each Kafka broker:

```
-Djava.security.auth.login.config=/etc/kafka/kafka_server_jaas.conf
```

3. Configure SASL port and SASL mechanisms in server.properties as described here. For example:

```
listeners=SASL_SSL://host.name:port
security.inter.broker.protocol=SASL_SSL
sasl.mechanism.inter.broker.protocol=SCRAM-SHA-256 (or SCRAM-SHA-512)
sasl.enabled.mechanisms=SCRAM-SHA-256 (or SCRAM-SHA-512)
```

3. **Configuring Kafka Clients**

To configure SASL authentication on the clients:

1. Configure the JAAS configuration property for each client in producer.properties or consumer.properties. The login module describes how the clients like producer and consumer can connect to the Kafka Broker. The following is an example configuration for a client for the SCRAM mechanisms:

```
sasl.jaas.config=org.apache.kafka.common.security.scram.ScramLoginModule required \
    username="alice" \
    password="alice-secret";
```

The options `username` and `password` are used by clients to configure the user for client connections. In this example, clients connect to the broker as user *alice*. Different clients within a JVM may connect as different users by specifying different user names and passwords in `sasl.jaas.config`.

JAAS configuration for clients may alternatively be specified as a JVM parameter similar to brokers as described here. Clients use the login section named `KafkaClient`. This option allows only one user for all client connections from a JVM.

2. Configure the following properties in producer.properties or consumer.properties:

```
security.protocol=SASL_SSL
sasl.mechanism=SCRAM-SHA-256 (or SCRAM-SHA-512)
```

4. **Security Considerations for SASL/SCRAM**

- The default implementation of SASL/SCRAM in Kafka stores SCRAM credentials in Zookeeper. This is suitable for production use in installations where Zookeeper is secure and on a private network.
- Kafka supports only the strong hash functions SHA-256 and SHA-512 with a minimum iteration count of 4096. Strong hash functions combined with strong passwords and high iteration counts protect against brute force attacks if Zookeeper security is compromised.
- SCRAM should be used only with TLS-encryption to prevent interception of SCRAM exchanges. This protects against dictionary or brute force attacks and against impersonation if Zookeeper is compromised.
- From Kafka version 2.0 onwards, the default SASL/SCRAM credential store may be overridden using custom callback handlers by configuring `sasl.server.callback.handler.class` in installations where Zookeeper is not secure.

- For more details on security considerations, refer to RFC 5802.

6. **Authentication using SASL/OAUTHBEARER**

The OAuth 2 Authorization Framework "enables a third-party application to obtain limited access to an HTTP service, either on behalf of a resource owner by orchestrating an approval interaction between the resource owner and the HTTP service, or by allowing the third-party application to obtain access on its own behalf." The SASL OAUTHBEARER mechanism enables the use of the framework in a SASL (i.e. a non-HTTP) context; it is defined in RFC 7628. The default OAUTHBEARER implementation in Kafka creates and validates Unsecured JSON Web Tokens and is only suitable for use in non-production Kafka installations. Refer to Security Considerations for more details.

1. **Configuring Kafka Brokers**

   1. Add a suitably modified JAAS file similar to the one below to each Kafka broker's config directory, let's call it kafka_server_jaas.conf for this example:

      ```
      KafkaServer {
          org.apache.kafka.common.security.oauthbearer.OAuthBearerLoginModule required
          unsecuredLoginStringClaim_sub="admin";
      };
      ```

      The property `unsecuredLoginStringClaim_sub` in the `KafkaServer` section is used by the broker when it initiates connections to other brokers. In this example, *admin* will appear in the subject (`sub`) claim and will be the user for inter-broker communication.
   2. Pass the JAAS config file location as JVM parameter to each Kafka broker:

      ```
      -Djava.security.auth.login.config=/etc/kafka/kafka_server_jaas.conf
      ```

   3. Configure SASL port and SASL mechanisms in server.properties as described here. For example:

      ```
      listeners=SASL_SSL://host.name:port (or SASL_PLAINTEXT if non-production)
      security.inter.broker.protocol=SASL_SSL (or SASL_PLAINTEXT if non-production)
      sasl.mechanism.inter.broker.protocol=OAUTHBEARER
      sasl.enabled.mechanisms=OAUTHBEARER
      ```

2. **Configuring Kafka Clients**

   To configure SASL authentication on the clients:

   1. Configure the JAAS configuration property for each client in producer.properties or consumer.properties. The login module describes how the clients like producer and consumer can connect to the Kafka Broker. The following is an example configuration for a client for the OAUTHBEARER mechanisms:

      ```
      sasl.jaas.config=org.apache.kafka.common.security.oauthbearer.OAuthBearerLoginModule required \
          unsecuredLoginStringClaim_sub="alice";
      ```

      The option `unsecuredLoginStringClaim_sub` is used by clients to configure the subject (`sub`) claim, which determines the user for client connections. In this example, clients connect to the broker as user *alice*. Different clients within a JVM may connect as different users by specifying different subject (`sub`) claims in `sasl.jaas.config`.

      JAAS configuration for clients may alternatively be specified as a JVM parameter similar to brokers as described here. Clients use the login section named `KafkaClient`. This option allows only one user for all client connections from a JVM.

   2. Configure the following properties in producer.properties or consumer.properties:

      ```
      security.protocol=SASL_SSL (or SASL_PLAINTEXT if non-production)
      sasl.mechanism=OAUTHBEARER
      ```

3. The default implementation of SASL/OAUTHBEARER depends on the jackson-databind library. Since it's an optional dependency, users have to configure it as a dependency via their build tool.

3. **Unsecured Token Creation Options for SASL/OAUTHBEARER**

- The default implementation of SASL/OAUTHBEARER in Kafka creates and validates Unsecured JSON Web Tokens. While suitable only for non-production use, it does provide the flexibility to create arbitrary tokens in a DEV or TEST environment.
- Here are the various supported JAAS module options on the client side (and on the broker side if OAUTHBEARER is the inter-broker protocol):

JAAS Module Option for Unsecured Token Creation	Documentation
`unsecuredLoginStringClaim_<claimname>="value"`	Creates a `String` claim with the given name and value. Any valid claim name can be specified except '`iat`' and '`exp`' (these are automatically generated).
`unsecuredLoginNumberClaim_<claimname>="value"`	Creates a `Number` claim with the given name and value. Any valid claim name can be specified except '`iat`' and '`exp`' (these are automatically generated).
`unsecuredLoginListClaim_<claimname>="value"`	Creates a `String List` claim with the given name and values parsed from the given value where the first character is taken as the delimiter. For example: `unsecuredLoginListClaim_fubar="|value1|value2"`. Any valid claim name can be specified except '`iat`' and '`exp`' (these are automatically generated).
`unsecuredLoginExtension_<extensionname>="value"`	Creates a `String` extension with the given name and value. For example: `unsecuredLoginExtension_traceId="123"`. A valid extension name is any sequence of lowercase or uppercase alphabet characters. In addition, the "auth" extension name is reserved. A valid extension value is any combination of characters with ASCII codes 1-127.
`unsecuredLoginPrincipalClaimName`	Set to a custom claim name if you wish the name of the `String` claim holding the principal name to be something other than '`sub`'.
`unsecuredLoginLifetimeSeconds`	Set to an integer value if the token expiration is to be set to something other than the default value of 3600 seconds (which is 1 hour). The '`exp`' claim will be set to reflect the expiration time.
`unsecuredLoginScopeClaimName`	Set to a custom claim name if you wish the name of the `String` or `String List` claim holding any token scope to be something other than '`scope`'.

4. **Unsecured Token Validation Options for SASL/OAUTHBEARER**

- Here are the various supported JAAS module options on the broker side for Unsecured JSON Web Token validation:

JAAS Module Option for Unsecured Token Validation	Documentation
`unsecuredValidatorPrincipalClaimName="value"`	Set to a non-empty value if you wish a particular `String` claim holding a principal name to be checked for

	existence; the default is to check for the existence of the 'sub' claim.
`unsecuredValidatorScopeClaimName="value"`	Set to a custom claim name if you wish the name of the `String` or `String List` claim holding any token scope to be something other than '`scope`'.
`unsecuredValidatorRequiredScope="value"`	Set to a space-delimited list of scope values if you wish the `String/String List` claim holding the token scope to be checked to make sure it contains certain values.
`unsecuredValidatorAllowableClockSkewMs="value"`	Set to a positive integer value if you wish to allow up to some number of positive milliseconds of clock skew (the default is 0).

- The default unsecured SASL/OAUTHBEARER implementation may be overridden (and must be overridden in production environments) using custom login and SASL Server callback handlers.
- For more details on security considerations, refer to RFC 6749, Section 10.

5. **Token Refresh for SASL/OAUTHBEARER**

Kafka periodically refreshes any token before it expires so that the client can continue to make connections to brokers. The parameters that impact how the refresh algorithm operates are specified as part of the producer/consumer/broker configuration and are as follows. See the documentation for these properties elsewhere for details. The default values are usually reasonable, in which case these configuration parameters would not need to be explicitly set.

Producer/Consumer/Broker Configuration Property
`sasl.login.refresh.window.factor`
`sasl.login.refresh.window.jitter`
`sasl.login.refresh.min.period.seconds`
`sasl.login.refresh.min.buffer.seconds`

6. **Secure/Production Use of SASL/OAUTHBEARER**

Production use cases will require writing an implementation of `org.apache.kafka.common.security.auth.AuthenticateCallbackHandler` that can handle an instance of `org.apache.kafka.common.security.oauthbearer.OAuthBearerTokenCallback` and declaring it via either the `sasl.login.callback.handler.class` configuration option for a non-broker client or via the `listener.name.sasl_ssl.oauthbearer.sasl.login.callback.handler.class` configuration option for brokers (when SASL/OAUTHBEARER is the inter-broker protocol).

Production use cases will also require writing an implementation of `org.apache.kafka.common.security.auth.AuthenticateCallbackHandler` that can handle an instance of `org.apache.kafka.common.security.oauthbearer.OAuthBearerValidatorCallback` and declaring it via the `listener.name.sasl_ssl.oauthbearer.sasl.server.callback.handler.class` broker configuration option.

7. **Security Considerations for SASL/OAUTHBEARER**

   - The default implementation of SASL/OAUTHBEARER in Kafka creates and validates Unsecured JSON Web Tokens. This is suitable only for non-production use.
   - OAUTHBEARER should be used in production enviromnments only with TLS-encryption to prevent interception of tokens.
   - The default unsecured SASL/OAUTHBEARER implementation may be overridden (and must be overridden in production environments) using custom login and SASL Server callback handlers as described above.
   - For more details on OAuth 2 security considerations in general, refer to RFC 6749, Section 10.

