Apache Kafka

Real-Time Data Pipelines

http://kafka.apache.org/

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  Big Data Open Source Security LLC provides professional services and product solutions for the collection, storage, transfer, real-time analytics, batch processing and reporting for complex data streams, data sets and distributed systems. BDOSS is all about the "glue" and helping companies to not only figure out what Big Data Infrastructure Components to use but also how to change their existing (or build new) systems to work with them.

- Apache Kafka Committer & PMC member
- Blog & Podcast - http://allthingshadoop.com
- Twitter @allthingshadoop

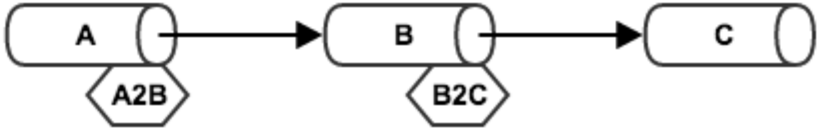
Overview

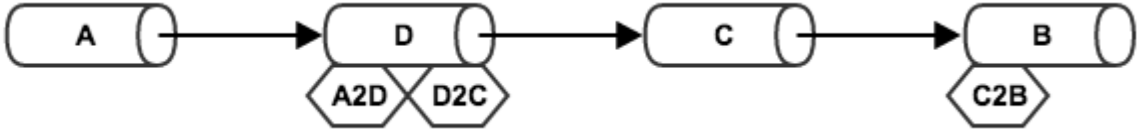
- What is Apache Kafka?
    - Data pipelines
    - Architecture
- How does Apache Kafka work?
    - Brokers
    - Producers
    - Consumers
    - Topics
    - Partitions
- How to use Apache Kafka?
    - Existing Integrations
    - Client Libraries
    - Out of the box API
    - Tools

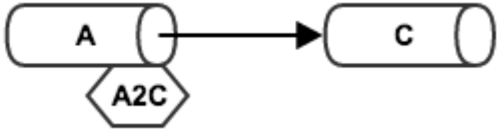
Apache Kafka

- Apache Kafka
  - http://kafka.apache.org
- Apache Kafka Source Code
  - https://github.com/apache/kafka
- Documentation
  - http://kafka.apache.org/documentation.html
- Wiki
  - https://cwiki.apache.org/confluence/display/KAFKA/Index

