Building LinkedIn’s Real-time Data Pipeline

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Recommendations	1 person has recommended Jay
Connections	**500+** connections
Websites	Blog
	Project Voldemort
	Apache Kafka

What is a data pipeline?

What data is there?

- Database data
- Activity data
  - Page Views, Ad Impressions, etc
- Messaging
  - JMS, AMQP, etc
- Application and System Metrics
  - Rrdtool, graphite, etc
- Logs
  - Syslog, log4j, etc

"One Size Fits All": An Idea Whose Time Has Come and Gone

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Abstract

The last 25 years of commercial DBMS development can be summed up in a single phrase: "One size fits all". This phrase refers to the fact that the traditional DBMS architecture (originally designed and optimized for business data processing) has been used to support many data-centric applications with widely varying

of multiple code lines causes various practical problems, including:

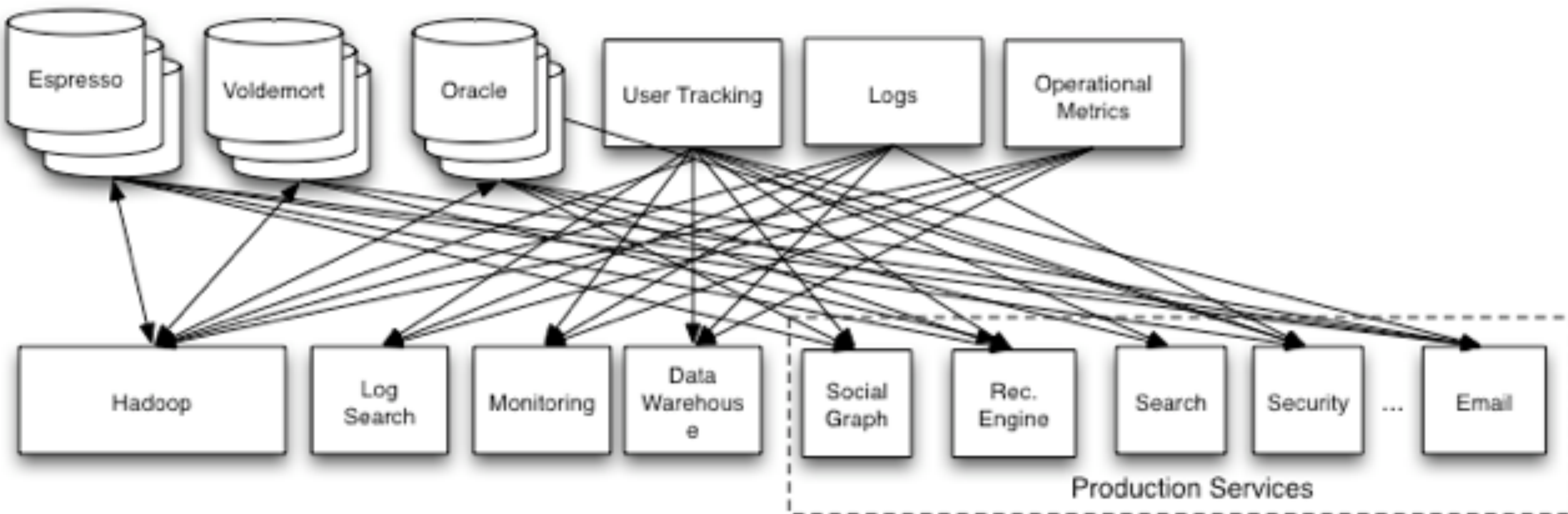
- *a cost problem*, because maintenance costs increase at least linearly with the number of code lines;
- *a compatibility problem*, because all applications have to run against every code line;
- *a sales problem*, because salespeople get confused

