Apache Kafka from Scratch

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Data Infrastructure Streaming

Agenda

- Apache Zookeeper
- Apache Kafka
- Producing and Consuming Messages
- Kafka Clusters
- Use Cases for Kafka
- More Time? More Fun!

Schedule

- Tutorial, Part the First
  - 9:00 AM to 10:30 AM
- Break
  - 10:30 AM to 11:00 AM
- Tutorial, the Thrilling Conclusion
  - 11:00 AM to 12:30 PM

Before We Start

- Make sure you have Java 8 installed
  - Java 7 will work for now
  - Java 6 may be OK, but I won't guarantee it
- Also make sure you have the JAVA_HOME environment variable set properly in your .profile (or local variant)
- You will not need root privileges
  - We'll be using your home directory, and high numbered TCP ports

Who Do You Think You Are?

- Staff Site Reliability Engineer for Kafka at LinkedIn

- LinkedIn pushes a lot of data around
  - Over 1 trillion messages a day written to Kafka
  - Approaching 1 petabyte a day read out of Kafka

- We run a lot of Kafka
  - Over 75 clusters, in 10 different fabrics
  - Over 1300 Kafka brokers, each with at least 6.5 TB of useable storage

Apache Zookeeper

Apache Zookeeper

- Distributed coordination service

- What does it have?
  - Hierarchical Namespace
  - Ordered Transactions
  - Ephemeral Nodes
  - Watches

What is Zookeeper NOT?

- Queue
  - Yes, some people say you can do this
  - Not tuned for this kind of use, and it can overwhelm ZK
- Logging Service
  - Sequential nodes are provided as part of Zookeeper
  - Storing large amounts of data is not recommended
- Large Data Store
  - Zookeeper nodes have a size limit (default 1 MB)

Installing Zookeeper

- Unpack the zookeeper-3.4.6.tar.gz distribution
- Create a configuration file:

```
# cat > zookeeper-3.4.6/conf/zoo.cfg << EOF
> tickTime=2000
> dataDir=/tmp/zookeeper
> clientPort=2181
> EOF
```

- Create the /tmp/zookeeper directory
- Start Zookeeper:

```
zookeeper-3.4.6/bin/zkServer.sh start
```

Four Letter Words

- Zookeeper has basic admin functions on the port it is listening to
  - The commands are called “four letter words”

- Connect to port 2181 on localhost and try the following commands:
  - ruok
  - srvr
  - mntr
  - conf
  - cons

Zookeeper CLI

- Zookeeper ships with a basic CLI tool for viewing and modifying data
- Run it with the following command:

```
# zookeeper-3.4.6/bin/zkCli.sh -server localhost:2181
```

- Through this interface you can inspect the Zookeeper data
- You can also create, modify, and delete data
  - This means you can cause a massive amount of damage

Playing with Zookeeper

- Create a new node in the CLI:

```
[zk: localhost:2181(CONNECTED) 0] create /foo bar
```

- Get the information about that node:

```
[zk: localhost:2181(CONNECTED) 1] get /foo
```

- Update the data in that node:

```
[zk: localhost:2181(CONNECTED) 2] set /foo baz
[zk: localhost:2181(CONNECTED) 3] get /foo
```

- Delete the node:

