Many Streams Lead to Kafka

Introduction

Founded by creators of Kafka

- @jaykreps, @nehanarkhede, @junrao
- Started at LinkedIn
- Widely used

We help you gather, transport, organize, and analyze all of your stream data

What we offer

- Confluent Platform
  - Kafka **plus** critical bug fixes not yet applied in Apache release
  - Kafka ecosystem projects
  - Enterprise support
- Training and Professional Services

Confluent training partner

Previously:

- Curriculum Developer and Instructor @ Cloudera
- Senior Software Engineer @ Intuit
- Lead Developer @ Dibbs

Covered, Conferences and Published In:

- GigaOM, ArsTecnica, Pragmatic Programmers, Strata, OSCON, Wall Street Journal, CNN, BBC, NPR

See Me On:

- @jessetanderson
- http://tiny.smokinghand.com/linkedin
- http://tiny.smokinghand.com/youtube

Your experience as a developer, analyst or administrator

Which language(s) you use

Experience with Publish/Subscribe, Client/Server, Hadoop, Big Data or NoSQL

Expectations from this class

Start at 9 AM

Breaks and lunch

- Morning break 10:30 AM

Downloads

- Exercise guide (required)
- Slides (recommended)
- VM (required)

Data Movement Concepts

There are many means of storage

Choosing the right one depends on the access pattern

Are you storing archival data?

Are you randomly accessing data?

Is data coming more as an event?

Many data pipelines start out simple

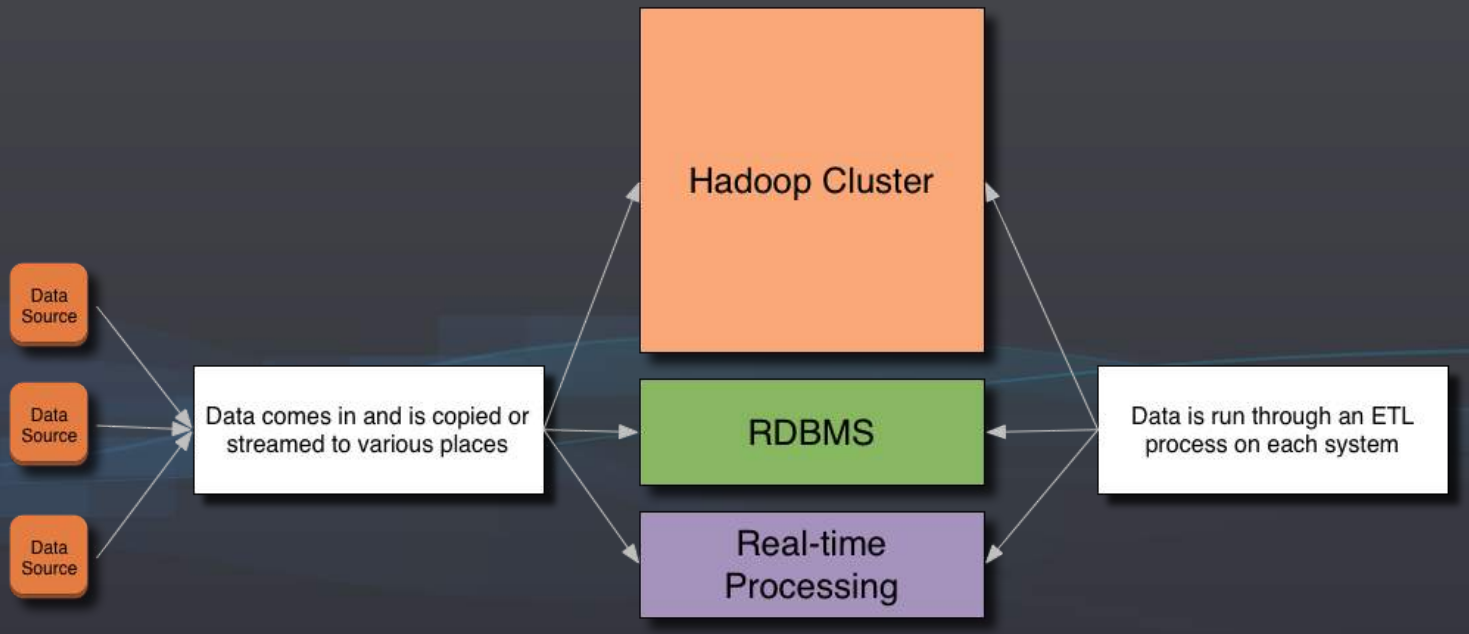
- There was a single place where all data resided
- There was a single ETL process

