AWS re:Invent

Unmeltable Infrastructure at Scale:
Using Apache Kafka, Twitter Storm, and ElasticSearch on AWS

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amazon web services

What Loggly Does

- Log Management as a service
  - Near real-time indexing of events
- Distributed architecture, built on AWS
- Initial production services in 2010
  - Loggly Generation 2 released in Sept 2013
- Thousands of customers

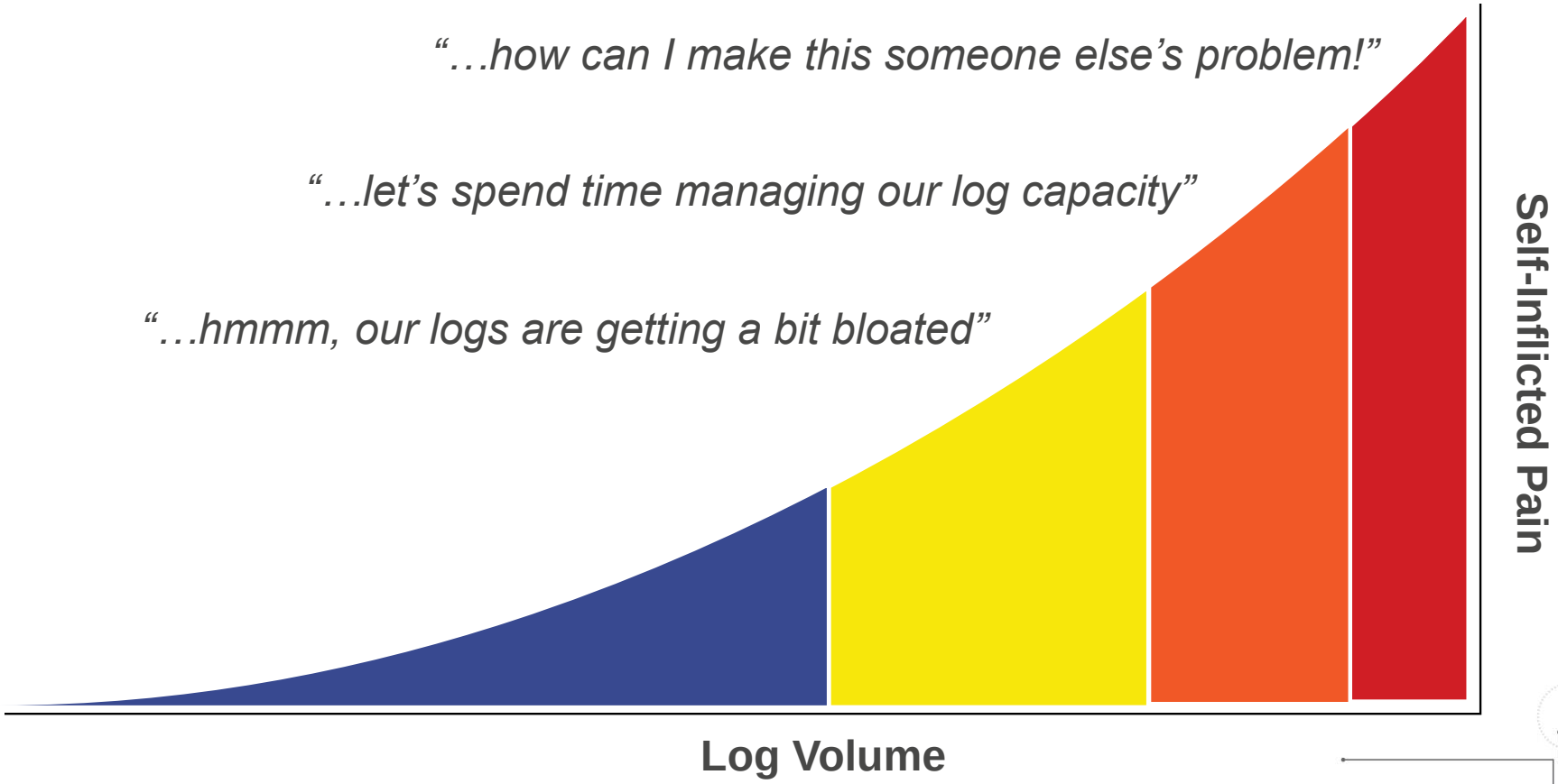
Agenda for this Presentation

- A bit about logging
- Lessons learned from our first generation
- How we leverage AWS services
- Our use of Kafka, Storm, ElasticSearch
- What worked well for us and what did not

Log Management

- Everyone starts with …
  - A bunch of log files (syslog, application specific)
  - On a bunch of machines

- Management consists of doing the simple stuff
  - Rotate files, compress and delete
  - Information is there but awkward to find specific events
  - Weird log retention policies evolve over time

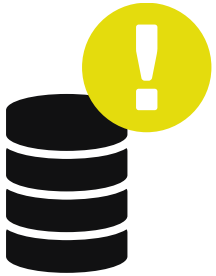

"…how can I make this someone else's problem!"
"…let's spend time managing our log capacity"
"…hmmm, our logs are getting a bit bloated"
Self-Inflicted Pain
Log Volume

Best Practices in Log Management

- Use existing logging infrastructure
  - Real time syslog forwarding is built in
  - Application log file watching
- Store logs externally
  - Accessible when there is a system failure
- Log messages in machine parsable format
  - JSON encoding when logging structured information
  - Key-value pairs

From the Trenches…

- Managing Applications vs. Managing Logs
  - Do not make this is an either/or proposition!



If you get a disk space alert, first login…

```
% sudo rm –rf /var/log/apache2/*
```

Admit it, we've all seen this kind of thing!