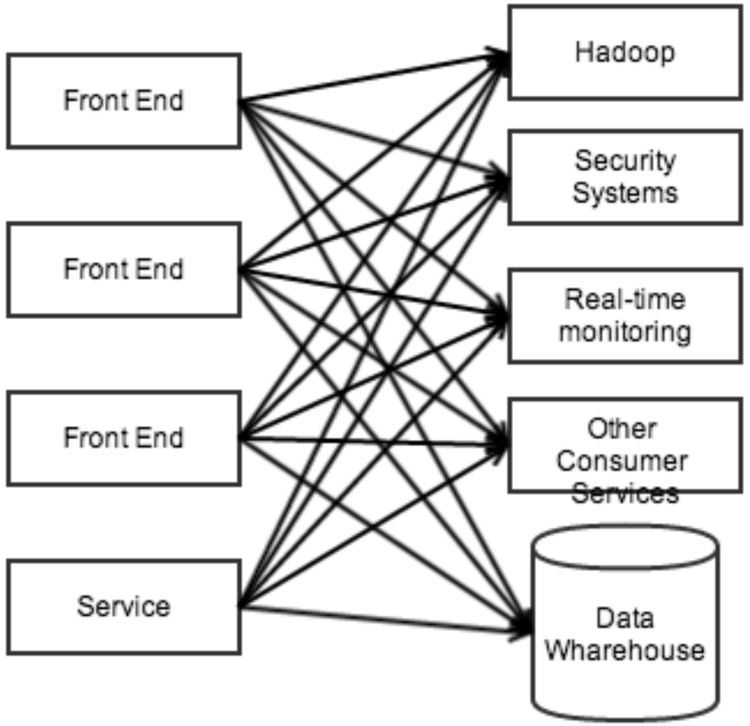
Data Pipelines



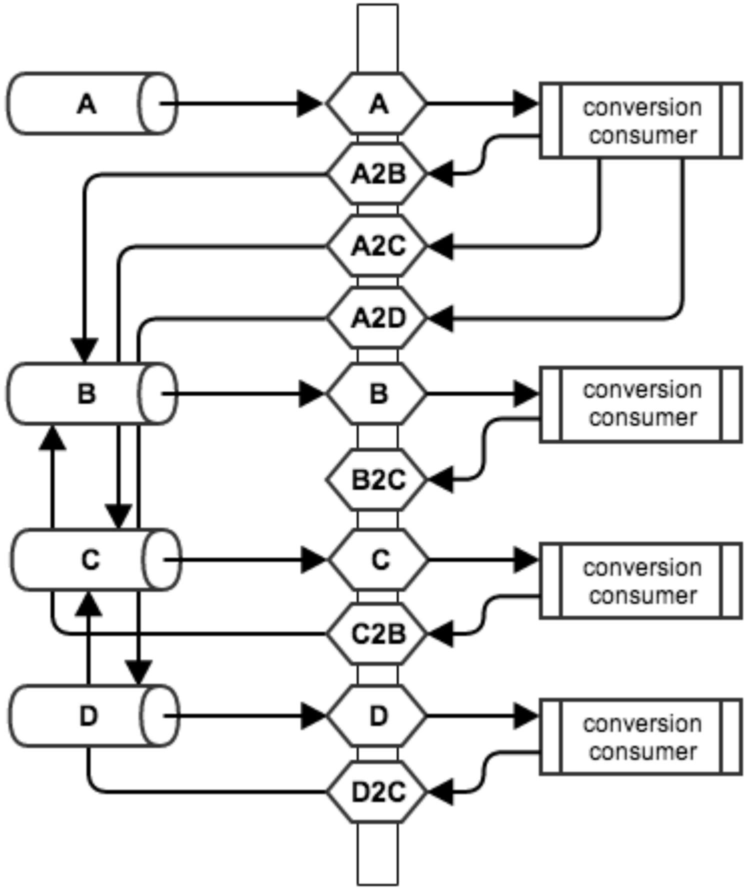




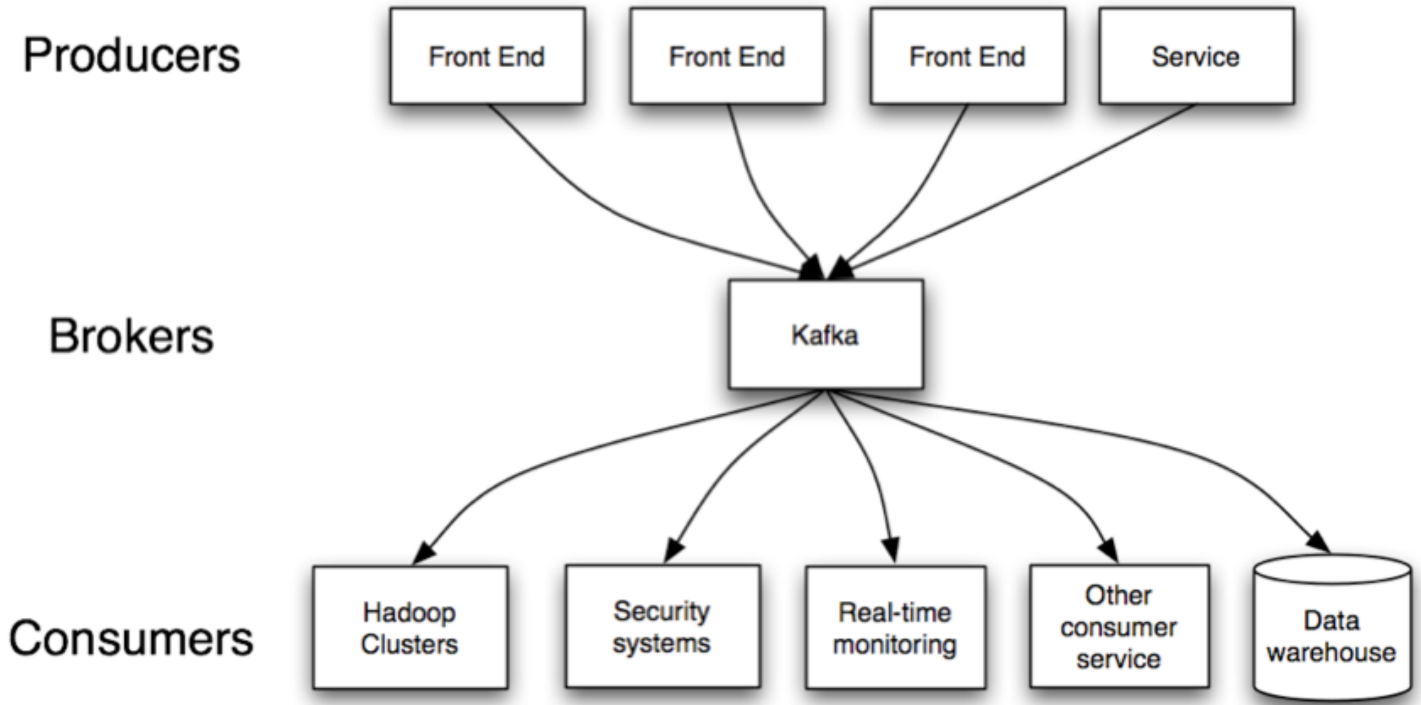
Point to Point Data Pipelines are Problematic