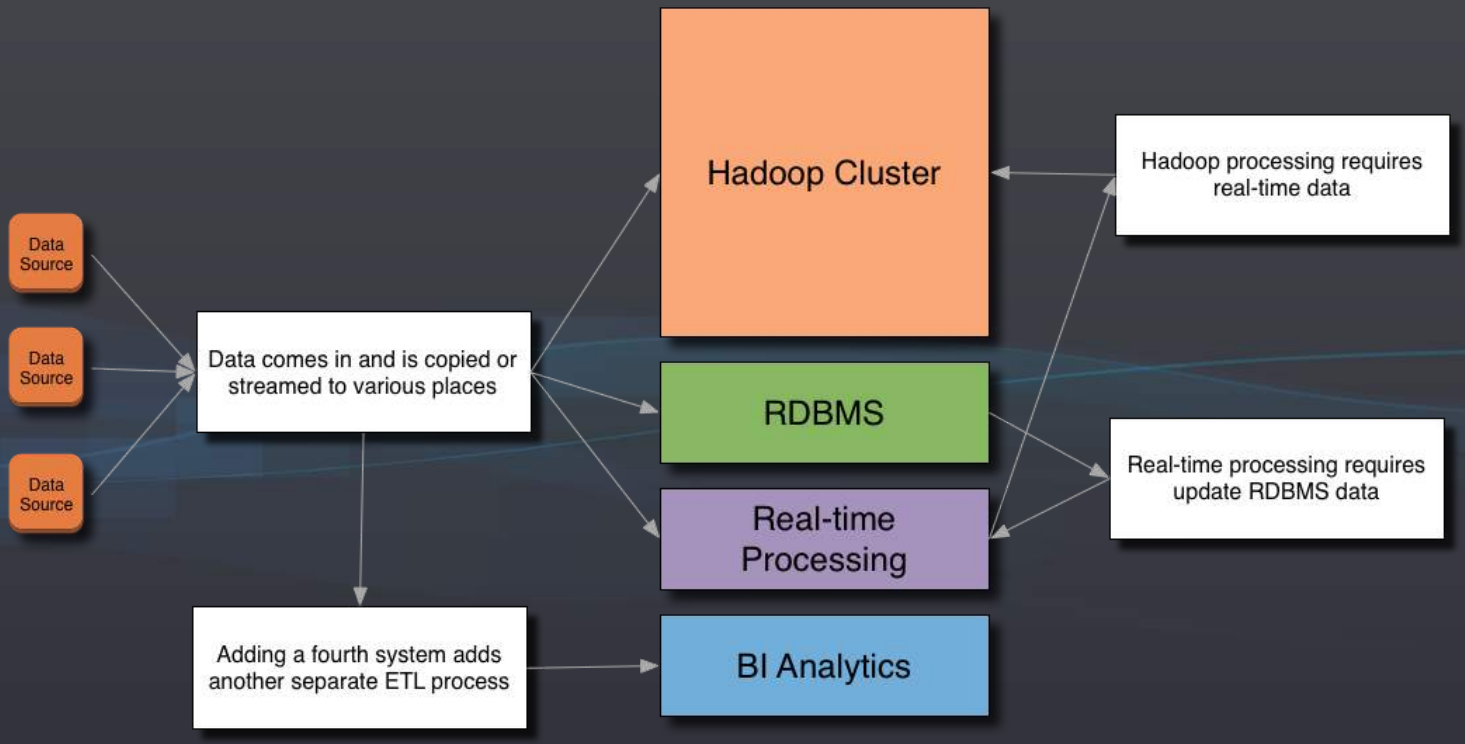
Many data pipelines grow over time

- New systems are added with data needs
- Each system has to do its own ETL

Each ETL and system starts to deviate

- Codebase
- Data





A publish subscribe pattern is used to decouple systems

Data is published or sent to another system

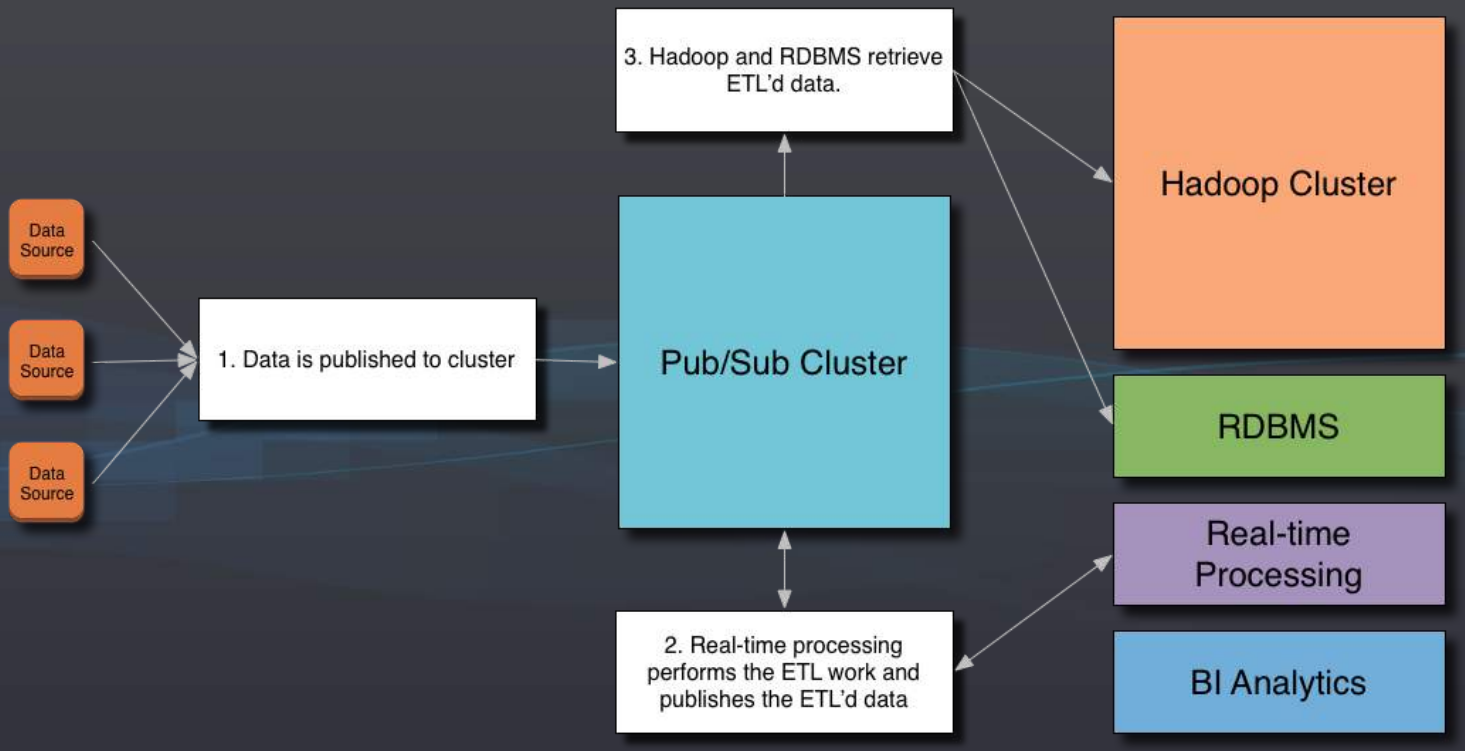
- Called a publisher

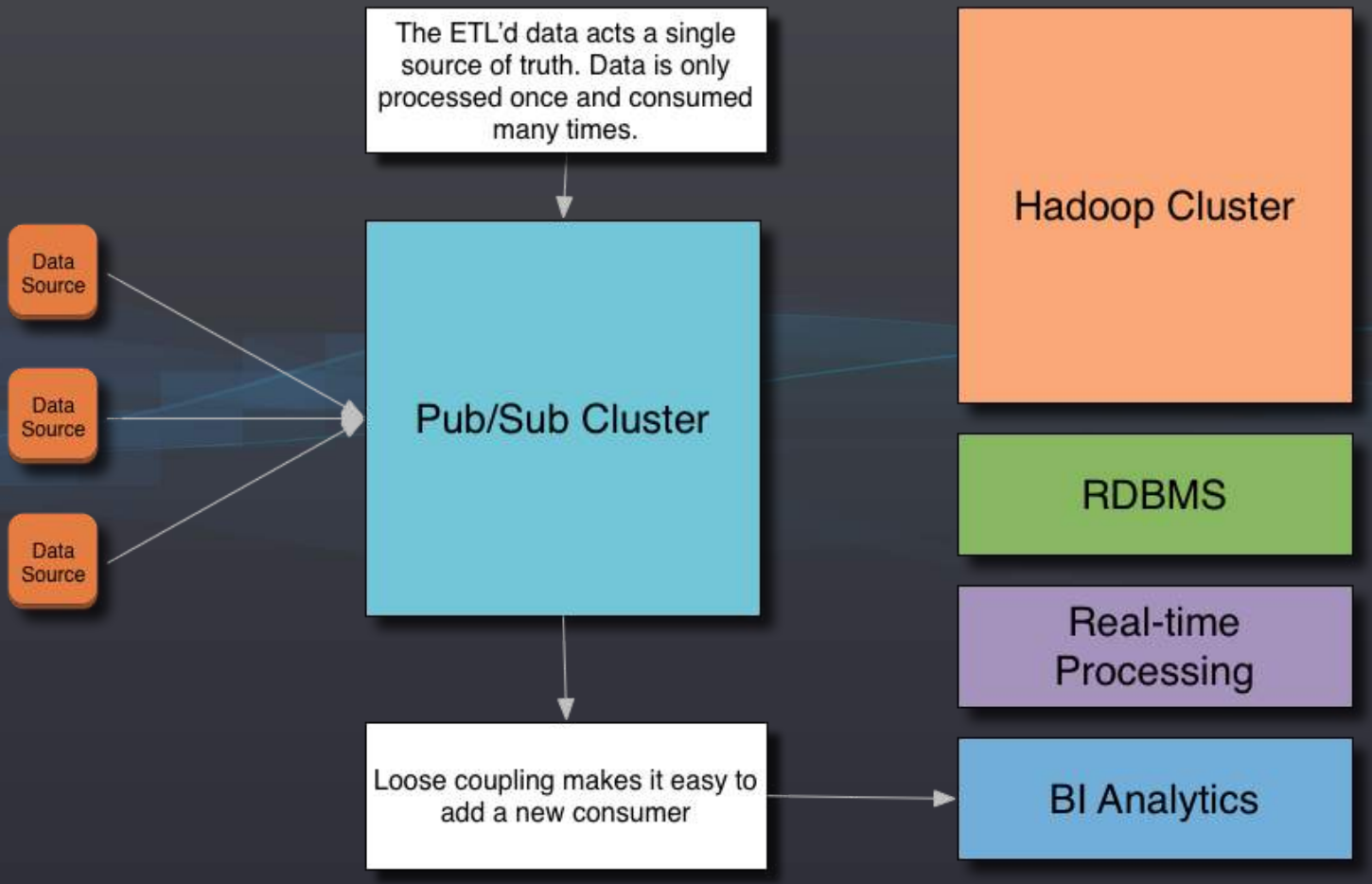
Data is consumed by another system

- Called a subscriber or consumer

The publisher and consumer don't know anything about each other

- They follow a contract about the data format





Kafka System

Kafka is a distributed publish subscribe system

It uses a commit log to track changes

Kafka was originally created at LinkedIn

- Open sourced in 2011
- Graduated to a top-level Apache project in 2012

Many Big Data projects are open source implementations of closed source products

- Unlike Hadoop, HBase or Cassandra, Kafka actually isn't a clone of an existing closed source product

The same codebase being used for years at LinkedIn answers the questions:

- Does it scale?
- Is it fast?
- Is it robust?
- Is it production ready?

