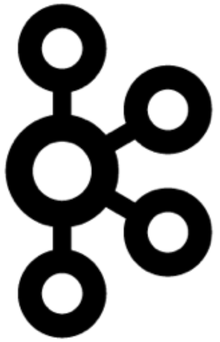

kafka

a high throughput messaging system for log processing

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What is log data

- Tech companies nowadays are dealing with various types of log data
- user activities: likes, login records, comments, queries
- operational metrics: CPU, memory, disk utilisation

Log data is valuable

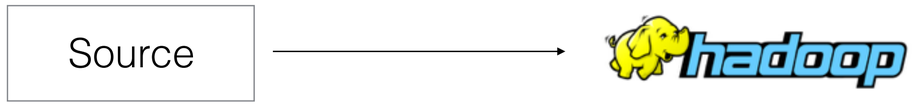
- Companies need those data to improve user experience of their services:
  - recommendation system
  - news feed aggregation
  - search relevance
  - ad targeting
  - spam detection

Problem

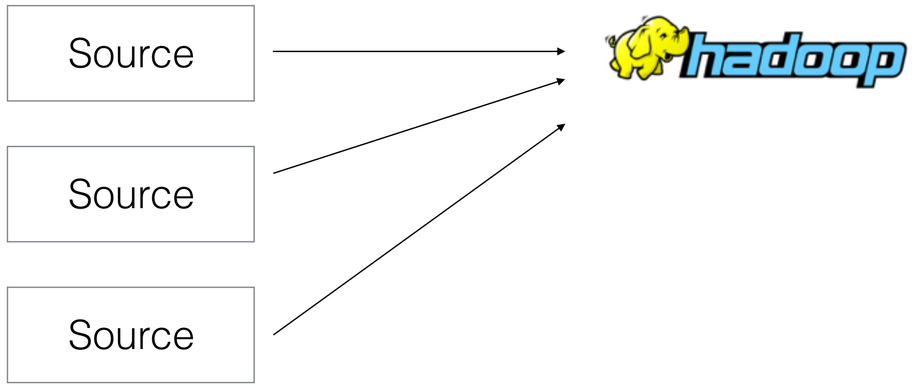
- large data volume: TB level

- Build a specialised pipeline between data producer and data consumer is not scalable

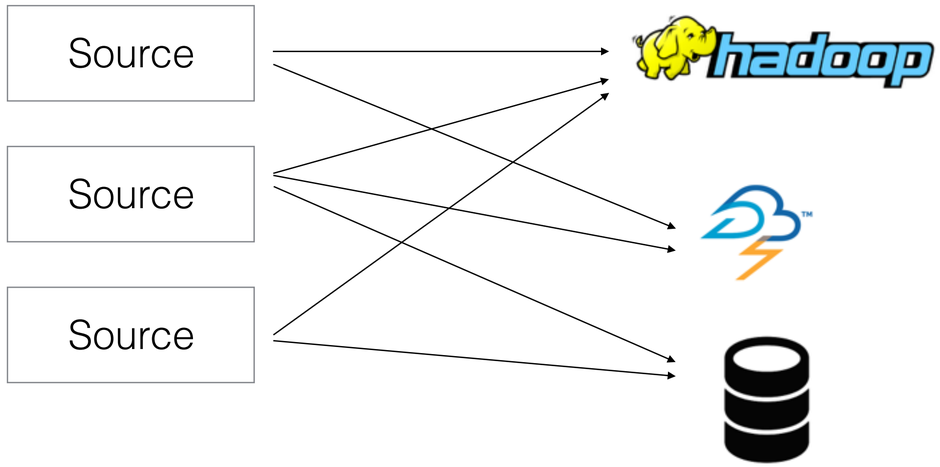
At the beginning:



Then, we have more data sources to process..