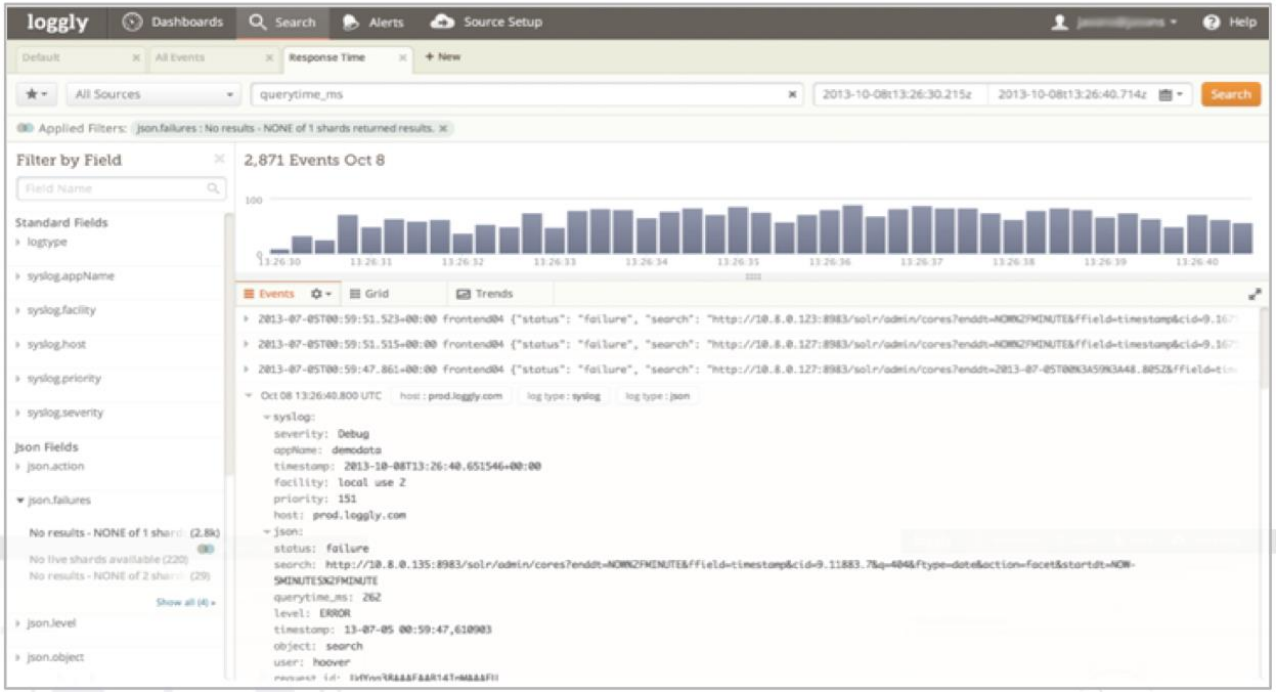
You Have Logs...

```
2013-10-25T18:35:43.387+0000: 441.482: [GC [PSYoungGen: 2430541K->268617K(2484544K)] 7687523K->5660738K(8076992K), 0.3266870 secs] [Times: user=1.05 sys=0.17, real=0.33 secs]
2013-10-25T18:35:43.714+0000: 441.809: [Full GC [PSYoungGen: 268617K->0K(2484544K)] [ParOldGen: 5392121K->354965K(5592448K)] 5660738K->354965K(8076992K) [PSPermGen: 44444K->44395K(83968K)], 0.9225290 secs] [Times: user=2.22 sys=0.26, real=0.92 secs]
```

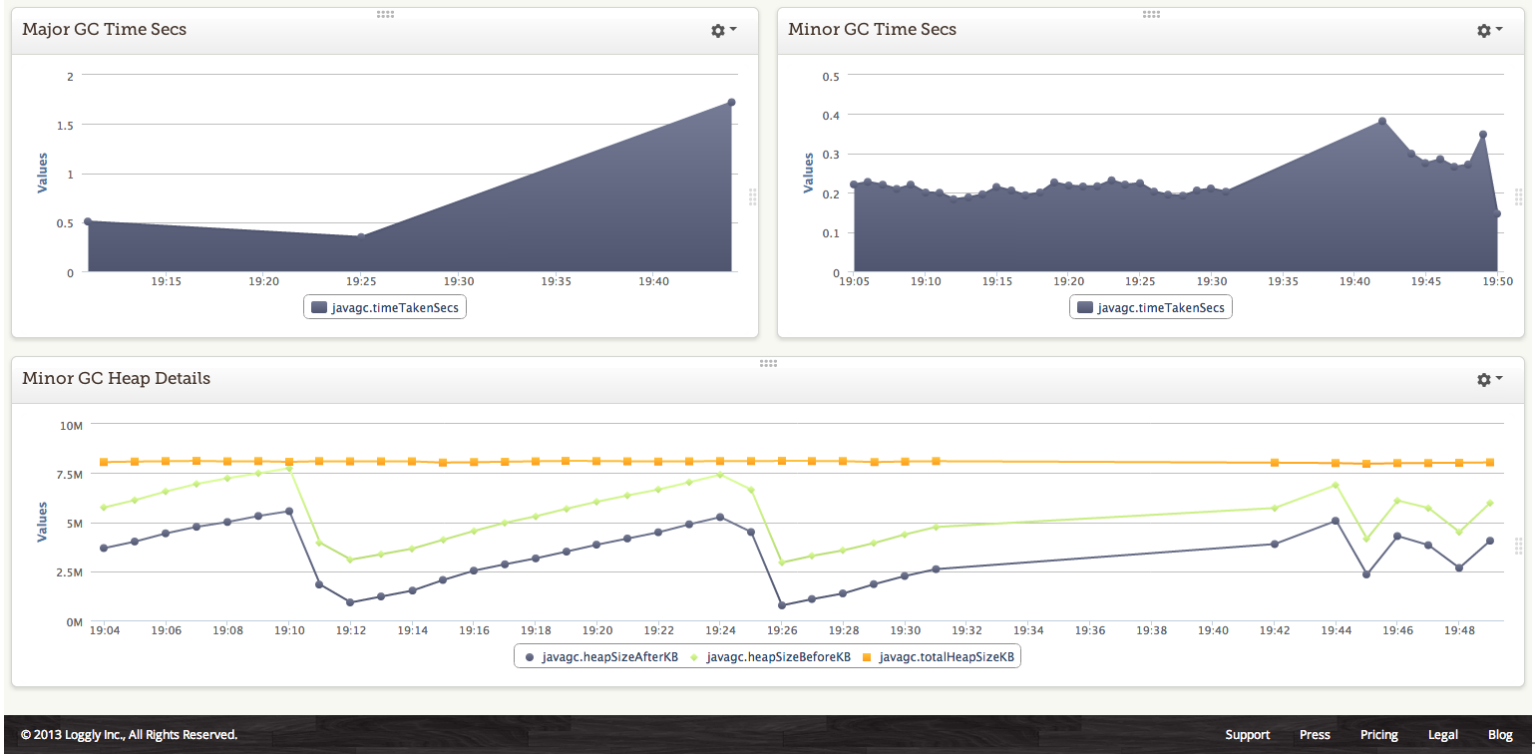
- In this case, JVM garbage collection logs enabled with…

```
-XX:+PrintGCDetails -XX:+PrintGCDateStamps -XX:+PrintGCTimeStamps
```

Yes, you need to search these logs



But you also need to to spot trends



Loggly Offers Logging as a Service

Loggly First Generation

- Logging as a service
  - Near real-time searchable logs
- Thousands of customers
  - Transmission rates from 10 events/sec to 100k events/sec
  - When customers systems are busy they send more logs
  - Log traffic has distinct bursts; bursts can last for several hours
- Amazon EC2 deployment
  - We used EC2 Instance storage
- SOLR Cloud
  - Full power of Lucene search
  - Tens of thousands of shards (with special ‘sleep shard’ logic)
- ZeroMQ for message queue