Kafka supports the traditional publish/subscribe features

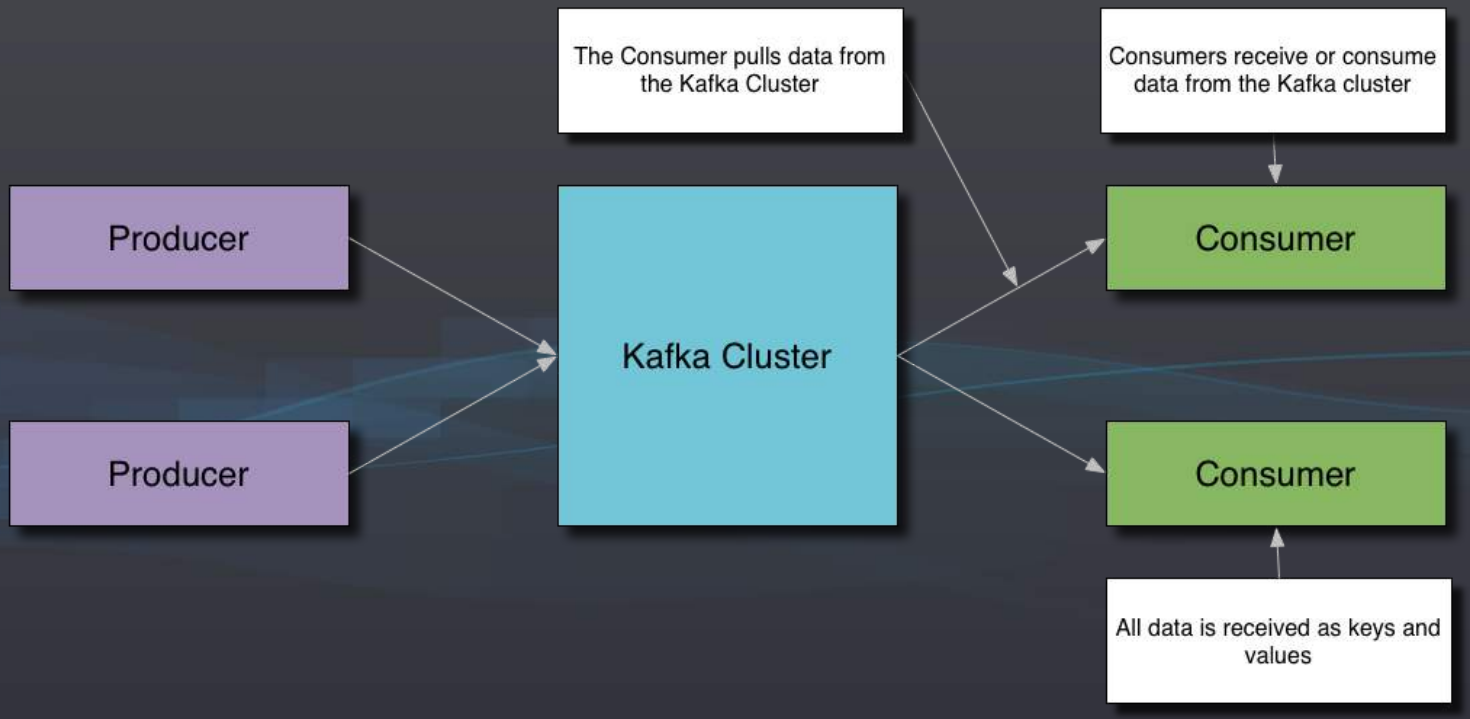
It has other features aimed at Big Data

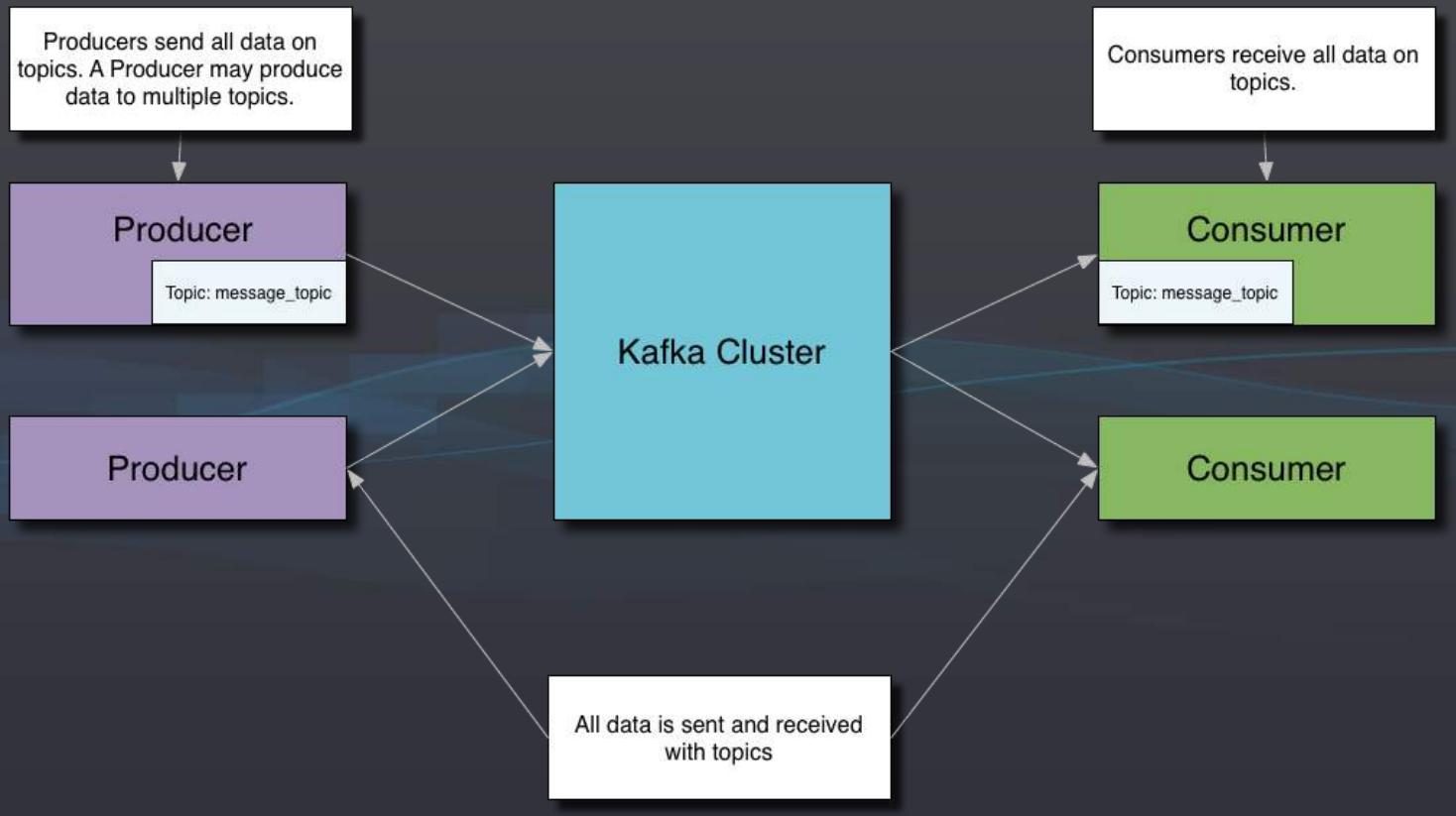
- Kafka scales by partitioning the data
- Failovers are automated
- Data can be consumed in batch and real-time

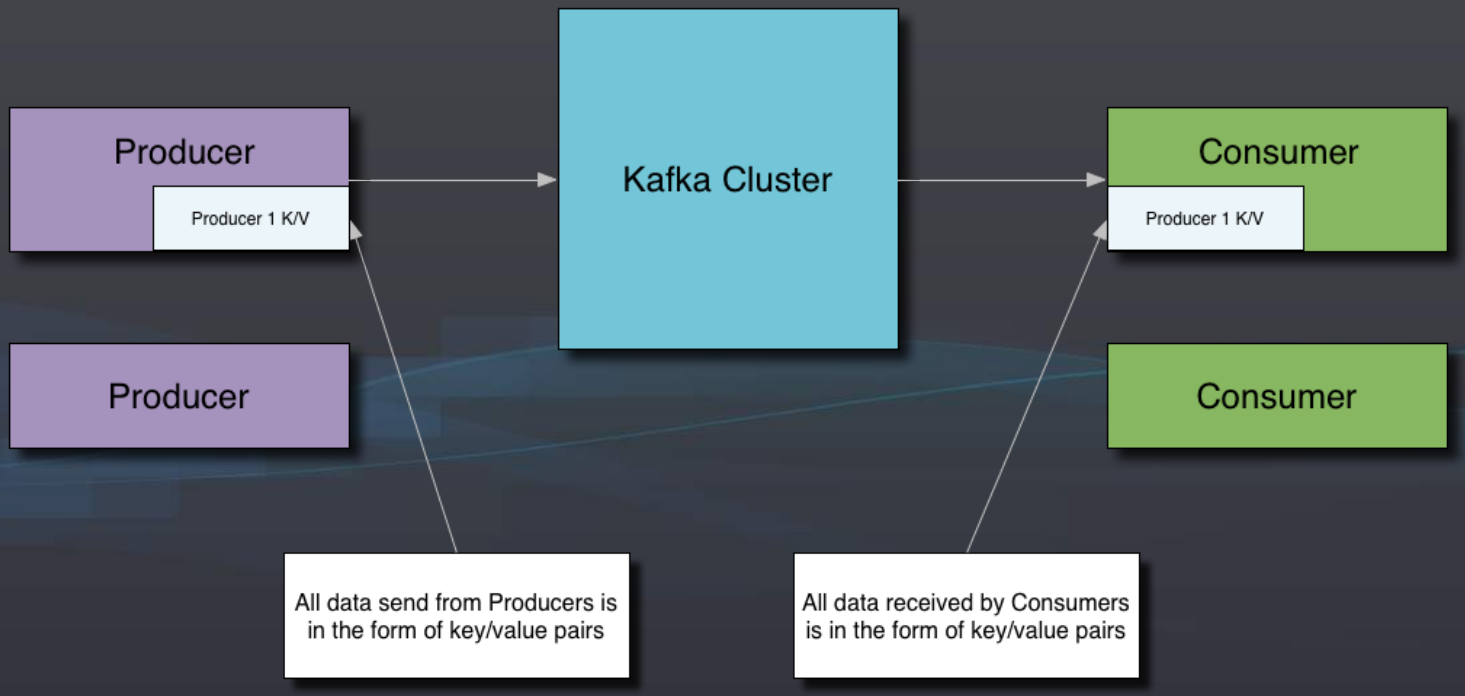
We will now demonstrate how Kafka works with Legos

Concepts shown:

- Publish/Subscribe
- Topics
- Partitioning
- Commit Logs
- Log compaction







Keys and values in Kafka can be Strings or byte arrays

Avro is a serialization format used extensively with Kafka and Big Data

- Avro can be serialized to byte arrays

Kafka uses a Schema Registry to keep track of Avro schemas

- Verifies that the correct schemas are being used
- Publisher and consumers need to use compatible versions of the schema