Data Systems at LinkedIn

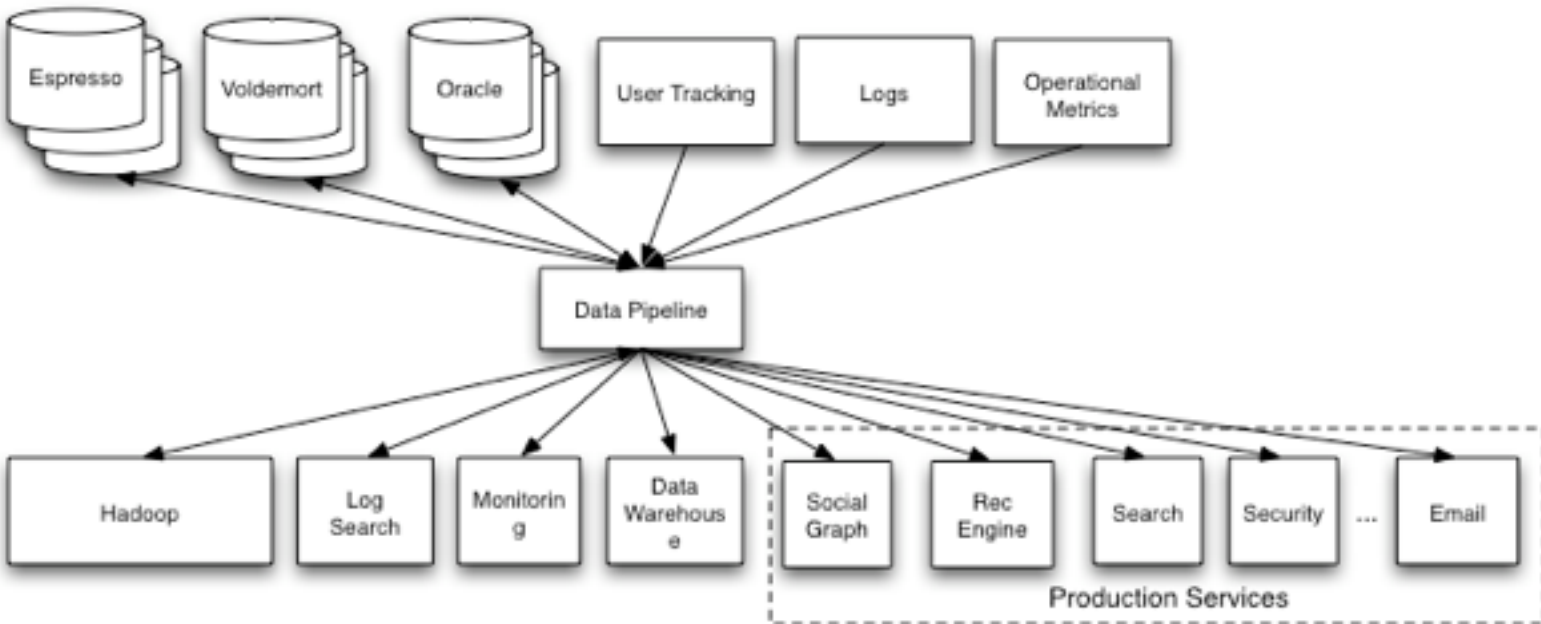
- Search
- Social Graph
- Recommendations
- Live Storage
- Hadoop
- Data Warehouse
- Monitoring Systems
- …

Problem: Data Integration

Point-to-Point Pipelines



Centralized Pipeline



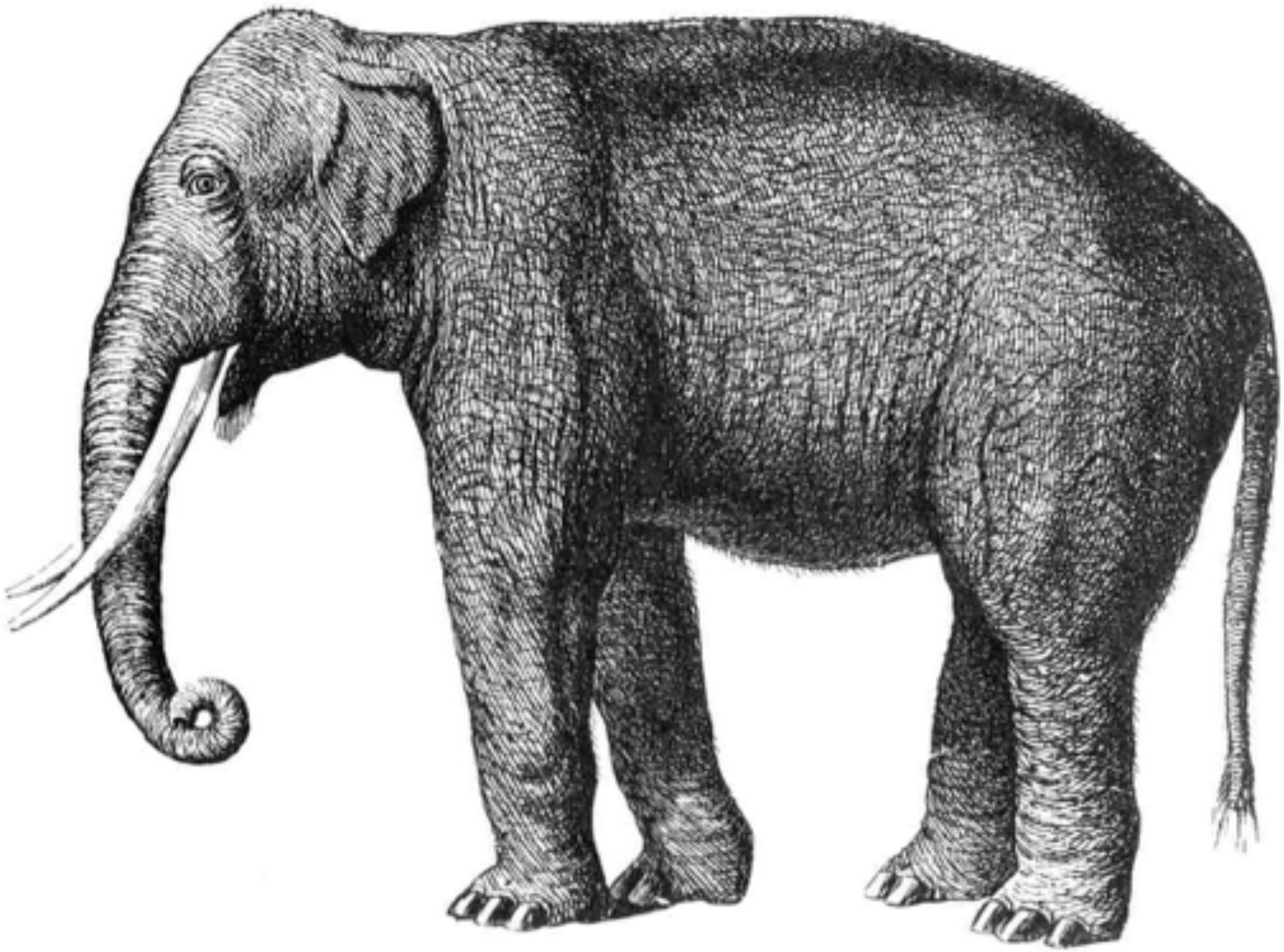
How have companies solved this problem?