More consumer come…



Previous Systems

Enterprise messaging systems:

- Overkill features: IBM WebSphere MQ provide API to insert message to multiples queues atomically
- Throughput is not the top concern: JMS has no batch delivery, one message per network round trip
- Not distributed
- Assume immediate consumption of the message

Log aggregator:

- Mostly designed for offline data consumption
- use a push model

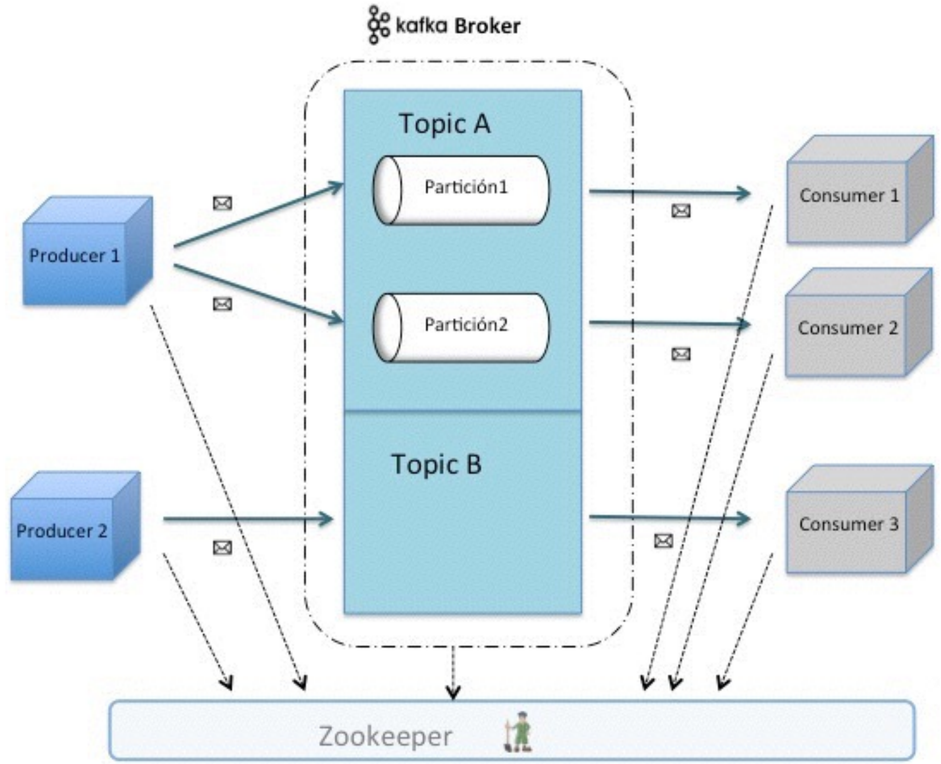
Kafka introduction

- Initially developed in LinkedIn, now become part of Apache
- Decouples data pipelines from producers and consumers
- Pull model instead of push model
- Support both online and offline data consumption
- Scalable, fault-tolerant and focuses on throughput

Key terminology

- **Topic**: a stream of messages of a particular type
- **Producer**: a process that publishes messages to a Kafka topic
- **Broker**: a server that stores message data, Kafka runs on a cluster of brokers
- **Consumer**: process that subscribes one or more topics and pulls messages from brokers

Kafka Architecture



reference: http://bigdata-blog.com/real-time-data-processing-with-apache-kafka

Sample Producer Code

```
import java.util.*;

import kafka.javaapi.producer.Producer;
import kafka.producer.KeyedMessage;
import kafka.producer.ProducerConfig;

public class TestProducer {
    public static void main(String[] args) {
        long events = Long.parseLong(args[0]);
        Random rnd = new Random();

        Properties props = new Properties();
        props.put("metadata.broker.list", "broker1:9092,broker2:9092 ");
        props.put("serializer.class", "kafka.serializer.StringEncoder");
        props.put("partitioner.class", "example.producer.SimplePartitioner");
        props.put("request.required.acks", "1");

        ProducerConfig config = new ProducerConfig(props);

        Producer<String, String> producer = new Producer<String, String>(config);

        for (long nEvents = 0; nEvents < events; nEvents++) {
               long runtime = new Date().getTime();
               String ip = “192.168.2.” + rnd.nextInt(255);
               String msg = runtime + “,www.example.com,” + ip;
               KeyedMessage<String, String> data = new KeyedMessage<String, String>("page_visits", ip, msg);
               producer.send(data);
        }
        producer.close();
    }
}
```