Kafka can be accessed pragmatically using various technologies and languages

The primary, real-time access is via the Java API

The REST interface allows access from many languages and programs

There are several interfaces for bringing data into Hadoop

- Camus is a project for offloading Kafka data into Hadoop

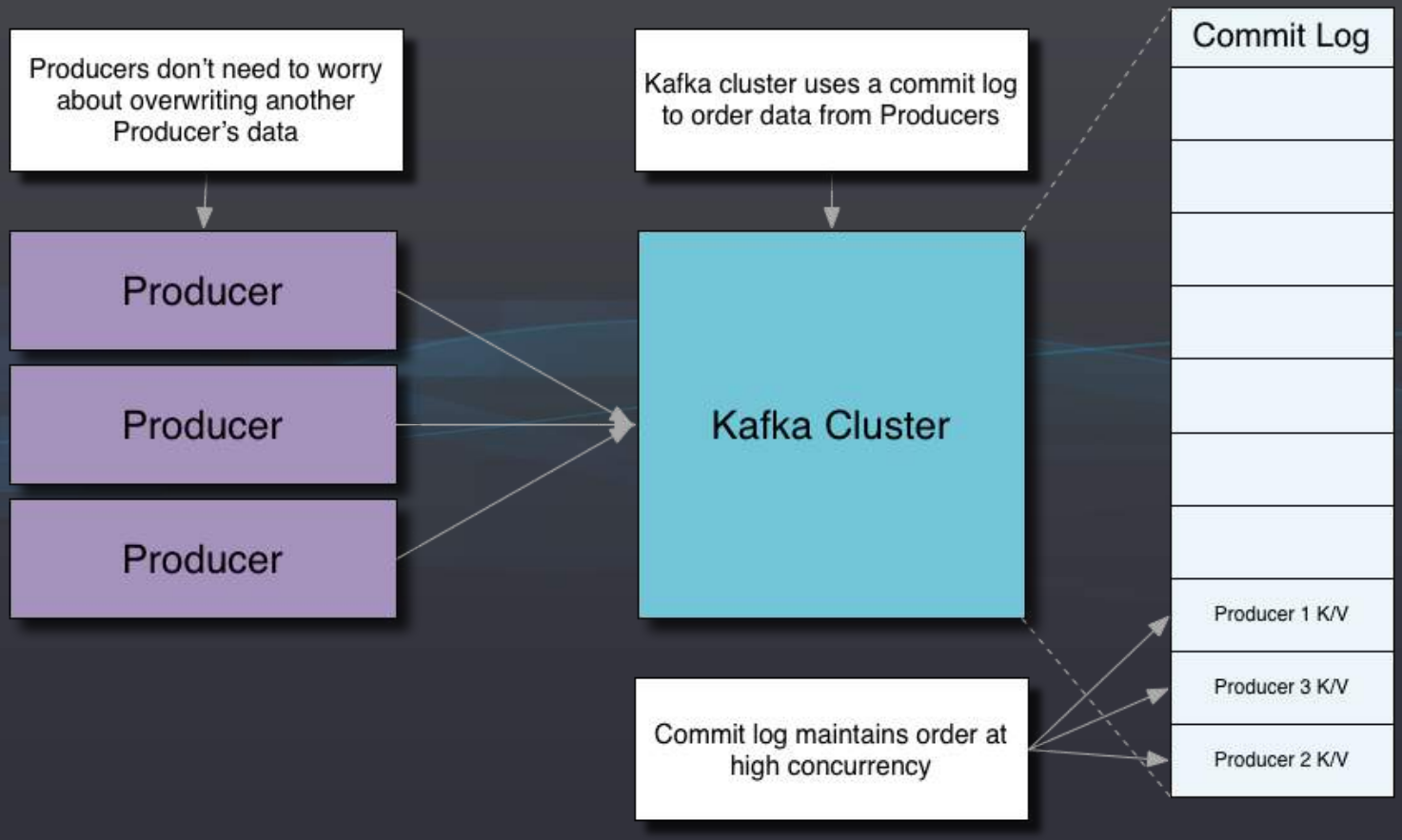
Commit Logs

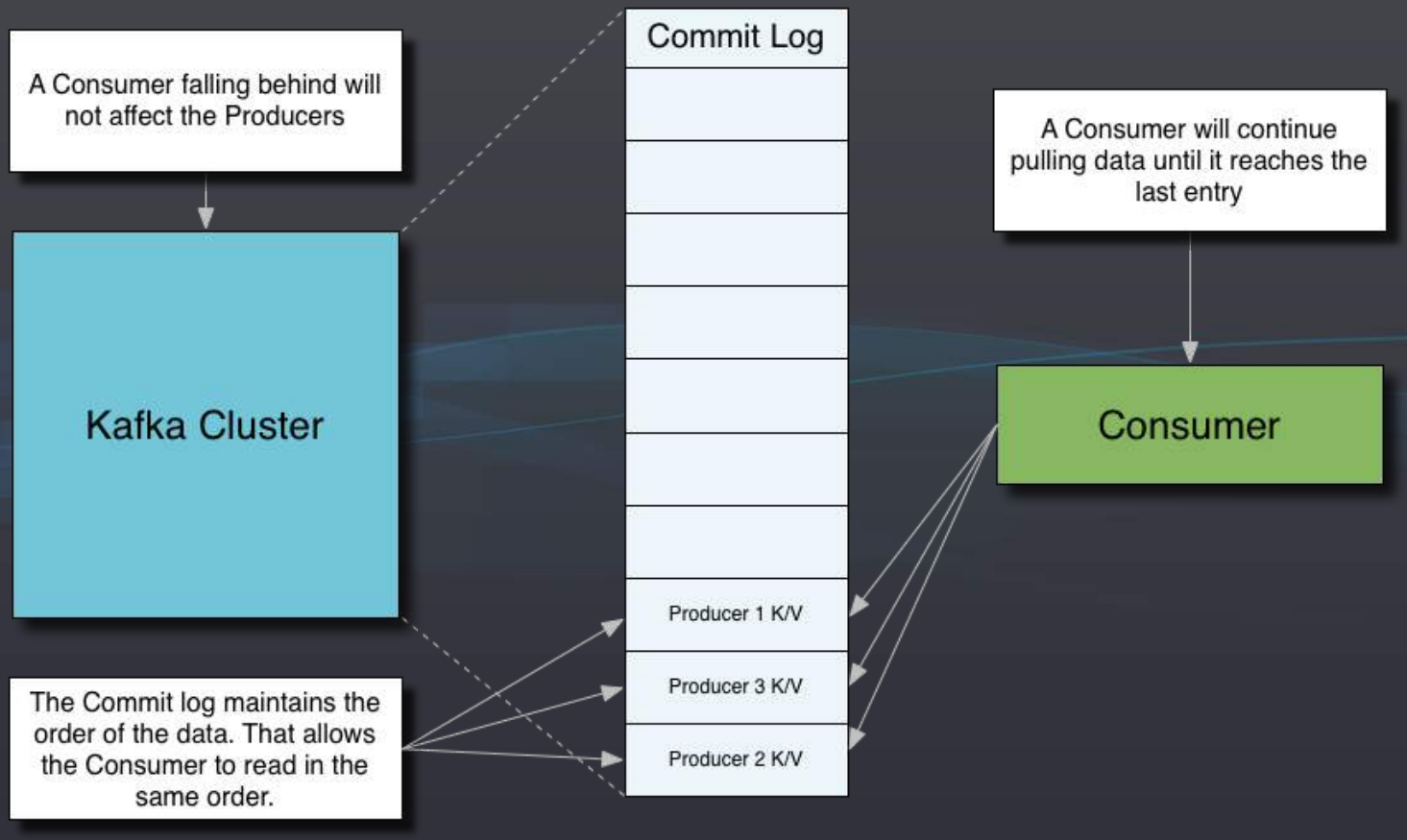
Commit logs are a way to keep track of changes as they happen

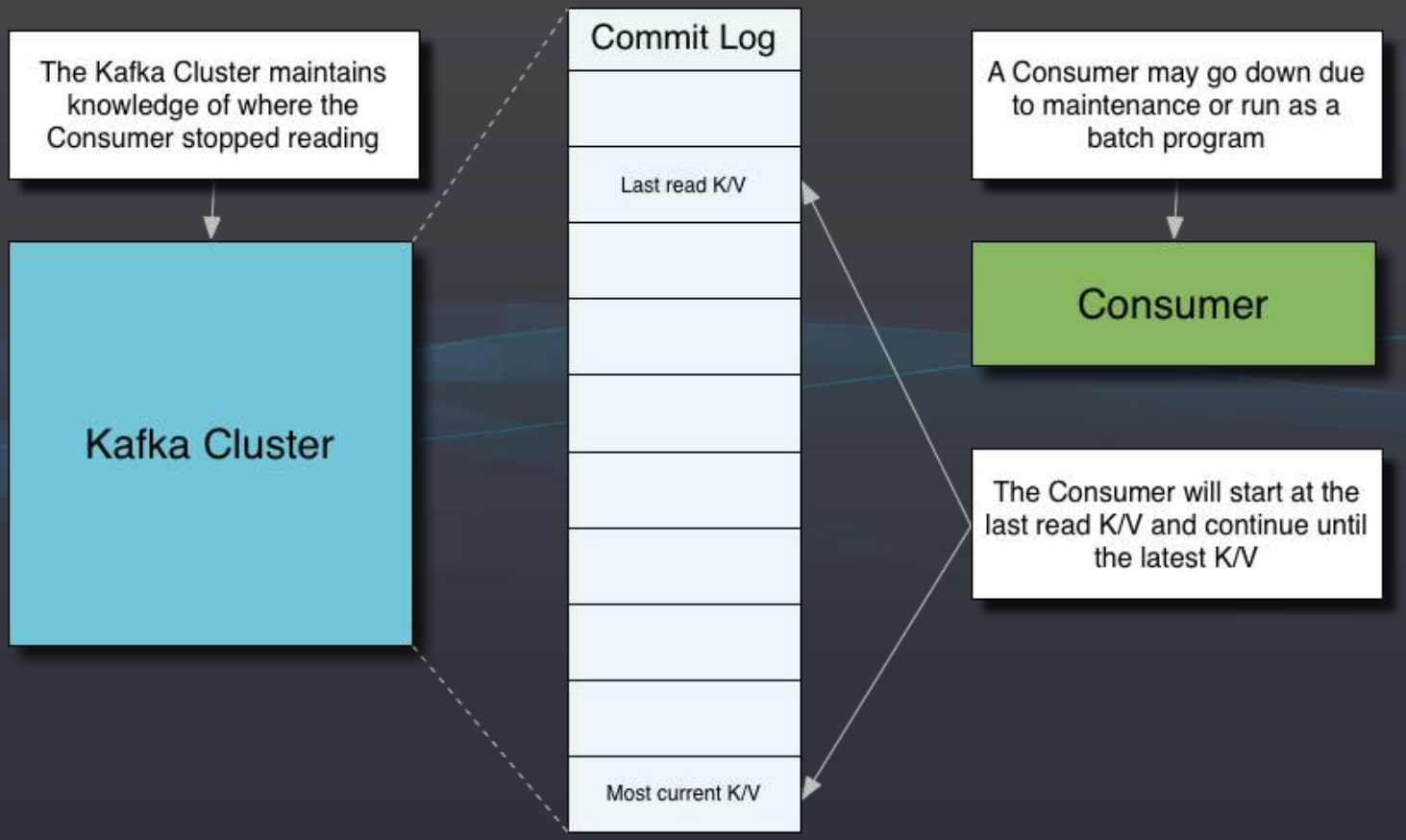
They are commonly used with databases to keep track of changes