The Enterprise Data Warehouse

Problems

- Data warehouse is a batch system
- Central team that cleans all data?
- One person’s cleaning…
- Relational mapping is non-trivial…

My Experience

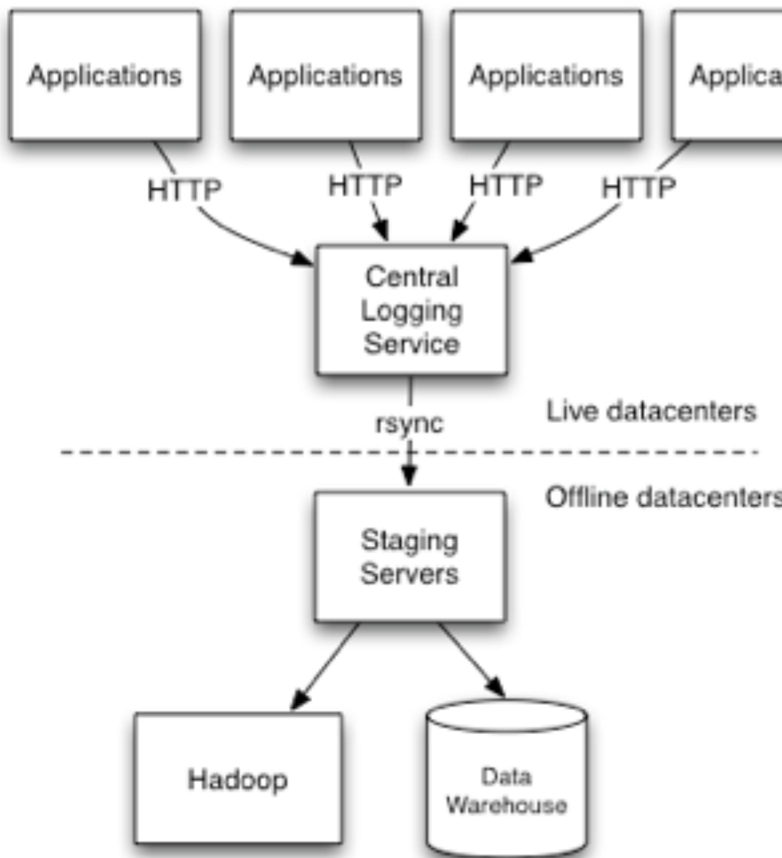


LinkedIn’s Pipeline

LinkedIn Circa 2010

- Messaging: ActiveMQ
- User Activity: In house log aggregation
- Logging: Splunk
- Metrics: JMX => Zenoss
- Database data: Databus, custom ETL

2010 User Activity Data Flow



Problems

- Fragility
- Multi-hour delay
- Coverage
- Labor intensive
- Slow
- Does it work?