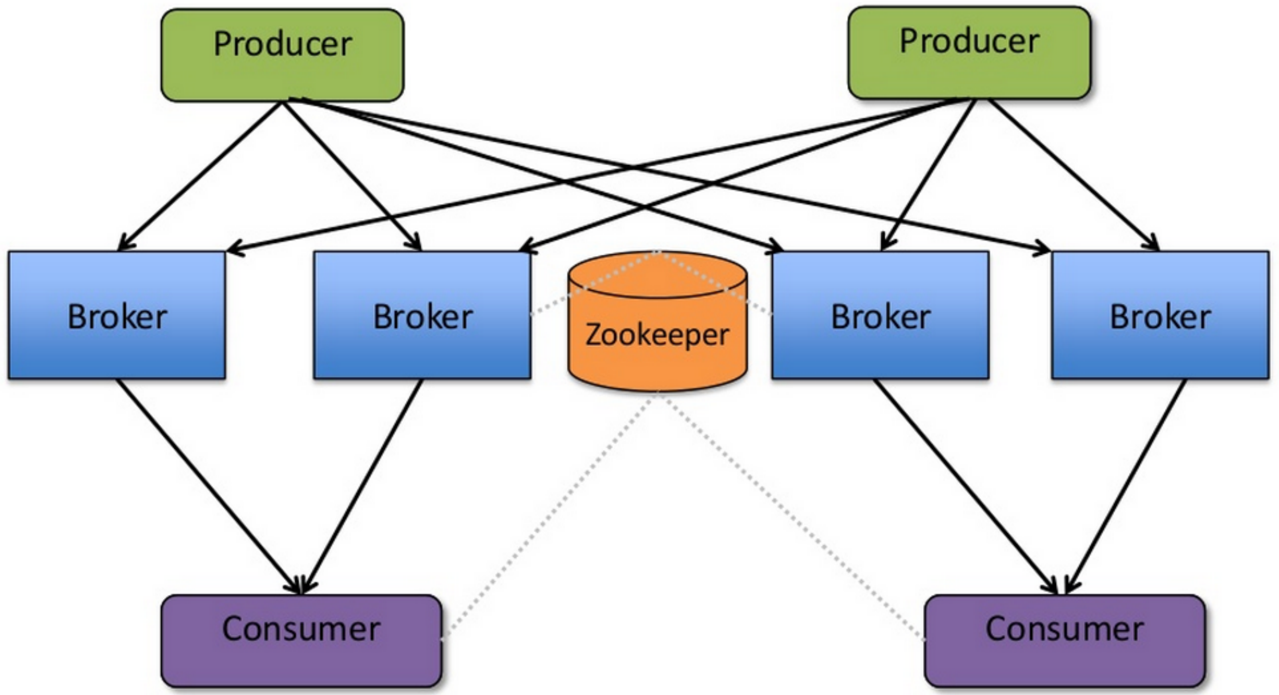
Decouple


A
A
conversion consumer
A2B
A2C
A2D
B
B
conversion consumer
B2C
C
C
conversion consumer
C2B
D
D
conversion consumer
D2C