Kafka uses commit logs to keep track of changes for a topic

Consumers can use the commit logs to retrieve previous data

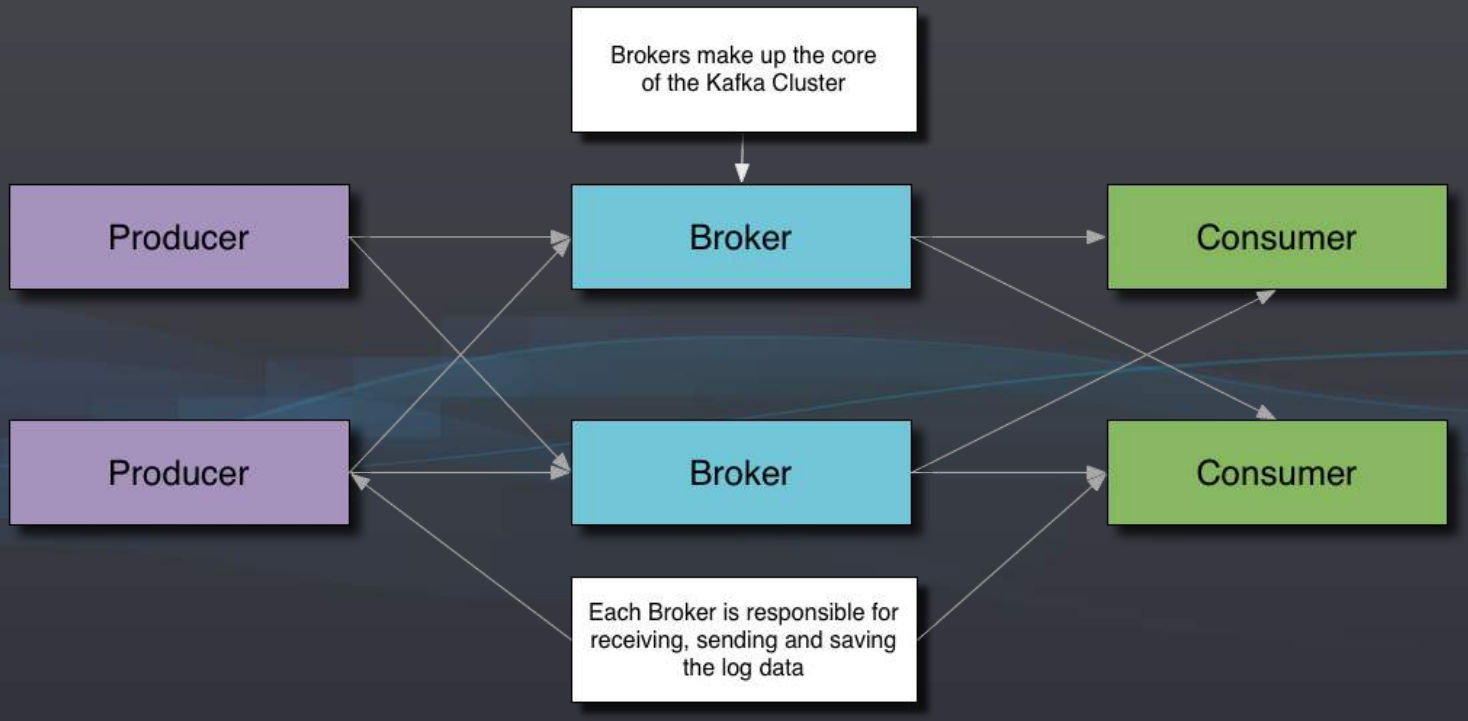


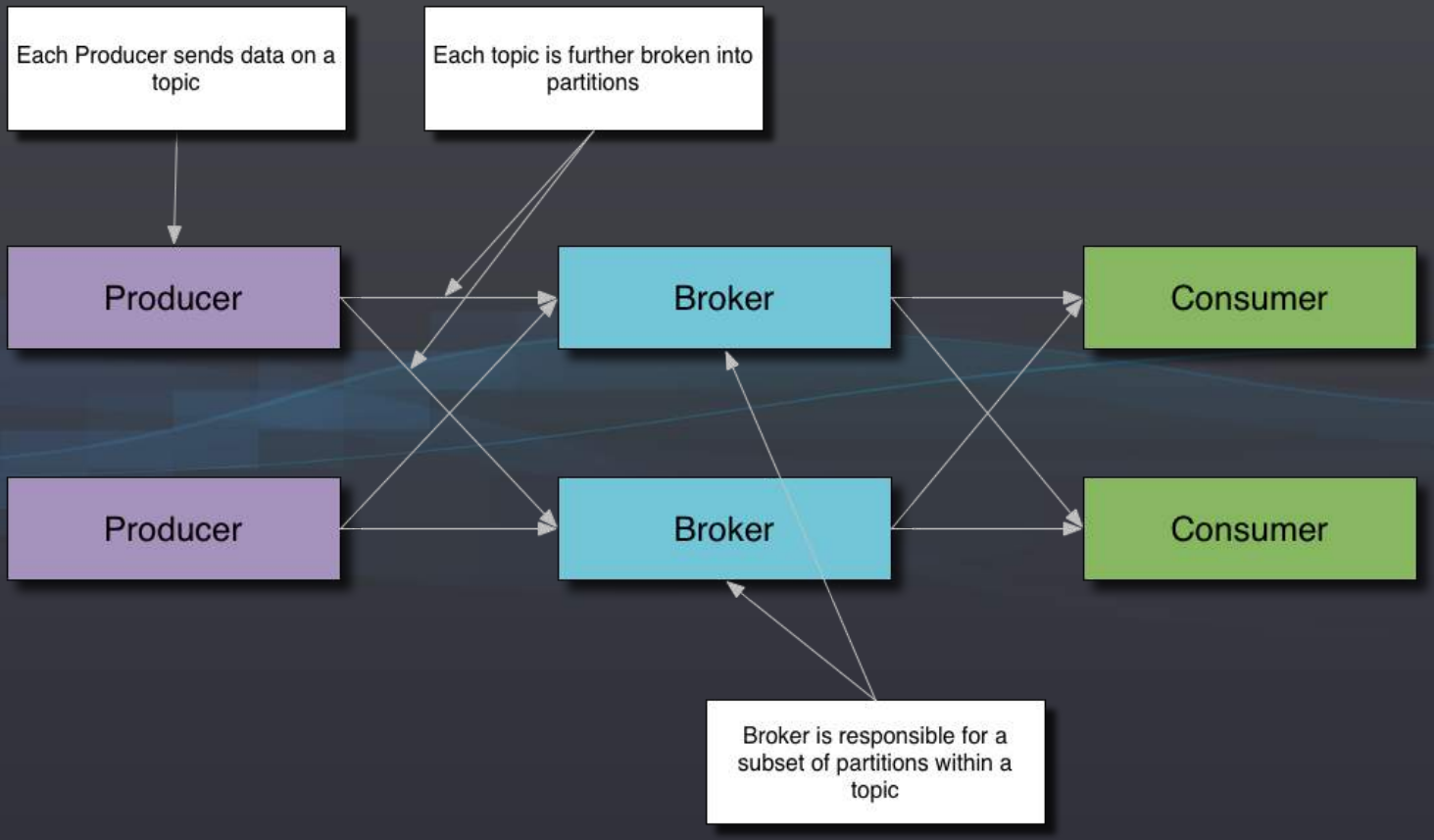


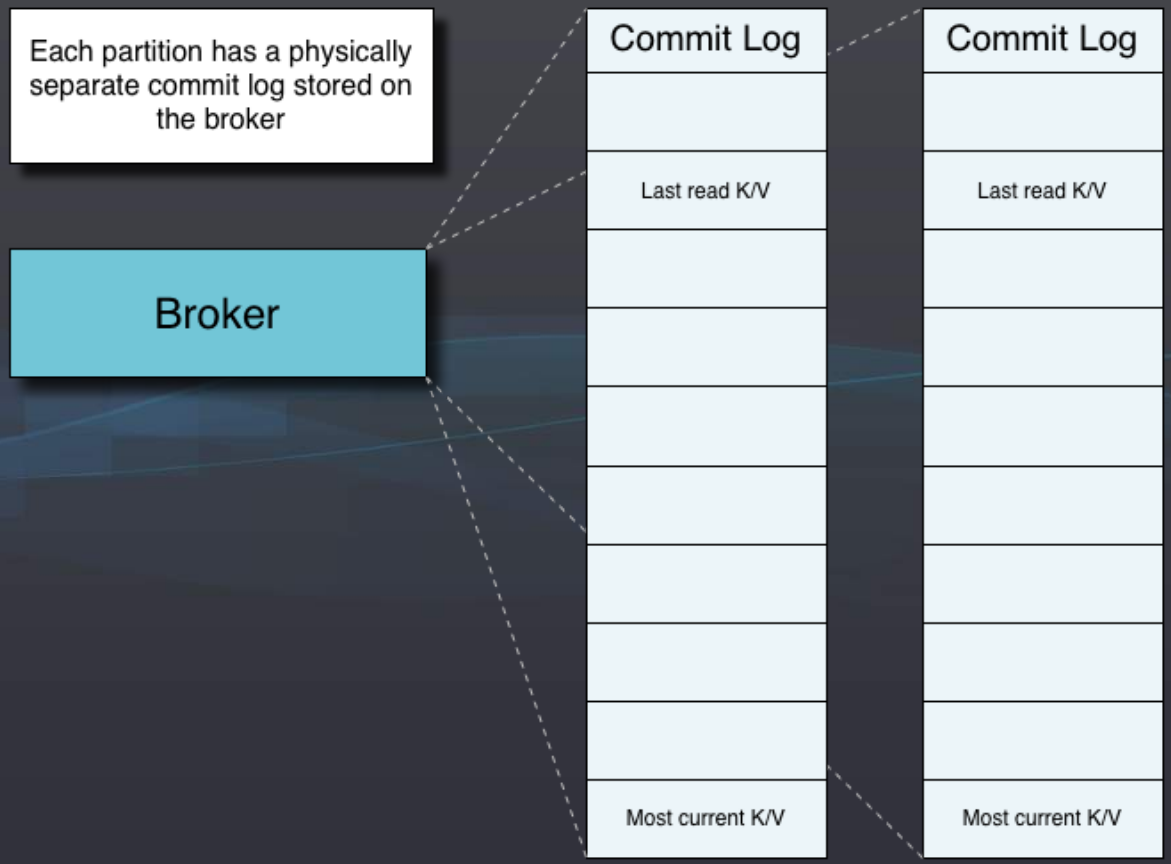


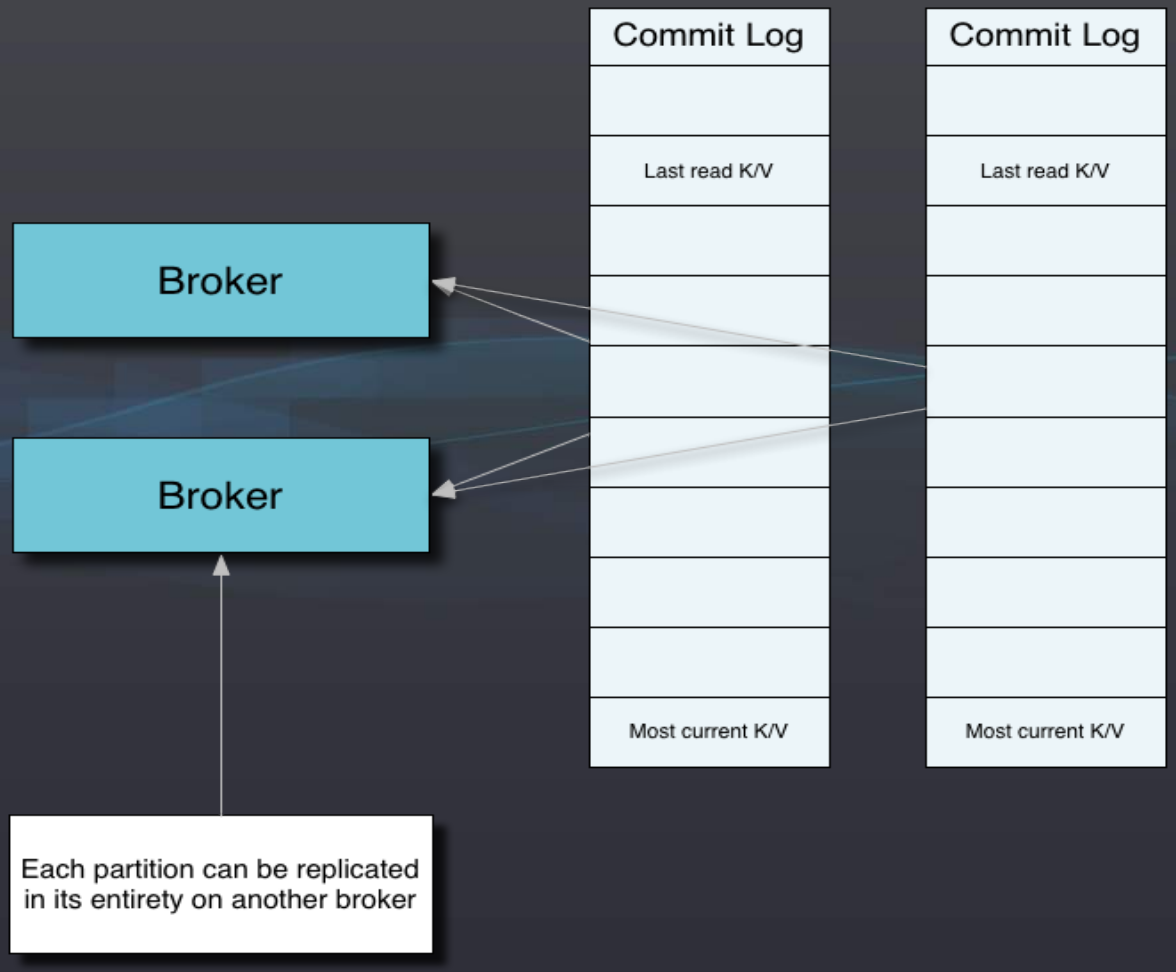
Kafka Architecture

Term	Definition
Producer	A program that sends messages to Kafka
Topic	A way to group similar messages
Key/Value Pair	The form a message takes
Consumer	A program that pulls messages from Kafka
Consumer Group	A group of Consumers that allows for scaling and high availability
Offset	A logical identifier of a message within a partition
Broker	The daemon responsible for sending, receiving and saving data