Four Ideas

1. Central commit log for all data
2. Push data cleanliness upstream
3. O(1) ETL
4. Evidence-based correctness

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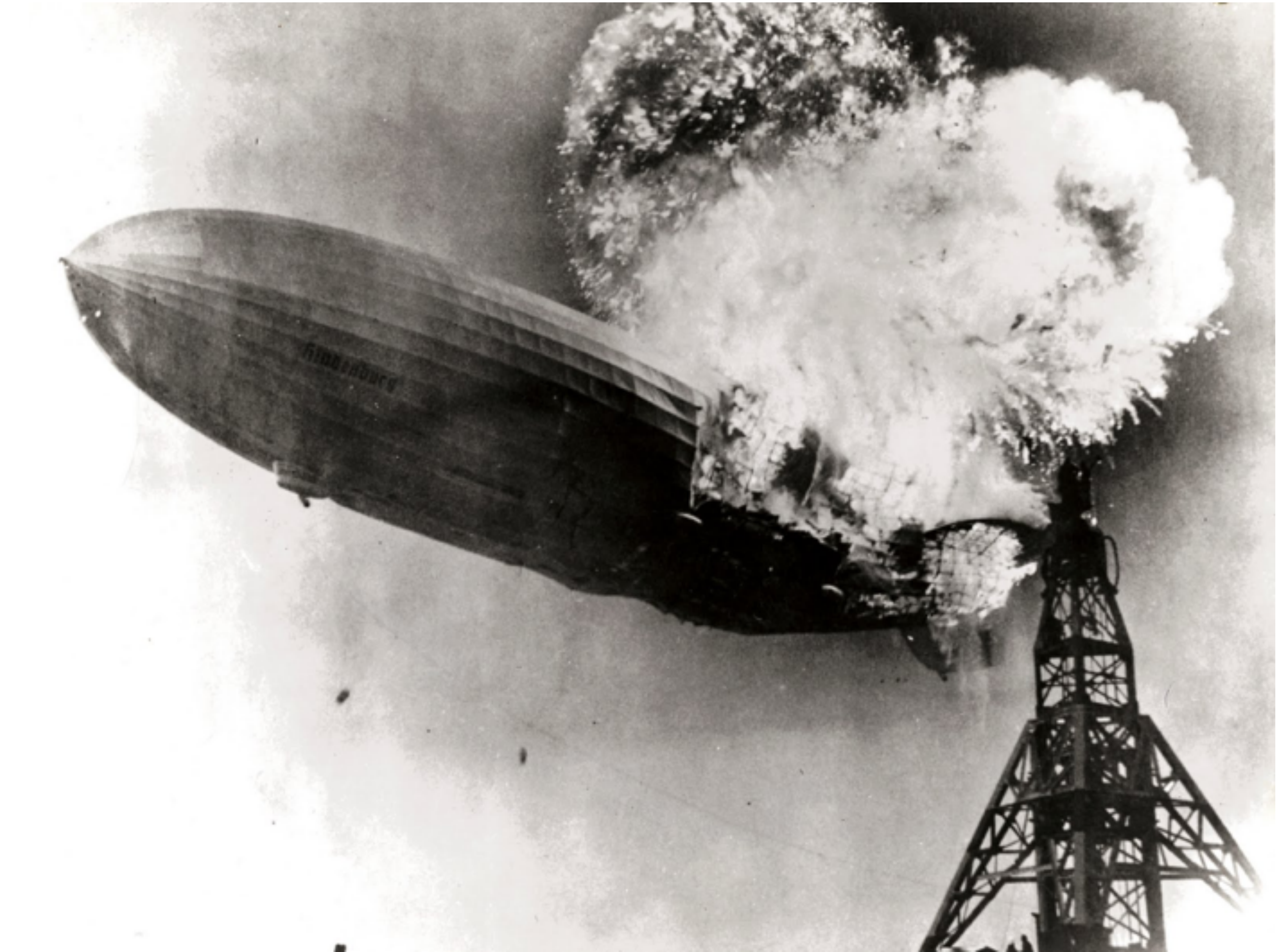
What kind of infrastructure is needed?

Very confused

- Messaging (JMS, AMQP, …)
- Log aggregation
- CEP, Streaming

First Attempt:
Don’t reinvent the wheel!



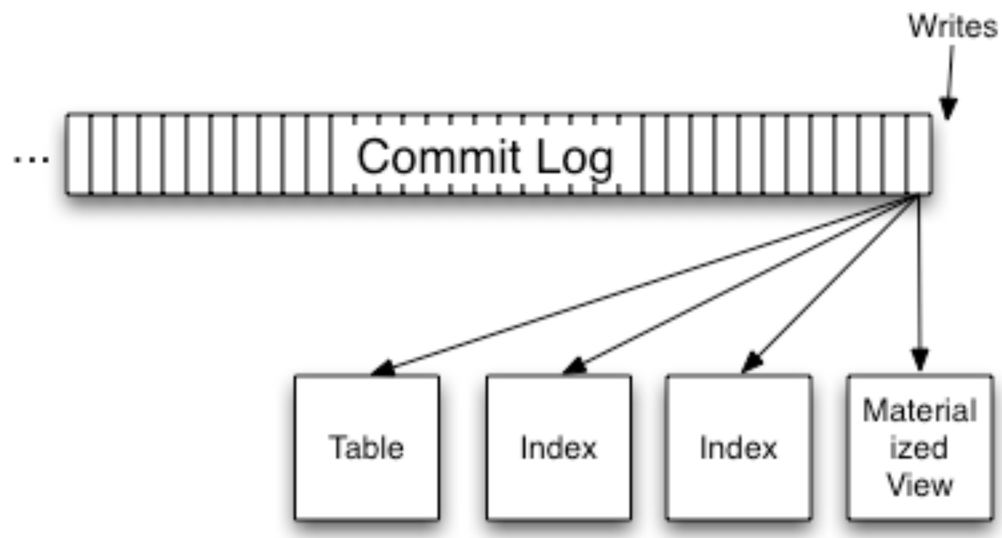
Problems With Messaging Systems

- Persistence is an afterthought
- Ad hoc distribution
- Odd semantics
- Featuritis