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

Sample Consumer Code

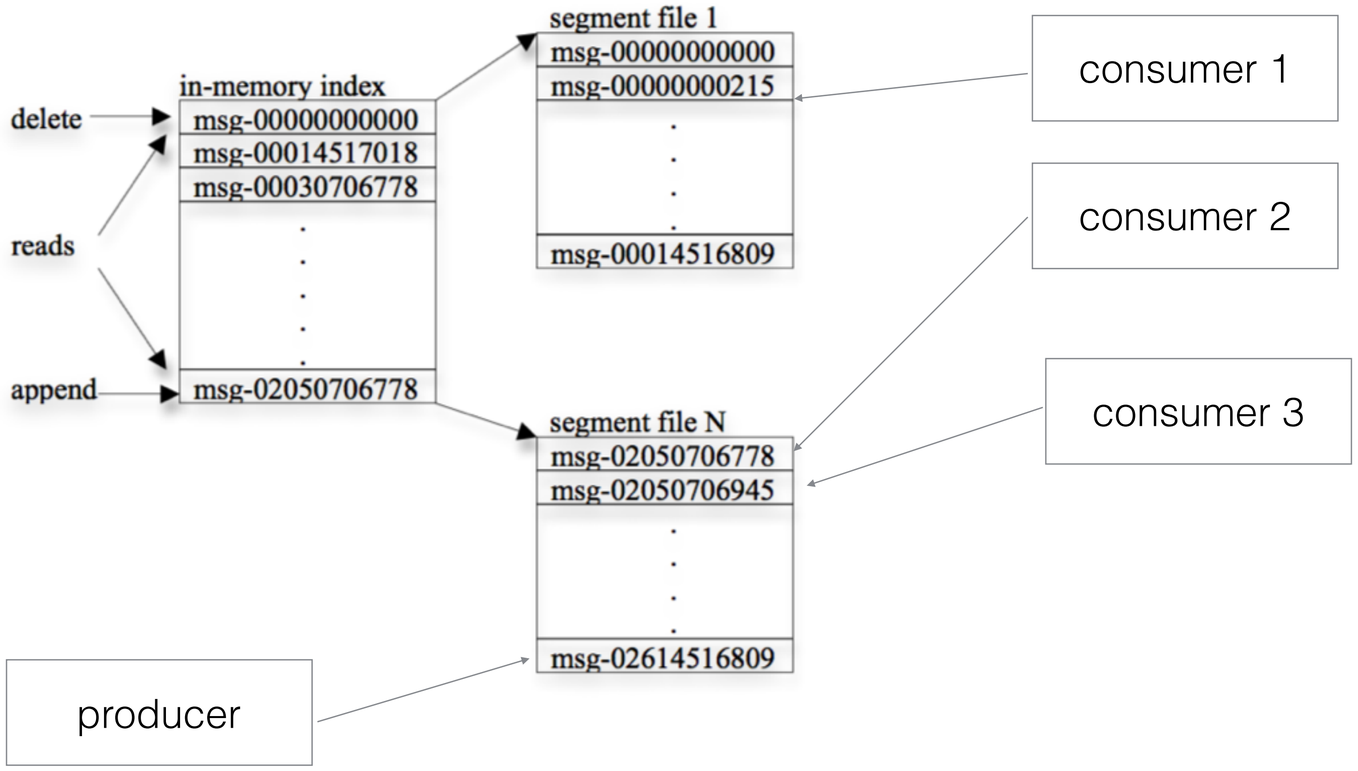
```
FetchRequest req = new FetchRequestBuilder()
        .clientId(clientName)
        .addFetch(a_topic, a_partition, readOffset, 100000)
        .build();
FetchResponse fetchResponse = consumer.fetch(req);

long numRead = 0;
for (MessageAndOffset messageAndOffset : fetchResponse.messageSet(a_topic, a_partition)) {
    long currentOffset = messageAndOffset.offset();
    if (currentOffset < readOffset) {
        System.out.println("Found an old offset: " + currentOffset + " Expecting: " + readOffset);
        continue;
    }
    readOffset = messageAndOffset.nextOffset();
    ByteBuffer payload = messageAndOffset.message().payload();

    byte[] bytes = new byte[payload.limit()];
    payload.get(bytes);
    System.out.println(String.valueOf(messageAndOffset.offset()) + ": " + new String(bytes, "UTF-8"));
    numRead++;
    a_maxReads--;
}

if (numRead == 0) {
    try {
        Thread.sleep(1000);
    } catch (InterruptedException ie) {
    }
}
```

