Apache Kafka - Real-time Data Processing

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Abstract
Apache Kafka is creating a lot of buzz these days. While LinkedIn, where Kafka was founded, is the most well known user, there are many companies that use this technology successfully. Kafka has several features that make it a good fit for companies’ requirements: scalability, data partitioning, low latency, and the ability to handle large number of diverse consumers. It works with Apache Storm and Apache Spark for real-time analysis and rendering of streaming data. The combination of messaging and processing technologies enables stream processing at linear scale. Common use cases include: Messaging, Website activity tracking, Log aggregation, Stream Processing, Commit log.

Keywords: Messaging, Website activity tracking, Log aggregation, Stream Processing.

Introduction
Kafka is one of those systems that is very simple to describe at a high level but has an incredible depth of technical detail when you look into it deeper. The Kafka documentation does an excellent job of explaining the many designs and implementation subtleties in the system. Kafka is a distributed, partitioned, and replicated commit log service. It provides the functionality of a messaging system but with a unique design. In this article, we will begin by briefly introducing Kafka, and then demonstrate some of Kafka’s unique features by walking through an example scenario. We will also cover some additional usage cases and also compare Kafka to existing solutions.

Real Time Data Processing Challenges
Real Time data processing challenges are very complex. As we all know, Big Data is commonly categorized into volume, velocity, and variety of the data, and Hadoop like system handles the Volume and Variety part of it. Along with the volume and variety, the real time system needs to handle the velocity of the data as well. And handling the velocity of Big Data is not an easy task. First, the system should be able to collect the data generated by real time events streams coming in at a rate of millions of events per seconds. Second, it needs to handle the parallel processing of this data as and when it is being collected. Third, it should perform event correlation using a Complex Event Processing engine to extract the meaningful information from this moving stream. These three steps should happen in a fault tolerant and distributed way. The real time system should be a low latency system so that the computation can happen very fast with near real time response capabilities.

How Kafka works
Like many publish-subscribe messaging systems, Kafka maintains feeds of messages in topics. Producers write data to topics and consumers read from topics. Since Kafka is a distributed system, topics are partitioned and replicated across multiple nodes. Messages are simply byte arrays and the developers can use them to store any object in any format—with String, JSON, and Avro, the most common one. It is possible to attach a key to each message, in that case the producer guarantees that all messages with the same key will arrive to the same partition. When consuming from a topic, it is possible to configure a consumer group with multiple consumers. Each consumer in a consumer group will read messages from a unique subset of partitions in each topic they subscribe to, so each message is delivered to one consumer in the group, and all messages with the same key arrive at the same consumer. What makes Kafka unique is that it treats each topic partition as a log (an ordered set of messages). Each message in a partition is assigned a unique offset. Kafka does not attempt to track which messages were read by each consumer and only retain unread messages; rather, Kafka retains all messages for a set amount of time, and consumers are responsible to track their location in each log. Consequently, Kafka can support a large number of consumers and retain large amounts of data with very little overhead.

Massaging system
Apache Kafka is the messaging system originally developed at LinkedIn for processing LinkedIn’s activity stream.
The overall architecture of Kafka is shown in Figure 2. Kafka is distributed in nature which typically consists of multiple brokers. To balance load, a topic is divided into multiple partitions and each broker stores one or more of those partitions. Multiple producers and consumers can publish and retrieve messages at the same time. Kafka relies heavily on the file system 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; 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 6 7200rpm SATA RAID-5 where array is about 300MB/sec but the performance of random writes is only about 50k/sec with differences of nearly 10000X! These linear reads and writes are the most predictable of all usage patterns, and hence the one detected and optimized best by the operating system using read-ahead and write-behind techniques. Kafka has a very simple storage layout. Each partition of a topic corresponds to a logical log. Physically, a log is implemented as a set of segment files of approximately the same size (e.g., 1GB). Every time a producer publishes a message to a partition, the broker simply appends the message to the last segment file. For better performance, Kafka flush the segment files to disk only after a configurable number of messages have been published or a certain amount of time has elapsed. A message is only exposed to the consumers after it is flushed.

Kafka components

1. Quick start: install vagrant, install virtual box, git clone, cd skala-kafka, vagrant up. Zookeeper should be running.

2. Creating producers:

```java
val producer = new KafkaProducer("test-topic","192.168.84.10:9092")
producer.send("hello distributed commit log")
```

3. Creating consumers:

```java
def KateMessage(topic: Message, partition: int, offset: long) {
   ...}
def send(message: Message, partition: int) {
   ...}
def loop() {
   ...}
```

3. Creating consumers:
The Java Producer API

Producer: Kafka provides the Producer class (class Producer<K,V>) for creating messages for single or multiple topics with message partition as an optional feature. The following is the class diagram and its explanation:

Here, Producer is a type of Java generic written in Scala where we need to specify the type of parameters: K and value, respectively. Keyed Message: The Keyed Message class takes the topic name, partition key, and the message value that needs to be passed from the producer as follows: class KeyedMessage[K, V] (val topic: String, val key: K, val message: V)

Producer Config: The Producer Config class encapsulates the values required for establishing the connection with brokers such as the broker list, message partition class, serializer class for the message, and partition key.

This Simple Producer class is used to create a message for a specific topic and transmit it. As the first step, we need to import the following classes:

As the next step in writing the producer, we need to define properties for making a connection with Kafka broker and pass these properties to the Kafka producer:

As the final step, we need to build the message and send it to the broker as shown in the following code:

Compile the preceding program and use the following command to run it: [root@localhost kafka-0.8]# java SimpleProducer kafka topic Hello_There_Here, kafka topic is the topic that will be created automatically when the message Hello_There is sent to the broker.

Conclusion

References


Barrera, P. Reliable RT processing Onnen, E. (September 27, 2012). Data Models and Consumer Idioms Using Apache Kafka for Continuous Data Stream Processing.