First Generation Lessons Learned

- Event ingestion too tightly coupled to indexing
  - Manual re-indexing for temporary SOLR issues
- Multiple Indexing strategies needed
  - 4 orders of magnitude difference between our high volume users and our low volume users (10 eps vs. 100,000+ eps)
  - Too much system overhead for low volume users
  - Difficult to support changing indexing strategies for a customer

Big Data Infrastructure Solutions

We are not alone…

- Our challenges
  - Massive incoming event stream
  - Fundamentally multi-tenant
  - Scalable framework for analysis
  - Near real-time indexing
  - Time series index management

Apache Kafka

- Overview
  - An Apache project initially developed at LinkedIn
  - Distributed publish-subscribe messaging system
  - Specifically designed for real time activity streams
  - Does not follow JMS Standards nor uses JMS APIs

- Key Features
  - Persistent messaging
  - High throughput, low overhead
  - Uses ZooKeeper for forming a cluster of nodes
  - Supports both queue and topic semantics

Message Queue Performance

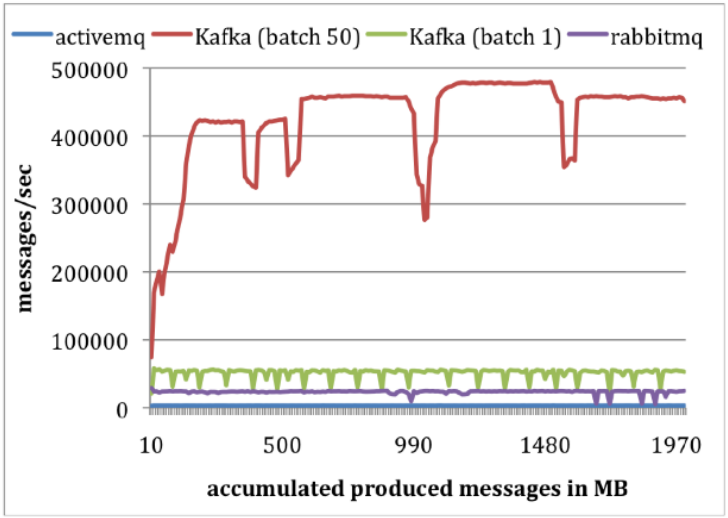


Figure 4. Producer Performance

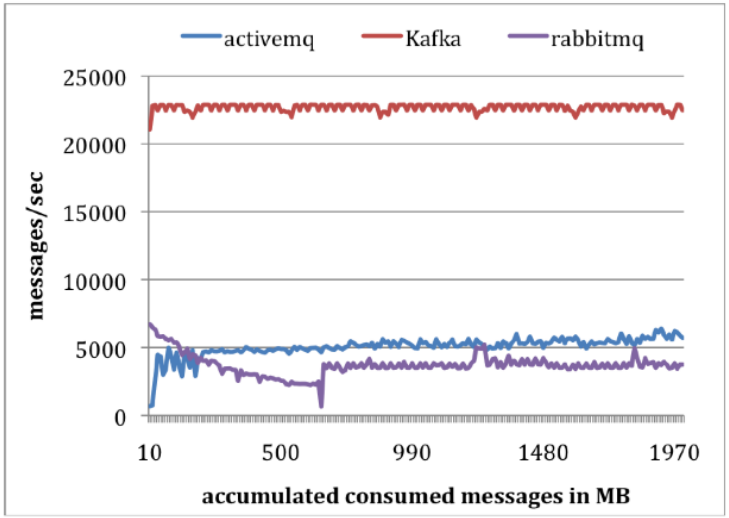


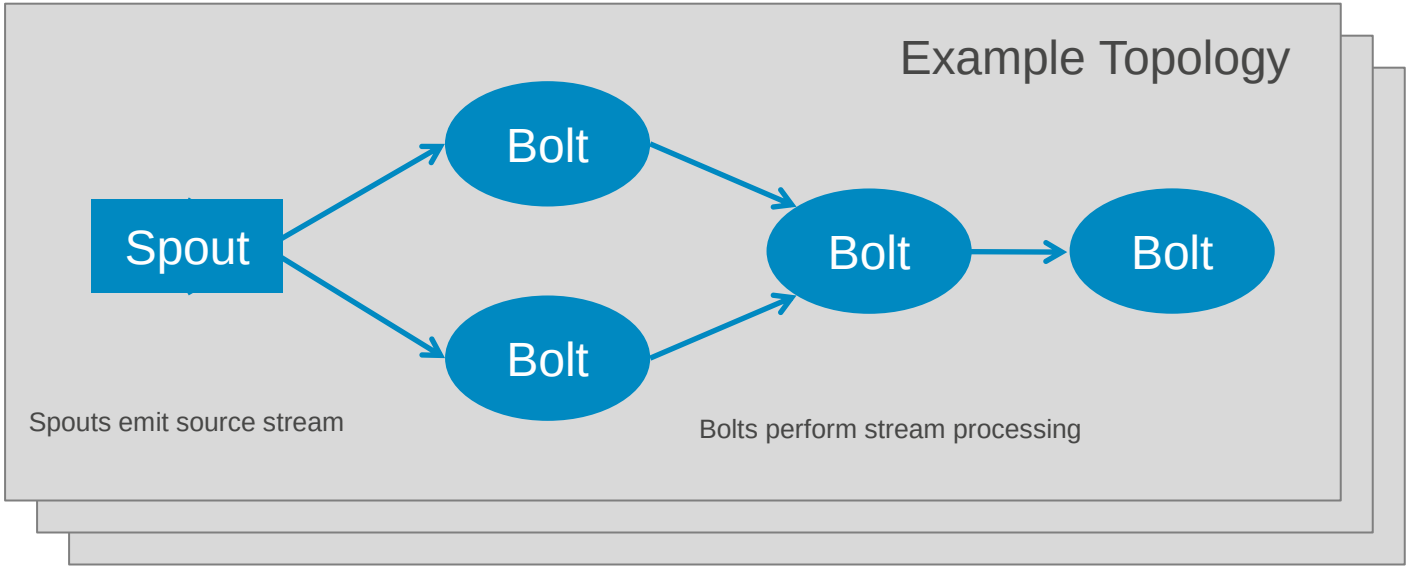
Figure 5. Consumer Performance

http://research.microsoft.com/en-us/um/people/srikanth/netdb11/netdb11papers/netdb11-final12.pdf

Storm Framework

- Storm (open sourced by Twitter)
  - Open sourced September 2011
  - Now an Apache Software Foundation project
    - Currently Incubator Status
- Framework is for stream processing
  - Distributed
  - Fault tolerant
  - Computation
  - Fail-fast components

