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Introduction to Apache Kafka

Chris Curtin
Head of Technical Research

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About Me

- 20+ years in technology
- Head of Technical Research at Silverpop (12 + years at Silverpop)
- Built a SaaS platform before the term 'SaaS' was being used
- Prior to Silverpop: real-time control systems, factory automation and warehouse management
- Always looking for technologies and algorithms to help with our challenges
- Car nut

Silverpop Open Positions

- Senior Software Engineer (Java, Oracle, Spring, Hibernate, MongoDB)
- Senior Software Engineer – MIS (.NET stack)
- Software Engineer
- Software Engineer – Integration Services (PHP, MySQL)
- Delivery Manager – Engineering
- Technical Lead – Engineering
- Technical Project Manager – Integration Services
- http://www.silverpop.com – Go to Careers under About

Caveats

- We don't use Kafka in production
- I don't have any experience with Kafka in operations
- I am not an expert on messaging systems/JMS/MQSeries etc.

Apache Kafka – from Apache

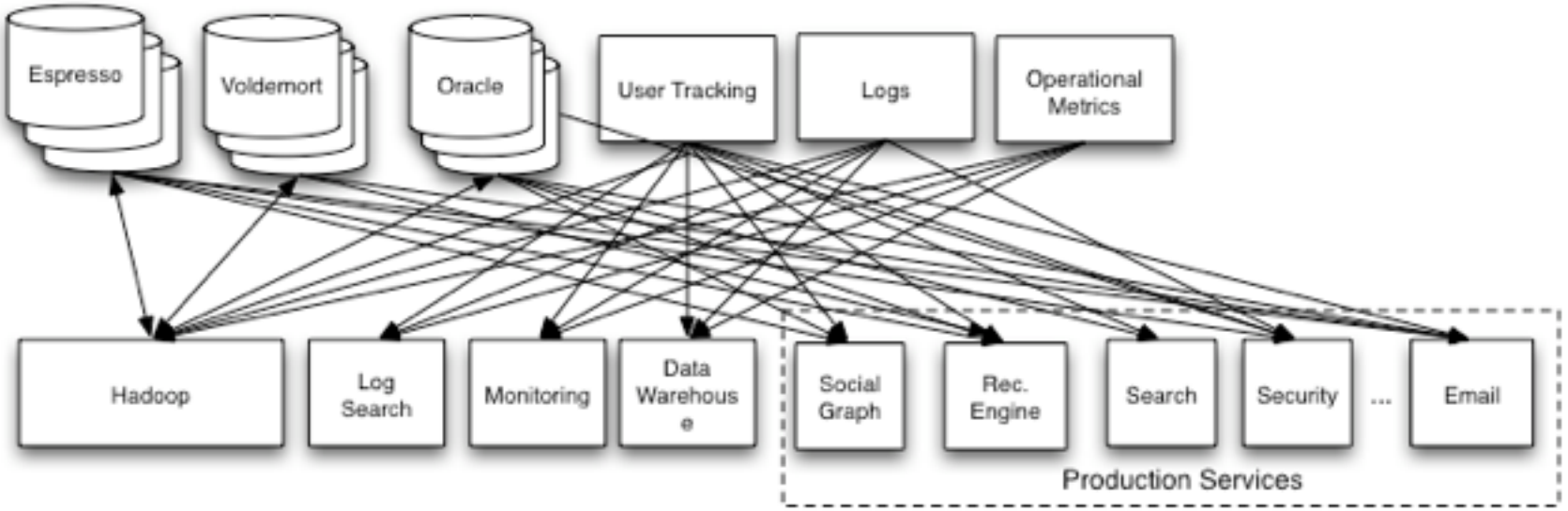
- Apache Kafka is a distributed publish-subscribe messaging system. It is designed to support the following
  - Persistent messaging with O(1) disk structures that provide constant time performance even with many TB of stored messages.
  - High-throughput: even with very modest hardware Kafka can support hundreds of thousands of messages per second.
  - Explicit support for partitioning messages over Kafka servers and distributing consumption over a cluster of consumer machines while maintaining per-partition ordering semantics.
  - Support for parallel data load into Hadoop.