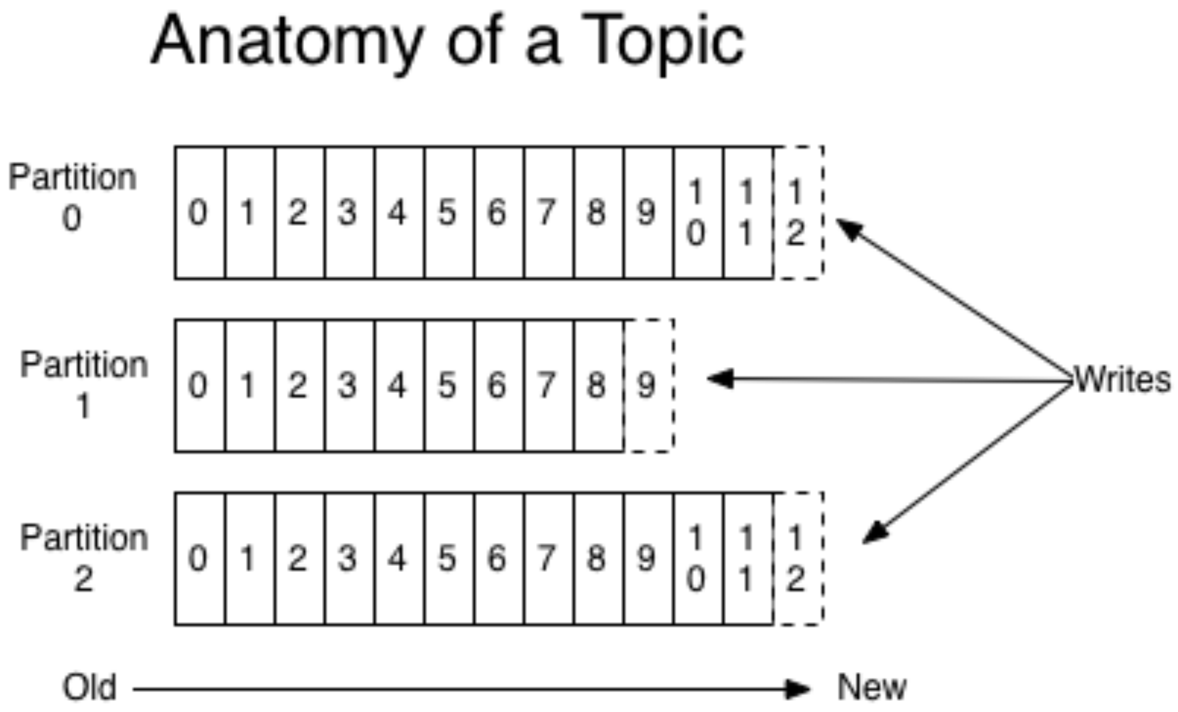
Kafka decouples data-pipelines



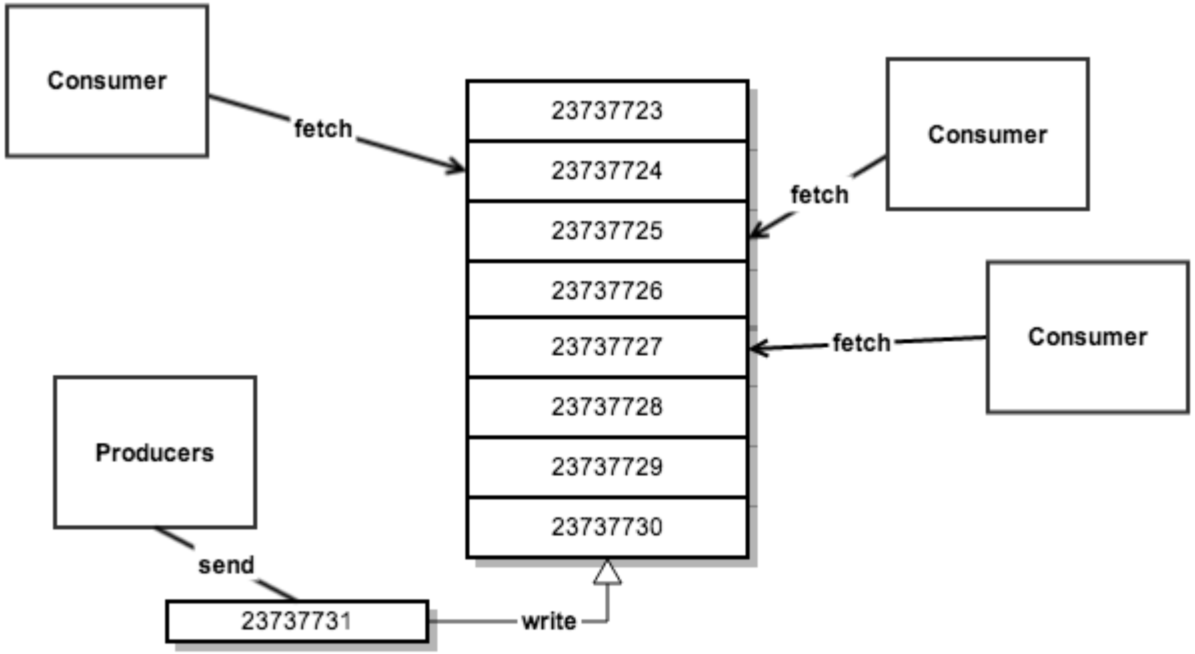
Kafka Architecture



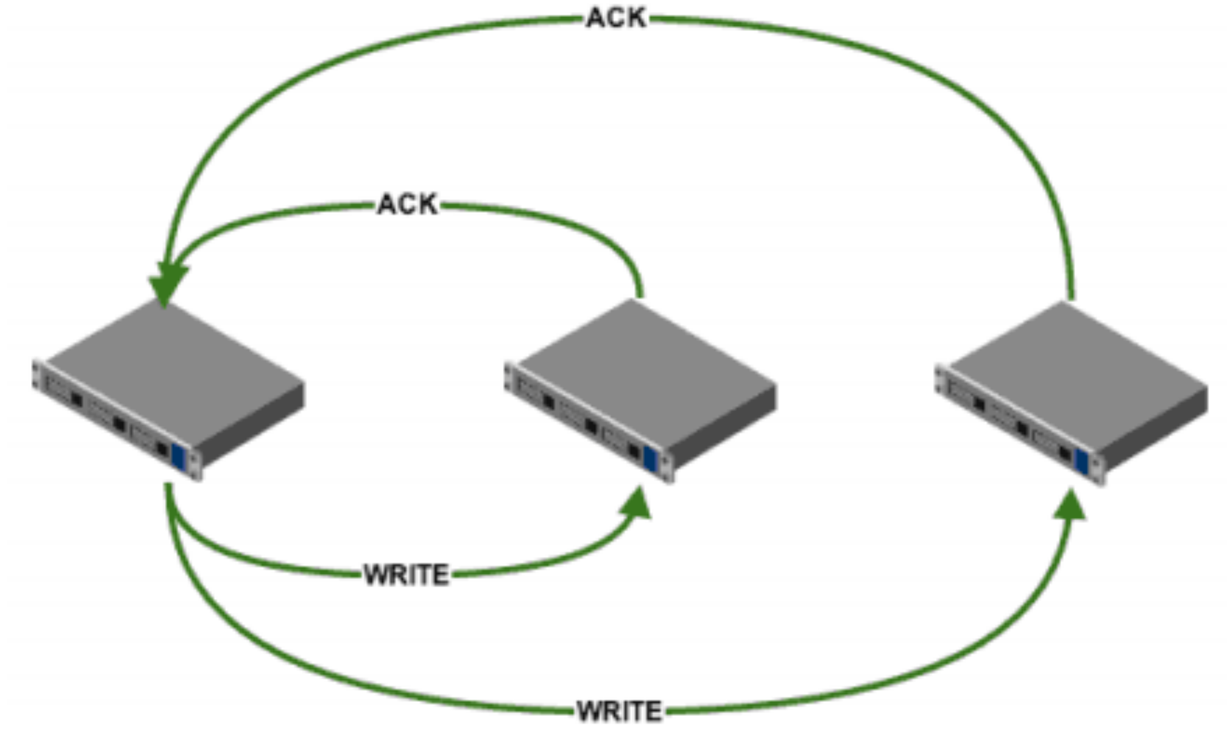
Topics & Partitions



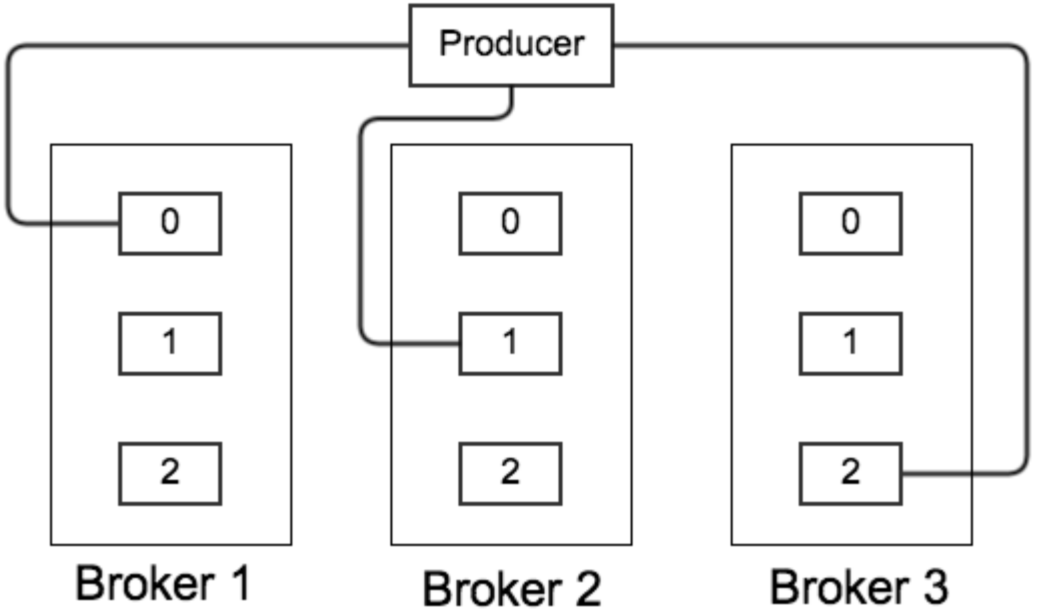
A high-throughput distributed messaging system rethought as a distributed commit log.