7. Enabling multiple SASL mechanisms in a broker

1. Specify configuration for the login modules of all enabled mechanisms in the `KafkaServer` section of the JAAS config file. For example:

```
KafkaServer {
    com.sun.security.auth.module.Krb5LoginModule required
    useKeyTab=true
    storeKey=true
    keyTab="/etc/security/keytabs/kafka_server.keytab"
    principal="kafka/kafka1.hostname.com@EXAMPLE.COM";

    org.apache.kafka.common.security.plain.PlainLoginModule required
    username="admin"
    password="admin-secret"
    user_admin="admin-secret"
    user_alice="alice-secret";
};
```

2. Enable the SASL mechanisms in server.properties:

```
sasl.enabled.mechanisms=GSSAPI,PLAIN,SCRAM-SHA-256,SCRAM-SHA-512,OAUTHBEARER
```

3. Specify the SASL security protocol and mechanism for inter-broker communication in server.properties if required:

```
security.inter.broker.protocol=SASL_PLAINTEXT (or SASL_SSL)
sasl.mechanism.inter.broker.protocol=GSSAPI (or one of the other enabled mechanisms)
```

4. Follow the mechanism-specific steps in GSSAPI (Kerberos), PLAIN, SCRAM and OAUTHBEARER to configure SASL for the enabled mechanisms.

8. Modifying SASL mechanism in a Running Cluster

SASL mechanism can be modified in a running cluster using the following sequence:

1. Enable new SASL mechanism by adding the mechanism to `sasl.enabled.mechanisms` in server.properties for each broker. Update JAAS config file to include both mechanisms as described here. Incrementally bounce the cluster nodes.
2. Restart clients using the new mechanism.
3. To change the mechanism of inter-broker communication (if this is required), set `sasl.mechanism.inter.broker.protocol` in server.properties to the new mechanism and incrementally bounce the cluster again.
4. To remove old mechanism (if this is required), remove the old mechanism from `sasl.enabled.mechanisms` in server.properties and remove the entries for the old mechanism from JAAS config file. Incrementally bounce the cluster again.

9. **Authentication using Delegation Tokens**

Delegation token based authentication is a lightweight authentication mechanism to complement existing SASL/SSL methods. Delegation tokens are shared secrets between kafka brokers and clients. Delegation tokens will help processing frameworks to distribute the workload to available workers in a secure environment without the added cost of distributing Kerberos TGT/keytabs or keystores when 2-way SSL is used. See KIP-48 for more details.

Typical steps for delegation token usage are:

1. User authenticates with the Kafka cluster via SASL or SSL, and obtains a delegation token. This can be done using Admin APIs or using `kafka-delegation-tokens.sh` script.
2. User securely passes the delegation token to Kafka clients for authenticating with the Kafka cluster.
3. Token owner/renewer can renew/expire the delegation tokens.

1. **Token Management**

A master key/secret is used to generate and verify delegation tokens. This is supplied using config option `delegation.token.master.key`. Same secret key must be configured across all the brokers. If the secret is not set or set to empty string, brokers will disable the delegation token authentication.

In current implementation, token details are stored in Zookeeper and is suitable for use in Kafka installations where Zookeeper is on a private network. Also currently, master key/secret is stored as plain text in server.properties config file. We intend to make these configurable in a future Kafka release.

A token has a current life, and a maximum renewable life. By default, tokens must be renewed once every 24 hours for up to 7 days. These can be configured using `delegation.token.expiry.time.ms` and `delegation.token.max.lifetime.ms` config options.

Tokens can also be cancelled explicitly. If a token is not renewed by the token's expiration time or if token is beyond the max life time, it will be deleted from all broker caches as well as from zookeeper.

2. **Creating Delegation Tokens**

Tokens can be created by using Admin APIs or using `kafka-delegation-tokens.sh` script. Delegation token requests (create/renew/expire/describe) should be issued only on SASL or SSL authenticated channels. Tokens can not be requests if the initial authentication is done through delegation token. `kafka-delegation-tokens.sh` script examples are given below.

Create a delegation token:

```
> bin/kafka-delegation-tokens.sh --bootstrap-server localhost:9092 --create   --max-life-time-period
```

Renew a delegation token:

```
> bin/kafka-delegation-tokens.sh --bootstrap-server localhost:9092 --renew    --renew-time-period -1
```

Expire a delegation token:

```
> bin/kafka-delegation-tokens.sh --bootstrap-server localhost:9092 --expire   --expiry-time-period -
```

Existing tokens can be described using the --describe option:

```
> bin/kafka-delegation-tokens.sh --bootstrap-server localhost:9092 --describe --command-config clien
```

3. **Token Authentication**

Delegation token authentication piggybacks on the current SASL/SCRAM authentication mechanism. We must enable SASL/SCRAM mechanism on Kafka cluster as described in here.

Configuring Kafka Clients:

1. Configure the JAAS configuration property for each client in producer.properties or consumer.properties. The login module describes how the clients like producer and consumer can connect to the Kafka Broker. The following is an example

configuration for a client for the token authentication:

```
sasl.jaas.config=org.apache.kafka.common.security.scram.ScramLoginModule required \
     username="tokenID123" \
     password="lAYYSFmLs4bTjf+lTZ1LCHR/ZZFNA==" \
     tokenauth="true";
```

The options `username` and `password` are used by clients to configure the token id and token HMAC. And the option `tokenauth` is used to indicate the server about token authentication. In this example, clients connect to the broker using token id: *tokenID123*. Different clients within a JVM may connect using different tokens by specifying different token details in `sasl.jaas.config`.

JAAS configuration for clients may alternatively be specified as a JVM parameter similar to brokers as described here. Clients use the login section named `KafkaClient`. This option allows only one user for all client connections from a JVM.

4. **Procedure to manually rotate the secret:**

We require a re-deployment when the secret needs to be rotated. During this process, already connected clients will continue to work. But any new connection requests and renew/expire requests with old tokens can fail. Steps are given below.

1. Expire all existing tokens.
2. Rotate the secret by rolling upgrade, and
3. Generate new tokens

We intend to automate this in a future Kafka release.

5. **Notes on Delegation Tokens**

- Currently, we only allow a user to create delegation token for that user only. Owner/Renewers can renew or expire tokens. Owner/renewers can always describe their own tokens. To describe others tokens, we need to add DESCRIBE permission on Token Resource.

7.4 Authorization and ACLs

Kafka ships with a pluggable Authorizer and an out-of-box authorizer implementation that uses zookeeper to store all the acls. The Authorizer is configured by setting `authorizer.class.name` in server.properties. To enable the out of the box implementation use:

```
authorizer.class.name=kafka.security.auth.SimpleAclAuthorizer
```

Kafka acls are defined in the general format of "Principal P is [Allowed/Denied] Operation O From Host H on any Resource R matching ResourcePattern RP". You can read more about the acl structure in KIP-11 and resource patterns in KIP-290. In order to add, remove or list acls you can use the Kafka authorizer CLI. By default, if no ResourcePatterns match a specific Resource R, then R has no associated acls, and therefore no one other than super users is allowed to access R. If you want to change that behavior, you can include the following in server.properties.

```
allow.everyone.if.no.acl.found=true
```

One can also add super users in server.properties like the following (note that the delimiter is semicolon since SSL user names may contain comma). Default PrincipalType string "User" is case sensitive.

```
super.users=User:Bob;User:Alice
```

Customizing SSL User Name

By default, the SSL user name will be of the form "CN=writeuser,OU=Unknown,O=Unknown,L=Unknown,ST=Unknown,C=Unknown". One can change that by setting `ssl.principal.mapping.rules` to a customized rule in server.properties. This config allows a list of rules for mapping X.500 distinguished name to short name. The rules are evaluated in order and the first rule that matches a distinguished name is used to map it to a short name. Any later rules in the list are ignored.
The format of `ssl.principal.mapping.rules` is a list where each rule starts with "RULE:" and contains an expression as the following formats. Default rule will return string representation of the X.500 certificate distinguished name. If the distinguished name matches the pattern, then the replacement command will be run over the name. This also supports lowercase/uppercase options, to force the translated result to be all lower/uppercase case. This is done by adding a "/L" or "/U' to the end of the rule.

```
        RULE:pattern/replacement/
        RULE:pattern/replacement/[LU]
```

Example `ssl.principal.mapping.rules` values are:

```
        RULE:^CN=(.*?),OU=ServiceUsers.*$/$1/,
        RULE:^CN=(.*?),OU=(.*?),O=(.*?),L=(.*?),ST=(.*?),C=(.*?)$/$1@$2/L,
        RULE:^.*[Cc][Nn]=([a-zA-Z0-9.]*).*$/$1/L,
        DEFAULT
```

Above rules translate distinguished name "CN=serviceuser,OU=ServiceUsers,O=Unknown,L=Unknown,ST=Unknown,C=Unknown" to "serviceuser" and "CN=adminUser,OU=Admin,O=Unknown,L=Unknown,ST=Unknown,C=Unknown" to "adminuser@admin".
For advanced use cases, one can customize the name by setting a customized PrincipalBuilder in server.properties like the following.

```
principal.builder.class=CustomizedPrincipalBuilderClass
```

Customizing SASL User Name

By default, the SASL user name will be the primary part of the Kerberos principal. One can change that by setting `sasl.kerberos.principal.to.local.rules` to a customized rule in server.properties. The format of `sasl.kerberos.principal.to.local.rules` is a list where each rule works in the same way as the auth_to_local in [Kerberos configuration file (krb5.conf)](). This also support additional lowercase/uppercase rule, to force the translated result to be all lowercase/uppercase. This is done by adding a "/L" or "/U" to the end of the rule. check below formats for syntax. Each rules starts with RULE: and contains an expression as the following formats. See the kerberos documentation for more details.

```
        RULE:[n:string](regexp)s/pattern/replacement/
        RULE:[n:string](regexp)s/pattern/replacement/g
        RULE:[n:string](regexp)s/pattern/replacement//L
        RULE:[n:string](regexp)s/pattern/replacement/g/L
        RULE:[n:string](regexp)s/pattern/replacement//U
        RULE:[n:string](regexp)s/pattern/replacement/g/U
```

An example of adding a rule to properly translate user@MYDOMAIN.COM to user while also keeping the default rule in place is:

```
sasl.kerberos.principal.to.local.rules=RULE:[1:$1@$0](.*@MYDOMAIN.COM)s/@.*//,DEFAULT
```

Command Line Interface

Kafka Authorization management CLI can be found under bin directory with all the other CLIs. The CLI script is called **kafka-acls.sh**. Following lists all the options that the script supports:

OPTION	DESCRIPTION	DEFAULT	OPTION TYPE
--add	Indicates to the script that user is trying to add an acl.		Action
--remove	Indicates to the script that user is trying to remove an acl.		Action
--list	Indicates to the script that user is trying to list acls.		Action
--authorizer	Fully qualified class name of the authorizer.	kafka.security.auth.SimpleAclAuthorizer	Configuration
--authorizer-properties	key=val pairs that will be passed to authorizer for initialization. For the default authorizer the example values are: zookeeper.connect=localhost:2181		Configuration
--bootstrap-server	A list of host/port pairs to use for establishing the connection to the Kafka cluster. Only one of --bootstrap-server or --authorizer option must be specified.		Configuration
--command-config	A property file containing configs to be passed to Admin Client. This option can only be used with --bootstrap-server option.		Configuration
--cluster	Indicates to the script that the user is trying to interact with acls on the singular cluster resource.		ResourcePattern
--topic [topic-name]	Indicates to the script that the user is trying to interact with acls on topic resource pattern(s).		ResourcePattern
--group [group-name]	Indicates to the script that the user is trying to interact with acls on consumer-group resource pattern(s)		ResourcePattern
--transactional-id [transactional-id]	The transactionalId to which ACLs should be added or removed. A value of * indicates the ACLs should apply to all transactionalIds.		ResourcePattern
--delegation-token [delegation-token]	Delegation token to which ACLs should be added or removed. A value of * indicates ACL should apply to all tokens.		ResourcePattern
--resource-pattern-type [pattern-type]	Indicates to the script the type of resource pattern, (for --add), or resource pattern filter, (for --list and --remove), the user wishes to use. When adding acls, this should be a specific pattern type, e.g. 'literal' or 'prefixed'. When listing or removing acls, a specific pattern type filter can be used to list or	literal	Configuration

	remove acls from a specific type of resource pattern, or the filter values of 'any' or 'match' can be used, where 'any' will match any pattern type, but will match the resource name exactly, and 'match' will perform pattern matching to list or remove all acls that affect the supplied resource(s). WARNING: 'match', when used in combination with the '--remove' switch, should be used with care.		
--allow-principal	Principal is in PrincipalType:name format that will be added to ACL with Allow permission. Default PrincipalType string "User" is case sensitive. You can specify multiple --allow-principal in a single command.		Principal
--deny-principal	Principal is in PrincipalType:name format that will be added to ACL with Deny permission. Default PrincipalType string "User" is case sensitive. You can specify multiple --deny-principal in a single command.		Principal
--principal	Principal is in PrincipalType:name format that will be used along with --list option. Default PrincipalType string "User" is case sensitive. This will list the ACLs for the specified principal. You can specify multiple --principal in a single command.		Principal
--allow-host	IP address from which principals listed in --allow-principal will have access.	if --allow-principal is specified defaults to * which translates to "all hosts"	Host
--deny-host	IP address from which principals listed in --deny-principal will be denied access.	if --deny-principal is specified defaults to * which translates to "all hosts"	Host
--operation	Operation that will be allowed or denied. Valid values are: • Read • Write • Create • Delete • Alter • Describe • ClusterAction • DescribeConfigs • AlterConfigs • IdempotentWrite • All	All	Operation
--producer	Convenience option to add/remove acls for producer role. This will generate acls that allows WRITE, DESCRIBE and CREATE on topic.		Convenience

--consumer	Convenience option to add/remove acls for consumer role. This will generate acls that allows READ, DESCRIBE on topic and READ on consumer-group.		Convenience
--idempotent	Enable idempotence for the producer. This should be used in combination with the --producer option. Note that idempotence is enabled automatically if the producer is authorized to a particular transactional-id.		Convenience
--force	Convenience option to assume yes to all queries and do not prompt.		Convenience

Examples

- **Adding Acls**
  Suppose you want to add an acl "Principals User:Bob and User:Alice are allowed to perform Operation Read and Write on Topic Test-Topic from IP 198.51.100.0 and IP 198.51.100.1". You can do that by executing the CLI with following options:

  ```
  bin/kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --add --allow-principal User:Bob
  ```

  By default, all principals that don't have an explicit acl that allows access for an operation to a resource are denied. In rare cases where an allow acl is defined that allows access to all but some principal we will have to use the --deny-principal and --deny-host option. For example, if we want to allow all users to Read from Test-topic but only deny User:BadBob from IP 198.51.100.3 we can do so using following commands:

  ```
  bin/kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --add --allow-principal User:* -
  ```

  Note that ``--allow-host`` and ``deny-host`` only support IP addresses (hostnames are not supported). Above examples add acls to a topic by specifying --topic [topic-name] as the resource pattern option. Similarly user can add acls to cluster by specifying --cluster and to a consumer group by specifying --group [group-name]. You can add acls on any resource of a certain type, e.g. suppose you wanted to add an acl "Principal User:Peter is allowed to produce to any Topic from IP 198.51.200.0" You can do that by using the wildcard resource '*', e.g. by executing the CLI with following options:

  ```
  bin/kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --add --allow-principal User:Pet
  ```

  You can add acls on prefixed resource patterns, e.g. suppose you want to add an acl "Principal User:Jane is allowed to produce to any Topic whose name starts with 'Test-' from any host". You can do that by executing the CLI with following options:

  ```
  bin/kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --add --allow-principal User:Jan
  ```

  Note, --resource-pattern-type defaults to 'literal', which only affects resources with the exact same name or, in the case of the wildcard resource name '*', a resource with any name.
- **Removing Acls**
  Removing acls is pretty much the same. The only difference is instead of --add option users will have to specify --remove option. To remove the acls added by the first example above we can execute the CLI with following options:

  ```
  bin/kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --remove --allow-principal User:
  ```

  If you wan to remove the acl added to the prefixed resource pattern above we can execute the CLI with following options:

  ```
  bin/kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --remove --allow-principal User:
  ```

- **List Acls**
  We can list acls for any resource by specifying the --list option with the resource. To list all acls on the literal resource pattern Test-topic, we can execute the CLI with following options:

  ```
  bin/kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --list --topic Test-topic
  ```

  However, this will only return the acls that have been added to this exact resource pattern. Other acls can exist that affect access to the topic, e.g. any acls on the topic wildcard '*', or any acls on prefixed resource patterns. Acls on the wildcard resource pattern can be queried explicitly:

  ```
  bin/kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --list --topic *
  ```

However, it is not necessarily possible to explicitly query for acls on prefixed resource patterns that match Test-topic as the name of such patterns may not be known. We can list *all* acls affecting Test-topic by using '--resource-pattern-type match', e.g.

```
bin/kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --list --topic Test-topic --reso
```

This will list acls on all matching literal, wildcard and prefixed resource patterns.

- **Adding or removing a principal as producer or consumer**
  The most common use case for acl management are adding/removing a principal as producer or consumer so we added convenience options to handle these cases. In order to add User:Bob as a producer of Test-topic we can execute the following command:

```
bin/kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --add --allow-principal User:Bob
```

  Similarly to add Alice as a consumer of Test-topic with consumer group Group-1 we just have to pass --consumer option:

```
bin/kafka-acls.sh --authorizer-properties zookeeper.connect=localhost:2181 --add --allow-principal User:Bob
```

  Note that for consumer option we must also specify the consumer group. In order to remove a principal from producer or consumer role we just need to pass --remove option.

- **Admin API based acl management**
  Users having Alter permission on ClusterResource can use Admin API for ACL management. kafka-acls.sh script supports AdminClient API to manage ACLs without interacting with zookeeper/authorizer directly. All the above examples can be executed by using **--bootstrap-server** option. For example:

```
bin/kafka-acls.sh --bootstrap-server localhost:9092 --command-config /tmp/adminclient-configs.conf --add --
bin/kafka-acls.sh --bootstrap-server localhost:9092 --command-config /tmp/adminclient-configs.conf --add --
bin/kafka-acls.sh --bootstrap-server localhost:9092 --command-config /tmp/adminclient-configs.conf --list -
```

Authorization Primitives

Protocol calls are usually performing some operations on certain resources in Kafka. It is required to know the operations and resources to set up effective protection. In this section we'll list these operations and resources, then list the combination of these with the protocols to see the valid scenarios.

Operations in Kafka

There are a few operation primitives that can be used to build up privileges. These can be matched up with certain resources to allow specific protocol calls for a given user. These are:

- Read
- Write
- Create
- Delete
- Alter
- Describe
- ClusterAction
- DescribeConfigs
- AlterConfigs
- IdempotentWrite
- All

Resources in Kafka

The operations above can be applied on certain resources which are described below.

- **Topic:** this simply represents a Topic. All protocol calls that are acting on topics (such as reading, writing them) require the corresponding privilege to be added. If there is an authorization error with a topic resource, then a TOPIC_AUTHORIZATION_FAILED (error code: 29) will be returned.
- **Group:** this represents the consumer groups in the brokers. All protocol calls that are working with consumer groups, like joining a group must have privileges with the group in subject. If the privilege is not given then a GROUP_AUTHORIZATION_FAILED (error code: 30) will be returned in the protocol response.

- **Cluster:** this resource represents the cluster. Operations that are affecting the whole cluster, like controlled shutdown are protected by privileges on the Cluster resource. If there is an authorization problem on a cluster resource, then a CLUSTER_AUTHORIZATION_FAILED (error code: 31) will be returned.
- **TransactionalId:** this resource represents actions related to transactions, such as committing. If any error occurs, then a TRANSACTIONAL_ID_AUTHORIZATION_FAILED (error code: 53) will be returned by brokers.
- **DelegationToken:** this represents the delegation tokens in the cluster. Actions, such as describing delegation tokens could be protected by a privilege on the DelegationToken resource. Since these objects have a little special behavior in Kafka it is recommended to read KIP-48 and the related upstream documentation at Authentication using Delegation Tokens.

Operations and Resources on Protocols

In the below table we'll list the valid operations on resources that are executed by the Kafka API protocols.

PROTOCOL (API KEY)	OPERATION	RESOURCE	NOTE
PRODUCE (0)	Write	TransactionalId	An transactional producer which has its transactional.id set requires this privilege.
PRODUCE (0)	IdempotentWrite	Cluster	An idempotent produce action requires this privilege.
PRODUCE (0)	Write	Topic	This applies to a normal produce action.
FETCH (1)	ClusterAction	Cluster	A follower must have ClusterAction on the Cluster resource in order to fetch partition data.
FETCH (1)	Read	Topic	Regular Kafka consumers need READ permission on each partition they are fetching.
LIST_OFFSETS (2)	Describe	Topic	
METADATA (3)	Describe	Topic	
METADATA (3)	Create	Cluster	If topic auto-creation is enabled, then the broker-side API will check for the existence of a Cluster level privilege. If it's found then it'll allow creating the topic, otherwise it'll iterate through the Topic level privileges (see the next one).
METADATA (3)	Create	Topic	This authorizes auto topic creation if enabled but the given user doesn't have a cluster level permission (above).
LEADER_AND_ISR (4)	ClusterAction	Cluster	
STOP_REPLICA (5)	ClusterAction	Cluster	
UPDATE_METADATA (6)	ClusterAction	Cluster	
CONTROLLED_SHUTDOWN (7)	ClusterAction	Cluster	
OFFSET_COMMIT (8)	Read	Group	An offset can only be committed if it's authorized to the given group and the topic too (see below). Group access is checked first, then Topic access.
OFFSET_COMMIT (8)	Read	Topic	Since offset commit is part of the consuming process, it needs privileges for the read action.