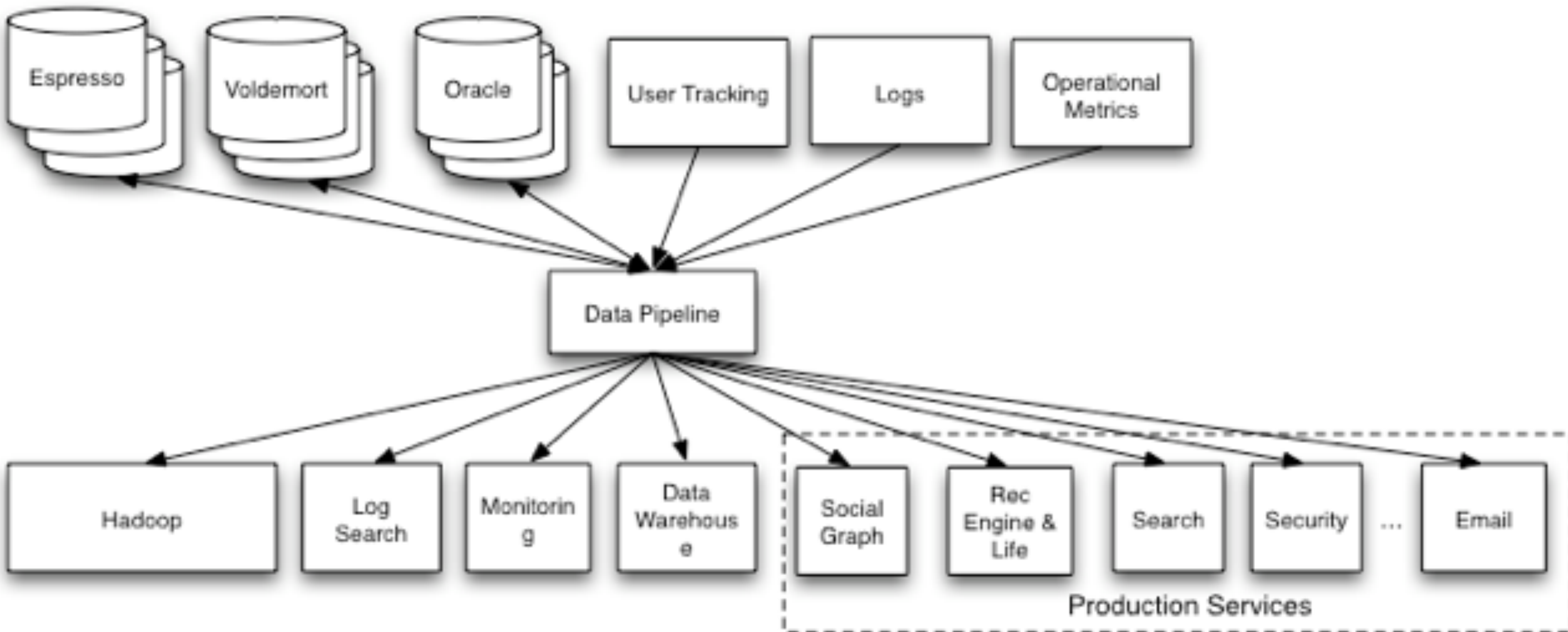
Second Attempt:
Reinvent the wheel!

Idea: Central, Distributed Commit Log

What is a commit log?



Data Flow



Espresso
Voldemort
Oracle
User Tracking
Logs
Operational Metrics
Data Pipeline
Hadoop
Log Search
Monitorin g
Data Warehous e
Social Graph
Rec Engine & Life
Search
Security
...
Email
Production Services