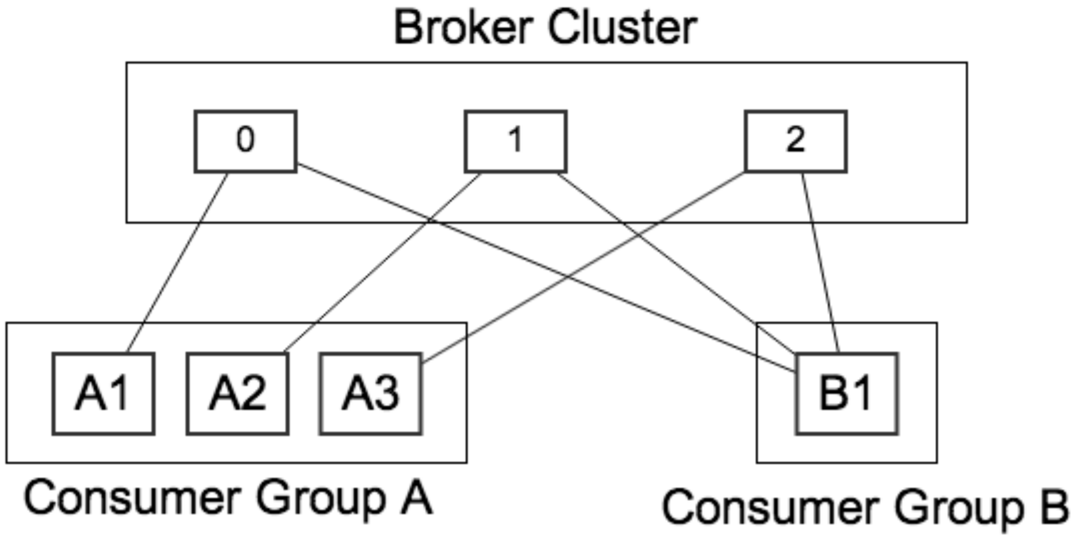
Replication



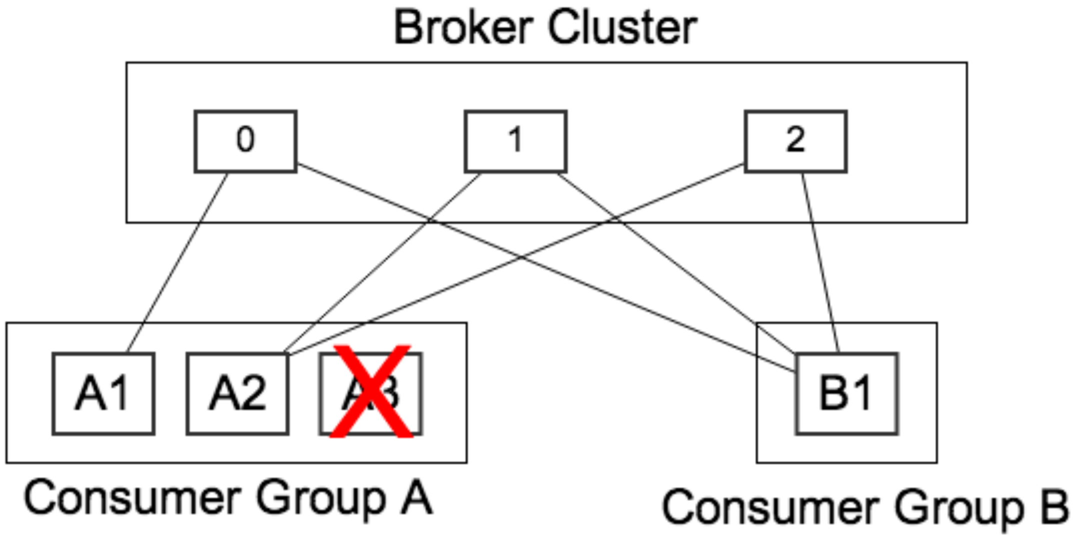
Brokers load balance producers by partition