PROTOCOL (API KEY)	OPERATION	RESOURCE	NOTE
OFFSET_FETCH (9)	Describe	Group	Similarly to OFFSET_COMMIT, the application must have privileges on group and topic level too to be able to fetch. However in this case it requires describe access instead of read. Group access is checked first, then Topic access.
OFFSET_FETCH (9)	Describe	Topic	
FIND_COORDINATOR (10)	Describe	Group	The FIND_COORDINATOR request can be of "Group" type in which case it is looking for consumergroup coordinators. This privilege would represent the Group mode.
FIND_COORDINATOR (10)	Describe	TransactionalId	This applies only on transactional producers and checked when a producer tries to find the transaction coordinator.
JOIN_GROUP (11)	Read	Group	
HEARTBEAT (12)	Read	Group	
LEAVE_GROUP (13)	Read	Group	
SYNC_GROUP (14)	Read	Group	
DESCRIBE_GROUPS (15)	Describe	Group	
LIST_GROUPS (16)	Describe	Cluster	When the broker checks to authorize a list_groups request it first checks for this cluster level authorization. If none found then it proceeds to check the groups individually. This operation doesn't return CLUSTER_AUTHORIZATION_FAILED.
LIST_GROUPS (16)	Describe	Group	If none of the groups are authorized, then just an empty response will be sent back instead of an error. This operation doesn't return CLUSTER_AUTHORIZATION_FAILED. This is applicable from the 2.1 release.
SASL_HANDSHAKE (17)			The SASL handshake is part of the authentication process and therefore it's not possible to apply any kind of authorization here.
API_VERSIONS (18)			The API_VERSIONS request is part of the Kafka protocol handshake and happens on connection and before any authentication. Therefore it's not possible to control this with authorization.
CREATE_TOPICS (19)	Create	Cluster	If there is no cluster level authorization then it won't return CLUSTER_AUTHORIZATION_FAILED but fall back to use topic level, which is just below. That'll throw error if there is a problem.

PROTOCOL (API KEY)	OPERATION	RESOURCE	NOTE
CREATE_TOPICS (19)	Create	Topic	This is applicable from the 2.0 release.
DELETE_TOPICS (20)	Delete	Topic	
DELETE_RECORDS (21)	Delete	Topic	
INIT_PRODUCER_ID (22)	Write	TransactionalId	
INIT_PRODUCER_ID (22)	IdempotentWrite	Cluster	
OFFSET_FOR_LEADER_EPOCH (23)	ClusterAction	Cluster	If there is no cluster level privilege for this operation, then it'll check for topic level one.
OFFSET_FOR_LEADER_EPOCH (23)	Describe	Topic	This is applicable from the 2.1 release.
ADD_PARTITIONS_TO_TXN (24)	Write	TransactionalId	This API is only applicable to transactional requests. It first checks for the Write action on the TransactionalId resource, then it checks the Topic in subject (below).
ADD_PARTITIONS_TO_TXN (24)	Write	Topic	
ADD_OFFSETS_TO_TXN (25)	Write	TransactionalId	Similarly to ADD_PARTITIONS_TO_TXN this is only applicable to transactional request. It first checks for Write action on the TransactionalId resource, then it checks whether it can Read on the given group (below).
ADD_OFFSETS_TO_TXN (25)	Read	Group	
END_TXN (26)	Write	TransactionalId	
WRITE_TXN_MARKERS (27)	ClusterAction	Cluster	
TXN_OFFSET_COMMIT (28)	Write	TransactionalId	
TXN_OFFSET_COMMIT (28)	Read	Group	
TXN_OFFSET_COMMIT (28)	Read	Topic	
DESCRIBE_ACLS (29)	Describe	Cluster	
CREATE_ACLS (30)	Alter	Cluster	
DELETE_ACLS (31)	Alter	Cluster	
DESCRIBE_CONFIGS (32)	DescribeConfigs	Cluster	If broker configs are requested, then the broker will check cluster level privileges.
DESCRIBE_CONFIGS (32)	DescribeConfigs	Topic	If topic configs are requested, then the broker will check topic level privileges.
ALTER_CONFIGS (33)	AlterConfigs	Cluster	If broker configs are altered, then the broker will check cluster level privileges.
ALTER_CONFIGS (33)	AlterConfigs	Topic	If topic configs are altered, then the broker will check topic level privileges.
ALTER_REPLICA_LOG_DIRS (34)	Alter	Cluster	
DESCRIBE_LOG_DIRS (35)	Describe	Cluster	An empty response will be returned on authorization failure.

PROTOCOL (API KEY)	OPERATION	RESOURCE	NOTE
SASL_AUTHENTICATE (36)			SASL_AUTHENTICATE is part of the authentication process and therefore it's not possible to apply any kind of authorization here.
CREATE_PARTITIONS (37)	Alter	Topic	
CREATE_DELEGATION_TOKEN (38)			Creating delegation tokens has special rules, for this please see the Authentication using Delegation Tokens section.
RENEW_DELEGATION_TOKEN (39)			Renewing delegation tokens has special rules, for this please see the Authentication using Delegation Tokens section.
EXPIRE_DELEGATION_TOKEN (40)			Expiring delegation tokens has special rules, for this please see the Authentication using Delegation Tokens section.
DESCRIBE_DELEGATION_TOKEN (41)	Describe	DelegationToken	Describing delegation tokens has special rules, for this please see the Authentication using Delegation Tokens section.
DELETE_GROUPS (42)	Delete	Group	
ELECT_PREFERRED_LEADERS (43)	ClusterAction	Cluster	
INCREMENTAL_ALTER_CONFIGS (44)	AlterConfigs	Cluster	If broker configs are altered, then the broker will check cluster level privileges.
INCREMENTAL_ALTER_CONFIGS (44)	AlterConfigs	Topic	If topic configs are altered, then the broker will check topic level privileges.
ALTER_PARTITION_REASSIGNMENTS (45)	Alter	Cluster	
LIST_PARTITION_REASSIGNMENTS (46)	Describe	Cluster	
OFFSET_DELETE (47)	Delete	Group	
OFFSET_DELETE (47)	Read	Topic	

7.5 Incorporating Security Features in a Running Cluster

You can secure a running cluster via one or more of the supported protocols discussed previously. This is done in phases:

- Incrementally bounce the cluster nodes to open additional secured port(s).
- Restart clients using the secured rather than PLAINTEXT port (assuming you are securing the client-broker connection).
- Incrementally bounce the cluster again to enable broker-to-broker security (if this is required)
- A final incremental bounce to close the PLAINTEXT port.

The specific steps for configuring SSL and SASL are described in sections 7.2 and 7.3. Follow these steps to enable security for your desired protocol(s).

The security implementation lets you configure different protocols for both broker-client and broker-broker communication. These must be enabled in separate bounces. A PLAINTEXT port must be left open throughout so brokers and/or clients can continue to communicate.

When performing an incremental bounce stop the brokers cleanly via a SIGTERM. It's also good practice to wait for restarted replicas to return to the ISR list before moving onto the next node.

As an example, say we wish to encrypt both broker-client and broker-broker communication with SSL. In the first incremental bounce, an SSL port is opened on each node:

```
            listeners=PLAINTEXT://broker1:9091,SSL://broker1:9092
```

We then restart the clients, changing their config to point at the newly opened, secured port:

```
            bootstrap.servers = [broker1:9092,...]
            security.protocol = SSL
            ...etc
```

In the second incremental server bounce we instruct Kafka to use SSL as the broker-broker protocol (which will use the same SSL port):

```
            listeners=PLAINTEXT://broker1:9091,SSL://broker1:9092
            security.inter.broker.protocol=SSL
```

In the final bounce we secure the cluster by closing the PLAINTEXT port:

```
            listeners=SSL://broker1:9092
            security.inter.broker.protocol=SSL
```

Alternatively we might choose to open multiple ports so that different protocols can be used for broker-broker and broker-client communication. Say we wished to use SSL encryption throughout (i.e. for broker-broker and broker-client communication) but we'd like to add SASL authentication to the broker-client connection also. We would achieve this by opening two additional ports during the first bounce:

```
            listeners=PLAINTEXT://broker1:9091,SSL://broker1:9092,SASL_SSL://broker1:9093
```

We would then restart the clients, changing their config to point at the newly opened, SASL & SSL secured port:

```
            bootstrap.servers = [broker1:9093,...]
            security.protocol = SASL_SSL
            ...etc
```

The second server bounce would switch the cluster to use encrypted broker-broker communication via the SSL port we previously opened on port 9092:

```
            listeners=PLAINTEXT://broker1:9091,SSL://broker1:9092,SASL_SSL://broker1:9093
            security.inter.broker.protocol=SSL
```

The final bounce secures the cluster by closing the PLAINTEXT port.

```
        listeners=SSL://broker1:9092,SASL_SSL://broker1:9093
        security.inter.broker.protocol=SSL
```

ZooKeeper can be secured independently of the Kafka cluster. The steps for doing this are covered in section 7.6.2.

7.6 ZooKeeper Authentication

7.6.1 New clusters

To enable ZooKeeper authentication on brokers, there are two necessary steps:

1. Create a JAAS login file and set the appropriate system property to point to it as described above
2. Set the configuration property `zookeeper.set.acl` in each broker to true

The metadata stored in ZooKeeper for the Kafka cluster is world-readable, but can only be modified by the brokers. The rationale behind this decision is that the data stored in ZooKeeper is not sensitive, but inappropriate manipulation of that data can cause cluster disruption. We also recommend limiting the access to ZooKeeper via network segmentation (only brokers and some admin tools need access to ZooKeeper).