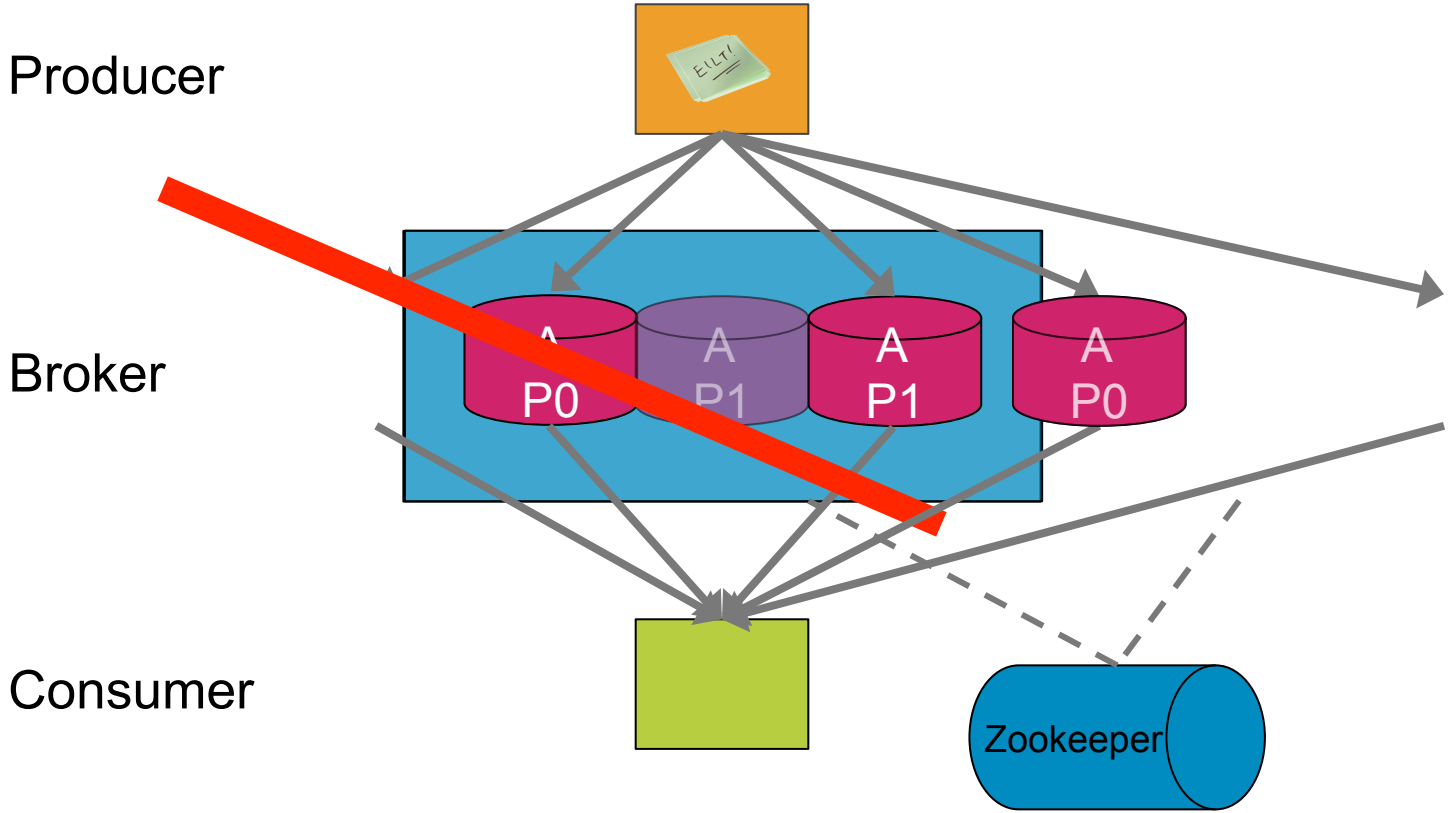
```
[zk: localhost:2181(CONNECTED) 4] delete /foo
```

More About Zookeeper

- Zookeeper has more functionality than the basic CRUD operations
  - Watches
  - ACLs
  - rmr
- For getting started with Kafka, this is all we need to know
- Once you have Zookeeper running, you will want to use it for other things
  - Be smart: not everything is a nail to hit with your hammer