Consumer groups provides isolation to topics and partitions



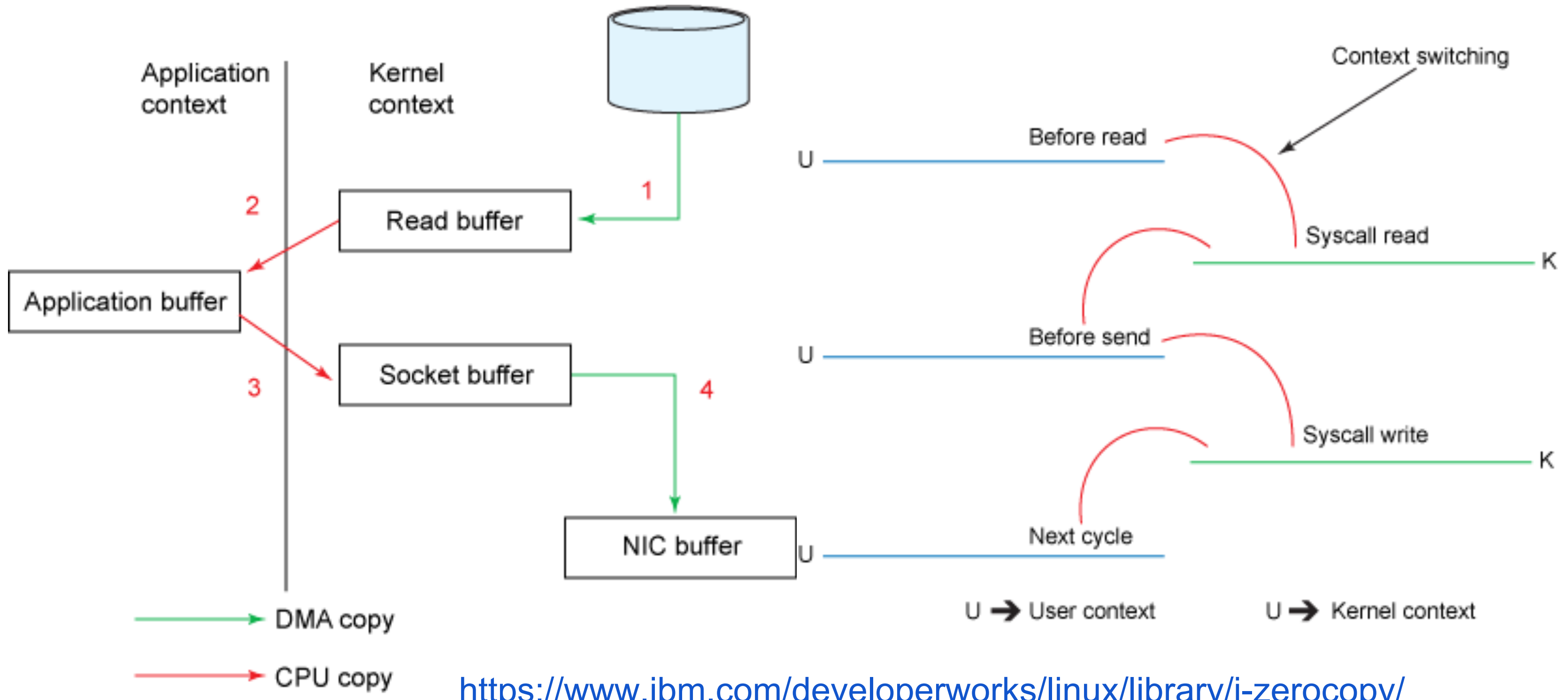
Consumers rebalance themselves for partitions



How does Kafka do all of this?

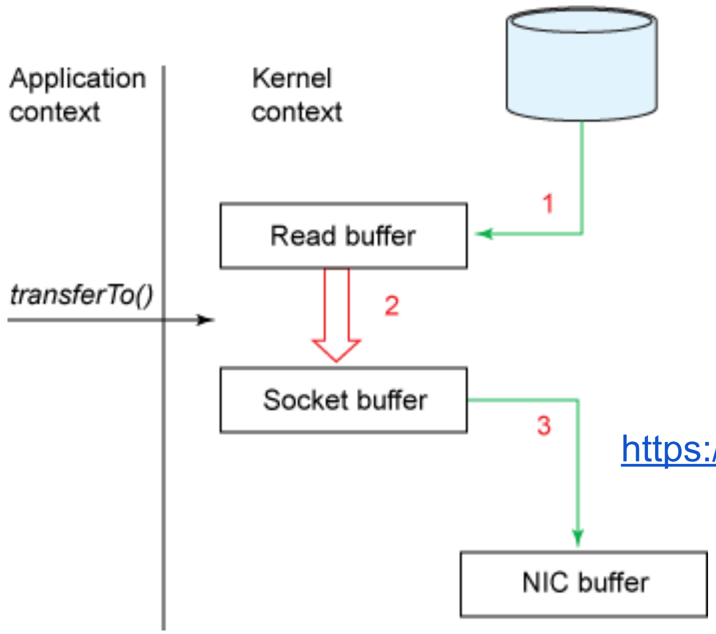
- Producers - ** push **
  - Batching
  - Compression
  - Sync (Ack), Async (auto batch)
  - Replication
  - Sequential writes, guaranteed ordering within each partition
- Consumers - ** pull **
  - No state held by broker
  - Consumers control reading from the stream
- Zero Copy for producers and consumers to and from the broker http://kafka.apache.org/documentation.html#maximizingefficiency
- Message stay on disk when consumed, deletes on TTL with compaction available in 0.8.1 https://kafka.apache.org/documentation.html#compaction

