OpenSOC

The Open Security Operations Center

for

Analyzing 1.2 Million Network Packets per Second in Real Time

James Sirota,
Big Data Architect
Cisco Security Solutions Practice
jsirota@cisco.com

Sheetal Dolas
Principal Architect
Hortonworks
sheetal@hortonworks.com

June 3, 2014

Over Next Few Minutes

- Problem Statement & Business Case for OpenSOC
- Solution Architecture and Design
- Best Practices and Lessons Learned
- Q & A

Business Case

“There's now a growing sense of fatalism:

It's no longer if or when you get hacked, but the assumption is that you've already been hacked,

with a focus on minimizing the damage.”

Source: Dark Reading / Security’s New Reality: Assume The Worst

Breaches Happen in Hours…

But Go Undetected for Months or Even Years

In 60% of breaches, data is stolen in hours

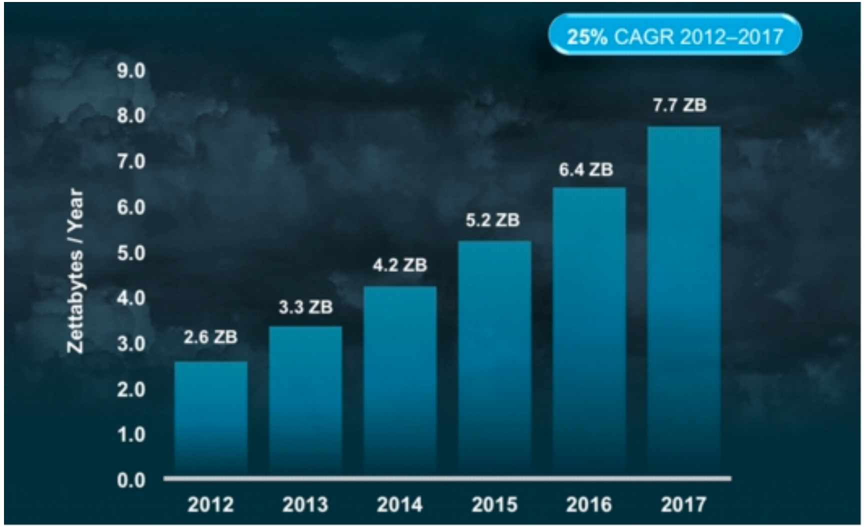
54% of breaches are not discovered for months

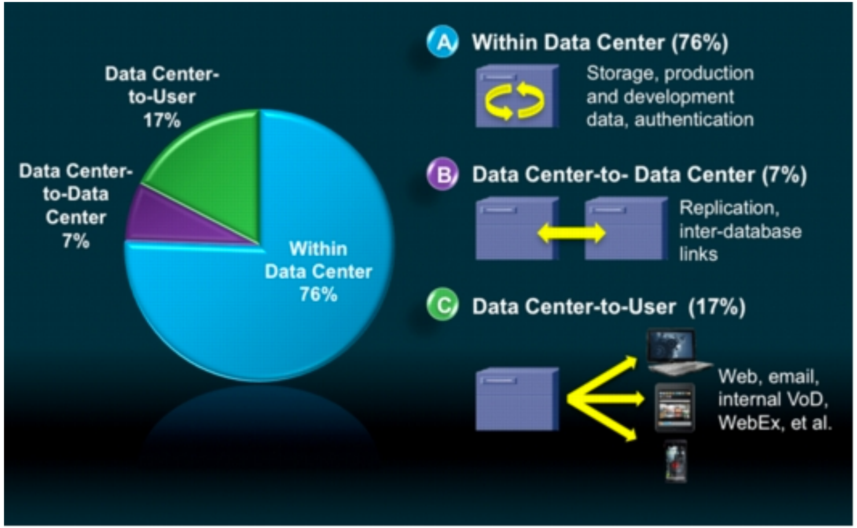
	Seconds	Minutes	Hours	Days	Weeks	Months	Years
Initial Attack to Initial Compromise	10%	75%	12%	2%	0%	1%	1%
Initial Compromise to Data Exfiltration	8%	38%	14%	25%	8%	8%	0%
Initial Compromise to Discovery	0%	0%	2%	13%	29%	54%	2%
Discovery to Containment/ Restoration	0%	1%	9%	32%	38%	17%	4%