Apache Kafka

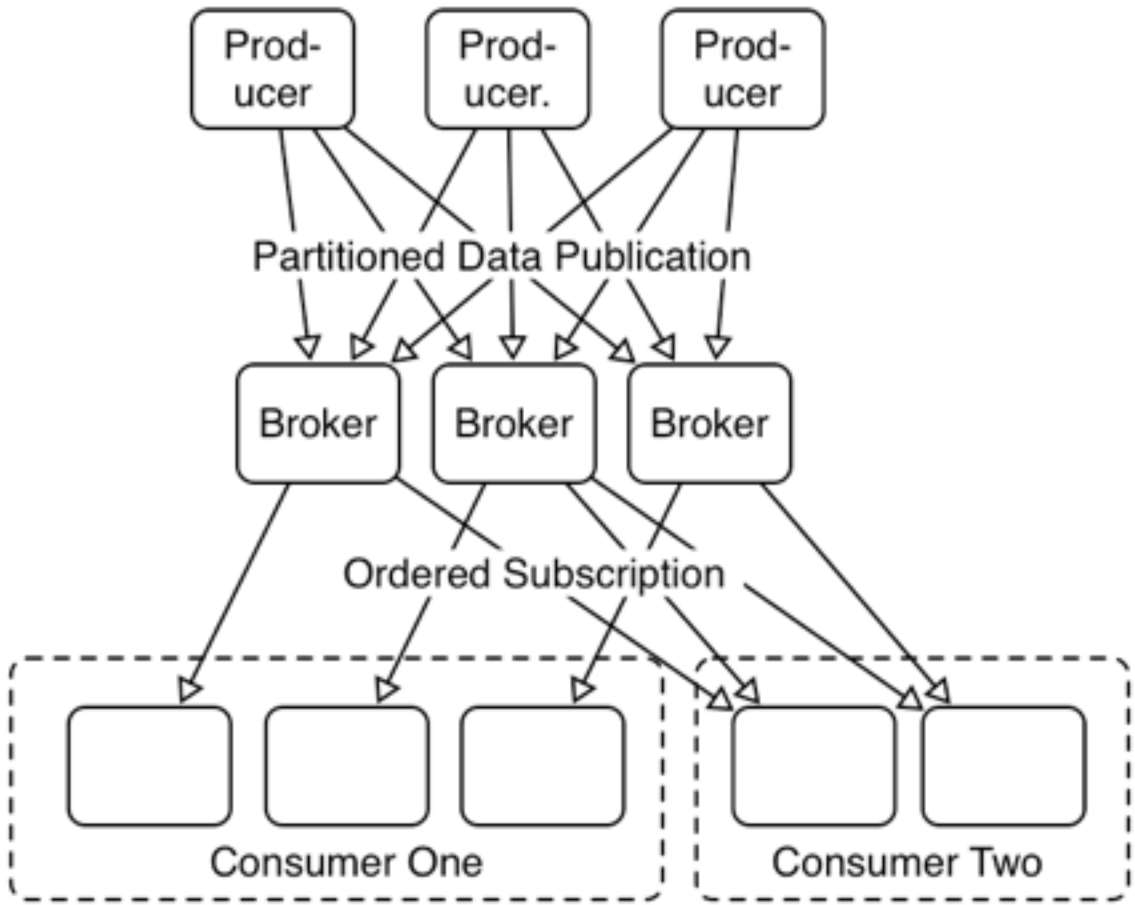
Some Terminology

- Producers send messages to Brokers
- Consumers read messages from Brokers
- Messages are sent to a Topic
- Each topic is broken into one or more ordered partitions of messages

APIs

- send(String topic, String key, Message message)
- Iterator<Message>

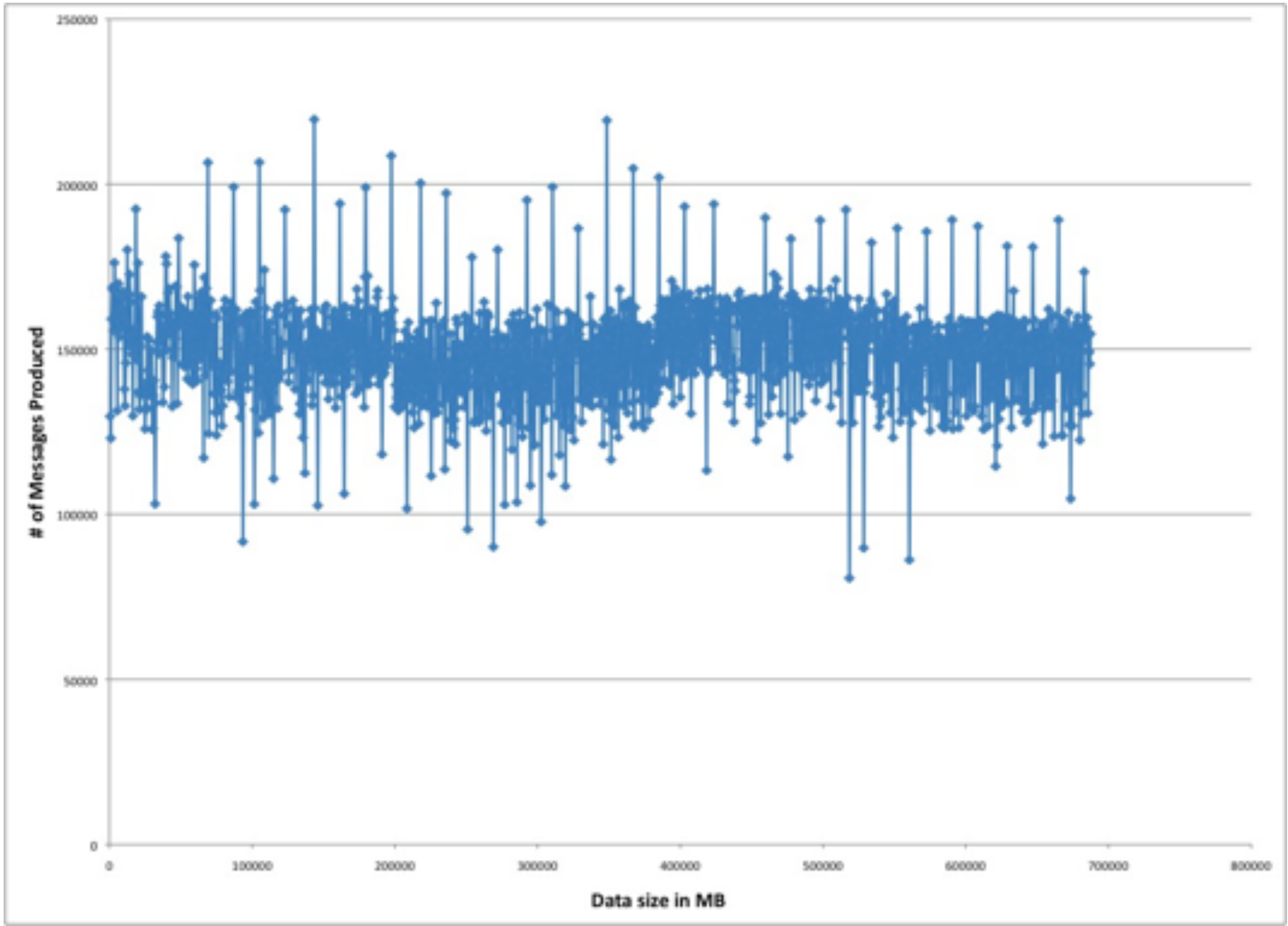
Distribution



Performance

- 50MB/sec writes
- 110MB/sec reads

Performance



Performance Tricks

- Batching
  - Producer
  - Broker
  - Consumer
- Avoid large in-memory structures
  - Pagecache friendly
- Avoid data copying
  - sendfile
- Batch Compression