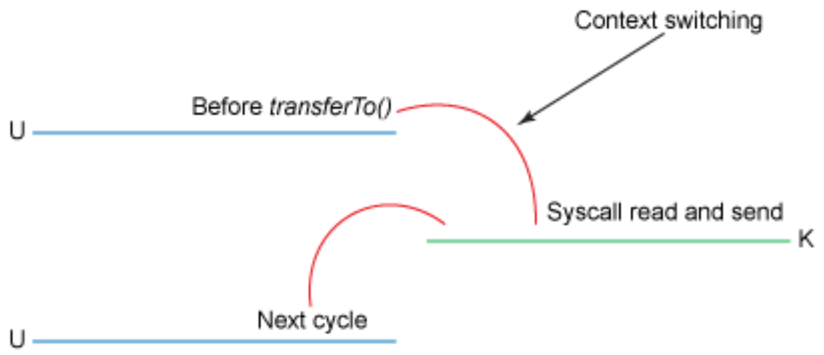
Traditional Data Copy



https://www.ibm.com/developerworks/linux/library/j-zerocopy/

Zero Copy





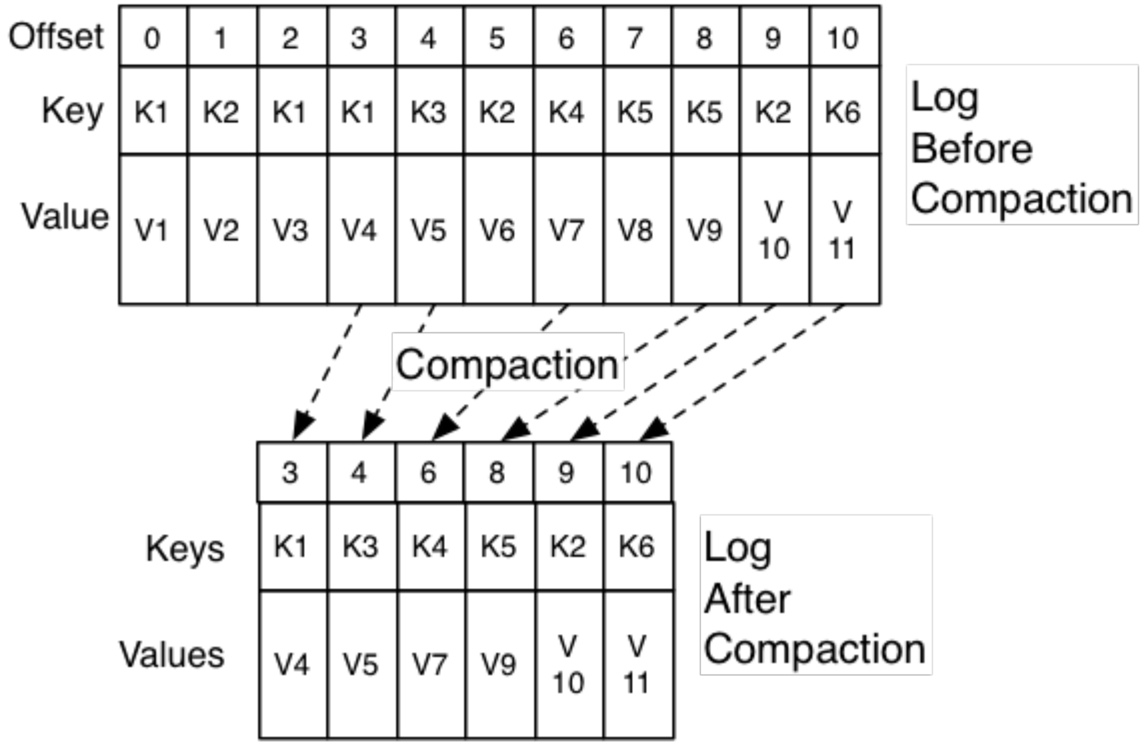
https://www.ibm.com/developerworks/linux/library/j-zerocopy/

Performance comparison: Traditional approach vs. zero copy

File size	Normal file transfer (ms)	transferTo (ms)
7MB	156	45
21MB	337	128
63MB	843	387
98MB	1320	617
200MB	2124	1150
350MB	3631	1762
700MB	13498	4422
1GB	18399	8537

https://www.ibm.com/developerworks/linux/library/j-zerocopy/

Log Compaction



Offset	0	1	2	3	4	5	6	7	8	9	10
Key	K1	K2	K1	K1	K3	K2	K4	K5	K5	K2	K6
Value	V1	V2	V3	V4	V5	V6	V7	V8	V9	V 10	V 11

	3	4	6	8	9	10
Keys	K1	K3	K4	K5	K2	K6
Values	V4	V5	V7	V9	V 10	V 11

Existing Integrations

https://cwiki.apache.org/confluence/display/KAFKA/Ecosystem

- log4j Appender
- Apache Storm
- Apache Camel
- Apache Samza
- Apache Hadoop
- Apache Flume
- Camus
- AWS S3
- Rieman
- Sematext
- Dropwizard
- LogStash
- Fluent

Client Libraries

Community Clients https://cwiki.apache.org/confluence/display/KAFKA/Clients

- Python - Pure Python implementation with full protocol support. Consumer and Producer implementations included, GZIP and Snappy compression supported.
- C - High performance C library with full protocol support
- C++ - Native C++ library with protocol support for Metadata, Produce, Fetch, and Offset.
- Go (aka golang) Pure Go implementation with full protocol support. Consumer and Producer implementations included, GZIP and Snappy compression supported.
- Ruby - Pure Ruby, Consumer and Producer implementations included, GZIP and Snappy compression supported. Ruby 1.9.3 and up (CI runs MRI 2.
- Clojure - Clojure DSL for the Kafka API
- JavaScript (NodeJS) - NodeJS client in a pure JavaScript implementation

Wire Protocol Developers Guide
https://cwiki.apache.org/confluence/display/KAFKA/A+Guide+To+The+Kafka+Protocol

Really Quick Start

1) Install Vagrant http://www.vagrantup.com/
2) Install Virtual Box https://www.virtualbox.org/
3) git clone https://github.com/stealthly/scala-kafka
4) cd scala-kafka
5) vagrant up

Zookeeper will be running on 192.168.86.5
BrokerOne will be running on 192.168.86.10
All the tests in ./src/test/scala/* should pass (which is also /vagrant/src/test/scala/* in the vm)

6) ./gradlew test

Developing Producers

https://github.com/stealthly/scala-kafka/blob/master/src/test/scala/KafkaSpec.scala

```
val producer = new KafkaProducer(“test-topic”,"192.168.86.10:9092")
producer.send(“hello distributed commit log”)
```

Producers

https://github.com/stealthly/scala-kafka/blob/master/src/main/scala/KafkaProducer.scala

```
case class KafkaProducer(
  topic: String,
  brokerList: String,
  /** brokerList - This is for bootstrapping and the producer will only use it for
getting metadata (topics, partitions and replicas). The socket connections for
sending the actual data will be established based on the broker information
returned in the metadata. The format is host1:port1,host2:port2, and the list can
be a subset of brokers or a VIP pointing to a  subset of brokers.
  */
```

Producer

```
clientId: String = UUID.randomUUID().toString,
  /** clientId - The client id is a user-specified string sent in each request to help
trace calls. It should logically identify  the application making the request. */
  synchronously: Boolean = true,
  /** synchronously - This parameter specifies whether the messages are sent
asynchronously in a background thread. Valid values are false for
asynchronous send and true for synchronous send. By setting the producer to
async we allow batching together of requests (which is great for throughput) but
open the possibility of a failure of the client machine dropping unsent data.*/
```