Timespan of events by percent of breaches

Source: 2013 Data Breach Investigations Report

Cisco Global Cloud Index

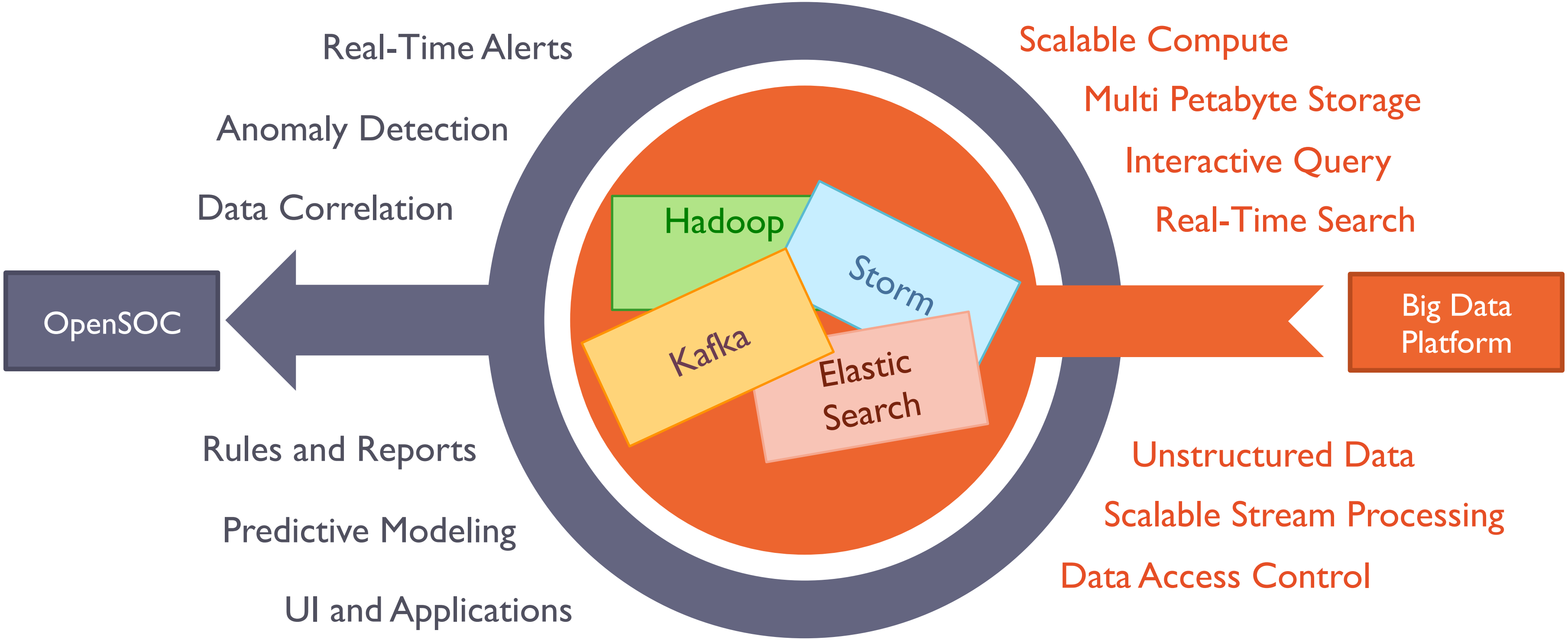




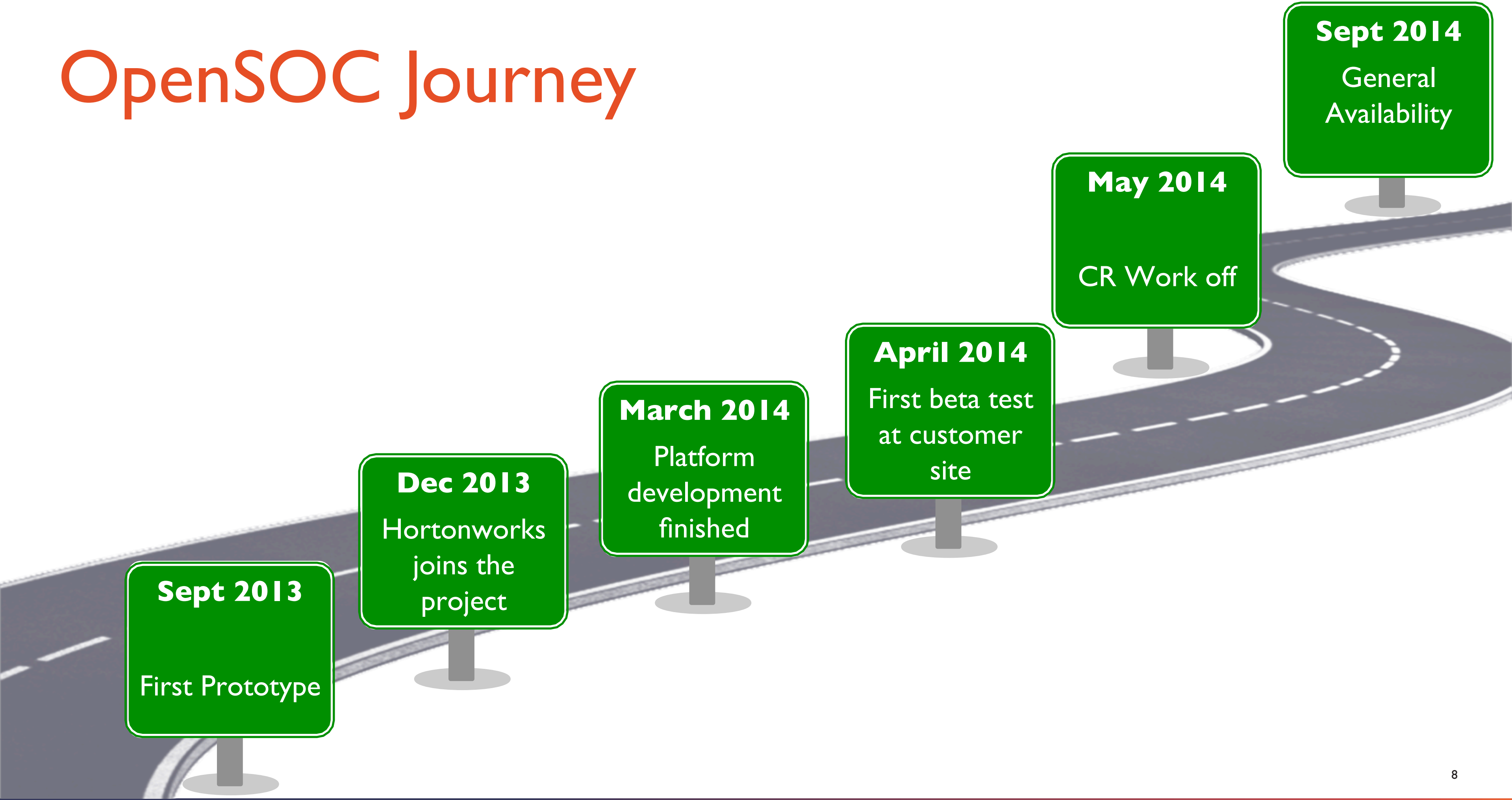
Source: 2014 Cisco Global Cloud Index

Introducing OpenSOC

Intersection of Big Data and Security Analytics



OpenSOC Journey



Sept 2013
First Prototype

Dec 2013
Hortonworks joins the project

March 2014
Platform development finished

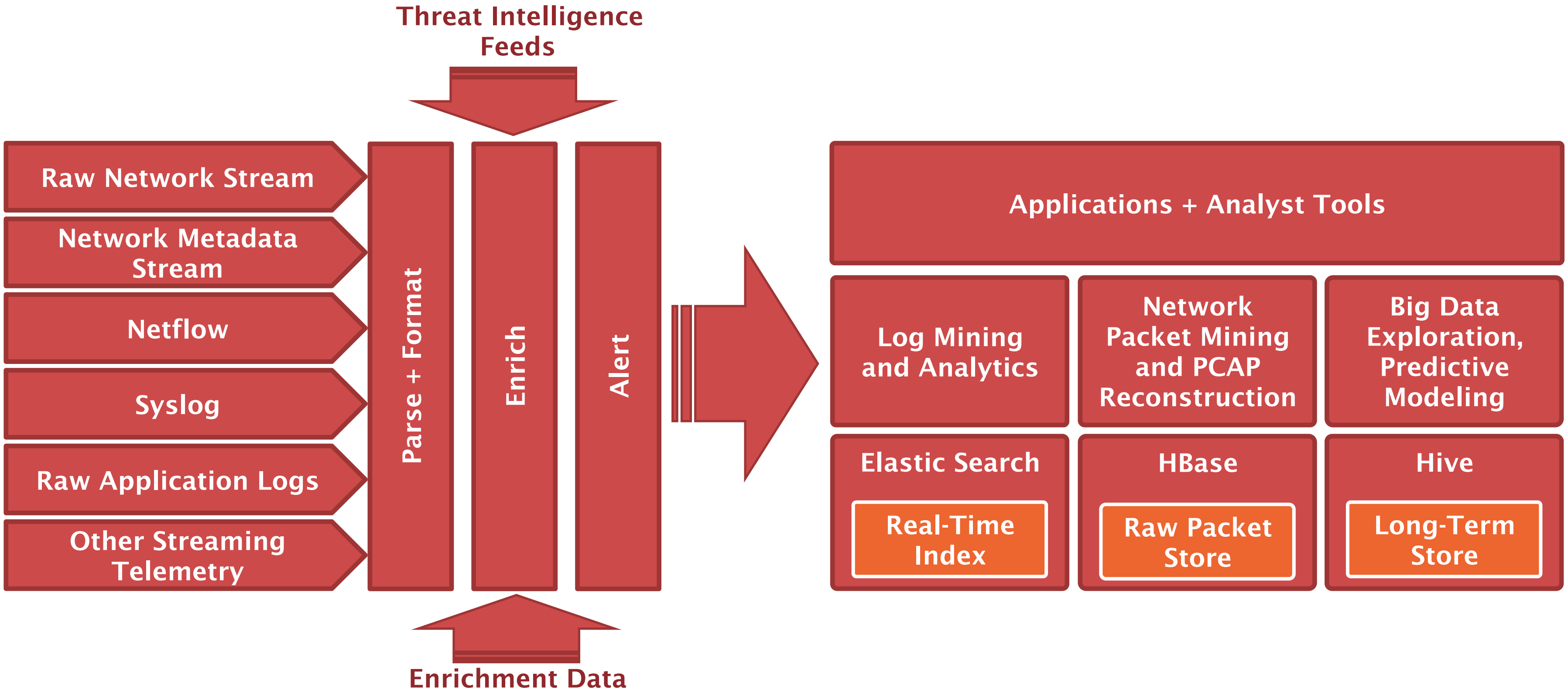
April 2014
First beta test at customer site

May 2014
CR Work off

Sept 2014
General Availability

Solution Architecture & Design

OpenSOC Conceptual Architecture



Key Functional Capabilities

- Raw Network Packet Capture, Store, Traffic Reconstruction
- Telemetry Ingest, Enrichment and Real-Time Rules-Based Alerts
- Real-Time Telemetry Search and Cross-Telemetry Matching
- Automated Reports, Anomaly Detection and Anomaly Alerts
- Rich Analytics Apps and Integration with Existing Analytics Tools

The OpenSOC Advantage

- Fully-Backed by Cisco and Used Internally for Multiple Customers
- Free, Open Source and Apache Licensed
- Built on Highly-Scalable and Proven Platforms (Hadoop, Kafka, Storm)
- Extensible and Pluggable Design
- Flexible Deployment Model (On-Premise or Cloud)
- Centralize your processes, people and data

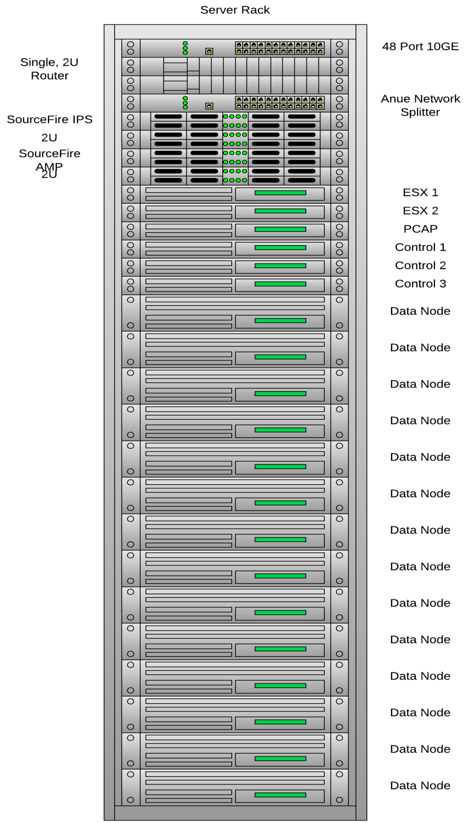
OpenSOC Deployment at Cisco

Hardware footprint (40u)