Background

- LinkedIn product donated to Apache
- Most core developers are from LinkedIn
- Pretty good pickup outside of LinkedIn: Air BnB & Urban Airship for example
- Fun fact: no logo yet

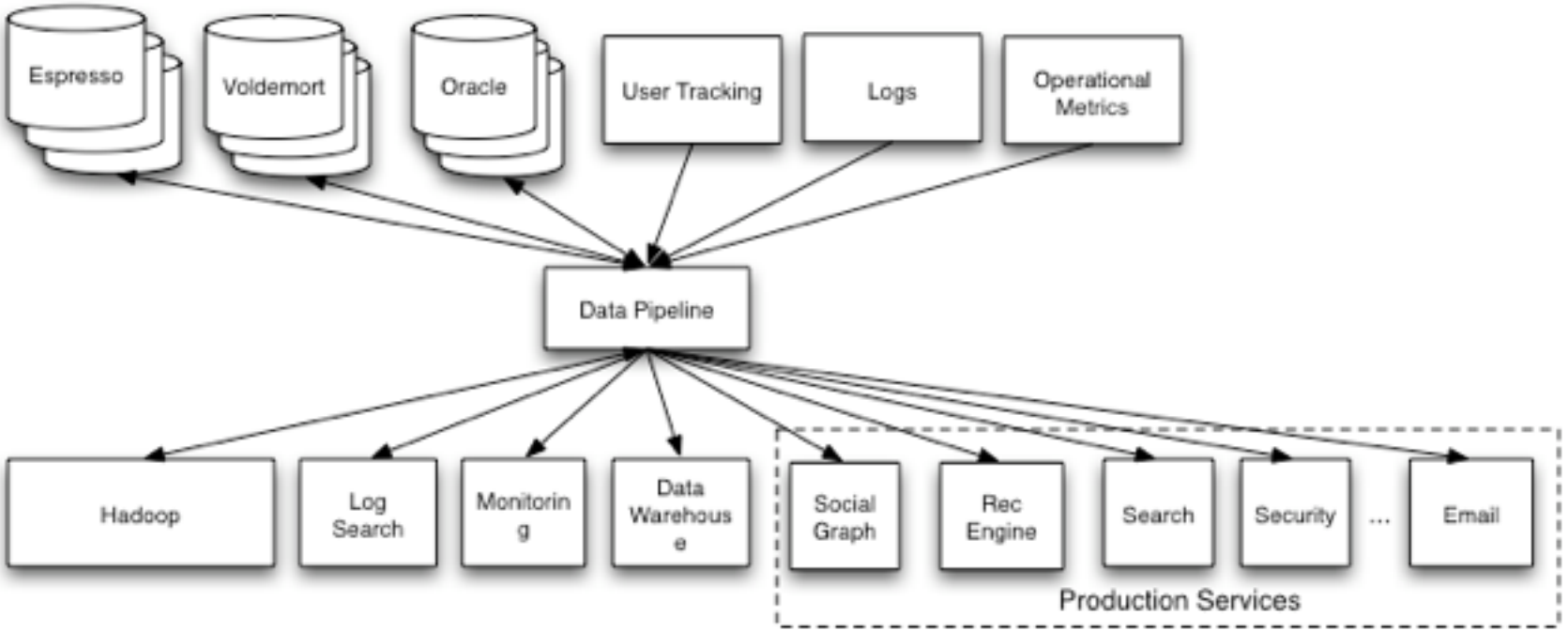
Data Integration

Point to Point integration (thanks to LinkedIn for slide)



(Thanks to http://linkstate.wordpress.com/2011/04/19/recabling-project/)

What we'd really like (thanks to LinkedIn for slide)



Looks Familiar: JMS to the rescue!