Apache Kafka

Kafka Pub/Sub Basics

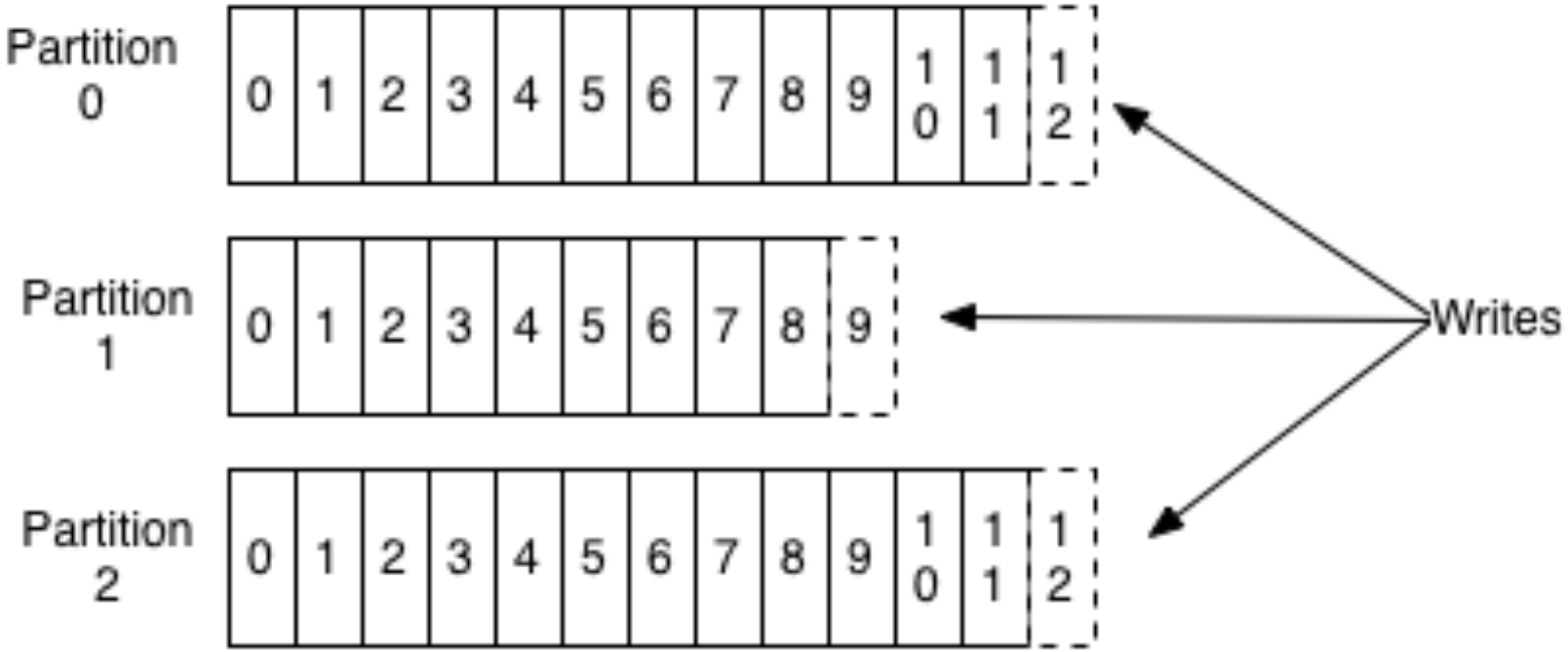


What Is Kafka?

- Publish / Subscribe messaging platform
  - Implemented as a distributed commit log

- Features
  - Disk Based
  - Durable
  - Scalable
  - Low Latency
  - Finite Retention

Distributed Commit Log



Installing Kafka

- Unpack the kafka_2.11-0.8.2.2.tgz distribution
- Create the /tmp/kafka-logs directory
- Start Kafka