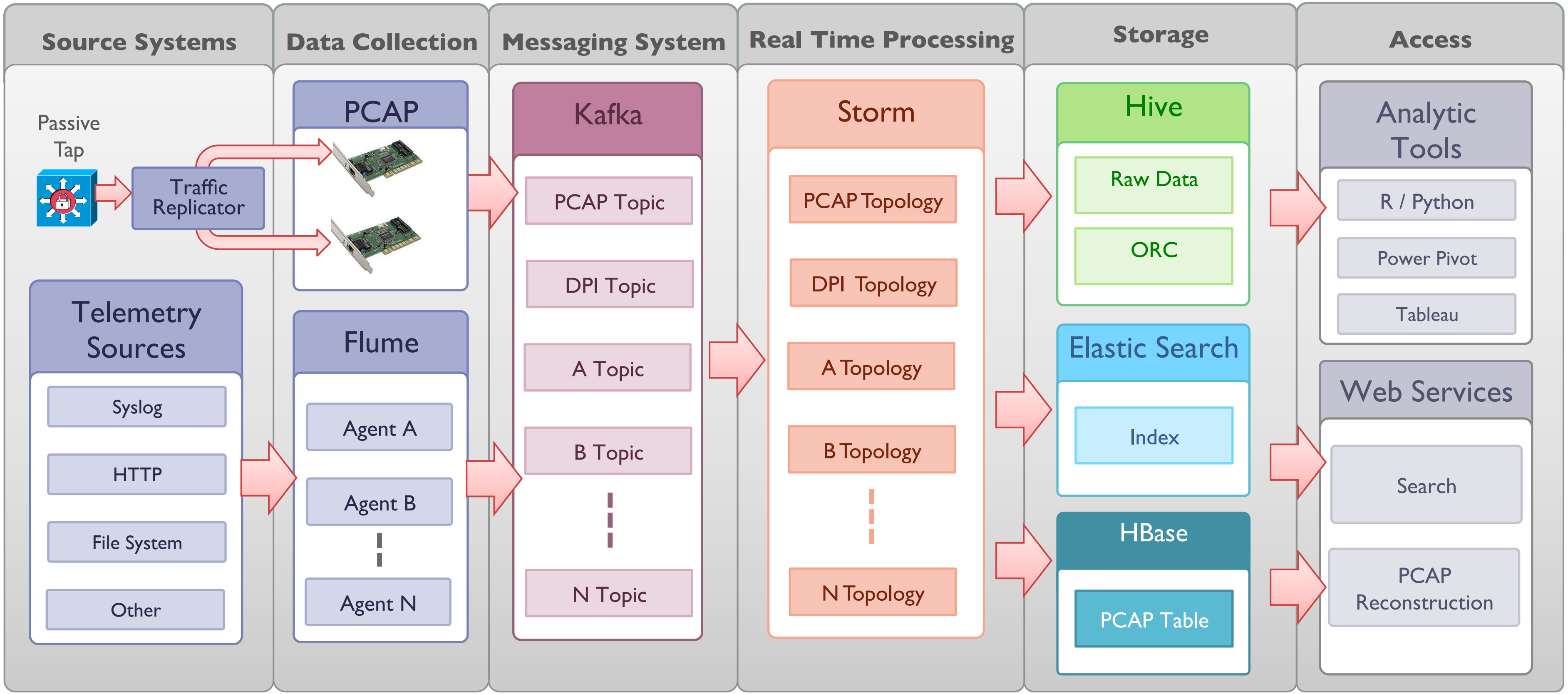
- **14 Data Nodes** (UCS C240 M3)
- 3 Cluster Control Nodes (UCS C220 M3)
- 2 ESX Hypervisor Hosts (UCS C220 M3)
- **1 PCAP Processor** (UCS C220 M3 + Napatech NIC)
- 2 SourceFire Threat alert processors
- 1 Anue Network Traffic splitter
- 1 Router
- 1 48 Port **10GE Switch**

Software Stack

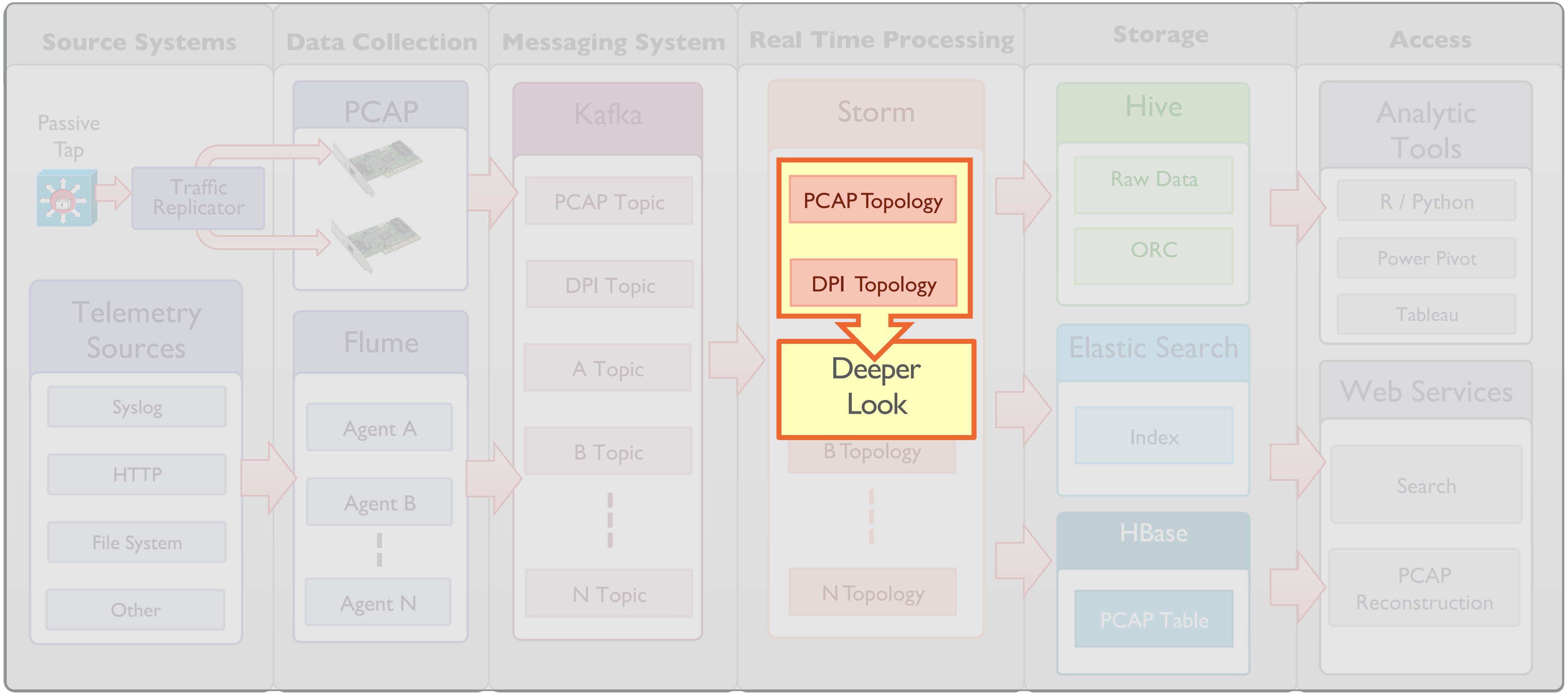
- HDP 2.1
- Kafka 0.8
- Elastic Search 1.1
- MySQL 5.5