Okay: Data warehouse to the rescue!

Okay: CICS to the rescue!

Kafka changes the paradigm

Kafka doesn't keep track of who consumed which message

Consumption Management

- Kafka leaves management of what was consumed up to the business logic
- Each message has a unique identifier (within the topic and partition)
- Consumers can ask for message by identifier, even if they are days old
- Identifiers are sequential within a topic and partition.

Why is Kafka Interesting?

Horizontally scalable messaging system

Terminology

- Topics are the main grouping mechanism for messages
- Brokers store the messages, take care of redundancy issues
- Producers write messages to a broker for a specific topic
- Consumers read from Brokers for a specific topic
- Topics can be further segmented by partitions
- Consumers can read a specific partition from a Topic

API (1 of 25) - Basics

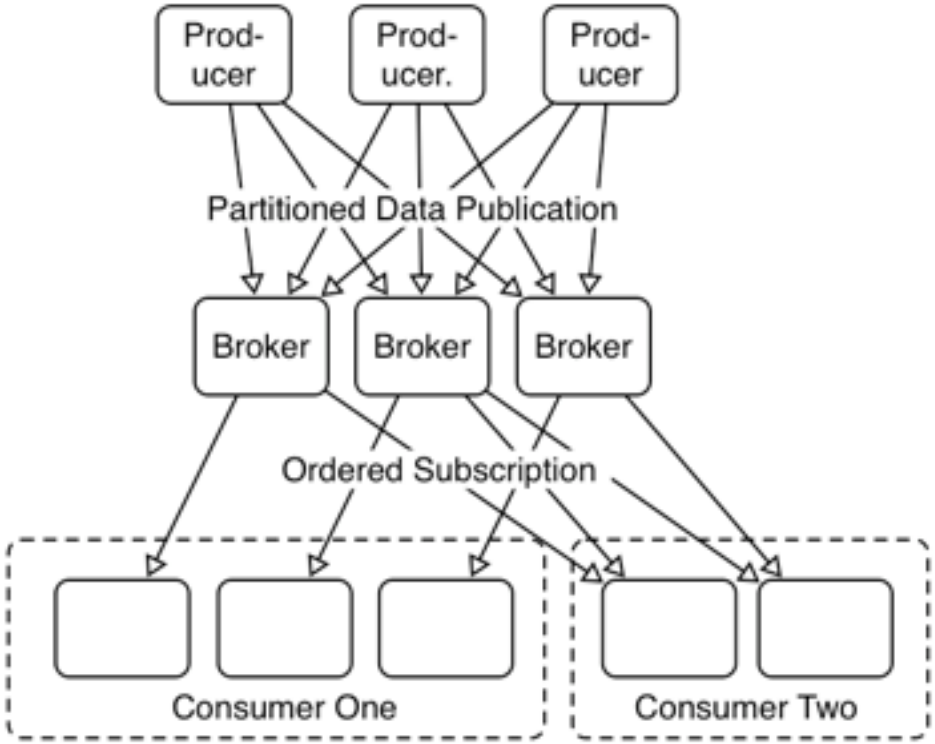
- Producer: send(String topic, String key, Message message)
- Consumer: Iterator<Message> fetch(…)

API

- Just kidding – that's pretty much it for the API

- Minor variation on the consumer for 'Simple' consumers but that's really it
- 'under the covers' functions to get current offsets or implement non-trivial consumers

Architecture (thanks to LinkedIn for slide)



Producers

- Pretty Basic API
- Partitioning is a little odd, requires Producers to know about partition scheme
- Producers DO NOT know about consumers

Consumers: Consumer Groups

- Easiest to get started with
- Kafka makes sure only one thread in the group sees a message for a topic (or a message within a Partition)
- Uses Zookeeper to keep track of what messages were consumed in which topic/partitions
- No 'once and only once' delivery semantics here
- Rebalance may mean a message gets replayed