Producer

```
compress: Boolean = true,
  /** compress -This parameter allows you to specify the compression codec for all data generated by this producer. When set to true gzip is used.  To override and use snappy you need to implement that as the default codec for compression using SnappyCompressionCodec.codec instead of DefaultCompressionCodec.codec below. */
batchSize: Integer = 200,
  /** batchSize -The number of messages to send in one batch when using async mode. The producer will wait until either this number of messages are ready to send or queue.buffer.max.ms is reached.*/
```

Producer

messageSendMaxRetries: Integer = 3,

/** messageSendMaxRetries - This property will cause the producer to automatically retry a failed send request. This property specifies the number of retries when such failures occur. Note that setting a non-zero value here can lead to duplicates in the case of network errors that cause a message to be sent but the acknowledgement to be lost.*/

Producer

requestRequiredAcks: Integer = -1

/** requestRequiredAcks

0) which means that the producer never waits for an acknowledgement from the broker (the same behavior as 0.7). This option provides the lowest latency but the weakest durability guarantees (some data will be lost when a server fails).

1) which means that the producer gets an acknowledgement after the leader replica has received the data. This option provides better durability as the client waits until the server acknowledges the request as successful (only messages that were written to the now-dead leader but not yet replicated will be lost).

-1) which means that the producer gets an acknowledgement after all in-sync replicas have received the data. This option provides the best durability, we guarantee that no messages will be lost as long as at least one in sync replica remains.*/

Producer

```
val props = new Properties()
val codec = if(compress) DefaultCompressionCodec.codec else NoCompressionCodec.codec
props.put("compression.codec", codec.toString)
http://kafka.apache.org/documentation.html#producerconfigs
props.put("require.requred.acks",requestRequiredAcks.toString)
val producer = new Producer[AnyRef, AnyRef](new ProducerConfig(props))
def kafkaMesssage(message: Array[Byte], partition: Array[Byte]): KeyedMessage[AnyRef, AnyRef] = {
  if (partition == null) {
    new KeyedMessage(topic,message)
  } else {
    new KeyedMessage(topic,message, partition)
  }
}
```

Producer

```
def send(message: String, partition: String = null): Unit = {
   send(message.getBytes("UTF8"), if (partition == null) null else partition.getBytes("UTF8"))
}
def send(message: Array[Byte], partition: Array[Byte]): Unit = {
  try {
    producer.send(kafkaMesssage(message, partition))
  } catch {
    case e: Exception =>
      e.printStackTrace
      System.exit(1)
  }
}
```

High Level Consumer

https://github.com/stealthly/scala-kafka/blob/master/src/main/scala/KafkaConsumer.scala

```
class KafkaConsumer(
  topic: String,
  /** topic - The high-level API hides the details of brokers from the consumer
and allows consuming off the cluster of machines without concern for the
underlying topology. It also maintains the state of what has been consumed.
The high-level API also provides the ability to subscribe to topics that match a
filter expression (i.e., either a whitelist or a blacklist regular expression).*/
```

High Level Consumer

```
  groupId: String,
  /** groupId - A string that uniquely identifies the group of consumer processes
to which this consumer belongs. By setting the same group id multiple
processes indicate that they are all part of the same consumer group.*/
  zookeeperConnect: String,
  /** zookeeperConnect - 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 may also have a
zookeeper  chroot path as part of it's zookeeper connection string which puts its
data under some path in the global zookeeper namespace. */
```

High Level Consumer

```
val props = new Properties()
  props.put("group.id", groupId)
  props.put("zookeeper.connect", zookeeperConnect)
  props.put("auto.offset.reset", if(readFromStartOfStream) "smallest" else "largest")
  val config = new ConsumerConfig(props)
  val connector = Consumer.create(config)
  val filterSpec = new Whitelist(topic)
  val stream = connector.createMessageStreamsByFilter(filterSpec, 1, new
DefaultDecoder(), new DefaultDecoder()).get(0)
```

High Level Consumer

```
def read(write: (Array[Byte])=>Unit) = {
  for(messageAndTopic <- stream) {
    try {
      write(messageAndTopic.message)
    } catch {
      case e: Throwable =>  error("Error processing message, skipping this message: ", e)
    }
  }
}
```

High Level Consumer

https://github.com/stealthly/scala-kafka/blob/master/src/test/scala/KafkaSpec.scala

```
val consumer = new KafkaConsumer(“test-topic”,”groupTest”,"192.168.86.5:2181")

def exec(binaryObject: Array[Byte]) = {
  //magic happens
}

consumer.read(exec)
```

Simple Consumer

https://cwiki.apache.org/confluence/display/KAFKA/0.8.0+SimpleConsumer+Example

https://github.com/apache/kafka/blob/0.8/core/src/main/scala/kafka/tools/SimpleConsumerShell.scala

```
val fetchRequest = fetchRequestBuilder
                    .addFetch(topic, partitionId, offset, fetchSize)
                    .build()
```

System Tools

https://cwiki.apache.org/confluence/display/KAFKA/System+Tools

- Consumer Offset Checker
- Dump Log Segment
- Export Zookeeper Offsets
- Get Offset Shell
- Import Zookeeper Offsets
- JMX Tool
- Kafka Migration Tool
- Mirror Maker
- Replay Log Producer
- Simple Consumer Shell
- State Change Log Merger
- Update Offsets In Zookeeper
- Verify Consumer Rebalance

Replication Tools

https://cwiki.apache.org/confluence/display/KAFKA/Replication+tools

- Controlled Shutdown
- Preferred Replica Leader Election Tool
- List Topic Tool
- Create Topic Tool
- Add Partition Tool
- Reassign Partitions Tool
- StateChangeLogMerger Tool

Questions?

/**
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