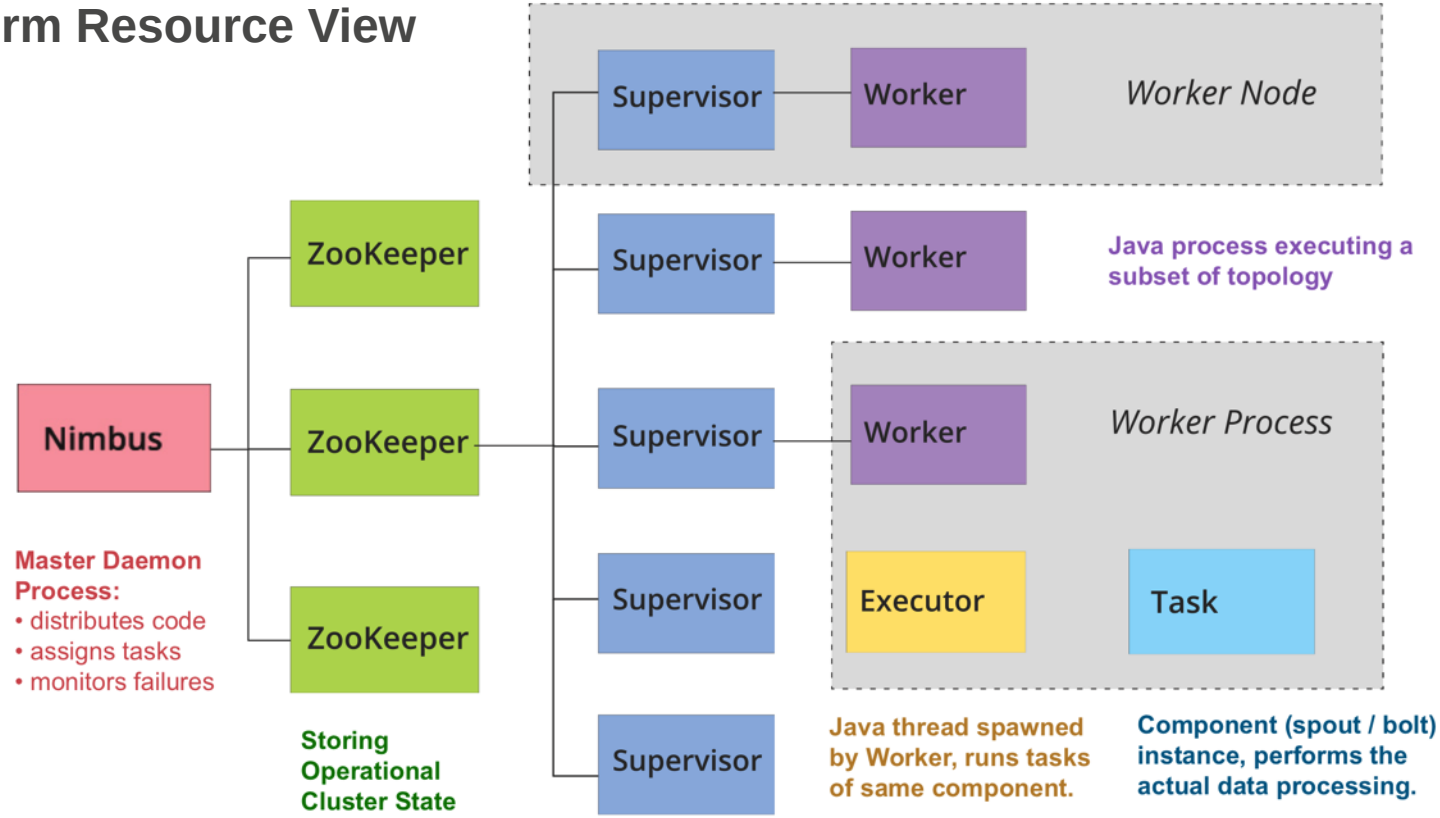
Storm Logical View



Storm terminology

- Streams, Spouts, Bolts, Tasks, Workers, Stream Groups and Topologies

Storm Resource View



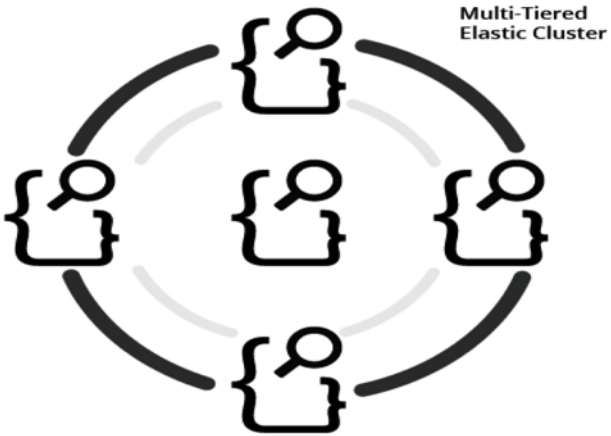
ElasticSearch

- Open source
  - Commercial support available from ElasticSearch.com
  - Growing open-source community

- Distributed search engine
- Fully exposes Lucene search functionality
- Built for clustering from the ground-up
- High availability
- Multi-tenancy

ElasticSearch In Action

- Add/delete nodes dynamically
- Add indices with REST API
- Indices and Nodes have attributes
  - Indices automatically moved to best Nodes
- Indices can be sharded
- Supports bulk insertion of events
- Plugins for monitoring cluster



Our Second Generation

Generation 2 – The Challenge

- Always accept log data
  - Never make a customer's incident worse
- Never drop log data
  - A single log message could be critical
- True Elasticity