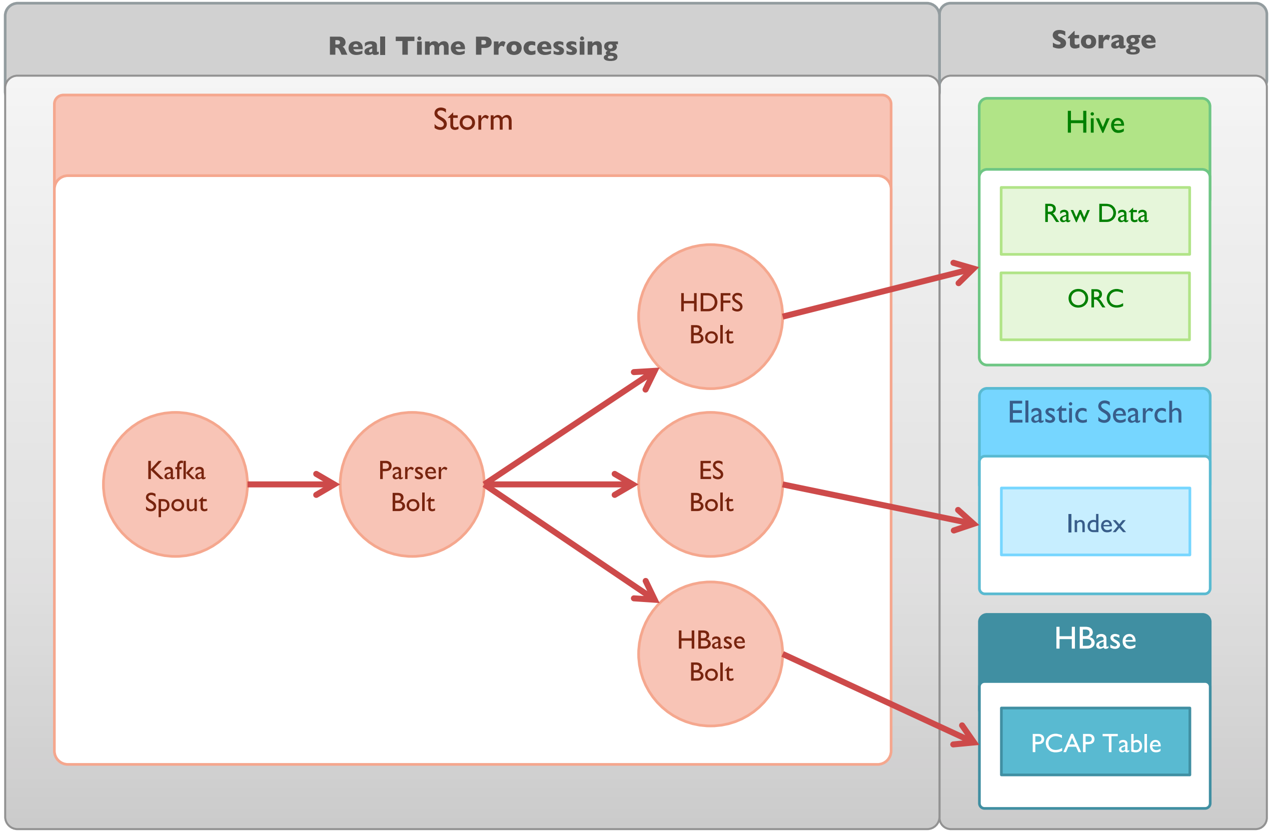
OpenSOC - Stitching Things Together



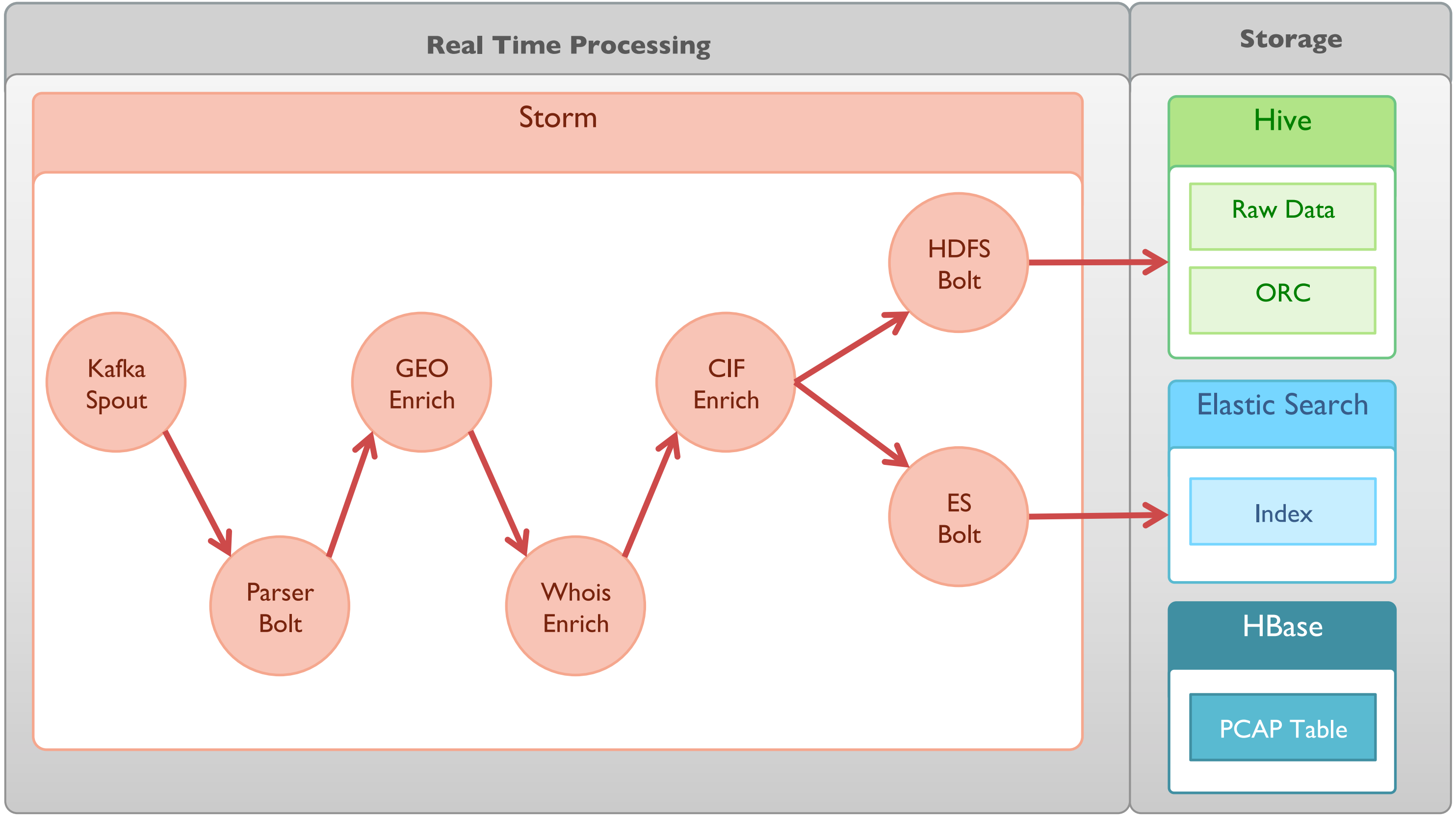
OpenSOC - Stitching Things Together



PCAP Topology



DPI Topology & Telemetry Enrichment

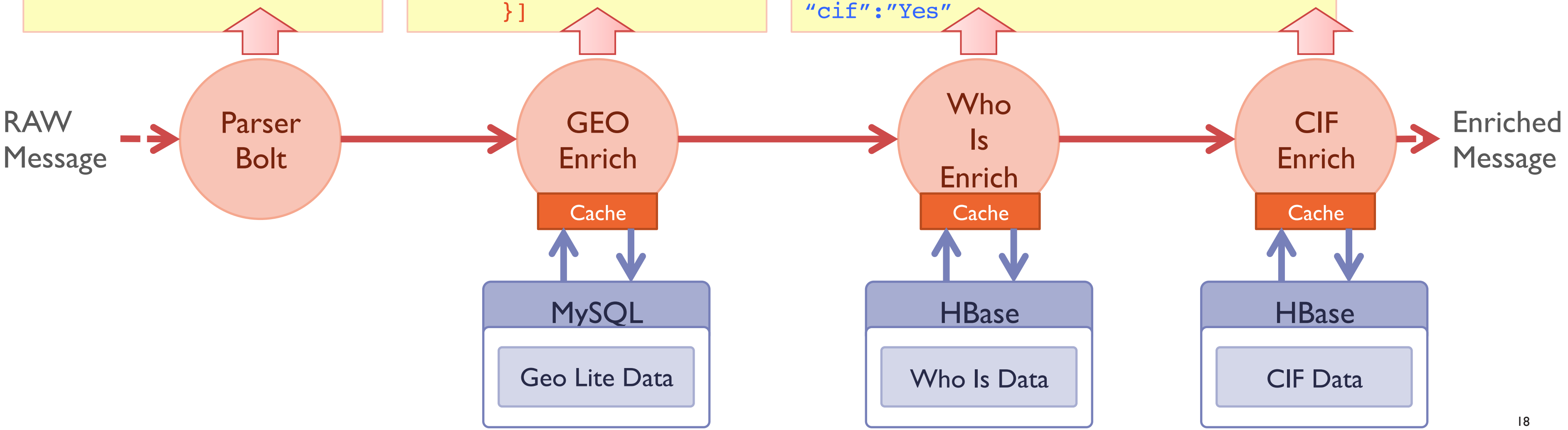


Enrichments

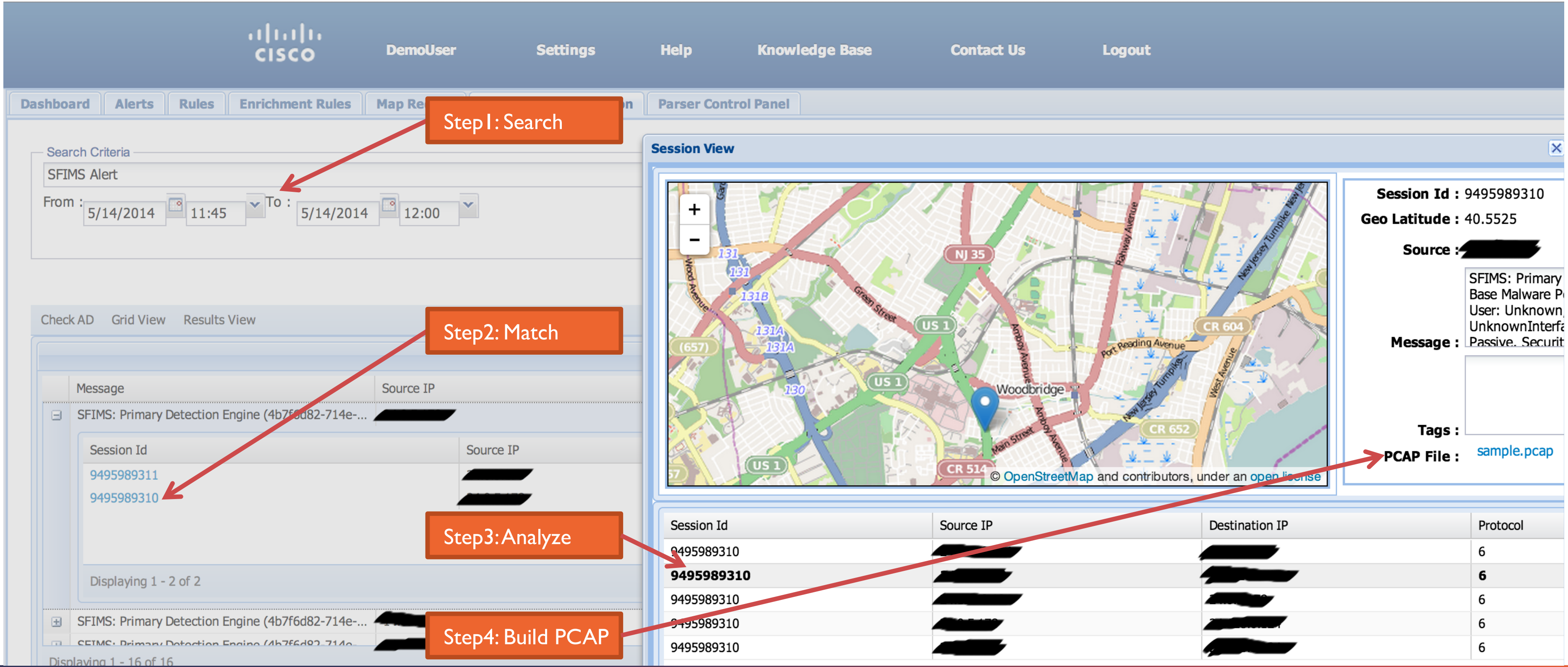
```
{
“msg_key1”: “msg value1”,
“src_ip”: “10.20.30.40”,
“dest_ip”: “20.30.40.50”,
“domain”: “mydomain.com”
}
```

```
"geo":[ {"region":"CA",
"postalCode":"95134",
"areaCode":"408",
"metroCode":"807",
"longitude":-121.946,
"latitude":37.425,
"locId":4522,
"city":"San Jose",
"country":"US"
       }]
```

```
"whois":[ {
"OrgId":"CISCOS",
"Parent":"NET-144-0-0-0-0",
"OrgAbuseName":"Cisco Systems Inc",
"RegDate":"1991-01-171991-01-17",
"OrgName":"Cisco Systems",
"Address":"170 West Tasman Drive",
"NetType":"Direct Assignment"
} ],
“cif”:”Yes”
```



Applications: Telemetry Matching and DPI



Step1: Search

Step2: Match