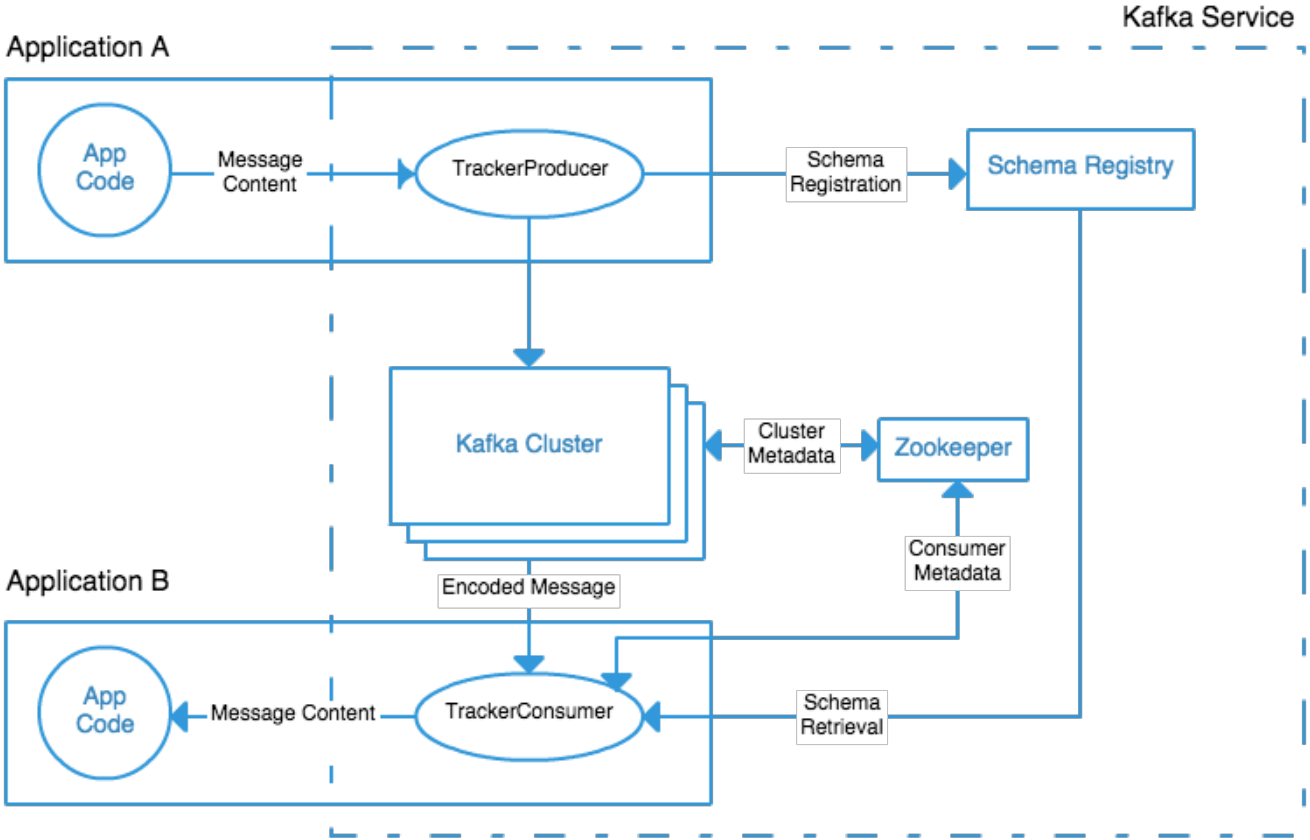
```
kafka_2.11-0.8.2.2/bin/kafka-server-start.sh –daemon
/usr/local/kafka/config/server.properties
```

Producing and Consuming

Message Schemas

- Why enforce schemas?
  - Documentation for message formats
  - Decouple consumers from producers
- Types of schemas
  - JSON
  - Protobuf
  - Avro
- Centralized Registry
  - Not part of Kafka, but a good idea

Kafka with Schema Registry



Console Producer

- Simple CLI producer provided with Kafka

- Important options
  - --broker-list – semicolon separated list of host:port pairs
  - --compress – enable compression of messages
  - --request-required-acks – Set to 1 to wait for acknowledgement of receipt
  - --topic – Where to send your message

- More options exist to facilitate batching, serialization

Explicitly Creating a Topic

- Example assumes you have started Kafka on the default port of 9092, and your current working directory is the installation directory

- Execute the following command:

```
bin/kafka-topics.sh --zookeeper localhost:2181 --create --topic
mytopic --replication-factor 1 --partitions 1
```

- replication-factor and partitions are required options
  - replication-factor will be explained later
  - partitions is the number of partitions to create for the topic