Consumers: Simple Consumer

- Consumer subscribes to a specific topic and partition
- Consumer has to keep track of what message offset was last consumed
- A lot more error handling required if Brokers have issues
- But a lot more control over which messages are read. Does allow for 'exactly once' messaging

Consumer Model Design

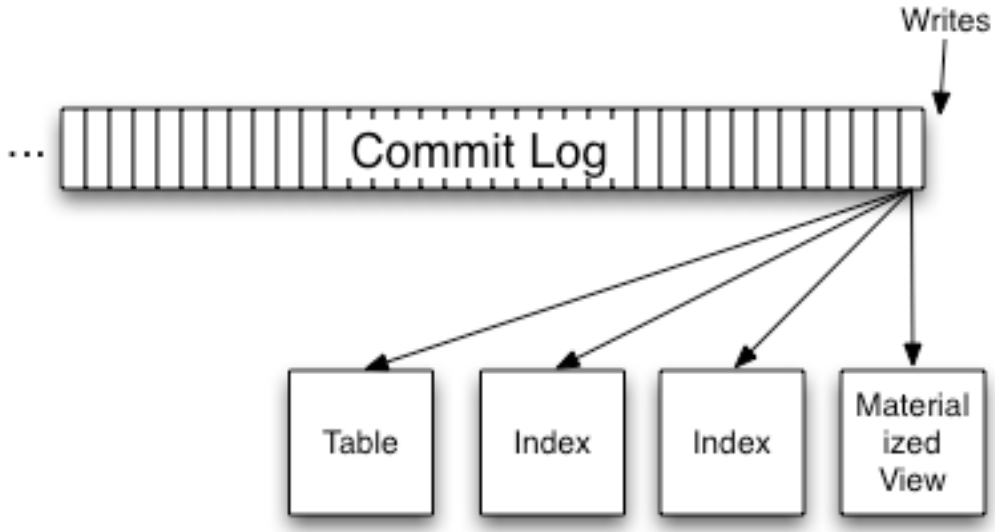
- Partition design impacts overall throughput
  - Producers know partitioning class
  - Producers write to single Broker 'leader' for a partition
- Offsets as only transaction identifier complicates consumer
  - 'throw more hardware' at the backlog is complicated
  - Consumer Groups == 1 thread per partition
    - If expensive operations can't throw more threads at it
- Not a lot of 'real world' examples on balancing # of topics vs. # of partitions

Why is Kafka Interesting?

Memory Mapped Files

Kernel-space processing

What is a commit log? (thanks to LinkedIn for slide)



Brokers

- Lightweight, very fast message storing
- Writes messages to disk using kernel space NOT JVM
- Uses OS Pagecache
- Data is stored in flat files on disk, directory per topic and partition
- Handles the replication

Brokers continued

- Very low memory utilization – almost nothing is held in memory
- (Remember, Broker doesn't keep track of who has consumed a message)
- Handle TTL operations on data
- Drop a **file** when the data is too old

Why is Kafka Interesting?

Stuff just works

Producers and Consumers are about business logic

Consumer Use Case: batch loading

- Consumers don't have to be online all the time
- Wake up every hour, ask Kafka for events since last request
- Load into a database, push to external systems etc.
- Load into Hadoop (Stream if using MapR)