7.6.2 Migrating clusters

If you are running a version of Kafka that does not support security or simply with security disabled, and you want to make the cluster secure, then you need to execute the following steps to enable ZooKeeper authentication with minimal disruption to your operations:

1. Perform a rolling restart setting the JAAS login file, which enables brokers to authenticate. At the end of the rolling restart, brokers are able to manipulate znodes with strict ACLs, but they will not create znodes with those ACLs
2. Perform a second rolling restart of brokers, this time setting the configuration parameter `zookeeper.set.acl` to true, which enables the use of secure ACLs when creating znodes
3. Execute the ZkSecurityMigrator tool. To execute the tool, there is this script: `./bin/zookeeper-security-migration.sh` with `zookeeper.acl` set to secure. This tool traverses the corresponding sub-trees changing the ACLs of the znodes

It is also possible to turn off authentication in a secure cluster. To do it, follow these steps:

1. Perform a rolling restart of brokers setting the JAAS login file, which enables brokers to authenticate, but setting `zookeeper.set.acl` to false. At the end of the rolling restart, brokers stop creating znodes with secure ACLs, but are still able to authenticate and manipulate all znodes
2. Execute the ZkSecurityMigrator tool. To execute the tool, run this script `./bin/zookeeper-security-migration.sh` with `zookeeper.acl` set to unsecure. This tool traverses the corresponding sub-trees changing the ACLs of the znodes
3. Perform a second rolling restart of brokers, this time omitting the system property that sets the JAAS login file

Here is an example of how to run the migration tool:

```
./bin/zookeeper-security-migration.sh --zookeeper.acl=secure --zookeeper.connect=localhost:2181
```

Run this to see the full list of parameters:

```
./bin/zookeeper-security-migration.sh --help
```

7.6.3 Migrating the ZooKeeper ensemble

It is also necessary to enable authentication on the ZooKeeper ensemble. To do it, we need to perform a rolling restart of the server and set a few properties. Please refer to the ZooKeeper documentation for more detail:

1. Apache ZooKeeper documentation
2. Apache ZooKeeper wiki

8. KAFKA CONNECT

8.1 Overview

Kafka Connect is a tool for scalably and reliably streaming data between Apache Kafka and other systems. It makes it simple to quickly define *connectors* that move large collections of data into and out of Kafka. Kafka Connect can ingest entire databases or collect metrics from all your application servers into Kafka topics, making the data available for stream processing with low latency. An export job can deliver data from Kafka topics into secondary storage and query systems or into batch systems for offline analysis.

Kafka Connect features include:

- **A common framework for Kafka connectors** - Kafka Connect standardizes integration of other data systems with Kafka, simplifying connector development, deployment, and management
- **Distributed and standalone modes** - scale up to a large, centrally managed service supporting an entire organization or scale down to development, testing, and small production deployments
- **REST interface** - submit and manage connectors to your Kafka Connect cluster via an easy to use REST API
- **Automatic offset management** - with just a little information from connectors, Kafka Connect can manage the offset commit process automatically so connector developers do not need to worry about this error prone part of connector development
- **Distributed and scalable by default** - Kafka Connect builds on the existing group management protocol. More workers can be added to scale up a Kafka Connect cluster.
- **Streaming/batch integration** - leveraging Kafka's existing capabilities, Kafka Connect is an ideal solution for bridging streaming and batch data systems

8.2 User Guide

The quickstart provides a brief example of how to run a standalone version of Kafka Connect. This section describes how to configure, run, and manage Kafka Connect in more detail.

Running Kafka Connect

Kafka Connect currently supports two modes of execution: standalone (single process) and distributed.

In standalone mode all work is performed in a single process. This configuration is simpler to setup and get started with and may be useful in situations where only one worker makes sense (e.g. collecting log files), but it does not benefit from some of the features of Kafka Connect such as fault tolerance. You can start a standalone process with the following command:

```
> bin/connect-standalone.sh config/connect-standalone.properties connector1.properties [connector2.properties
```

The first parameter is the configuration for the worker. This includes settings such as the Kafka connection parameters, serialization format, and how frequently to commit offsets. The provided example should work well with a local cluster running with the default configuration provided by `config/server.properties`. It will require tweaking to use with a different configuration or production deployment. All workers (both standalone and distributed) require a few configs:

- `bootstrap.servers` - List of Kafka servers used to bootstrap connections to Kafka
- `key.converter` - Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the keys in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro.
- `value.converter` - Converter class used to convert between Kafka Connect format and the serialized form that is written to Kafka. This controls the format of the values in messages written to or read from Kafka, and since this is independent of connectors it allows any connector to work with any serialization format. Examples of common formats include JSON and Avro.

The important configuration options specific to standalone mode are:

- `offset.storage.file.filename` - File to store offset data in

The parameters that are configured here are intended for producers and consumers used by Kafka Connect to access the configuration, offset and status topics. For configuration of Kafka source and Kafka sink tasks, the same parameters can be used but need to be prefixed with `consumer.` and `producer.` respectively. The only parameter that is inherited from the worker configuration is `bootstrap.servers`, which in most cases will be sufficient, since the same cluster is often used for all purposes. A notable exception is a secured cluster, which requires extra parameters to allow connections. These parameters will need to be set up to three times in the worker configuration, once for management access, once for Kafka sinks and once for Kafka sources.

The remaining parameters are connector configuration files. You may include as many as you want, but all will execute within the same process (on different threads).

Distributed mode handles automatic balancing of work, allows you to scale up (or down) dynamically, and offers fault tolerance both in the active tasks and for configuration and offset commit data. Execution is very similar to standalone mode:

```
> bin/connect-distributed.sh config/connect-distributed.properties
```

The difference is in the class which is started and the configuration parameters which change how the Kafka Connect process decides where to store configurations, how to assign work, and where to store offsets and task statues. In the distributed mode, Kafka Connect stores the offsets, configs and task statuses in Kafka topics. It is recommended to manually create the topics for offset, configs and statuses in order to achieve the desired the number of partitions and replication factors. If the topics are not yet created when starting Kafka Connect, the topics will be auto created with default number of partitions and replication factor, which may not be best suited for its usage.

In particular, the following configuration parameters, in addition to the common settings mentioned above, are critical to set before starting your cluster:

- `group.id` (default `connect-cluster`) - unique name for the cluster, used in forming the Connect cluster group; note that this **must not conflict** with consumer group IDs
- `config.storage.topic` (default `connect-configs`) - topic to use for storing connector and task configurations; note that this should be a single partition, highly replicated, compacted topic. You may need to manually create the topic to ensure the correct configuration as auto created topics may have multiple partitions or be automatically configured for deletion rather than compaction
- `offset.storage.topic` (default `connect-offsets`) - topic to use for storing offsets; this topic should have many partitions, be replicated, and be configured for compaction
- `status.storage.topic` (default `connect-status`) - topic to use for storing statuses; this topic can have multiple partitions, and should be replicated and configured for compaction

Note that in distributed mode the connector configurations are not passed on the command line. Instead, use the REST API described below to create, modify, and destroy connectors.

Configuring Connectors

Connector configurations are simple key-value mappings. For standalone mode these are defined in a properties file and passed to the Connect process on the command line. In distributed mode, they will be included in the JSON payload for the request that creates (or modifies) the connector.

Most configurations are connector dependent, so they can't be outlined here. However, there are a few common options:

- `name` - Unique name for the connector. Attempting to register again with the same name will fail.
- `connector.class` - The Java class for the connector
- `tasks.max` - The maximum number of tasks that should be created for this connector. The connector may create fewer tasks if it cannot achieve this level of parallelism.
- `key.converter` - (optional) Override the default key converter set by the worker.
- `value.converter` - (optional) Override the default value converter set by the worker.

The `connector.class` config supports several formats: the full name or alias of the class for this connector. If the connector is org.apache.kafka.connect.file.FileStreamSinkConnector, you can either specify this full name or use FileStreamSink or FileStreamSinkConnector to make the configuration a bit shorter.

Sink connectors also have a few additional options to control their input. Each sink connector must set one of the following:

- `topics` - A comma-separated list of topics to use as input for this connector
- `topics.regex` - A Java regular expression of topics to use as input for this connector

For any other options, you should consult the documentation for the connector.

Transformations

Connectors can be configured with transformations to make lightweight message-at-a-time modifications. They can be convenient for data massaging and event routing.

A transformation chain can be specified in the connector configuration.

- `transforms` - List of aliases for the transformation, specifying the order in which the transformations will be applied.
- `transforms.$alias.type` - Fully qualified class name for the transformation.
- `transforms.$alias.$transformationSpecificConfig` Configuration properties for the transformation

For example, lets take the built-in file source connector and use a transformation to add a static field.

Throughout the example we'll use schemaless JSON data format. To use schemaless format, we changed the following two lines in `connect-standalone.properties` from true to false:

```
key.converter.schemas.enable
value.converter.schemas.enable
```

The file source connector reads each line as a String. We will wrap each line in a Map and then add a second field to identify the origin of the event. To do this, we use two transformations:

- **HoistField** to place the input line inside a Map
- **InsertField** to add the static field. In this example we'll indicate that the record came from a file connector

After adding the transformations, `connect-file-source.properties` file looks as following:

```
name=local-file-source
connector.class=FileStreamSource
tasks.max=1
file=test.txt
topic=connect-test
transforms=MakeMap, InsertSource
transforms.MakeMap.type=org.apache.kafka.connect.transforms.HoistField$Value
transforms.MakeMap.field=line
transforms.InsertSource.type=org.apache.kafka.connect.transforms.InsertField$Value
transforms.InsertSource.static.field=data_source
transforms.InsertSource.static.value=test-file-source
```

All the lines starting with `transforms` were added for the transformations. You can see the two transformations we created: "InsertSource" and "MakeMap" are aliases that we chose to give the transformations. The transformation types are based on the list of built-in transformations you can see below. Each transformation type has additional configuration: HoistField requires a configuration called "field", which is the name of the field in the map that will include the original String from the file. InsertField transformation lets us specify the field name and the value that we are adding.

When we ran the file source connector on my sample file without the transformations, and then read them using `kafka-console-consumer.sh`, the results were:

```
"foo"
"bar"
"hello world"
```

We then create a new file connector, this time after adding the transformations to the configuration file. This time, the results will be:

```
{"line":"foo","data_source":"test-file-source"}
{"line":"bar","data_source":"test-file-source"}
{"line":"hello world","data_source":"test-file-source"}
```

You can see that the lines we've read are now part of a JSON map, and there is an extra field with the static value we specified. This is just one example of what you can do with transformations.

Several widely-applicable data and routing transformations are included with Kafka Connect:

- InsertField - Add a field using either static data or record metadata
- ReplaceField - Filter or rename fields
- MaskField - Replace field with valid null value for the type (0, empty string, etc)
- ValueToKey

- HoistField - Wrap the entire event as a single field inside a Struct or a Map
- ExtractField - Extract a specific field from Struct and Map and include only this field in results
- SetSchemaMetadata - modify the schema name or version
- TimestampRouter - Modify the topic of a record based on original topic and timestamp. Useful when using a sink that needs to write to different tables or indexes based on timestamps
- RegexRouter - modify the topic of a record based on original topic, replacement string and a regular expression

Details on how to configure each transformation are listed below:

org.apache.kafka.connect.transforms.InsertField

Insert field(s) using attributes from the record metadata or a configured static value.