Kafka Replication

- In 0.8 release
- Messages are highly available
- No centralized master

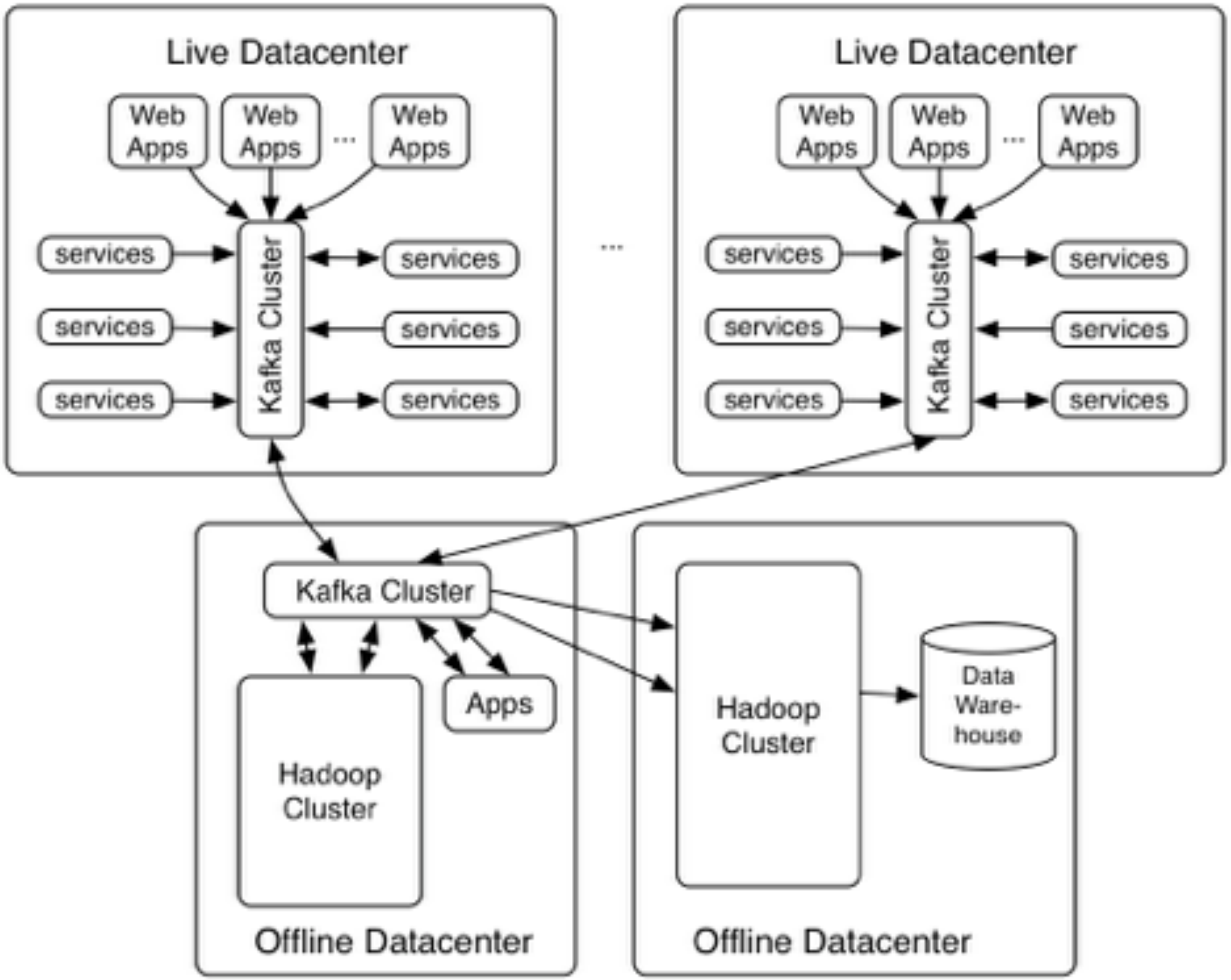
Kafka Info

http://incubator.apache.org/kafka

Usage at LinkedIn

- 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)

Datacenters



Four Ideas

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Problem

- Hundreds of message types
- Thousands of fields
- What do they all mean?
- What happens when they change?