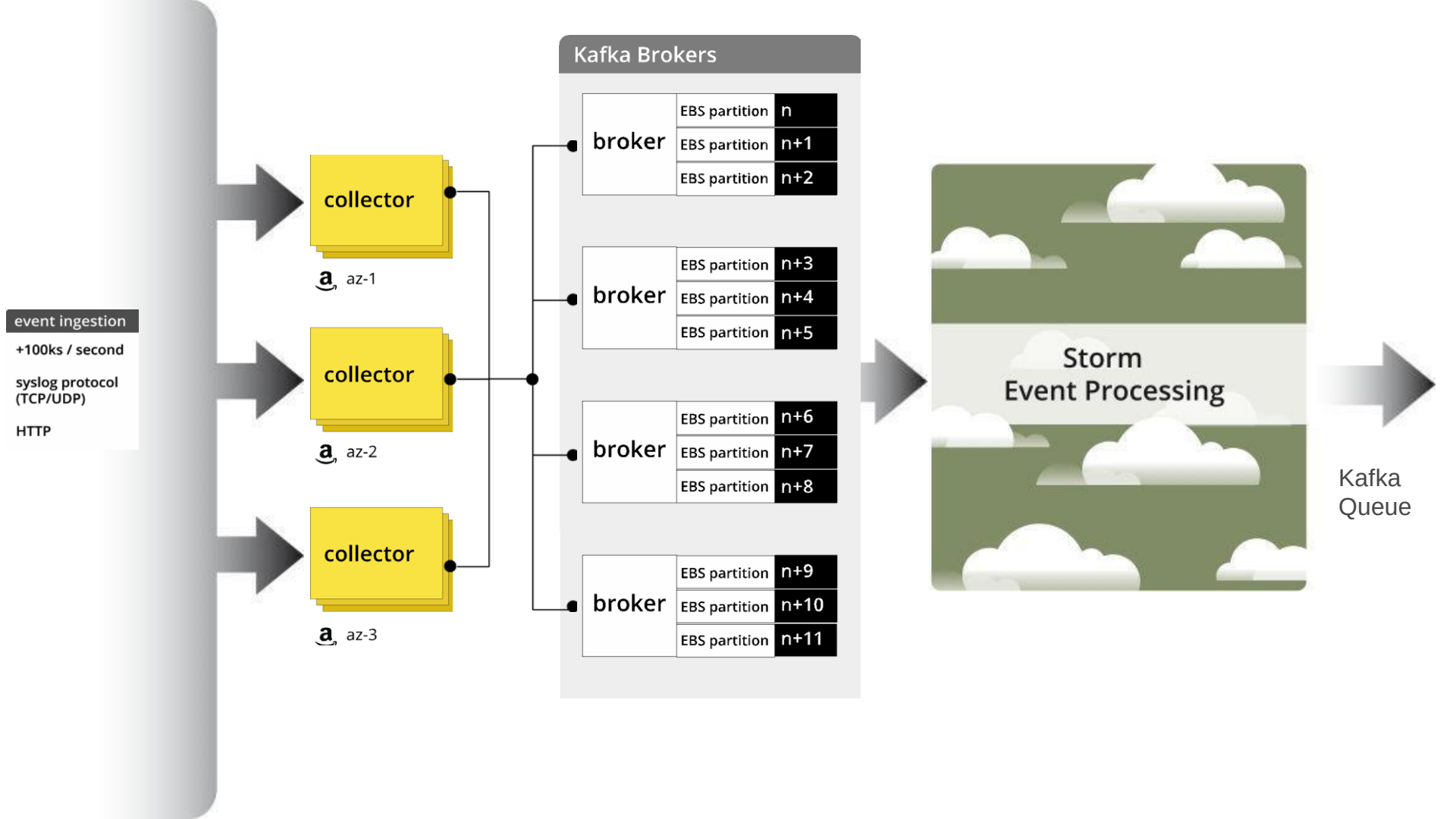
Perfect Match For Real Time Log Events

- Apache Kafka
  - Extremely high-performance pub-sub persistent queue
- Consumer tracks their location in queue
  - A good fit for our use cases
- Multiple Kafka brokers
  - Good match for AWS
    - Multiple brokers per region
    - Availability Zone separation

Real Time Event Processing

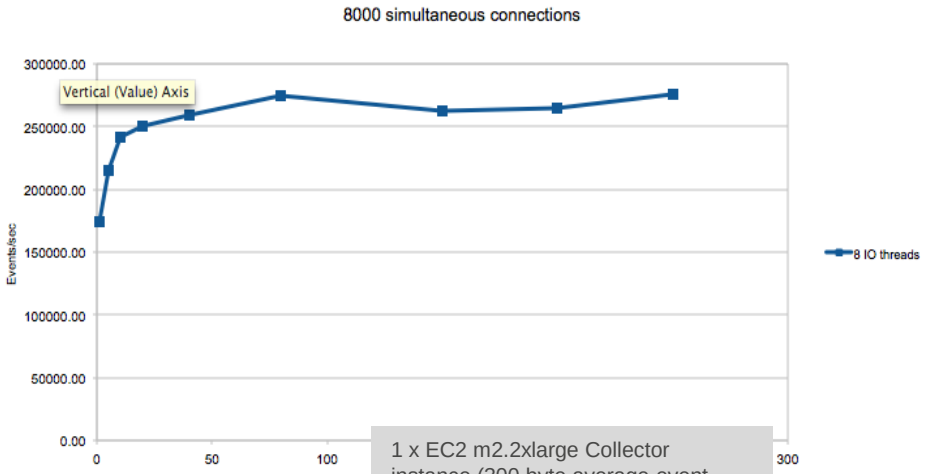
- Twitter Storm
  - Scalable real-time computation system
- Storm used as a “pull” system
  - Provisioned for average load, not peak load
  - Input from Kafka queue
    - Worker nodes can be scaled dynamically
- Elasticity is key
  - Another good match for AWS
    - Able to scale workers up and down dynamically

Log Event Ingestion


event ingestion
+100ks / second
syslog protocol (TCP/UDP)
HTTP
collector
az-1
collector
az-2
collector
az-3
Kafka Brokers
broker
EBS partition n
EBS partition n+1
EBS partition n+2
broker
EBS partition n+3
EBS partition n+4
EBS partition n+5
broker
EBS partition n+6
EBS partition n+7
EBS partition n+8
broker
EBS partition n+9
EBS partition n+10
EBS partition n+11
Storm
Event Processing
Kafka
Queue

Loggly Collector Performance

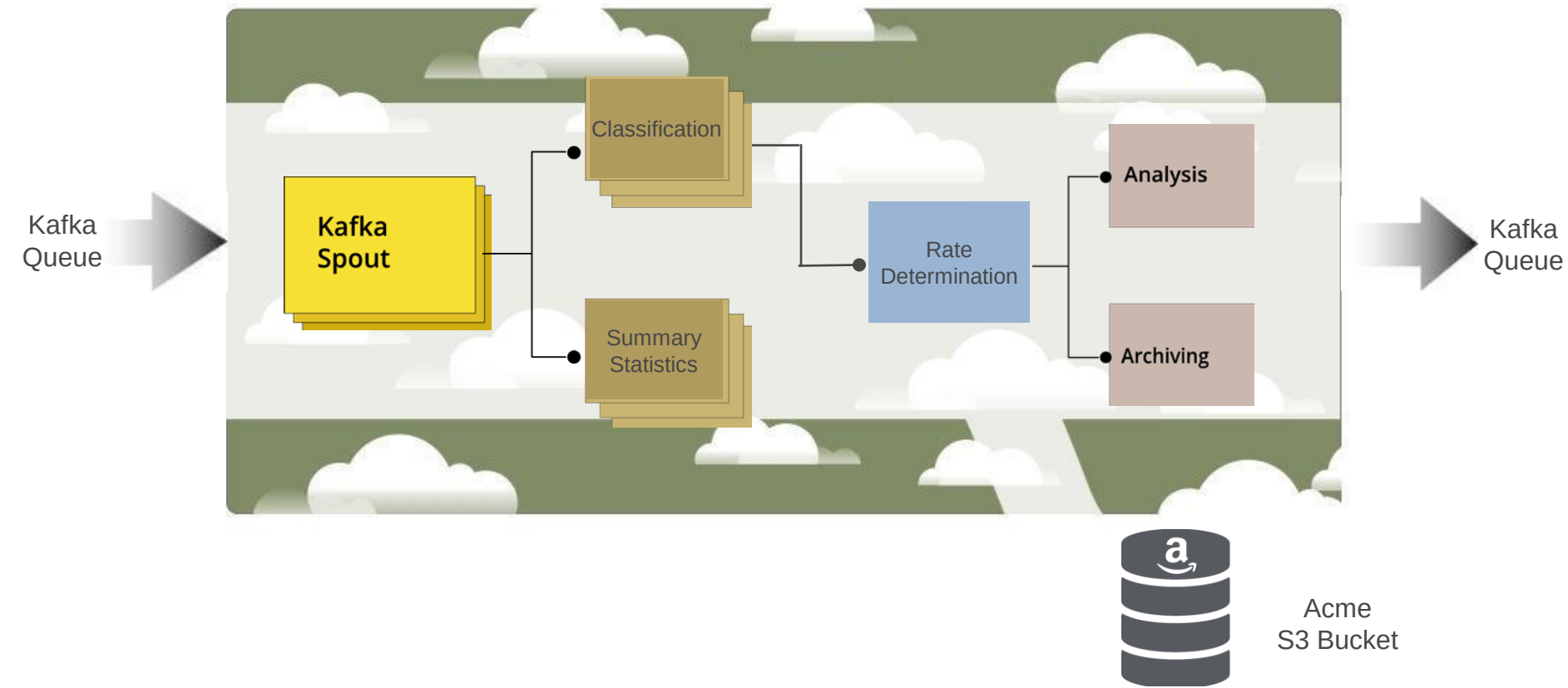
- C++ multi-threaded
- Boost ASIO framework
- Each Collector can handle 250k+ events per second
  - Per m2.2xlarge instance