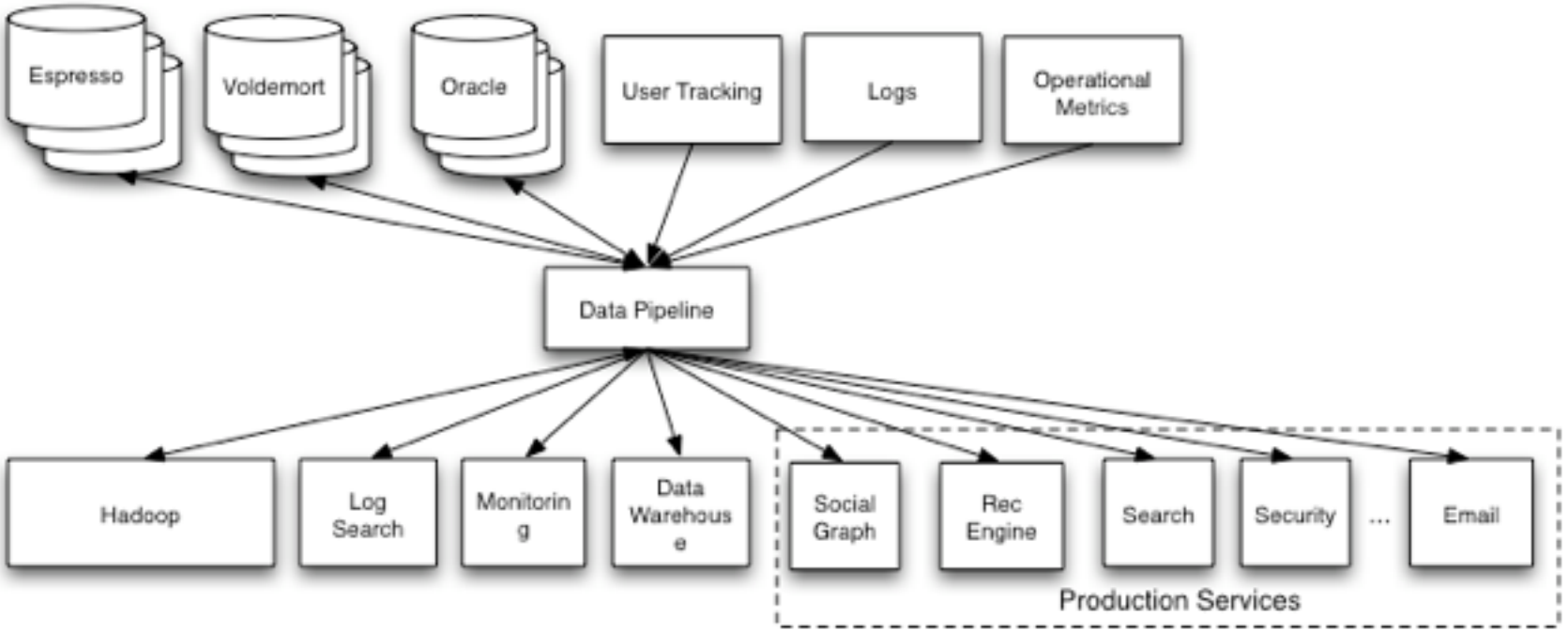
Consumer Use Case: Complex Event Processing

- Feed to Storm or similar CEP
- Partition on user id, subsystem, product etc. independent of Kafka's partition
- Execute rules on the data
- Made a mistake? Replay the events and fix it

Consumer Use Case: Operations Logs

- Load 'old' operational messages to debug problems
- Do it without impacting production systems (remember, consumers can start at any offset!)
- Have business logic write to different output store than production, but drive off production data

Adding New Business Logic (thanks to LinkedIn for slide)



Adding Producers

- Define Topics and # of partitions via Kafka tools
- (possibly tell Kafka to balance leaders across machines)
- Start producing

Adding Consumers

- Using Kafka adding consumers doesn't impact producers
- Minor impact on Brokers (just keeping track of connections)