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

What’s under the hood

- A partition consists of a set of segment files
  - roughly 1GB per segment file
- When producer publish a message to a partition, broker appends it to the end of the last segment file
- Segment files are flushed to disk after accumulating certain number of messages.
- Message id is its offset in each segment file.
- An in-memory index to support fast lookups

Storage Layout



Efficiency

- Relies on OS page cache
  - achieves great performance due to sequential access to segment files and lagging between broker and consumer
- Leverage linux **sendfile** system call for faster data transfer

Stateless Brokers

- Consumer maintains the offset for consumed messages (in ZooKeeper)
- Messages will be automatically deleted
- Consumer has a chance to rewind back:
  - make consumers more resilient to errors

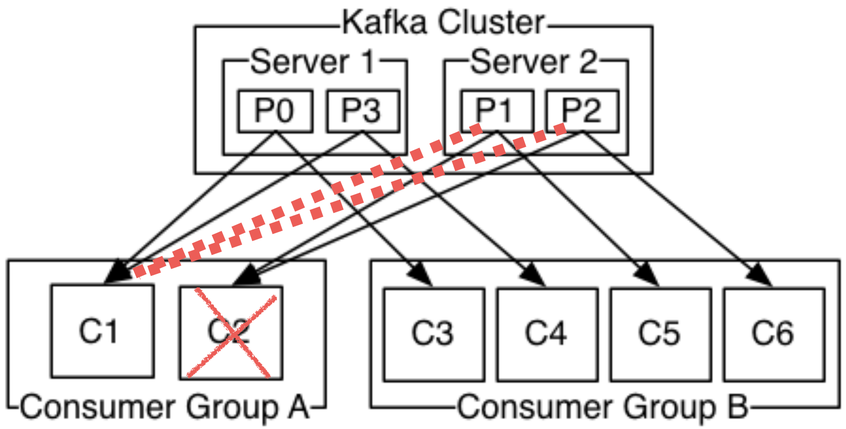
Coordination

- Consumer group
- No coordination between consumer groups
- Partition is the smallest unit for parallelism
- Coordination is only needed for load balancing when a broker or consumer is removed/added
- Decentralised coordination via ZooKeeper

Rebalancing workload

Algorithm 1: rebalance process for consumer C_i in group G

For each topic T that C_i subscribes to {
  remove partitions owned by C_i from the ownership registry
  read the broker and the consumer registries from Zookeeper
  compute P_T = partitions available in all brokers under topic T
  compute C_T = all consumers in G that subscribe to topic T
  sort P_T and C_T
  let j be the index position of C_i in C_T and let $N = |P_T|/|C_T|$
  assign partitions from j*N to (j+1)*N - 1 in P_T to consumer C_i
  for each assigned partition p {
    set the owner of p to C_i in the ownership registry
    let O_p = the offset of partition p stored in the offset registry
    invoke a thread to pull data in partition p from offset O_p
  }
}