1 x EC2 m2.2xlarge Collector instance (300 byte average event size).

Processing Events

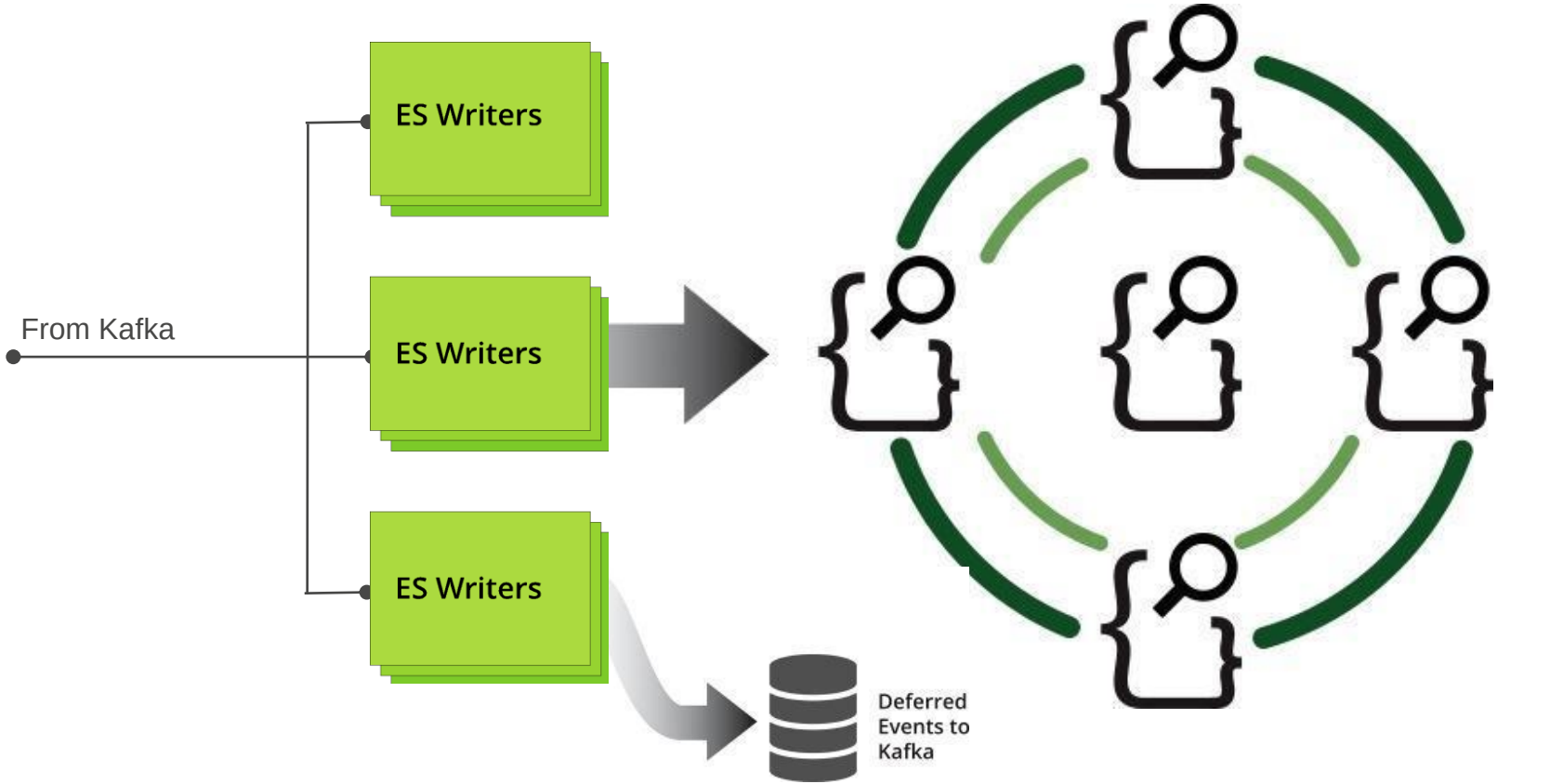
Storm Event Processing



Event Pipeline in Summary

- Storm provides *Complex Event Processing*
  - Where we run much of our secret-sauce
- Kafka contains both raw *and* processed Events
- Snapshot the last day of Kafka events to S3