ZooKeeper	A system for distributed coordination and service discovery
Partition	A smaller unit of a topic
Replica	Saving a partition's data on more than one node for durability







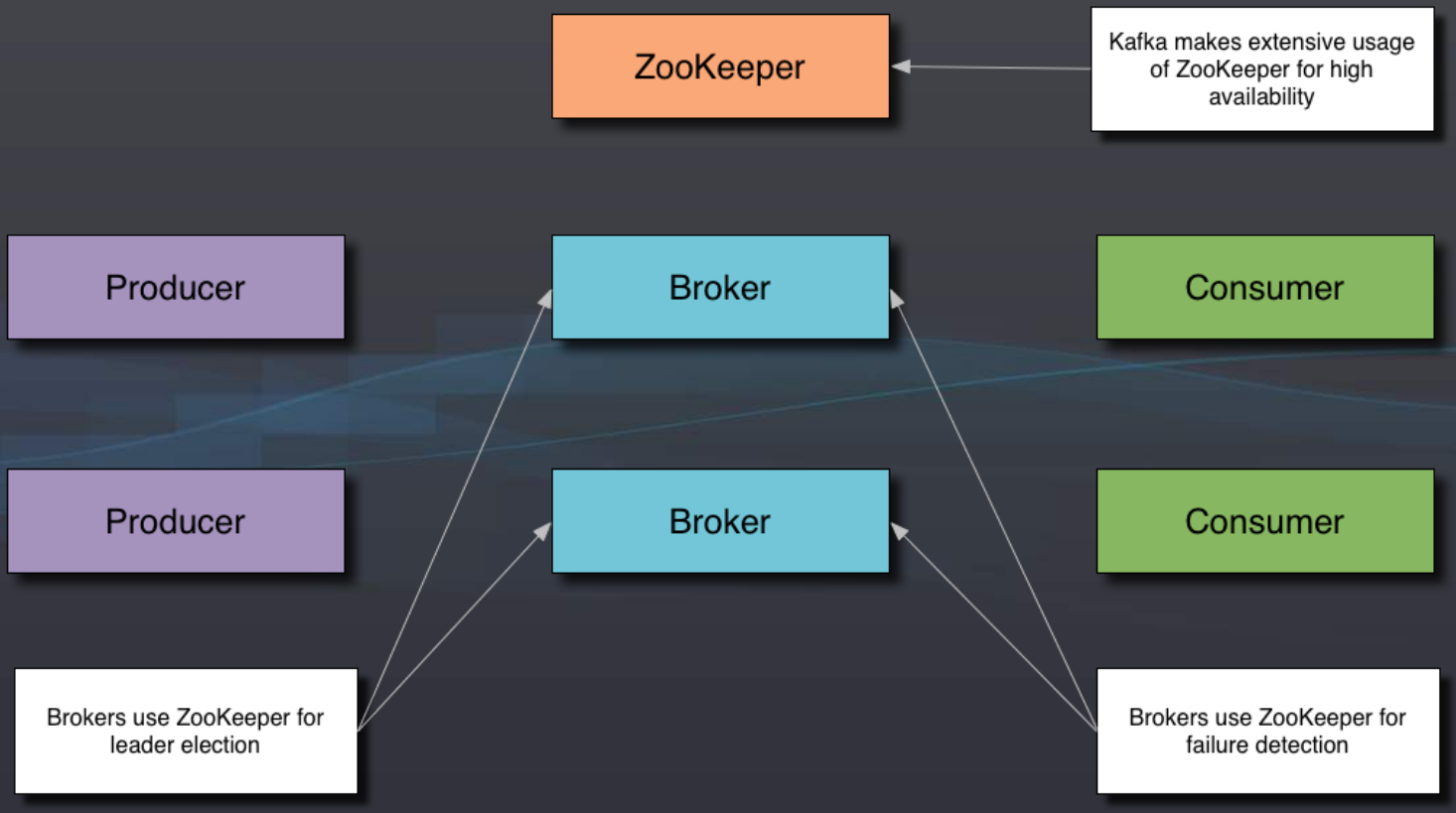


ZooKeeper is a system for distributed coordination and service discovery

- Is highly-available

ZooKeeper Features

- Distributed coordination
- Distributed queues
- Distributed locks
- Discovery service
- Leader election
- Watches can be placed



Kafka API

Kafka's Java API is the only first class citizen

The Java API abstracts out the communication and connections

- This allows you to focus on writing the code

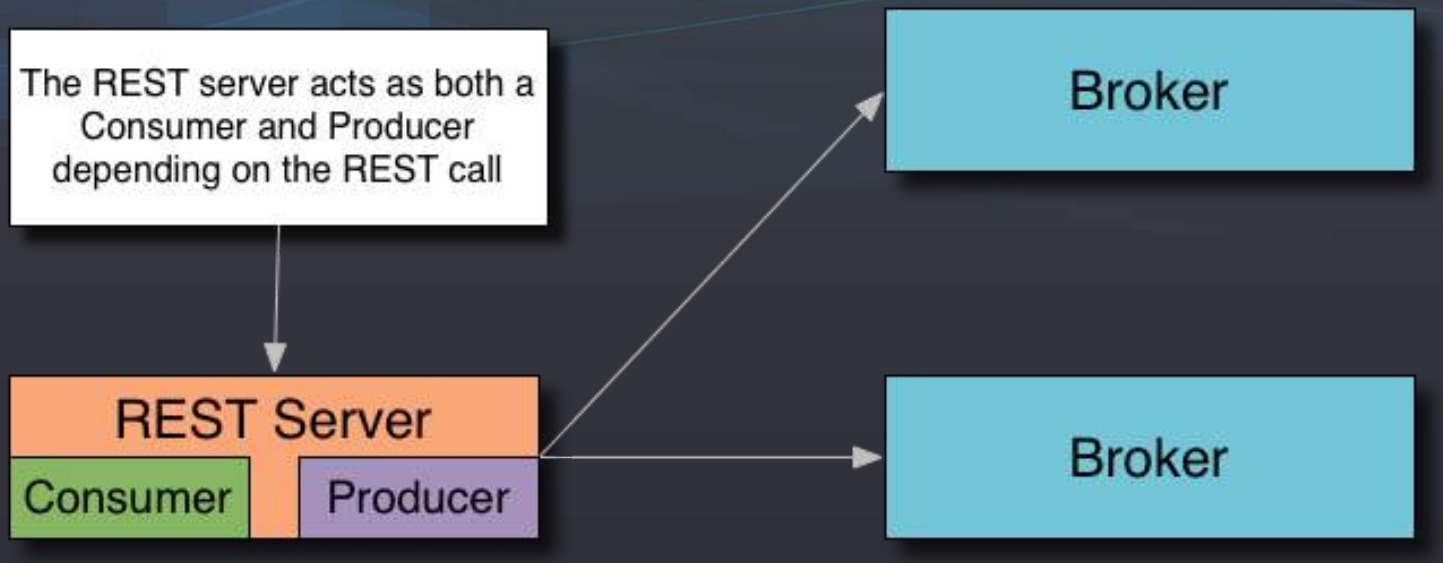
Data can be passed as `String`s or byte arrays