Use the concrete transformation type designed for the record key (`org.apache.kafka.connect.transforms.InsertField$Key`) or value (`org.apache.kafka.connect.transforms.InsertField$Value`).

offset.field: Field name for Kafka offset - only applicable to sink connectors.
Suffix with `!` to make this a required field, or `?` to keep it optional (the default).

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

partition.field: Field name for Kafka partition. Suffix with `!` to make this a required field, or `?` to keep it optional (the default).

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

static.field: Field name for static data field. Suffix with `!` to make this a required field, or `?` to keep it optional (the default).

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

static.value: Static field value, if field name configured.

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

timestamp.field: Field name for record timestamp. Suffix with `!` to make this a required field, or `?` to keep it optional (the default).

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

topic.field: Field name for Kafka topic. Suffix with `!` to make this a required field, or `?` to keep it optional (the default).

Type: string — **Default**: null — **Valid Values**: — **Importance**: medium

---

org.apache.kafka.connect.transforms.ReplaceField

Filter or rename fields.

Use the concrete transformation type designed for the record key (`org.apache.kafka.connect.transforms.ReplaceField$Key`) or value (`org.apache.kafka.connect.transforms.ReplaceField$Value`).

blacklist: Fields to exclude. This takes precedence over the whitelist.

Type: list — **Default**: "" — **Valid Values**: — **Importance**: medium

---

renames: Field rename mappings.

Type: list — **Default**: "" — **Valid Values**: list of colon-delimited pairs, e.g. `foo:bar,abc:xyz` — **Importance**: medium

whitelist: Fields to include. If specified, only these fields will be used.

Type: list — **Default**: "" — **Valid Values**: — **Importance**: medium

---

org.apache.kafka.connect.transforms.MaskField

Mask specified fields with a valid null value for the field type (i.e. 0, false, empty string, and so on).

Use the concrete transformation type designed for the record key (`org.apache.kafka.connect.transforms.MaskField$Key`) or value (`org.apache.kafka.connect.transforms.MaskField$Value`).

fields: Names of fields to mask.

Type: list — **Default**: — **Valid Values**: non-empty list — **Importance**: high

---

org.apache.kafka.connect.transforms.ValueToKey

Replace the record key with a new key formed from a subset of fields in the record value.

fields: Field names on the record value to extract as the record key.

Type: list — **Default**: — **Valid Values**: non-empty list — **Importance**: high

---

org.apache.kafka.connect.transforms.HoistField

Wrap data using the specified field name in a Struct when schema present, or a Map in the case of schemaless data.

Use the concrete transformation type designed for the record key (`org.apache.kafka.connect.transforms.HoistField$Key`) or value (`org.apache.kafka.connect.transforms.HoistField$Value`).

field: Field name for the single field that will be created in the resulting Struct or Map.

Type: string — **Default**: — **Valid Values**: — **Importance**: medium

---

org.apache.kafka.connect.transforms.ExtractField

Extract the specified field from a Struct when schema present, or a Map in the case of schemaless data. Any null values are passed through unmodified.

Use the concrete transformation type designed for the record key (`org.apache.kafka.connect.transforms.ExtractField$Key`) or value (`org.apache.kafka.connect.transforms.ExtractField$Value`).

field: Field name to extract.

Type: string — **Default**: — **Valid Values**: — **Importance**: medium

---

org.apache.kafka.connect.transforms.SetSchemaMetadata

Set the schema name, version or both on the record's key (`org.apache.kafka.connect.transforms.SetSchemaMetadata$Key`) or value (`org.apache.kafka.connect.transforms.SetSchemaMetadata$Value`) schema.

schema.name: Schema name to set.

Type: string — **Default**: null — **Valid Values**: — **Importance**: high

---

schema.version: Schema version to set.

Type: int — **Default**: null — **Valid Values**: — **Importance**: high

---

org.apache.kafka.connect.transforms.TimestampRouter

Update the record's topic field as a function of the original topic value and the record timestamp.

This is mainly useful for sink connectors, since the topic field is often used to determine the equivalent entity name in the destination system(e.g. database table or search index name).

timestamp.format: Format string for the timestamp that is compatible with `java.text.SimpleDateFormat` .

Type: string — **Default**: yyyyMMdd — **Valid Values**: — **Importance**: high

---

topic.format: Format string which can contain `${topic}` and `${timestamp}` as placeholders for the topic and timestamp, respectively.

Type: string — **Default**: ${topic}-${timestamp} — **Valid Values**: — **Importance**: high

---

org.apache.kafka.connect.transforms.RegexRouter

Update the record topic using the configured regular expression and replacement string.

Under the hood, the regex is compiled to a `java.util.regex.Pattern` . If the pattern matches the input topic, `java.util.regex.Matcher#replaceFirst()` is used with the replacement string to obtain the new topic.

regex: Regular expression to use for matching.

Type: string — **Default**: — **Valid Values**: valid regex — **Importance**: high

---

replacement: Replacement string.

Type: string — **Default**: — **Valid Values**: — **Importance**: high

---

org.apache.kafka.connect.transforms.Flatten

Flatten a nested data structure, generating names for each field by concatenating the field names at each level with a configurable delimiter character. Applies to Struct when schema present, or a Map in the case of schemaless data. The default delimiter is '.'.

Use the concrete transformation type designed for the record key (`org.apache.kafka.connect.transforms.Flatten$Key`) or value (`org.apache.kafka.connect.transforms.Flatten$Value`).

delimiter: Delimiter to insert between field names from the input record when generating field names for the output record

Type: string — **Default**: . — **Valid Values**: — **Importance**: medium

---

org.apache.kafka.connect.transforms.Cast

Cast fields or the entire key or value to a specific type, e.g. to force an integer field to a smaller width. Only simple primitive types are supported -- integers, floats, boolean, and string.

Use the concrete transformation type designed for the record key (`org.apache.kafka.connect.transforms.Cast$Key`) or value (`org.apache.kafka.connect.transforms.Cast$Value`).

spec: List of fields and the type to cast them to of the form field1:type,field2:type to cast fields of Maps or Structs. A single type to cast the entire value. Valid types are int8, int16, int32, int64, float32, float64, boolean, and string.

Type: list — **Default**: — **Valid Values**: list of colon-delimited pairs, e.g. `foo:bar,abc:xyz` — **Importance**: high

---

org.apache.kafka.connect.transforms.TimestampConverter

Convert timestamps between different formats such as Unix epoch, strings, and Connect Date/Timestamp types.Applies to individual fields or to the entire value.

Use the concrete transformation type designed for the record key (`org.apache.kafka.connect.transforms.TimestampConverter$Key`) or value (`org.apache.kafka.connect.transforms.TimestampConverter$Value`).

target.type: The desired timestamp representation: string, unix, Date, Time, or Timestamp

Type: string — **Default**: — **Valid Values**: — **Importance**: high

---

field: The field containing the timestamp, or empty if the entire value is a timestamp

Type: string — **Default**: "" — **Valid Values**: — **Importance**: high

---

format: A SimpleDateFormat-compatible format for the timestamp. Used to generate the output when type=string or used to parse the input if the input is a string.

Type: string — **Default**: "" — **Valid Values**: — **Importance**: medium

---

REST API

Since Kafka Connect is intended to be run as a service, it also provides a REST API for managing connectors. The REST API server can be configured using the `listeners` configuration option. This field should contain a list of listeners in the following format: `protocol://host:port,protocol2://host2:port2` . Currently supported protocols are `http` and `https` . For example:

```
listeners=http://localhost:8080,https://localhost:8443
```

By default, if no `listeners` are specified, the REST server runs on port 8083 using the HTTP protocol. When using HTTPS, the configuration has to include the SSL configuration. By default, it will use the `ssl.*` settings. In case it is needed to use different configuration for the REST API than for connecting to Kafka brokers, the fields can be prefixed with `listeners.https` . When using the prefix, only the prefixed options will be used and the `ssl.*` options without the prefix will be ignored. Following fields can be used to configure HTTPS for the REST API:

- `ssl.keystore.location`
- `ssl.keystore.password`
- `ssl.keystore.type`
- `ssl.key.password`
- `ssl.truststore.location`
- `ssl.truststore.password`
- `ssl.truststore.type`
- `ssl.enabled.protocols`
- `ssl.provider`

- `ssl.protocol`
- `ssl.cipher.suites`
- `ssl.keymanager.algorithm`
- `ssl.secure.random.implementation`
- `ssl.trustmanager.algorithm`
- `ssl.endpoint.identification.algorithm`
- `ssl.client.auth`

The REST API is used not only by users to monitor / manage Kafka Connect. It is also used for the Kafka Connect cross-cluster communication. Requests received on the follower nodes REST API will be forwarded to the leader node REST API. In case the URI under which is given host reachable is different from the URI which it listens on, the configuration options `rest.advertised.host.name`, `rest.advertised.port` and `rest.advertised.listener` can be used to change the URI which will be used by the follower nodes to connect with the leader. When using both HTTP and HTTPS listeners, the `rest.advertised.listener` option can be also used to define which listener will be used for the cross-cluster communication. When using HTTPS for communication between nodes, the same `ssl.*` or `listeners.https` options will be used to configure the HTTPS client.

The following are the currently supported REST API endpoints:

- `GET /connectors` - return a list of active connectors
- `POST /connectors` - create a new connector; the request body should be a JSON object containing a string `name` field and an object `config` field with the connector configuration parameters
- `GET /connectors/{name}` - get information about a specific connector
- `GET /connectors/{name}/config` - get the configuration parameters for a specific connector
- `PUT /connectors/{name}/config` - update the configuration parameters for a specific connector
- `GET /connectors/{name}/status` - get current status of the connector, including if it is running, failed, paused, etc., which worker it is assigned to, error information if it has failed, and the state of all its tasks
- `GET /connectors/{name}/tasks` - get a list of tasks currently running for a connector
- `GET /connectors/{name}/tasks/{taskid}/status` - get current status of the task, including if it is running, failed, paused, etc., which worker it is assigned to, and error information if it has failed
- `PUT /connectors/{name}/pause` - pause the connector and its tasks, which stops message processing until the connector is resumed
- `PUT /connectors/{name}/resume` - resume a paused connector (or do nothing if the connector is not paused)
- `POST /connectors/{name}/restart` - restart a connector (typically because it has failed)
- `POST /connectors/{name}/tasks/{taskId}/restart` - restart an individual task (typically because it has failed)
- `DELETE /connectors/{name}` - delete a connector, halting all tasks and deleting its configuration

Kafka Connect also provides a REST API for getting information about connector plugins:

- `GET /connector-plugins` - return a list of connector plugins installed in the Kafka Connect cluster. Note that the API only checks for connectors on the worker that handles the request, which means you may see inconsistent results, especially during a rolling upgrade if you add new connector jars
- `PUT /connector-plugins/{connector-type}/config/validate` - validate the provided configuration values against the configuration definition. This API performs per config validation, returns suggested values and error messages during validation.