Step3: Analyze

Step4: Build PCAP

Search Criteria

SFIMS Alert

From : 5/14/2014 11:45 To : 5/14/2014 12:00

	Message	Source IP
⊟	SFIMS: Primary Detection Engine (4b7f6d82-714e-...	[redacted]

Session Id	Source IP
9495989311	[redacted]
9495989310	[redacted]

Displaying 1 - 2 of 2

	Message	Source IP
⊞	SFIMS: Primary Detection Engine (4b7f6d82-714e-...	[redacted]
⊞	SFIMS: Primary Detection Engine (4b7f6d82-714e-...	[redacted]

Displaying 1 - 16 of 16

Session Id : 9495989310

Geo Latitude : 40.5525

Source : [redacted]

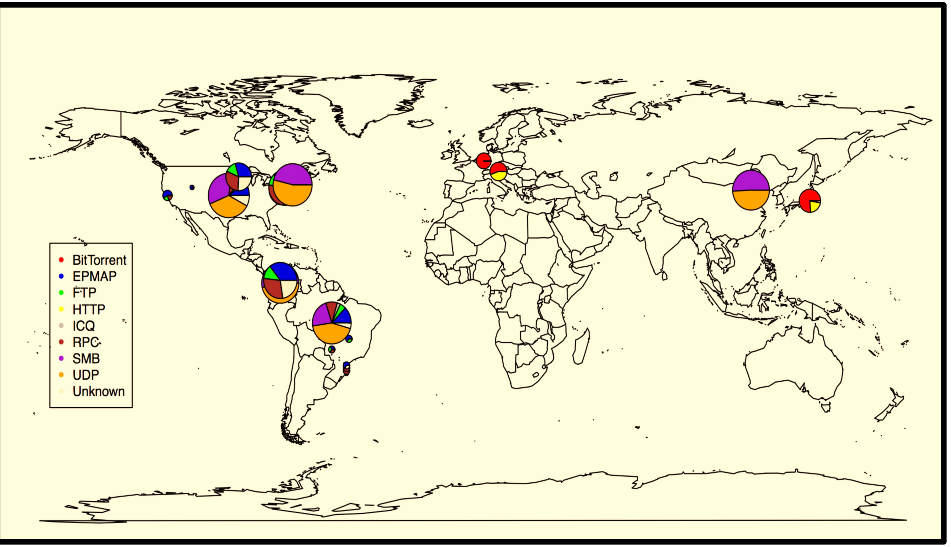
Message : SFIMS: Primary Base Malware P User: Unknown UnknownInterfa Passive. Securit

Tags :

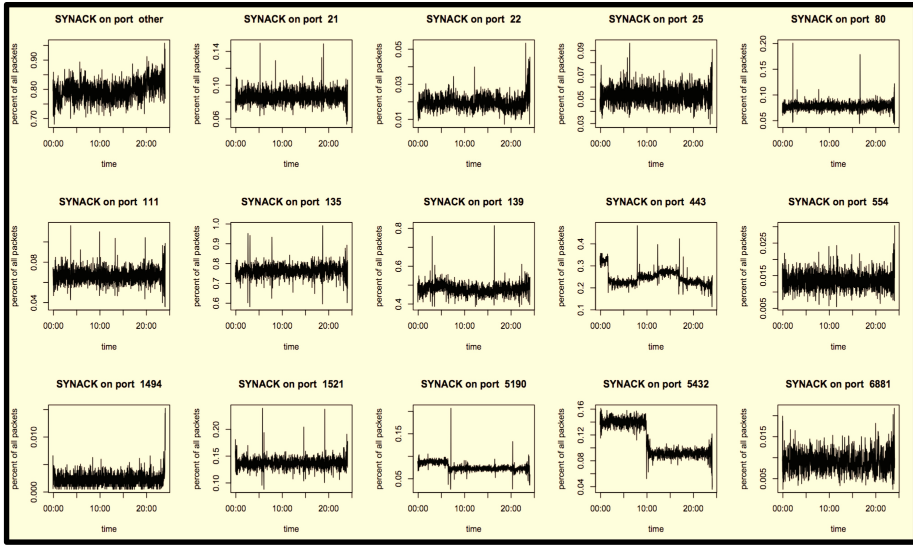
PCAP File : sample.pcap

Session Id	Source IP	Destination IP	Protocol
9495989310	[redacted]	[redacted]	6
9495989310	[redacted]	[redacted]	**6**
9495989310	[redacted]	[redacted]	6
9495989310	[redacted]	[redacted]	6
9495989310	[redacted]	[redacted]	6