Produce Messages to Kafka

- Start the kafka-console-producer.sh tool:

```
kafka_2.11-0.8.2.2/bin/kafka-console-producer.sh --broker-list
localhost:9092 --topic mytopic
```

- Produce some messages
  - Messages are simple strings
  - Hitting “Enter” sends the message
  - Control-D sends EOF and closes the producer

Console Consumer

- CLI tool for consuming messages, provided with Kafka
  - Very useful for examining messages while debugging applications
  - Can also be used as a consumer client inside other apps

- Important options
  - --zookeeper – semicolon separated list of host:port[/path] strings for ZK servers
  - --topic – Where to consume messages from
  - --from-beginning – Specifies to start from the earliest offset

- Group name is selected to be unique
  - If you need to specify a group, add a properties file with --consumer.config

Consume Messages from Kafka

- Start the kafka-console-consumer.sh tool:

```
kafka_2.11-0.8.2.2/bin/kafka-console-consumer.sh --zookeeper
localhost:2181 --topic mytopic --from-beginning
```

- Note that the from-beginning flag is important
  - Otherwise, we would only get messages produced from now forward
- The messages that you produced previously will be displayed
- Experiment
  - Produce more messages while you consume
  - Start up another consumer and run it in parallel

Client Libraries

- Java libraries are the only ones supported by Kafka
  - Maintained as part of the Kafka code base
  - Provide first-class services for producers and consumers

- 3rd Party Clients
  - Exist for many languages, including C++, Go, Python, Perl, etc.
  - https://cwiki.apache.org/confluence/display/KAFKA/Clients

- Many do not provide balanced consumer implementations
  - Requires a significant investment in Zookeeper logic
  - One client's implementation may not work with another's

Options for 3rd Party Consumers

- Use a client with balanced consumer support
  - Go: https://github.com/stealthly/go_kafka_client
  - Python: https://github.com/Parsely/pykafka
  - C++: https://github.com/edenhill/librdkafka
- Use the console consumer
- Use an HTTP interface layer
- Wait for the new consumer interface

Producing Messages from Python

- Run the python-producer.py script

- Experiment
  - What happens if you change the topic name to an unknown topic?
  - What happens the next time you run it?

Consume Messages from Python

- Run the python-consumer.py script
- Note that this is a simple consumer that does not balance
  - The group name is used for storing offsets in Kafka
- Experiment
  - What happens when you consume from a topic that doesn't exist?
  - Modify the producer to continually send messages and run in parallel

Kafka Clusters

Why Cluster?

- Replication of messages
  - Multiple brokers can be replicas
  - Only one broker is the leader
- Horizontal scalability
  - Partitions for one topic can be distributed to many brokers
  - Good for networking, good for storage
- Redundant array of inexpensive brokers

Create a Second Broker

- Create a second data directory (e.g. /tmp/kafka-logs-2)
- Make a copy of the config/server.properties file
- Edit the new configuration file
  - Change the broker.id value to 1
  - Change the log.dirs config to the new data directory
- Start a second copy of Kafka with the new config file

Increasing Replication Factor for a Topic

- There's no simple way to do this
  - The kafka-topics command does not let you change the RF
  - We have to use partition reassignment to add another replica

- Create a file on disk named /tmp/reassign.json with the following content:

```
{"partitions": [{"topic": ”mytopic", "partition": 0, "replicas": [0,1]}], "version":1}
```

- Execute the following command:

```
bin/kafka-reassign-partitions.sh –zookeeper localhost:2181 --reassignment-json-file /tmp/reassign.json --execute
```

Adding Partitions to a Topic

- Partitions can only be increased
- The cluster does not balance partitions to all brokers
  - Over time you will get hot nodes
  - External tools can be used for rebalancing the cluster
- Execute the following command:

```
bin/kafka-topics.sh --zookeeper localhost:2181 --alter --topic
mytopic --partitions 2
```

Shutting Down a Broker

- With a replicated topic, there is now redundancy
- Kill one of the broker processes
- Run the console consumer with the --from-beginning flag to see that it still works

Use Cases

What Can I Use Kafka For?