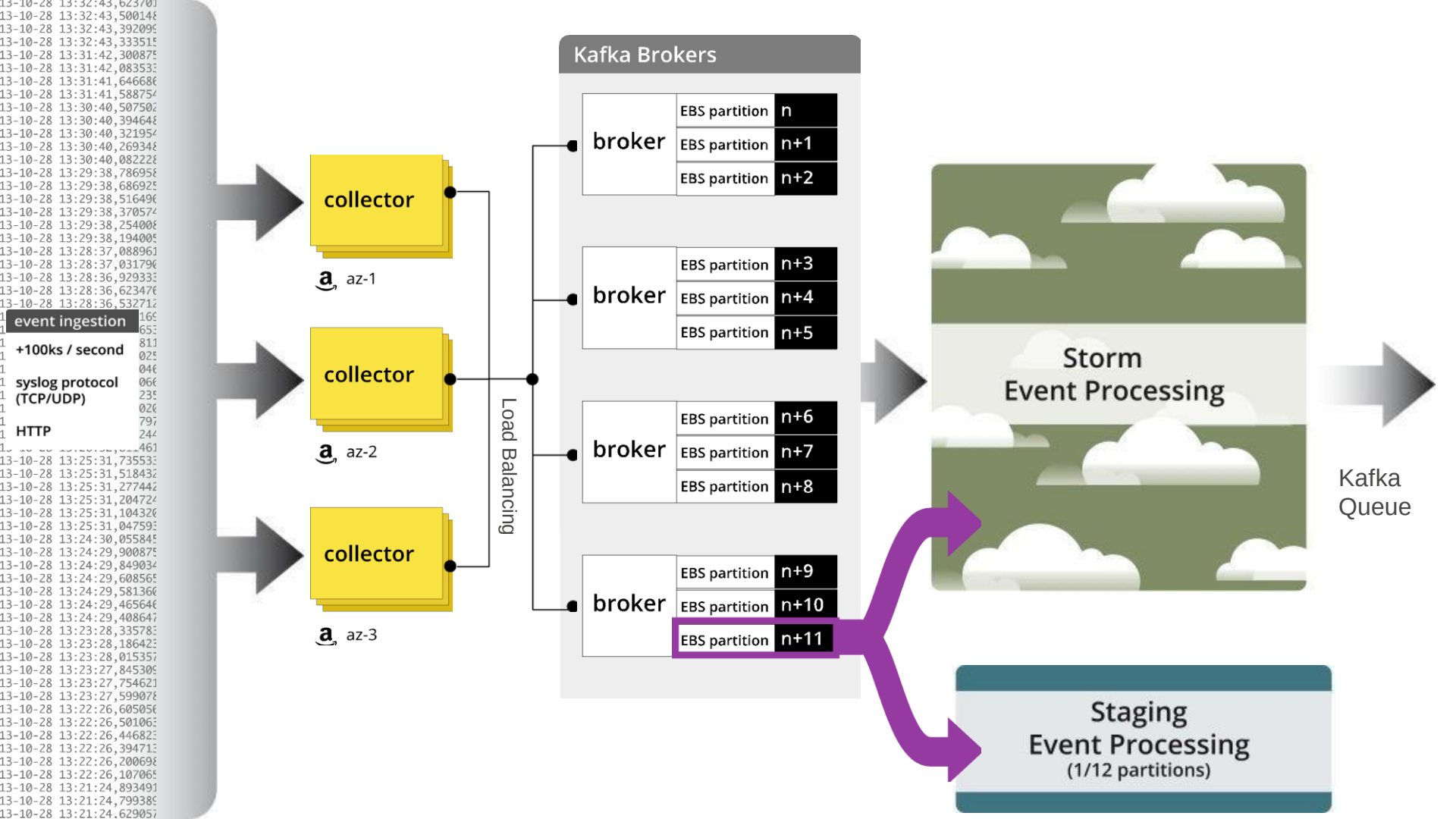
Elastic Search Clusters



Loggly and Index Management

- Indices are time-series data
  - Separated by customer
  - Represent slices of time
    - Higher volume index will have shorter time slice
- Multi-tier architecture for efficient indexing
  - Multiple indexing tiers mapped to different AWS instance types
- Efficient use of AWS resources

Staging Pre-Production System


event ingestion
+100ks / second
syslog protocol (TCP/UDP)
HTTP
collector
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Load Balancing
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broker
EBS partition n+3
EBS partition n+4
EBS partition n+5
broker
EBS partition n+6
EBS partition n+7
EBS partition n+8
broker
EBS partition n+9
EBS partition n+10
EBS partition n+11
Storm
Event Processing
Kafka
Queue
Staging
Event Processing
(1/12 partitions)

Kafka enables Staging Architecture

- Kafka Broker doesn’t care if there are multiple consumers
- Staging system runs pre-production code
- Pub-sub allows us to randomly index a fraction of our production load
- A highly-effective pre-production system

AWS Deployment Details

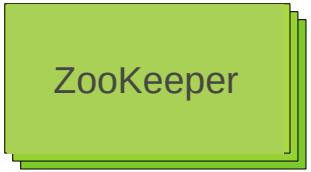
AWS Deployment Instances – Collection

c1.xlarge
- Compute-optimized
- High-traffic ingestion points
- Disk not important

m2.2xlarge
- Memory-optimized
- Disk buffer caching

4K Provisioned IOPs EBS
- Ensures consistent IO
- No noisy-neighbors
- Persistent storage

AWS Deployment Instances – Processing



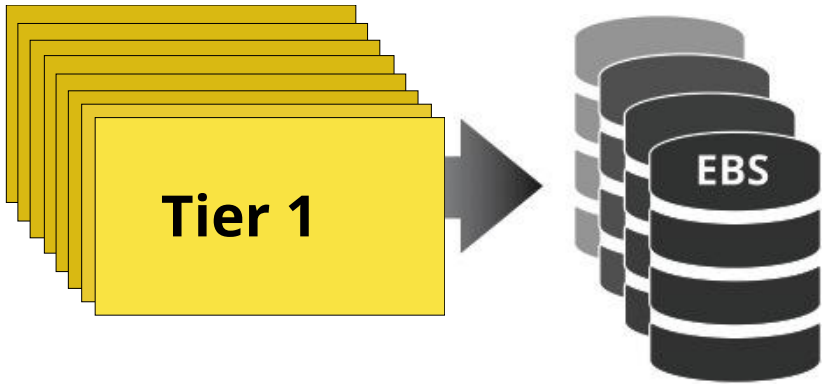
c1.xlarge

- Compute-optimized
- CPU-intensive processing
- Network IO

m1.xlarge

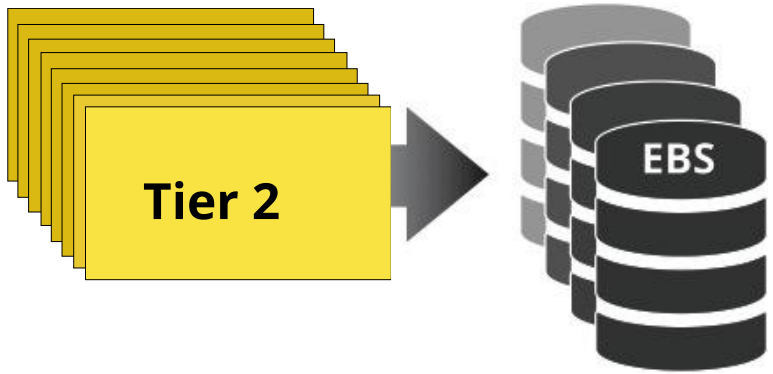
- General-purpose
- Configuration
- Management