Integration with Analytics Tools



Dashboards



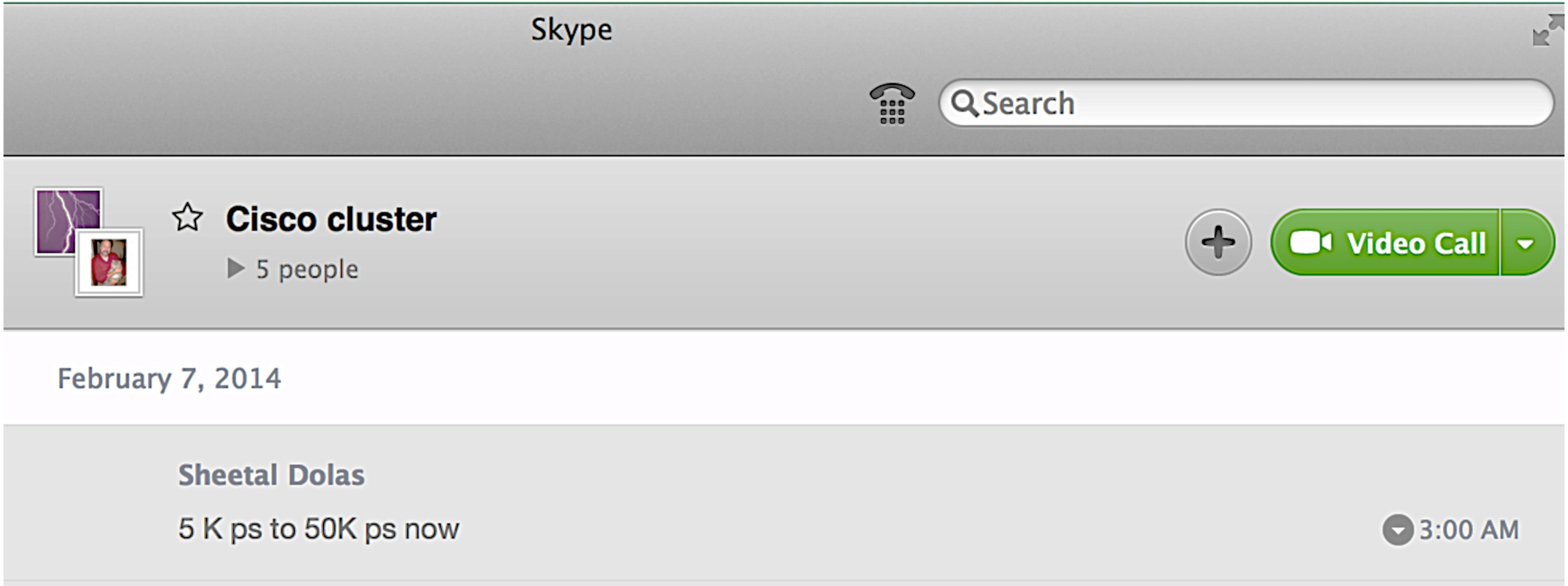
Reports

Best Practices and Lessons Learned

Journey Towards Highly Scalable Application

Kafka Tuning

This is where we began

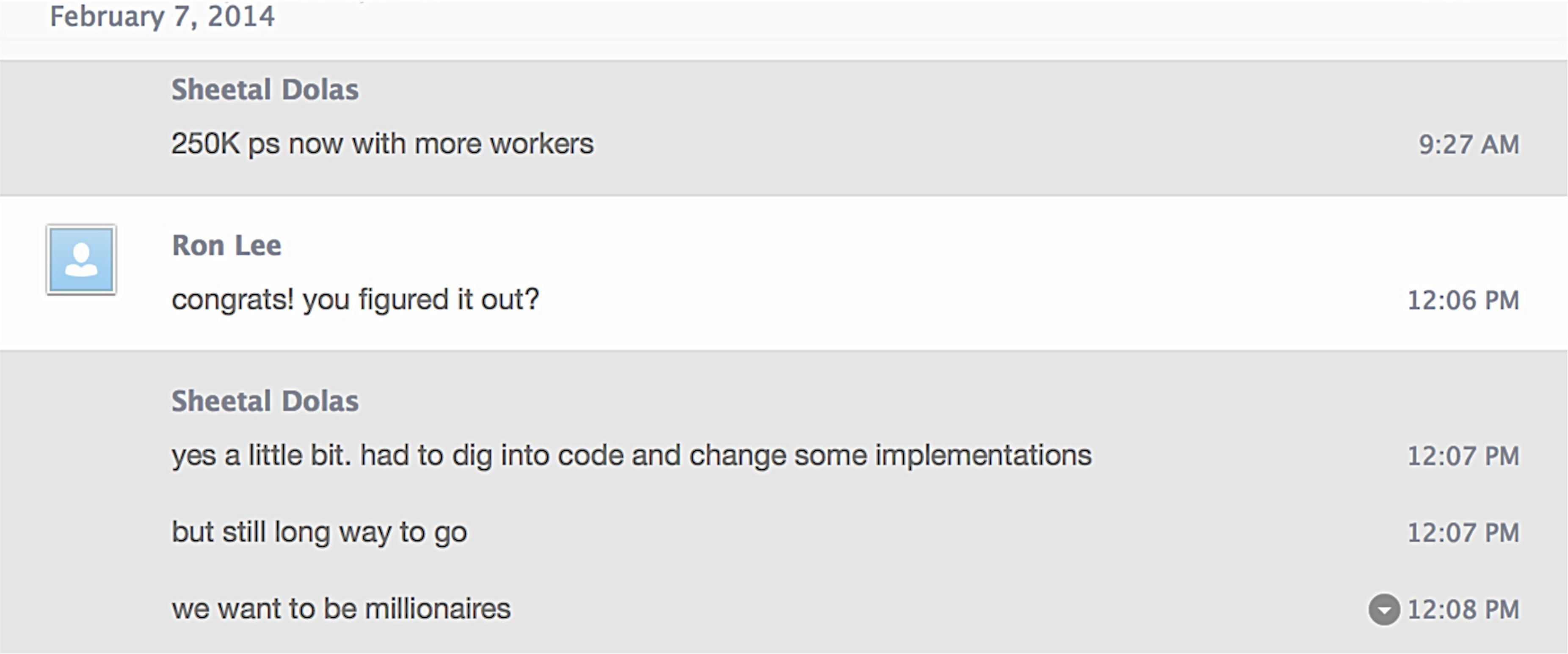


February 7, 2014

Sheetal Dolas

5 K ps to 50K ps now — 3:00 AM

Some code optimizations and increased parallelism



February 7, 2014

Sheetal Dolas

250K ps now with more workers 9:27 AM

Ron Lee

congrats! you figured it out? 12:06 PM

Sheetal Dolas

yes a little bit. had to dig into code and change some implementations 12:07 PM

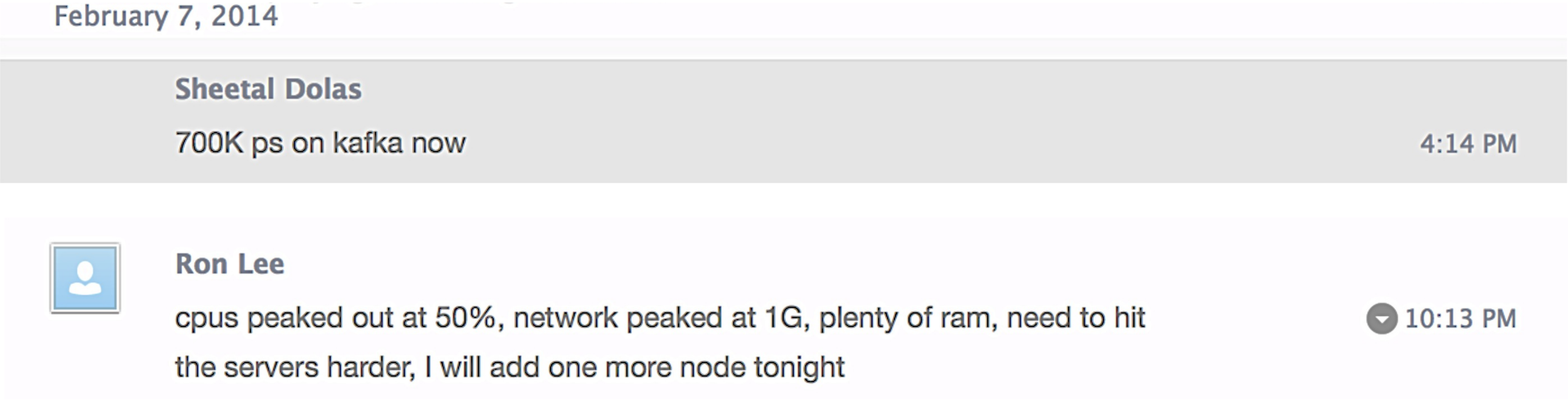
but still long way to go 12:07 PM

we want to be millionaires 12:08 PM

Kafka Tuning

- Is Disk I/O heavy
- Kafka 0.8+ supports replication and JBOD
  - Better performance compared to RAID
- Parallelism is largely driven by number of disks and partitions per topic
- Key configuration parameters:
  - `num.io.threads` - Keep it at least equal to number of disks provided to Kafka
  - `num.network.threads` - adjust it based on number of concurrent producers, consumers and replication factor