- Simple Queuing
- Tracking User Events
- Log Aggregation
- Real-time Metrics

Use Case - Queuing

- Most common case people think of

- Example – Sending emails
  - You need to send emails from multiple applications
  - All emails should look the same, so they are decorated by a common method

- Why Kafka?
  - Multiple producers of emails send emails to Kafka
  - Decorator service consumes messages to send, scaling horizontally by partitions
  - Reduces the need to maintain decoration everywhere

Use Case - Tracking

- Collection of events, often with offline processing in Hadoop
- Example – Page Views
  - Users hit multiple pages, and multiple applications
  - Reports need to be generated in Hadoop on a many different factors
- Why Kafka?
  - Multiple applications can produce messages with ease
  - Messages are protected with replication while in transit
  - Retain messages in Kafka long enough to get them to Hadoop

Use Case - Logging

- Application logs need to be collected for multiple types of analysis
- Example
  - Logs need to be collected from several applications
  - Many people are interested in them – developers, security, operations
- Why Kafka?
  - Multiple producers are no problem
  - Each interested party can consume the logs without interfering with the others
  - Collection is separated from use

Use Case - Metrics

- You want to be able to watch application and system metrics in real time when debugging problems
- Example
  - Applications emit metrics to a topic with fine granularity
  - You can start up a tool at any point to consume specific metrics and display them
- Why Kafka?
  - Each user can have a randomized consumer group
  - Metrics can be retained in Kafka for a very short period of time to reduce storage
  - You can also consume metrics with lower granularity into permanent storage

Additional Topics

Message Retention

- Kafka retains and expires messages via three options
  - Time-based (the default, which keeps messages for at least 168 hours)
  - Size-based (configurable amount of messages per-partition)
  - Key-based (one message is retained for each discrete key)
- Time and size retention can work together, but not with key-based
  - With time and size configured, messages are retained either until the size limit is reached OR the time limit is reached, whichever comes first
- Retention can be overridden per-topic
  - Use the kafka-topics.sh CLI to set these configs

Balancing Partitions

- Kafka attempts to spread out partitions for a topic as they are created
  - It doesn't remember state from topic to topic, however
  - It also does not know how to add or remove a broker
- External scripts can be created to perform functions like this
- kafka-assigner.py is what we use at LinkedIn
  - It can add and remove brokers
  - It can also perform rebalances by partition count and size
  - Requires Python, as well as the Kazoo and Paramiko libraries

Going to Production

- Zookeeper Setup
  - Zookeeper stays running if you have (n/2)+1 nodes still talking to each other
  - Run 5 nodes, not 3 nodes

- Kafka Clusters
  - Run at least as many Kafka brokers in a cluster as you want replicas, plus one
  - For most applications, replication factor 2 is sufficient
  - For “no data loss”, replication factor of 3 or more is required
  - The RF will determine the number of broker failures you can suffer

- Spread out to multiple racks (or the equivalent)

Resources

More Talks

- ApacheCon 2014: Kafka as a Service
  - Presentation – http://www.slideshare.net/ToddPalino/enterprise-kafka-kafka-as-a-service
  - YouTube – https://www.youtube.com/watch?v=7dkSze52i-o
- ApacheCon 2015: Kafka at Scale: Multi-Tier Architectures
  - Presentation - http://www.slideshare.net/ToddPalino/kafka-at-scale-multitier-architectures
- Tuning Kafka for Fun and Profit
  - http://www.slideshare.net/ToddPalino/tuning-kafka-for-fun-and-profit

Getting Involved With Kafka

- http://kafka.apache.org
- Join the mailing lists
  - users@kafka.apache.org
  - dev@kafka.apache.org
- irc.freenode.net - #apache-kafka
- Meetups
  - Apache Kafka - http://www.meetup.com/http-kafka-apache-org
  - Bay Area Samza - http://www.meetup.com/Bay-Area-Samza-Meetup/
- Contribute code