AWS Deployment Instances – Indexing



cc2.8xlarge

- 4K Provisioned IOPs EBS



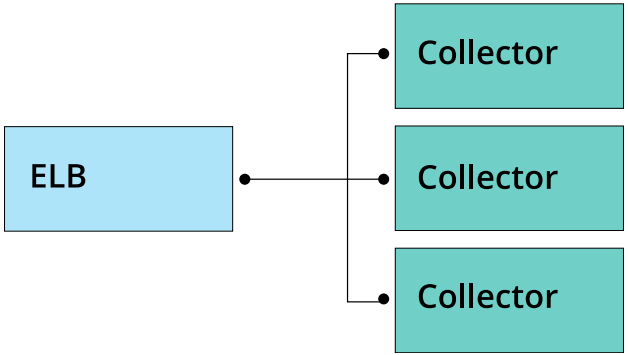
m2.4xlarge

- 4K Provisioned IOPs EBS

A Few False Starts

Elastic Load Balancing in front of Collector Had Limitations

- Initial testing used Elastic Load Balancing for incoming events:



- Elastic Load Balancing doesn't allow forwarding port 514 (syslog)
- Elastic Load Balancing doesn't support forwarding UDP
- Event traffic can burst and hit Elastic Load Balancing performance limits

Amazon Route 53 DNS Round Robin a Win

- DNS Round Robin is pretty basic load balancing
  - Not a bump in the wire
- Take advantage of AWS failover health checks
  - When a collector goes out of service, it will be out of the DNS rotation
- Round Robin across multiple regions, AZs
  - Latency based resolution optimizes inbound traffic

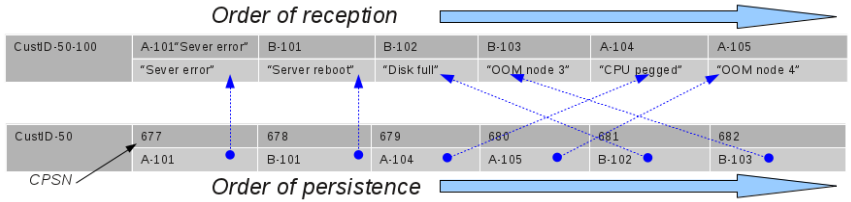
Our First Plan for Log Events

- Cassandra
  - Highly scalable key-value store
  - Impressive write performance a good match for us
  - Apache project plus commercial support with DataStax

- Use Cassandra for both our Event Queue and Persistent Store
  - Our strategy was to get the raw event in to Cassandra
  - …then perform workflow processing on events

Design meets Reality

- Cassandra not designed to be a message queue
  - Hard to

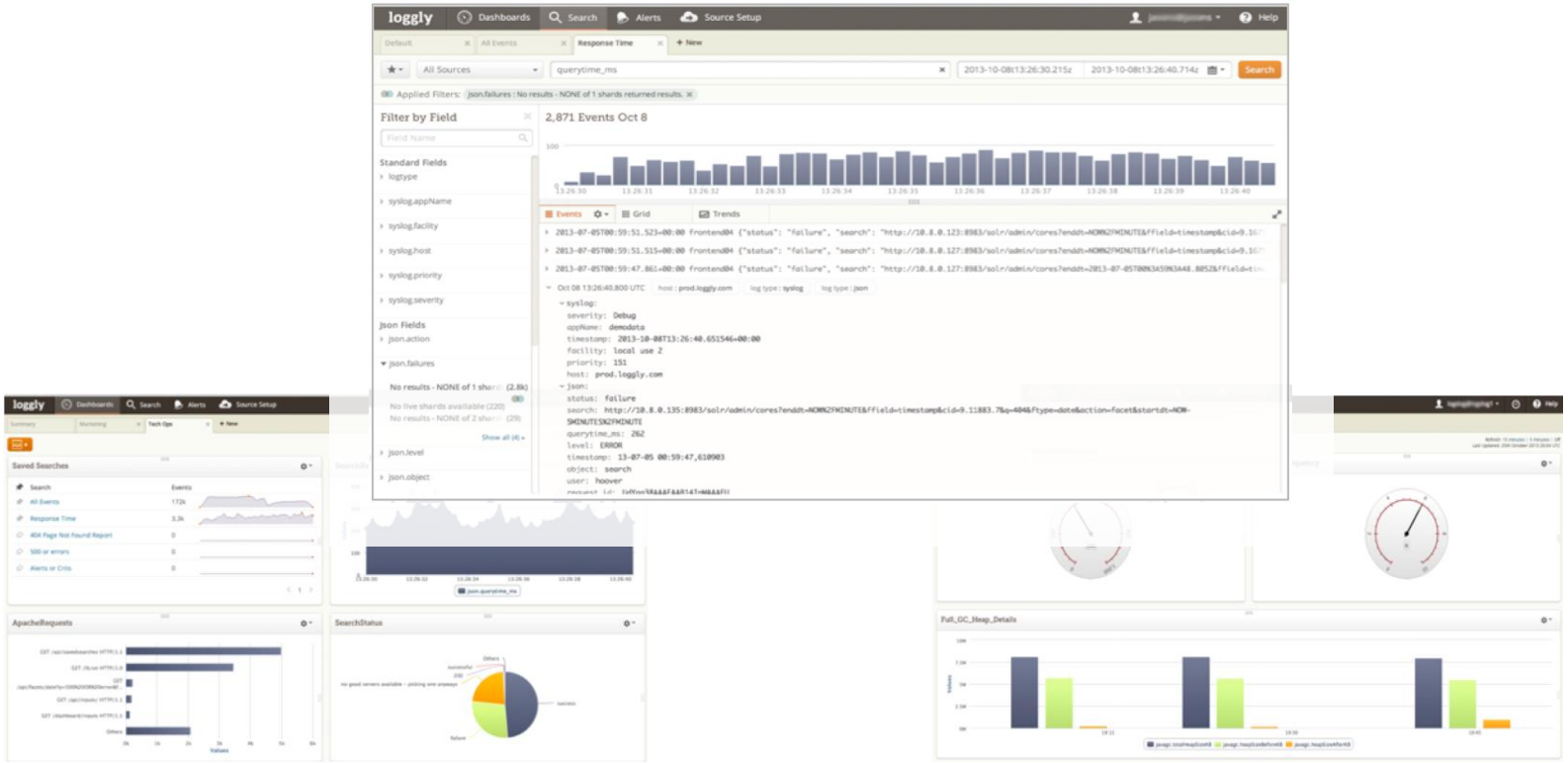


- Multi-tenancy requires handling data bursts
  - Collectors still needed to be able to buffer to disk
  - Added complexity and became a point of failure

Big Wins

- Leveraging AWS services
  - Multi-region, multi-AZ
  - Provisioned IOPS for availability and scale
  - Amazon Route 53 DNS support with latency resolution
  - Easy to increase and decrease Storm resources
- Leveraging Open Source infrastructure
  - Apache Kafka
  - Twitter Storm
  - ElasticSearch
- Pre-production “Staging” system

The Means to an End



Feedback

- Questions?

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