After Kafka Tuning



February 7, 2014

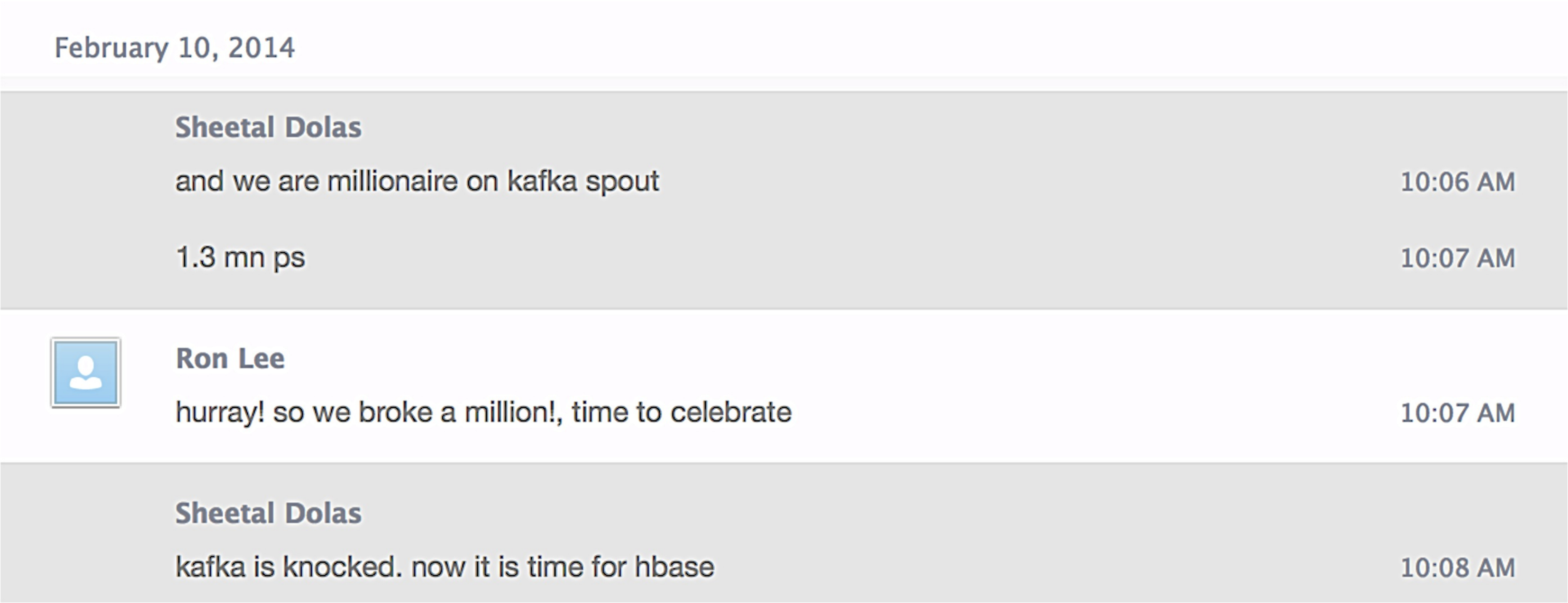
Sheetal Dolas

700K ps on kafka now 4:14 PM

Ron Lee

cpus peaked out at 50%, network peaked at 1G, plenty of ram, need to hit the servers harder, I will add one more node tonight 10:13 PM

Bottleneck Isolation, Resource Profiling, Load Balancing



February 10, 2014

Sheetal Dolas

and we are millionaire on kafka spout 10:06 AM

1.3 mn ps 10:07 AM

Ron Lee

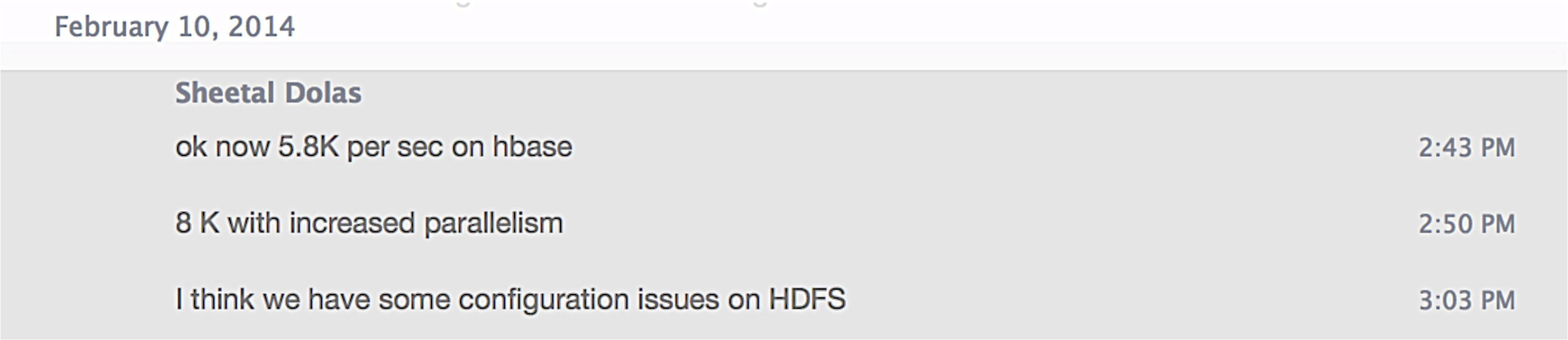
hurray! so we broke a million!, time to celebrate 10:07 AM

Sheetal Dolas

kafka is knocked. now it is time for hbase 10:08 AM

HBase Tuning

This is where we began



February 10, 2014

Sheetal Dolas

ok now 5.8K per sec on hbase 2:43 PM

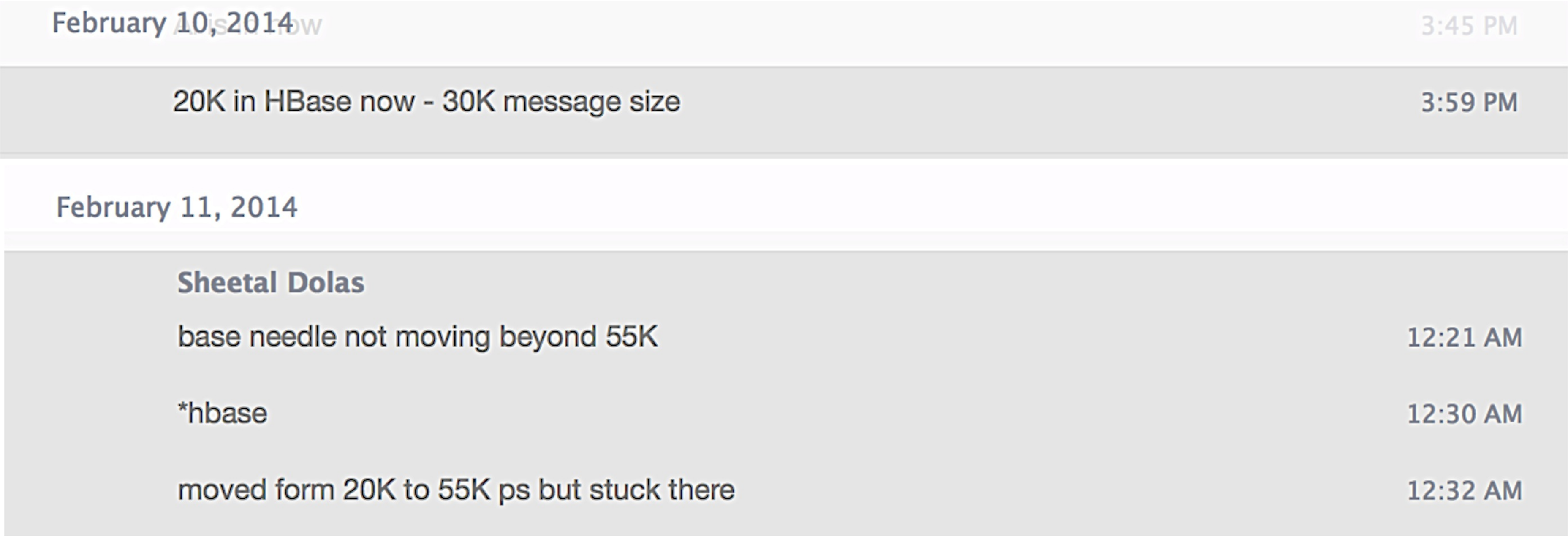
8 K with increased parallelism 2:50 PM

I think we have some configuration issues on HDFS 3:03 PM

Row Key Design

- Row Key design is critical (gets or scans or both?)
  - Keys with IP Addresses
    - Standard IP addresses have only two variations of the first character : 1 & 2
    - Minimum key length will be 7 characters and max 15 with a typical average of 12
    - Subnet range scans become difficult – range of 90 to 220 excludes 112
  - IP converted to hex (10.20.30.40 => 0a141e28)
    - gives 16 variations of first key character
    - consistently 8 character key
    - Easy to search for subnet ranges

Experiments with Row Key



February 10, 2014 3:45 PM

20K in HBase now - 30K message size 3:59 PM

February 11, 2014

Sheetal Dolas

base needle not moving beyond 55K 12:21 AM

*hbase 12:30 AM

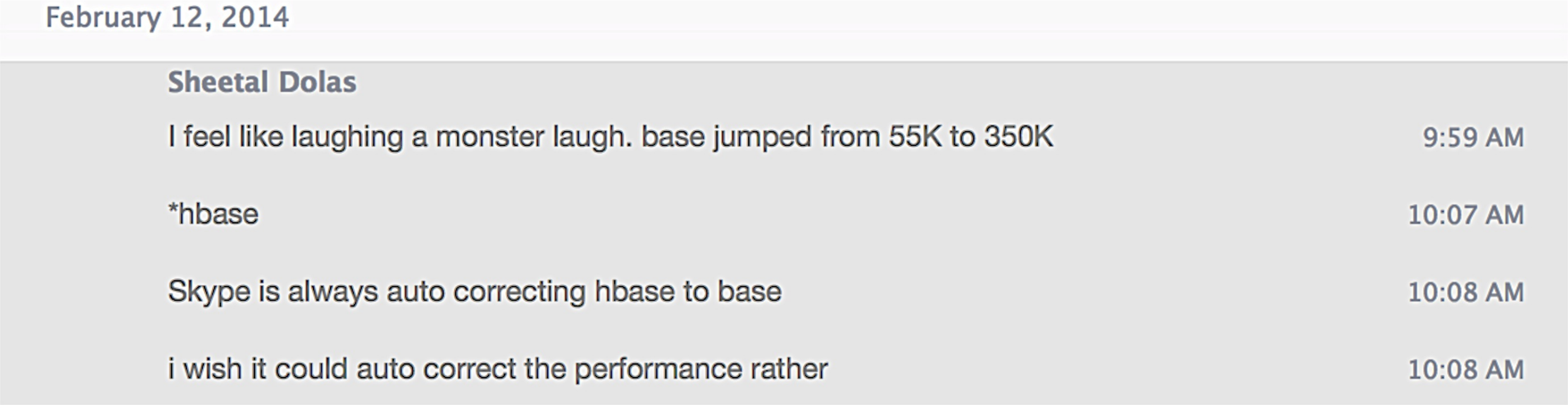
moved form 20K to 55K ps but stuck there 12:32 AM