Delivery Guarantee

- Kafka guarantee at least once delivery
- Message from a single partition will be delivered to consumer in order
- No order guarantee on messages from different partitions
- When broker is down, all not yet consumed messages are lost
- Later version of Kafka supports replication of partition across brokers

Experiment and Performance

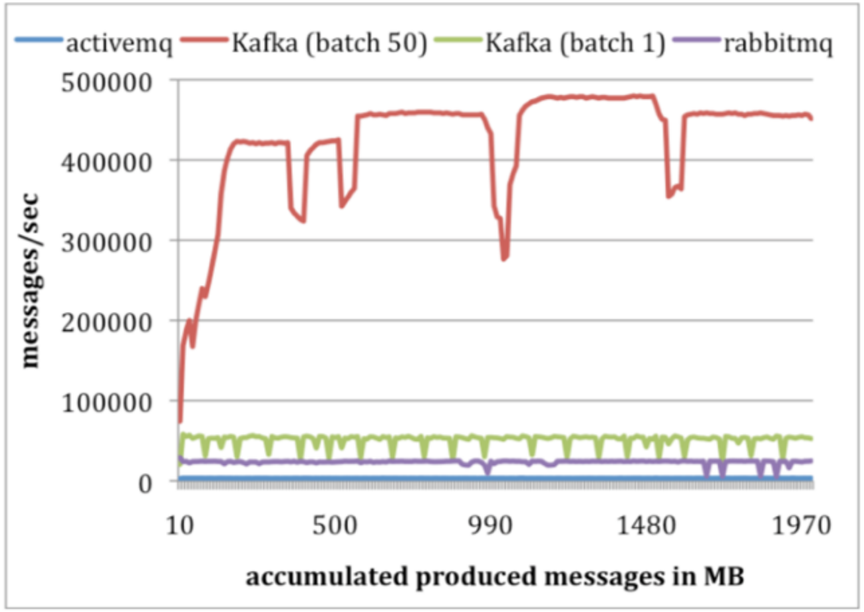


Figure 4. Producer Performance

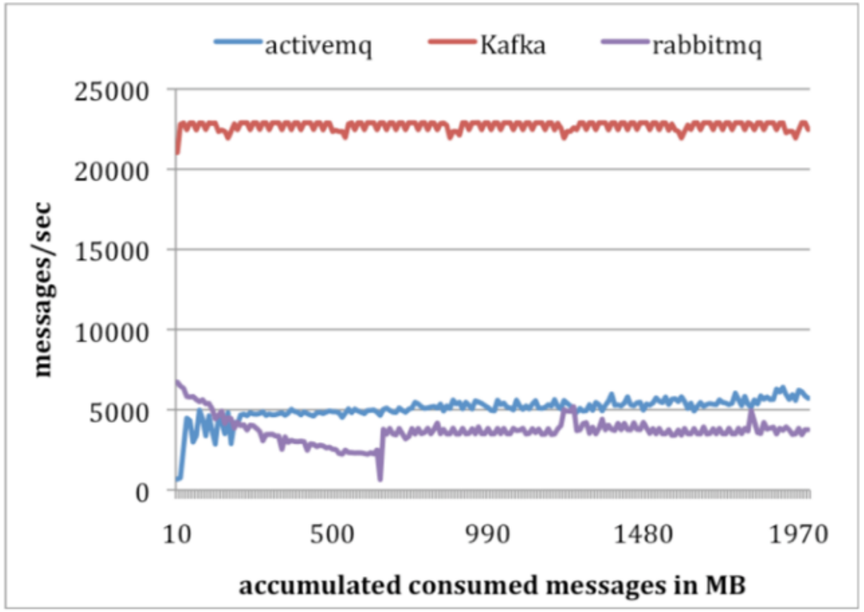


Figure 5. Consumer Performance

Discussion

- Any weak point of Kafka?
  - No exact-once guarantee
  - No order guarantee for messages from multiple partitions
  - Pull model vs push model

Thank you very much