Programs need to configure where ZooKeeper and Brokers are running

REST is a way of using HTTP to perform actions

The REST calls are translated to Kafka calls

Allows many non-Java languages to access Kafka



Other ecosystem Kafka clients exist

- These projects are not currently supported by Confluent

They often implement Kafka's line protocol

Your mileage may vary using these projects

- Project may not implement the latest protocol

These projects give native language bindings for Kafka

The Java API uses the `KafkaProducer` object

- Uses a `ProducerRecord` for the key and value

The REST API uses a `POST` to the `topics` URL

- Uses a base64 encoded JSON call for the key and value

The package names will be inconsistent

```
import org.apache.kafka.clients.producer.KafkaProducer;
import org.apache.kafka.clients.producer.ProducerRecord;
```

```
Properties props = new Properties();
// Configure brokers to connect to
props.put("bootstrap.servers", "broker1:9092");
// Configure serializer classes
props.put("key.serializer",
          "org.apache.kafka.common.serialization.StringSerializer");
props.put("value.serializer",
          "org.apache.kafka.common.serialization.StringSerializer");

KafkaProducer<String, String> producer = new
KafkaProducer<String, String>(
    props);

// Create ProducerRecord and send it
String key = "mykey";
String value = "myvalue";
ProducerRecord<String, String> record = new
ProducerRecord<String, String>(
    "my_topic", key, value);
producer.send(record);

producer.close();
```

```
#!/usr/bin/python

import requests
import base64
import json

url = "http://kafkarest1:8082/topics/my_topic"

headers = {
  "Content-Type" : "application/vnd.kafka.binary.v1+json"
    }

# Output messages
payload = {"records":
  [{
    "key":base64.b64encode("firstkey"),
    "value":base64.b64encode("firstvalue")
  }]}

# Send the message
r = requests.post(url, data=json.dumps(payload), headers=headers)

if r.status_code != 200:
  print "Status Code: " + str(r.status_code)
  print r.text
```

The Java API uses the `ConsumerConnector` object

- Uses a `KafkaStream` and `ConsumerIterator` for the key and value

The REST API uses a `GET` to the `topics` URL

- Gets a base64 encoded JSON for the key and value
- The keys and values must be base64 decoded

The package names will be inconsistent

```
import kafka.consumer.Consumer;
import kafka.consumer.ConsumerConfig;
import kafka.consumer.ConsumerIterator;
import kafka.consumer.KafkaStream;
import kafka.javaapi.consumer.ConsumerConnector;
import kafka.message.MessageAndMetadata;
```

```
String topic = "my_topic";

Properties props = new Properties();
// Configure ZooKeeper location
props.put("zookeeper.connect", "zookeeper1");
// Configure consumer group
props.put("group.id", "group1");

// Use the configuration to create the ConsumerConnector
ConsumerConfig consumerConfig = new ConsumerConfig(props);

// Create ConsumerConnector with createJavaConsumerConnector
ConsumerConnector consumerConnector = Consumer
                                      .createJavaConsumerConnector(consumerConfig);
```

```java
// Create a map of topics we are interested in with the number of
// streams (usually threads) to service the topic
Map<String, Integer> topicCountMap = new HashMap<String, Integer>();
topicCountMap.put(topic, 1);

// Get the list of streams and configure it to use Strings
Map<String, List<KafkaStream<String, String>>> consumerMap =
    consumerConnector
    .createMessageStreams(topicCountMap, new StringDecoder(null),
                          new StringDecoder(null));

// Get the stream for the topic we want to consume
KafkaStream<String, String> stream = consumerMap.get(topic).get(0);

// Iterate through all of the messages in the stream
ConsumerIterator<String, String> it = stream.iterator();

// Note this should done with threads as this is a blocking call
while (it.hasNext()) {
    MessageAndMetadata<String, String> messageAndMetadata = it.next();

    String key = messageAndMetadata.key();
    String value = messageAndMetadata.message();

    // Do something with message
}
```

```
#!/usr/bin/python

import requests
import base64
import json
import sys

# Base URL for interacting with REST server
baseurl = "http://kafkarest1:8082/consumers/group1"

# Create the consumer instance
print "Creating consumer instance"

payload = {
  "format": "binary"
  }

headers = {
"Content-Type" : "application/vnd.kafka.v1+json"
  }

r = requests.post(baseurl, data=json.dumps(payload), headers=headers)

if r.status_code != 200:
  print "Status Code: " + str(r.status_code)
  print r.text
  sys.exit("Error thrown while creating consumer")

# Base URI is used to identify the consumer instance
base_uri = r.json()["base_uri"]
```

```
# Get the message(s) from the consumer
headers = {
  "Accept" : "application/vnd.kafka.binary.v1+json"
    }

# Request messages for the instance on the topic
r = requests.get(base_uri + "/topics/my_topic", headers=headers, timeout=20)

if r.status_code != 200:
  print "Status Code: " + str(r.status_code)
  print r.text
  sys.exit("Error thrown while getting message")

# Output all messages
for message in r.json():
  if message["key"] is not None:
    print "Message Key:" + base64.b64decode(message["key"])

  print "Message Value:" + base64.b64decode(message["value"])

# Delete the consumer now that we've sent the messages
headers = {
  "Accept" : "application/vnd.kafka.v1+json"
    }

r = requests.delete(base_uri, headers=headers)

if r.status_code != 204:
  print "Status Code: " + str(r.status_code)
  print r.text
```

Data is sent to the Broker responsible for handling that data

Choosing the Broker is based on the key

- When there is no key, data is sent round robin

Programs can choose the partition to send to:

```
KafkaProducer<String, String> producer = new
KafkaProducer<String, String>(
    props);

// Get the list of partitions to decide which one to send to
List<PartitionInfo> partitionsList =
    producer.partitionsFor("my_topic");

String key = "mykey";
String value = "myvalue";
// Add the partition number when creating the ProducerRecord
ProducerRecord<String, String> record = new
ProducerRecord<String, String>(
    "my_topic", 0, key, value);
```

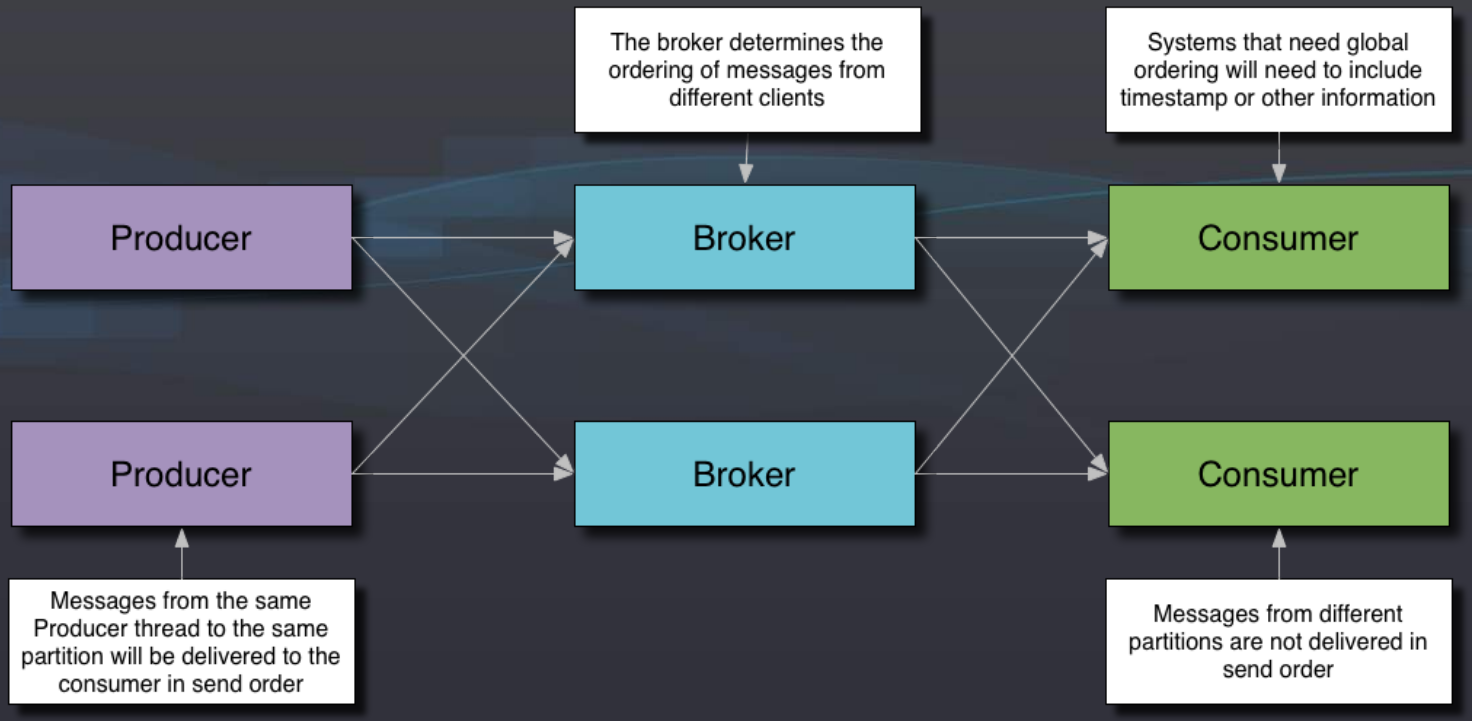
Topics are automatically created when a message is sent to them

The topic is created with all defaults

- Data is only stored on one Broker

To create a topic with configuration:

```
$ kafka-topics --zookeeper zk_host:port/chroot --create \
--topic my_topic_name --partitions 20 --replication-factor 3
```



```
ProducerRecord<String, String> record = new
    ProducerRecord<String, String>(
    "my_topic", key, value);

producer.send(record, new CustomCallback(record));
```

```
class CustomCallback implements Callback {
    ProducerRecord<String, String> record;

    public CustomCallback(ProducerRecord<String, String> record) {
        super();
        this.record = record;
    }

    @Override
    public void onCompletion(RecordMetadata metadata,
                             Exception exception) {
        if (exception != null) {
            // There was an error sending the ProducerRecord
            exception.printStackTrace();

            // Handle exception in some way
            System.out.println("Error sending message:" + record.value());
        } else {
            // The send was successful
            System.out.println("Record offset: " + metadata.offset());
        }
    }
}
```