8.3 Connector Development Guide

This guide describes how developers can write new connectors for Kafka Connect to move data between Kafka and other systems. It briefly reviews a few key concepts and then describes how to create a simple connector.

Core Concepts and APIs

Connectors and Tasks

To copy data between Kafka and another system, users create a `Connector` for the system they want to pull data from or push data to. Connectors come in two flavors: `SourceConnectors` import data from another system (e.g. `JDBCSourceConnector` would import a relational database into Kafka) and `SinkConnectors` export data (e.g. `HDFSSinkConnector` would export the contents of a Kafka topic to an HDFS file).

`Connectors` do not perform any data copying themselves: their configuration describes the data to be copied, and the `Connector` is responsible for breaking that job into a set of `Tasks` that can be distributed to workers. These `Tasks` also come in two corresponding flavors: `SourceTask` and `SinkTask`.

With an assignment in hand, each `Task` must copy its subset of the data to or from Kafka. In Kafka Connect, it should always be possible to frame these assignments as a set of input and output streams consisting of records with consistent schemas. Sometimes this mapping is obvious: each file in a set of log files can be considered a stream with each parsed line forming a record using the same schema and offsets stored as byte offsets in the file. In other cases it may require more effort to map to this model: a JDBC connector can map each table to a stream, but the offset is less clear. One possible mapping uses a timestamp column to generate queries incrementally returning new data, and the last queried timestamp can be used as the offset.

Streams and Records

Each stream should be a sequence of key-value records. Both the keys and values can have complex structure -- many primitive types are provided, but arrays, objects, and nested data structures can be represented as well. The runtime data format does not assume any particular serialization format; this conversion is handled internally by the framework.

In addition to the key and value, records (both those generated by sources and those delivered to sinks) have associated stream IDs and offsets. These are used by the framework to periodically commit the offsets of data that have been processed so that in the event of failures, processing can resume from the last committed offsets, avoiding unnecessary reprocessing and duplication of events.

Dynamic Connectors

Not all jobs are static, so `Connector` implementations are also responsible for monitoring the external system for any changes that might require reconfiguration. For example, in the `JDBCSourceConnector` example, the `Connector` might assign a set of tables to each `Task`. When a new table is created, it must discover this so it can assign the new table to one of the `Tasks` by updating its configuration. When it notices a change that requires reconfiguration (or a change in the number of `Tasks`), it notifies the framework and the framework updates any corresponding `Tasks`.

Developing a Simple Connector

Developing a connector only requires implementing two interfaces, the `Connector` and `Task`. A simple example is included with the source code for Kafka in the `file` package. This connector is meant for use in standalone mode and has implementations of a `SourceConnector` / `SourceTask` to read each line of a file and emit it as a record and a `SinkConnector` / `SinkTask` that writes each record to a file.

The rest of this section will walk through some code to demonstrate the key steps in creating a connector, but developers should also refer to the full example source code as many details are omitted for brevity.

Connector Example

We'll cover the `SourceConnector` as a simple example. `SinkConnector` implementations are very similar. Start by creating the class that inherits from `SourceConnector` and add a couple of fields that will store parsed configuration information (the filename to read from and the topic to send data to):

```
public class FileStreamSourceConnector extends SourceConnector {
    private String filename;
    private String topic;
```

The easiest method to fill in is `taskClass()`, which defines the class that should be instantiated in worker processes to actually read the data:

```
@Override
public Class<? extends Task> taskClass() {
    return FileStreamSourceTask.class;
}
```

We will define the `FileStreamSourceTask` class below. Next, we add some standard lifecycle methods, `start()` and `stop()`

:

```
@Override
public void start(Map<String, String> props) {
    // The complete version includes error handling as well.
    filename = props.get(FILE_CONFIG);
    topic = props.get(TOPIC_CONFIG);
}

@Override
public void stop() {
    // Nothing to do since no background monitoring is required.
}
```

Finally, the real core of the implementation is in `taskConfigs()`. In this case we are only handling a single file, so even though we may be permitted to generate more tasks as per the `maxTasks` argument, we return a list with only one entry:

```
@Override
public List<Map<String, String>> taskConfigs(int maxTasks) {
    ArrayList<Map<String, String>> configs = new ArrayList<>();
    // Only one input stream makes sense.
    Map<String, String> config = new HashMap<>();
    if (filename != null)
        config.put(FILE_CONFIG, filename);
    config.put(TOPIC_CONFIG, topic);
    configs.add(config);
    return configs;
}
```

Although not used in the example, `SourceTask` also provides two APIs to commit offsets in the source system: `commit` and `commitRecord`. The APIs are provided for source systems which have an acknowledgement mechanism for messages. Overriding these methods allows the source connector to acknowledge messages in the source system, either in bulk or individually, once they have been written to Kafka. The `commit` API stores the offsets in the source system, up to the offsets that have been returned by `poll`. The implementation of this API should block until the commit is complete. The `commitRecord` API saves the offset in the source system for each `SourceRecord` after it is written to Kafka. As Kafka Connect will record offsets automatically, `SourceTask`s are not required to implement them. In cases where a connector does need to acknowledge messages in the source system, only one of the APIs is typically required.

Even with multiple tasks, this method implementation is usually pretty simple. It just has to determine the number of input tasks, which may require contacting the remote service it is pulling data from, and then divvy them up. Because some patterns for splitting work among tasks are so common, some utilities are provided in `ConnectorUtils` to simplify these cases.

Note that this simple example does not include dynamic input. See the discussion in the next section for how to trigger updates to task configs.

Task Example - Source Task

Next we'll describe the implementation of the corresponding `SourceTask`. The implementation is short, but too long to cover completely in this guide. We'll use pseudo-code to describe most of the implementation, but you can refer to the source code for the full example.

Just as with the connector, we need to create a class inheriting from the appropriate base `Task` class. It also has some standard lifecycle methods:

```
public class FileStreamSourceTask extends SourceTask {
    String filename;
    InputStream stream;
    String topic;

    @Override
    public void start(Map<String, String> props) {
        filename = props.get(FileStreamSourceConnector.FILE_CONFIG);
        stream = openOrThrowError(filename);
        topic = props.get(FileStreamSourceConnector.TOPIC_CONFIG);
    }

    @Override
    public synchronized void stop() {
        stream.close();
```

```
    }
```

These are slightly simplified versions, but show that these methods should be relatively simple and the only work they should perform is allocating or freeing resources. There are two points to note about this implementation. First, the `start()` method does not yet handle resuming from a previous offset, which will be addressed in a later section. Second, the `stop()` method is synchronized. This will be necessary because `SourceTasks` are given a dedicated thread which they can block indefinitely, so they need to be stopped with a call from a different thread in the Worker.

Next, we implement the main functionality of the task, the `poll()` method which gets events from the input system and returns a `List<SourceRecord>`:

```
@Override
public List<SourceRecord> poll() throws InterruptedException {
    try {
        ArrayList<SourceRecord> records = new ArrayList<>();
        while (streamValid(stream) && records.isEmpty()) {
            LineAndOffset line = readToNextLine(stream);
            if (line != null) {
                Map<String, Object> sourcePartition = Collections.singletonMap("filename", filename);
                Map<String, Object> sourceOffset = Collections.singletonMap("position", streamOffset);
                records.add(new SourceRecord(sourcePartition, sourceOffset, topic, Schema.STRING_SCHEMA, line
            } else {
                Thread.sleep(1);
            }
        }
        return records;
    } catch (IOException e) {
        // Underlying stream was killed, probably as a result of calling stop. Allow to return
        // null, and driving thread will handle any shutdown if necessary.
    }
    return null;
}
```

Again, we've omitted some details, but we can see the important steps: the `poll()` method is going to be called repeatedly, and for each call it will loop trying to read records from the file. For each line it reads, it also tracks the file offset. It uses this information to create an output `SourceRecord` with four pieces of information: the source partition (there is only one, the single file being read), source offset (byte offset in the file), output topic name, and output value (the line, and we include a schema indicating this value will always be a string). Other variants of the `SourceRecord` constructor can also include a specific output partition, a key, and headers.

Note that this implementation uses the normal Java `InputStream` interface and may sleep if data is not available. This is acceptable because Kafka Connect provides each task with a dedicated thread. While task implementations have to conform to the basic `poll()` interface, they have a lot of flexibility in how they are implemented. In this case, an NIO-based implementation would be more efficient, but this simple approach works, is quick to implement, and is compatible with older versions of Java.

Sink Tasks

The previous section described how to implement a simple `SourceTask`. Unlike `SourceConnector` and `SinkConnector`, `SourceTask` and `SinkTask` have very different interfaces because `SourceTask` uses a pull interface and `SinkTask` uses a push interface. Both share the common lifecycle methods, but the `SinkTask` interface is quite different:

```
public abstract class SinkTask implements Task {
    public void initialize(SinkTaskContext context) {
        this.context = context;
    }

    public abstract void put(Collection<SinkRecord> records);

    public void flush(Map<TopicPartition, OffsetAndMetadata> currentOffsets) {
    }
```

The `SinkTask` documentation contains full details, but this interface is nearly as simple as the `SourceTask`. The `put()` method should contain most of the implementation, accepting sets of `SinkRecords`, performing any required translation, and storing them in the destination system. This method does not need to ensure the data has been fully written to the destination system before returning. In fact, in many cases internal buffering will be useful so an entire batch of records can be sent at once, reducing the overhead of inserting events into the downstream data store. The `SinkRecords` contain essentially the same information as `SourceRecords` : Kafka topic, partition, offset, the event key and value, and optional headers.

The `flush()` method is used during the offset commit process, which allows tasks to recover from failures and resume from a safe point such that no events will be missed. The method should push any outstanding data to the destination system and then block until the write has been acknowledged. The `offsets` parameter can often be ignored, but is useful in some cases where implementations want to store offset information in the destination store to provide exactly-once delivery. For example, an HDFS connector could do this and use atomic move operations to make sure the `flush()` operation atomically commits the data and offsets to a final location in HDFS.