Producer Code

```
public class TestProducer {
    public static void main(String[] args) {
        long events = Long.parseLong(args[0]);
        long blocks = Long.parseLong(args[1]);
        Random rnd = new Random();


        Properties props = new Properties();
        props.put("broker.list", "vrd01.atlnp1:9092,vrd02.atlnp1:9092,vrd03.atlnp1:9092");
        props.put("serializer.class", "kafka.serializer.StringEncoder");
        props.put("partitioner.class", "com.silverpop.kafka.playproducer.OrganizationPartitioner");
        ProducerConfig config = new ProducerConfig(props);


        Producer<Integer, String> producer = new Producer<Integer, String>(config);
          for (long nBlocks = 0; nBlocks < blocks; nBlocks++) {
            for (long nEvents = 0; nEvents < events; nEvents++) {
                long runtime = new Date().getTime();
                String msg = runtime + "," + (50 + nBlocks) + "," + nEvents+ "," + rnd.nextInt(1000);
                String key =  String.valueOf(orgId);
                KeyedMessage<Integer, String> data = new KeyedMessage<Integer, String>("test1", key, msg);
                producer.send(data);
            }
        }
        producer.close();
    }
}
```

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Simple Consumer Code

```
String topic = "test1";
 int partition = 0;
 SimpleConsumer simpleConsumer = new SimpleConsumer("vrd01.atlnp1", 9092,100000, 64 * 1024, "test");
 boolean loop = true;
 long maxOffset = -1;
 while (loop) {
    FetchRequest req = new FetchRequestBuilder().clientId("randomClient")
            .addFetch(topic, partition, maxOffset+1, 100000)
            .build();
    FetchResponse fetchResponse = simpleConsumer.fetch(req);
    loop = false;
    for (MessageAndOffset messageAndOffset : fetchResponse.messageSet(topic, partition)) {
       loop = true;
       ByteBuffer payload = messageAndOffset.message().payload();
       maxOffset = messageAndOffset.offset();
       byte[] bytes = new byte[payload.limit()];
       payload.get(bytes);
       System.out.println(String.valueOf(maxOffset) + ": " + new String(bytes, "UTF-8"));
    }
 }
 simpleConsumer.close();
```

Consumer Groups Code

```
// create 4 partitions of the stream for topic “test”, to allow 4 threads to consume
Map<String, List<KafkaStream<Message>>> topicMessageStreams =
    consumerConnector.createMessageStreams(ImmutableMap.of("test", 4));
List<KafkaStream<Message>> streams = topicMessageStreams.get("test");

// create list of 4 threads to consume from each of the partitions
ExecutorService executor = Executors.newFixedThreadPool(4);

// consume the messages in the threads
for(final KafkaStream<Message> stream: streams) {
  executor.submit(new Runnable() {
    public void run() {
      for(MessageAndMetadata msgAndMetadata: stream) {
        // process message (msgAndMetadata.message())
      }
    }
  });
}
```

Demo

- 4- node Kafka cluster
- 4 – node Storm cluster
- 4 – node MongoDB cluster
- Test Producer in IntelliJ creates website events into Kafka
- Storm-Kafka Spout reads from Kafka into Storm topology
  - Trident groups by organization and counts visits by day
- Trident end point writes to MongoDB
- MongoDB shell query to see counts change

LinkedIn Clusters (2012 presentation)

- 8 nodes per datacenter
  - ~20 GB RAM available for Kafka
  - 6TB storage, RAID 10, basic SATA drives
- 10,000 connections into the cluster for both production and consumption

Performance (LinkedIn 2012 presentation)

- 10 billion messages/day
- Sustained peak:
  - 172,000 messages/second written
  - 950,000 messages/second read
- 367 topics
- 40 real-time consumers
- Many ad hoc consumers
- 10k connections/colo
- 9.5TB log retained
- End-to-end delivery time: 10 seconds (avg)

Questions so far?