In this exercise you will use the Kafka command line utilities

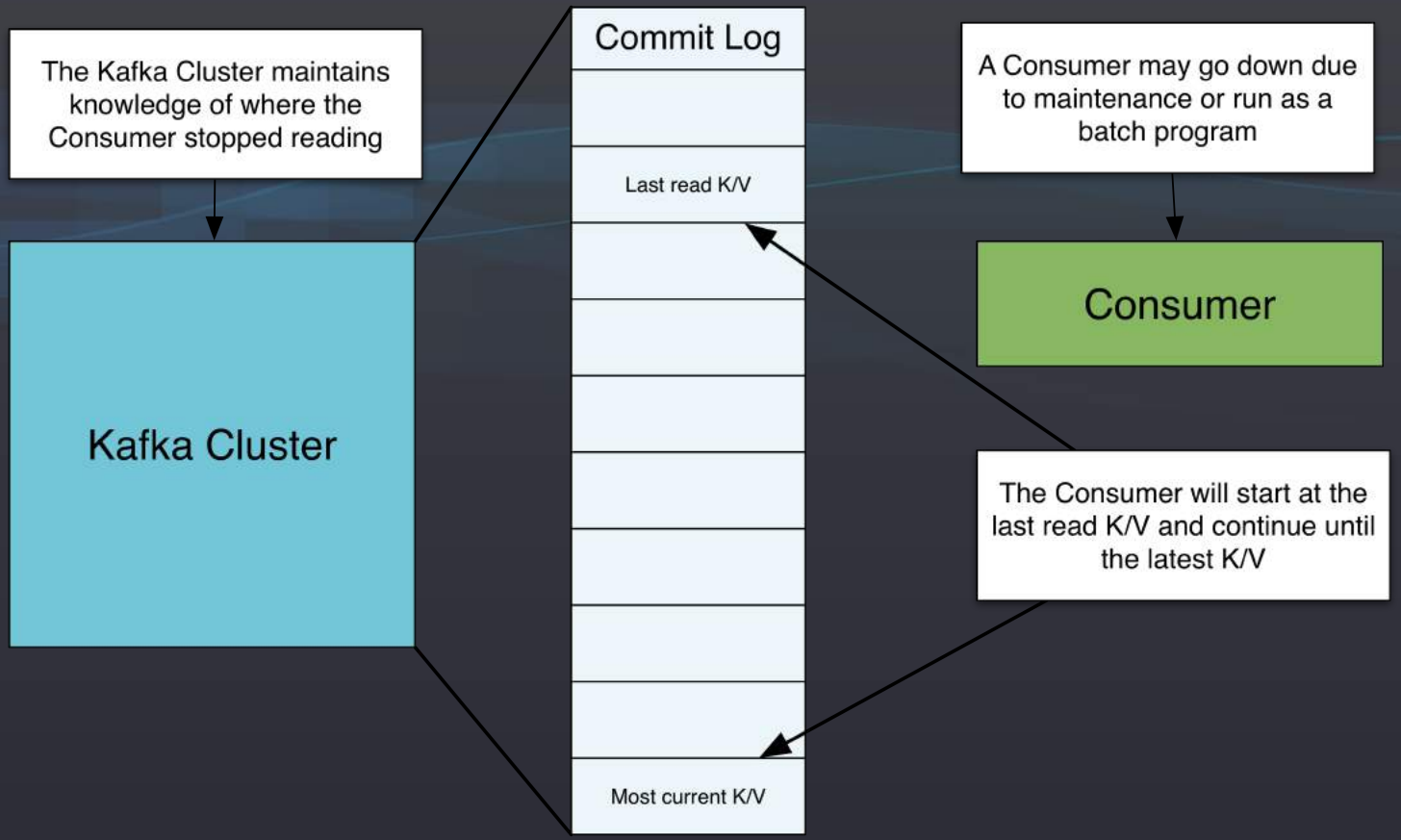
Time: 15 minutes

In this exercise you will write a Hello World program with the Kafka API

Time: 15 minutes

Advanced Consumers

Kafka is more than a simple Publish/Subscribe system



The API allows advanced Consumers to interact with the commit log

Offsets are committed via the API

- Offsets are committed automatically by default
- Offsets can be programmatically committed

Reading previous log data requires configuration changes in the API

```
Properties props = new Properties();
// Configure ZooKeeper location
props.put("zookeeper.connect", "zookeeper1");
// Configure consumer group
props.put("group.id", String.valueOf(new Random().nextInt()));
// Always start from beginning
props.put("auto.offset.reset", "smallest");
```

```
ConsumerIterator<String, String> it = stream.iterator();

// Note this should done with threads as this is a blocking call
while (it.hasNext()) {
    // Messages will arrive from the beginning of the log
}
```

```
payload = {
  "format": "binary",
  "auto.offset.reset": "smallest"
  }

headers = {
"Content-Type" : "application/vnd.kafka.v1+json"
  }

r = requests.post(baseurl, data=json.dumps(payload), headers=headers)

if r.status_code != 200:
  print "Status Code: " + str(r.status_code)
  print r.text
  sys.exit("Error thrown while creating consumer")
```

```
# Output all messages
for message in r.json():
  # Messages start from the beginning
```

By default, Consumers read from the end of the log

To specify, this configuration set `auto.offset.reset` to `largest`

```
Properties props = new Properties();
// Configure ZooKeeper location
props.put("zookeeper.connect", "zookeeper1");
// Configure consumer group
props.put("group.id", "manualcommitgroup");
// Always start from beginning
props.put("auto.offset.reset", "smallest");
// Manually/Programmatically commit offset
props.put("auto.commit.enable", "false");
// Configure to use Kafka for commits
props.put("offsets.storage", "kafka");
props.put("dual.commit.enabled", "false");
```

```
// Note this should done with threads as this is a blocking call
while (it.hasNext()) {
    // Do something with message

    if (shouldCommit()) {
        // Commit the offsets
        consumerConnector.commitOffsets();
    }
}
```

```
payload = {
  "format": "binary",
  "auto.offset.reset": "smallest",
  # Manually/Programmatically commit offset
  "auto.commit.enable": "false"
  }

headers = {
"Content-Type" : "application/vnd.kafka.v1+json"
  }

r = requests.post(baseurl, data=json.dumps(payload), headers=headers)
```

```
# Commit the offsets
if shouldCommit() == True:
  r = requests.post(base_uri + "/offsets", headers=headers, timeout=20)

  if r.status_code != 200:
    print "Status Code: " + str(r.status_code)
    print r.text
    sys.exit("Error thrown while committing")

  print "Committed"
```

The commit will use the offset of the last message sent in the JSON response

Kafka has another Consumer called the `SimpleConsumer`

This consumer allows more advanced ways of consuming a topic

- Allows you to read a message multiple times
- Consume only certain partitions
- Manage transactions to ensure a message is processed only once

You will need to handle more exceptions and offsets

Avro and Kafka

```
Properties props = new Properties();
// Configure brokers to connect to
props.put("bootstrap.servers", "broker1:9092");
// Configure serializer classes
props.put(ProducerConfig.KEY_SERIALIZER_CLASS_CONFIG,
          io.confluent.kafka.serializers.KafkaAvroSerializer.class);
props.put(ProducerConfig.VALUE_SERIALIZER_CLASS_CONFIG,
          io.confluent.kafka.serializers.KafkaAvroSerializer.class);
// Configure schema repository server
props.put("schema.registry.url", "http://schemaregistry1:8081");

// Create the producer expecting Avro objects
KafkaProducer<Object, Object> avroProducer = new
KafkaProducer<Object, Object>(
    props);

// Create the Avro objects for the key and value
CardSuit suit = new CardSuit("spades");
SimpleCard card = new SimpleCard("spades", "ace");

// Create the ProducerRecord with the Avro objects and send them
ProducerRecord<Object, Object> record = new
ProducerRecord<Object, Object>(
    "my_avro_topic", suit, card);

avroProducer.send(record);
```

```
# Read in the Avro files
key_schema = open("my_key.avsc", 'rU').read()
value_schema = open("my_value.avsc", 'rU').read()
```

```
producerurl = "http://kafkarest1:8082/topics/my_avro_topic"

headers = {
  "Content-Type" : "application/vnd.kafka.avro.v1+json"
}

payload = {
  "key_schema": key_schema,
  "value_schema": value_schema,
  "records":
  [{
    "key": {"suit": "spades"},
    "value": {"suit": "spades", "card": "ace"}
  }]}

# Send the message
r = requests.post(producerurl, data=json.dumps(payload), headers=headers)

if r.status_code != 200:
  print "Status Code: " + str(r.status_code)
  print r.text
```

```
// Initialize and configure the Kafka Avro objects
VerifiableProperties vProps = new VerifiableProperties(props);
KafkaAvroDecoder keyDecoder = new KafkaAvroDecoder(vProps);
KafkaAvroDecoder valueDecoder = new KafkaAvroDecoder(vProps);

Map<String, List<KafkaStream<Object, Object>>> consumerMap =
    consumerConnector
    .createMessageStreams(topicCountMap, keyDecoder, valueDecoder);

KafkaStream<Object, Object> stream = consumerMap.get(topic).get(0);
ConsumerIterator<Object, Object> it = stream.iterator();

while (it.hasNext()) {
    MessageAndMetadata<Object,Object> messageAndMetadata = it.next();

    // Kafka only gives back GenericRecords. This code converts the
    // GenericRecord to a SpecificRecord
    CardSuit suit = (CardSuit) SpecificData.get().deepCopy(
                        CardSuit.SCHEMA$,
                        messageAndMetadata.key());
    SimpleCard card = (SimpleCard) SpecificData.get().deepCopy(
                          SimpleCard.SCHEMA$, messageAndMetadata.message());

    // Do something with the Avro objects
}
```

```
# Get the message(s) from the consumer
headers = {
  "Accept" : "application/vnd.kafka.avro.v1+json"
    }

# Request messages for the instance on the topic
r = requests.get(base_uri + "/topics/my_avro_topic", headers=headers, timeout=20)

if r.status_code != 200:
  print "Status Code: " + str(r.status_code)
  print r.text
  sys.exit("Error thrown while getting message")

# Output all messages
for message in r.json():
  keysuit = message["key"]["suit"]

  valuesuit = message["value"]["suit"]
  valuecard = message["value"]["card"]

  # Do something with the data
```

Maintaining the same Avro schema across Producers and Consumers is important

- Avro schemas need a central place for storage

The Schema Registry allows Producers and Consumers to coordinate schema

- Allows newer schemas to be created and registered

The Schema Registry can be used to enforce Avro compatibility rules

- Updated Avro schemas will pass or fail based on the rules

Submitting the Avro schemas with each Producer request may be inefficient

A schema may be submitted once and use a schema ID after that

- The IDs are returned in the JSON reply
- The schema IDs are returned in the JSON reply as `key_schema_id` and `value_schema_id`

Conclusion

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