Make activity data part of the domain model

Schema free?

```
LOAD 'student' USING PigStorage()
AS (name:chararray, age:int, gpa:float)
```

Schemas

- Structure can be exploited
  - Performance
  - Size
- Compatibility
- Need a formal contract

Avro Schema

- Avro – data definition and schema
- Central repository of all schemas
- Reader always uses same schema as writer
- Programatic compatibility model

Workflow

1. Check in schema
2. Code review
3. Ship

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Hadoop Data Load

- Map/Reduce job does data load
- One job loads all events
- Hive registration done automatically
- Schema changes handled transparently
- ~5 minute lag on average to HDFS

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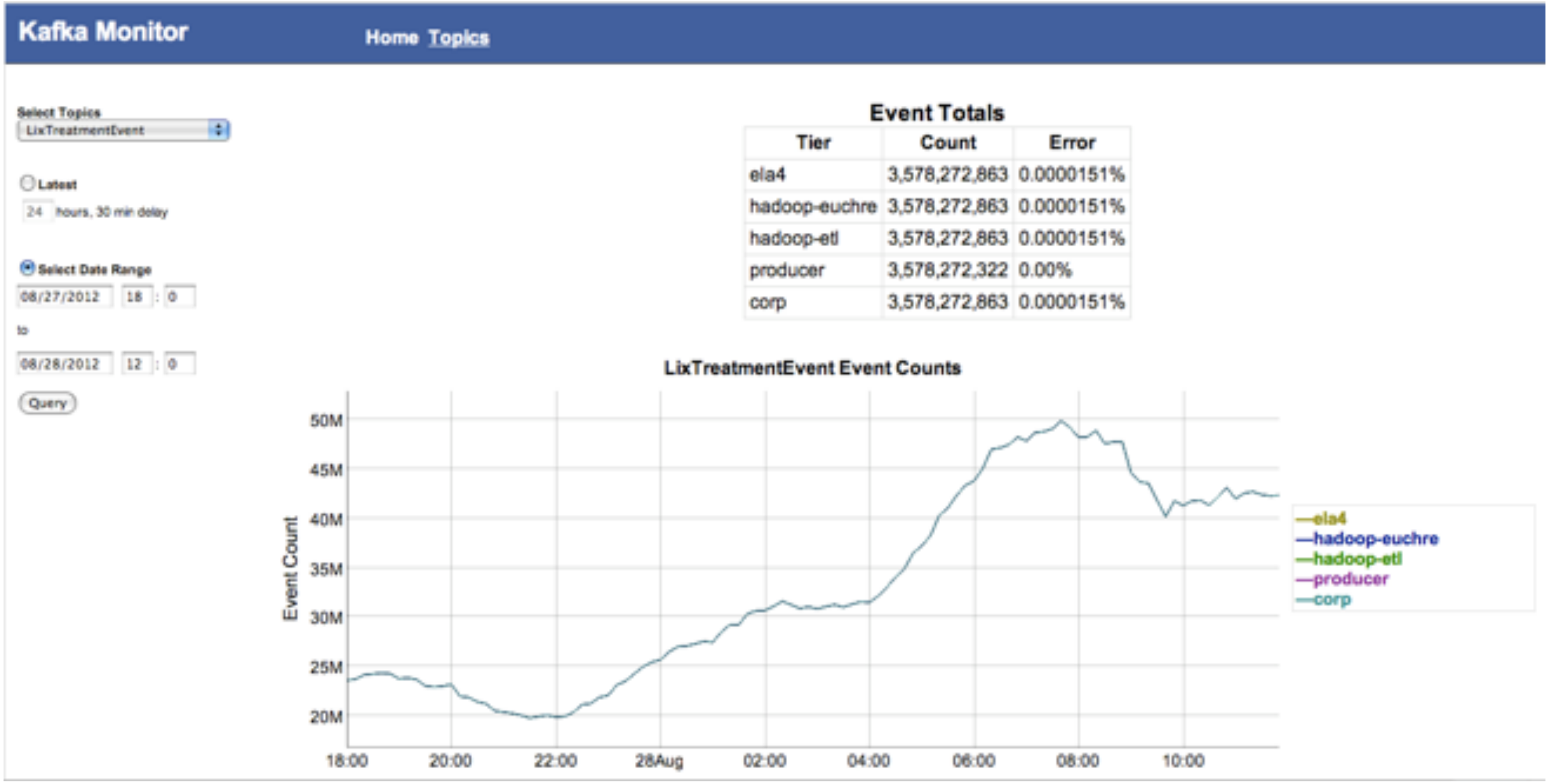
Does it work?

All messages sent must be delivered to all consumers (quickly)

Audit Trail

- Each producer, broker, and consumer periodically reports how many messages it saw
- Reconcile these counts every few minutes
- Graph and alert

Audit Trail


Kafka Monitor
Home Topics
Select Topics
LixTreatmentEvent
Latest
24 hours, 30 min delay
Select Date Range
08/27/2012 18 : 0
to
08/28/2012 12 : 0
Query
Event Totals
Tier Count Error
ela4 3,578,272,863 0.0000151%
hadoop-euchre 3,578,272,863 0.0000151%
hadoop-etl 3,578,272,863 0.0000151%
producer 3,578,272,322 0.00%
corp 3,578,272,863 0.0000151%
LixTreatmentEvent Event Counts
Event Count
50M
45M
40M
35M
30M
25M
20M
18:00
20:00
22:00
28Aug
02:00
04:00
06:00
08:00
10:00
—ela4
—hadoop-euchre
—hadoop-etl
—producer
—corp

Questions?