Something completely Different

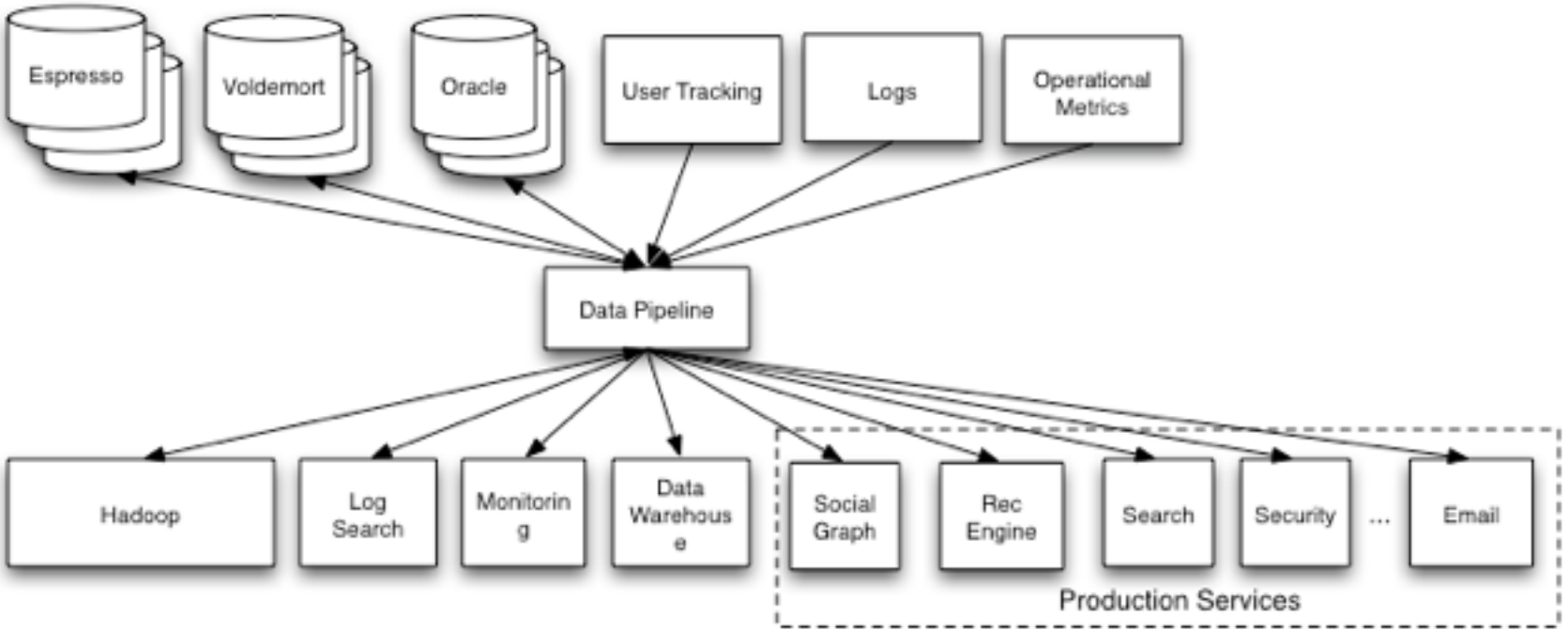
- Nathan Marz (twitter, BackType)
- Creator of Storm

Immutable Applications

- No updates to data
- Either insert or delete
- 'Functional Applications'

- http://manning.com/marz/BD_meap_ch01.pdf

(thanks to LinkedIn for slide)



Information

- Apache Kafka site: http://kafka.apache.org/
- List of presentations: https://cwiki.apache.org/confluence/display/KAFKA/Kafka+papers+and+presentations
- Kafka wiki: https://cwiki.apache.org/confluence/display/KAFKA/Index
- Paper: http://sites.computer.org/debull/A12june/pipeline.pdf
- Slides: http://www.slideshare.net/chriscurtin
- Me: ccurtin@silverpop.com @ChrisCurtin on twitter

Silverpop Open Positions

- Senior Software Engineer (Java, Oracle, Spring, Hibernate, MongoDB)
- Senior Software Engineer – MIS (.NET stack)
- Software Engineer
- Software Engineer – Integration Services (PHP, MySQL)
- Delivery Manager – Engineering
- Technical Lead – Engineering
- Technical Project Manager – Integration Services
- http://www.silverpop.com/marketing-company/careers/open-positions.html