Resuming from Previous Offsets

The `SourceTask` implementation included a stream ID (the input filename) and offset (position in the file) with each record. The framework uses this to commit offsets periodically so that in the case of a failure, the task can recover and minimize the number of events that are reprocessed and possibly duplicated (or to resume from the most recent offset if Kafka Connect was stopped gracefully, e.g. in standalone mode or due to a job reconfiguration). This commit process is completely automated by the framework, but only the connector knows how to seek back to the right position in the input stream to resume from that location.

To correctly resume upon startup, the task can use the `SourceContext` passed into its `initialize()` method to access the offset data. In `initialize()` , we would add a bit more code to read the offset (if it exists) and seek to that position:

```
stream = new FileInputStream(filename);
Map<String, Object> offset = context.offsetStorageReader().offset(Collections.singletonMap(FILENAME_FIELD, fil
if (offset != null) {
    Long lastRecordedOffset = (Long) offset.get("position");
    if (lastRecordedOffset != null)
        seekToOffset(stream, lastRecordedOffset);
}
```

Of course, you might need to read many keys for each of the input streams. The `OffsetStorageReader` interface also allows you to issue bulk reads to efficiently load all offsets, then apply them by seeking each input stream to the appropriate position.

Dynamic Input/Output Streams

Kafka Connect is intended to define bulk data copying jobs, such as copying an entire database rather than creating many jobs to copy each table individually. One consequence of this design is that the set of input or output streams for a connector can vary over time.

Source connectors need to monitor the source system for changes, e.g. table additions/deletions in a database. When they pick up changes, they should notify the framework via the `ConnectorContext` object that reconfiguration is necessary. For example, in a `SourceConnector` :

```
if (inputsChanged())
    this.context.requestTaskReconfiguration();
```

The framework will promptly request new configuration information and update the tasks, allowing them to gracefully commit their progress before reconfiguring them. Note that in the `SourceConnector` this monitoring is currently left up to the connector implementation. If an extra thread is required to perform this monitoring, the connector must allocate it itself.

Ideally this code for monitoring changes would be isolated to the `Connector` and tasks would not need to worry about them. However, changes can also affect tasks, most commonly when one of their input streams is destroyed in the input system, e.g. if a table is dropped from a database. If the `Task` encounters the issue before the `Connector` , which will be common if the `Connector` needs to poll for changes, the `Task` will need to handle the subsequent error. Thankfully, this can usually be handled simply by catching and handling the appropriate exception.

`SinkConnectors` usually only have to handle the addition of streams, which may translate to new entries in their outputs (e.g., a new database table). The framework manages any changes to the Kafka input, such as when the set of input topics changes because of a regex subscription. `SinkTasks` should expect new input streams, which may require creating new resources in the downstream system, such as a new table in a database. The trickiest situation to handle in these cases may be conflicts between multiple `SinkTasks` seeing a new input stream for the first time and simultaneously trying to create the new resource. `SinkConnectors` , on the other hand, will generally require no special code for handling a dynamic set of streams.

Connect Configuration Validation

Kafka Connect allows you to validate connector configurations before submitting a connector to be executed and can provide feedback about errors and recommended values. To take advantage of this, connector developers need to provide an implementation of `config()` to expose the configuration definition to the framework.

The following code in `FileStreamSourceConnector` defines the configuration and exposes it to the framework.

```
private static final ConfigDef CONFIG_DEF = new ConfigDef()
    .define(FILE_CONFIG, Type.STRING, Importance.HIGH, "Source filename.")
    .define(TOPIC_CONFIG, Type.STRING, Importance.HIGH, "The topic to publish data to");

public ConfigDef config() {
    return CONFIG_DEF;
}
```

`ConfigDef` class is used for specifying the set of expected configurations. For each configuration, you can specify the name, the type, the default value, the documentation, the group information, the order in the group, the width of the configuration value and the name suitable for display in the UI. Plus, you can provide special validation logic used for single configuration validation by overriding the `Validator` class. Moreover, as there may be dependencies between configurations, for example, the valid values and visibility of a configuration may change according to the values of other configurations. To handle this, `ConfigDef` allows you to specify the dependents of a configuration and to provide an implementation of `Recommender` to get valid values and set visibility of a configuration given the current configuration values.

Also, the `validate()` method in `Connector` provides a default validation implementation which returns a list of allowed configurations together with configuration errors and recommended values for each configuration. However, it does not use the recommended values for configuration validation. You may provide an override of the default implementation for customized configuration validation, which may use the recommended values.

Working with Schemas

The FileStream connectors are good examples because they are simple, but they also have trivially structured data -- each line is just a string. Almost all practical connectors will need schemas with more complex data formats.

To create more complex data, you'll need to work with the Kafka Connect `data` API. Most structured records will need to interact with two classes in addition to primitive types: `Schema` and `Struct`.

The API documentation provides a complete reference, but here is a simple example creating a `Schema` and `Struct`:

```
Schema schema = SchemaBuilder.struct().name(NAME)
    .field("name", Schema.STRING_SCHEMA)
    .field("age", Schema.INT_SCHEMA)
    .field("admin", new SchemaBuilder.boolean().defaultValue(false).build())
    .build();

Struct struct = new Struct(schema)
    .put("name", "Barbara Liskov")
    .put("age", 75);
```

If you are implementing a source connector, you'll need to decide when and how to create schemas. Where possible, you should avoid recomputing them as much as possible. For example, if your connector is guaranteed to have a fixed schema, create it statically and reuse a single instance.

However, many connectors will have dynamic schemas. One simple example of this is a database connector. Considering even just a single table, the schema will not be predefined for the entire connector (as it varies from table to table). But it also may not be fixed for a single table over the lifetime of the connector since the user may execute an `ALTER TABLE` command. The connector must be able to detect these changes and react appropriately.

Sink connectors are usually simpler because they are consuming data and therefore do not need to create schemas. However, they should take just as much care to validate that the schemas they receive have the expected format. When the schema does not match -- usually indicating the upstream producer is generating invalid data that cannot be correctly translated to the destination system -- sink connectors should throw an exception to indicate this error to the system.

Kafka Connect Administration

Kafka Connect's REST layer provides a set of APIs to enable administration of the cluster. This includes APIs to view the configuration of connectors and the status of their tasks, as well as to alter their current behavior (e.g. changing configuration and restarting tasks).

When a connector is first submitted to the cluster, a rebalance is triggered between the Connect workers in order to distribute the load that consists of the tasks of the new connector. This same rebalancing procedure is also used when connectors increase or decrease the number of tasks they require, when a connector's configuration is changed, or when a worker is added or removed from the group as part of an intentional upgrade of the Connect cluster or due to a failure.

In versions prior to 2.3.0, the Connect workers would rebalance the full set of connectors and their tasks in the cluster as a simple way to make sure that each worker has approximately the same amount of work. This behavior can be still enabled by setting `connect.protocol=eager`.

Starting with 2.3.0, Kafka Connect is using by default a protocol that performs incremental cooperative rebalancing that incrementally balances the connectors and tasks across the Connect workers, affecting only tasks that are new, to be removed, or need to move from one worker to another. Other tasks are not stopped and restarted during the rebalance, as they would have been with the old protocol.

If a Connect worker leaves the group, intentionally or due to a failure, Connect waits for `scheduled.rebalance.max.delay.ms` before triggering a rebalance. This delay defaults to five minutes (`300000ms`) to tolerate failures or upgrades of workers without immediately redistributing the load of a departing worker. If this worker returns within the configured delay, it gets its previously assigned tasks in full. However, this means that the tasks will remain unassigned until the time specified by `scheduled.rebalance.max.delay.ms` elapses. If a worker does not return within that time limit, Connect will reassign those tasks among the remaining workers in the Connect cluster.

The new Connect protocol is enabled when all the workers that form the Connect cluster are configured with `connect.protocol=compatible`, which is also the default value when this property is missing. Therefore, upgrading to the new Connect protocol happens automatically when all the workers upgrade to 2.3.0. A rolling upgrade of the Connect cluster will activate incremental cooperative rebalancing when the last worker joins on version 2.3.0.

You can use the REST API to view the current status of a connector and its tasks, including the ID of the worker to which each was assigned. For example, the `GET /connectors/file-source/status` request shows the status of a connector named `file-source`:

```
{
"name": "file-source",
"connector": {
    "state": "RUNNING",
    "worker_id": "192.168.1.208:8083"
},
"tasks": [
    {
    "id": 0,
    "state": "RUNNING",
    "worker_id": "192.168.1.209:8083"
    }
]
}
```

Connectors and their tasks publish status updates to a shared topic (configured with `status.storage.topic`) which all workers in the cluster monitor. Because the workers consume this topic asynchronously, there is typically a (short) delay before a state change is visible through the status API. The following states are possible for a connector or one of its tasks:

- **UNASSIGNED:** The connector/task has not yet been assigned to a worker.
- **RUNNING:** The connector/task is running.
- **PAUSED:** The connector/task has been administratively paused.
- **FAILED:** The connector/task has failed (usually by raising an exception, which is reported in the status output).
- **DESTROYED:** The connector/task has been administratively removed and will stop appearing in the Connect cluster.

In most cases, connector and task states will match, though they may be different for short periods of time when changes are occurring or if tasks have failed. For example, when a connector is first started, there may be a noticeable delay before the connector and its tasks have all transitioned to the RUNNING state. States will also diverge when tasks fail since Connect does not automatically restart failed tasks. To restart a connector/task manually, you can use the restart APIs listed above. Note that if you try to restart a task while a rebalance is taking place, Connect will return a 409 (Conflict) status code. You can retry after the rebalance completes, but it might not be necessary since rebalances effectively restart all the connectors and tasks in the cluster.

It's sometimes useful to temporarily stop the message processing of a connector. For example, if the remote system is undergoing maintenance, it would be preferable for source connectors to stop polling it for new data instead of filling logs with exception spam. For this use case, Connect offers a pause/resume API. While a source connector is paused, Connect will stop polling it for additional records. While a sink connector is paused, Connect will stop pushing new messages to it. The pause state is persistent, so even if you restart the cluster, the connector will not begin message processing again until the task has been resumed. Note that there may be a delay before all of a connector's tasks have transitioned to the PAUSED state since it may take time for them to finish whatever processing they were in the middle of when being paused. Additionally, failed tasks will not transition to the PAUSED state until they have been restarted.

9. KAFKA STREAMS

Kafka Streams is a client library for processing and analyzing data stored in Kafka. It builds upon important stream processing concepts such as properly distinguishing between event time and processing time, windowing support, exactly-once processing semantics and simple yet efficient management of application state.

Kafka Streams has a **low barrier to entry**: You can quickly write and run a small-scale proof-of-concept on a single machine; and you only need to run additional instances of your application on multiple machines to scale up to high-volume production workloads. Kafka Streams transparently handles the load balancing of multiple instances of the same application by leveraging Kafka's parallelism model.

Learn More about Kafka Streams read this Section.