Region Splits

- Know your data
  - Auto split under high workload can result into hotspots and split storms
  - Understand your data and presplit the regions
  - Identify how many regions a RS can have to perform optimally. Use the formula below

```
(RS memory)*(total memstore fraction)/((memstore size)*(# column families))
```

With Region Pre-Splits



February 12, 2014

Sheetal Dolas

I feel like laughing a monster laugh. base jumped from 55K to 350K 9:59 AM

*hbase 10:07 AM

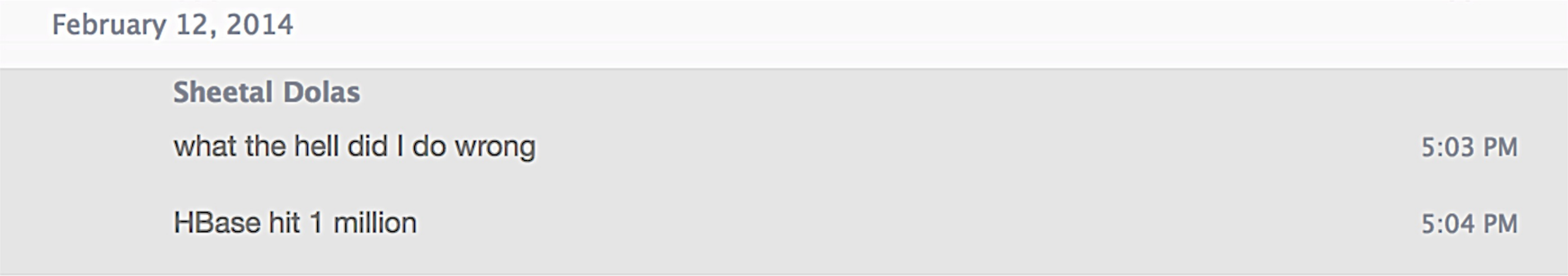
Skype is always auto correcting hbase to base 10:08 AM

i wish it could auto correct the performance rather 10:08 AM

Know Your Application

- Enable Micro Batching (client side buffer)
- Smart shuffle/grouping in storm
- Understand your data and situationally exploit various WAL options
- Watch for many minor compactions
  - For heavy ‘write’ workload Increase `hbase.hstore.blockingStoreFiles` (we used 200)

And Finally



February 12, 2014

Sheetal Dolas

what the hell did I do wrong 5:03 PM

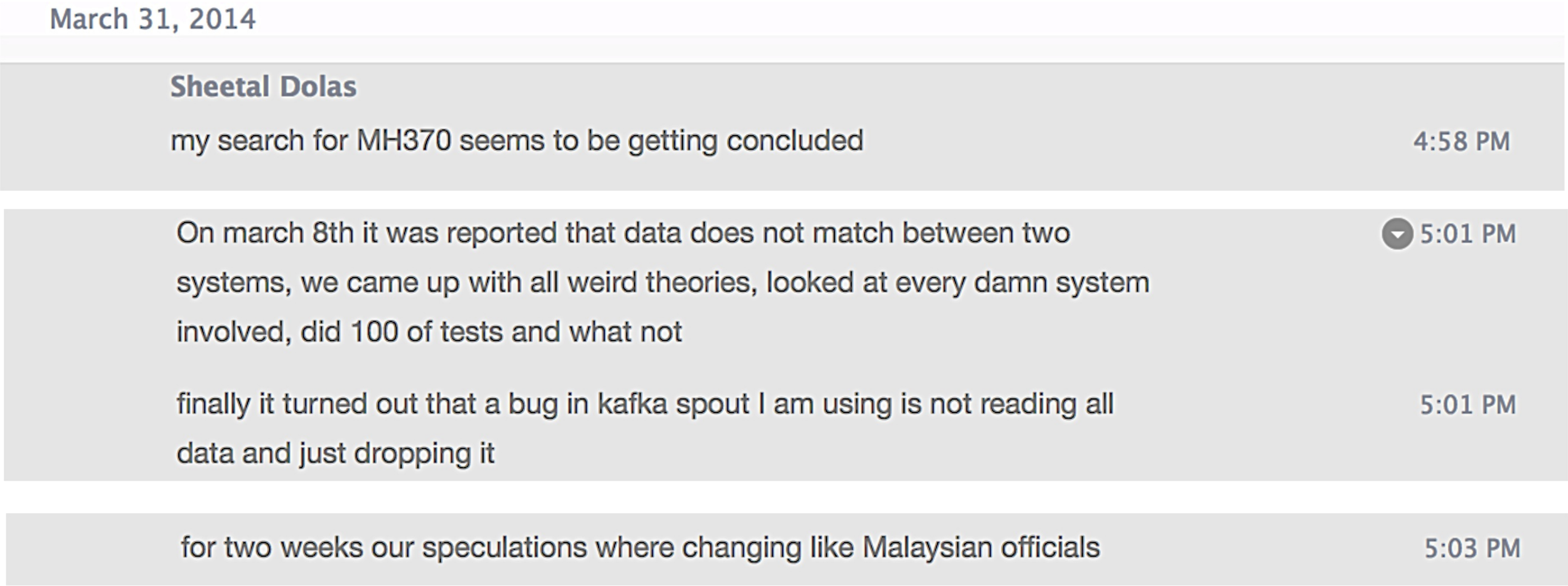
HBase hit 1 million 5:04 PM

Kafka Spout

Kafka Spout

- Parallelism is controlled by number of partitions per topic
  - Set Kafka spout parallelism equal to number of partitions in topic
  - Other key parameters that drive performance
    - `fetchSizeBytes`
    - `bufferSizeBytes`

Mysteriously Missing Data



March 31, 2014

Sheetal Dolas

my search for MH370 seems to be getting concluded 4:58 PM

On march 8th it was reported that data does not match between two systems, we came up with all weird theories, looked at every damn system involved, did 100 of tests and what not 5:01 PM

finally it turned out that a bug in kafka spout I am using is not reading all data and just dropping it 5:01 PM

for two weeks our speculations where changing like Malaysian officials 5:03 PM

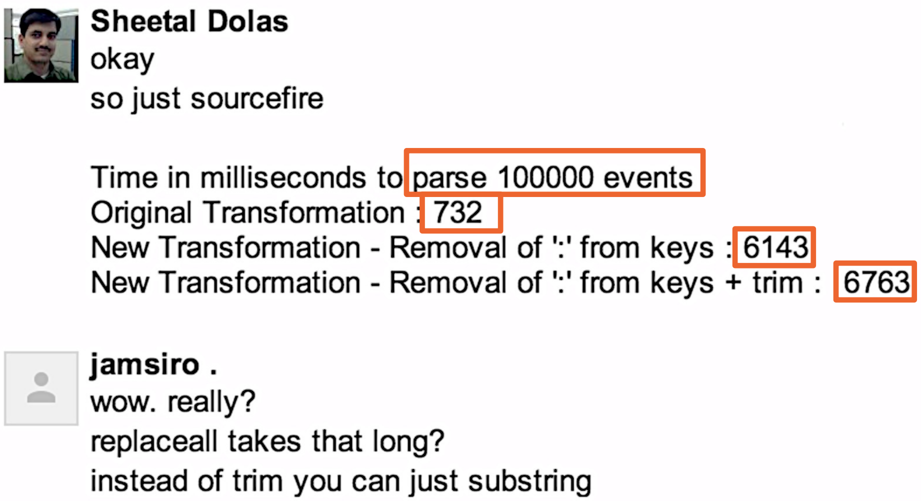
Mysteriously Missing Data Root Cause

- A bug in Kafka spout that used to miss out some partitions and loose data
  - It is now fixed and available from Hortonworks repository (http://repo.hortonworks.com/content/repositories/releases/org/apache/storm/storm-Kafka)

Storm

Storm

- Every small thing counts at scale
  - Even simple string operations can slowdown throughput when executed on millions of Tuples



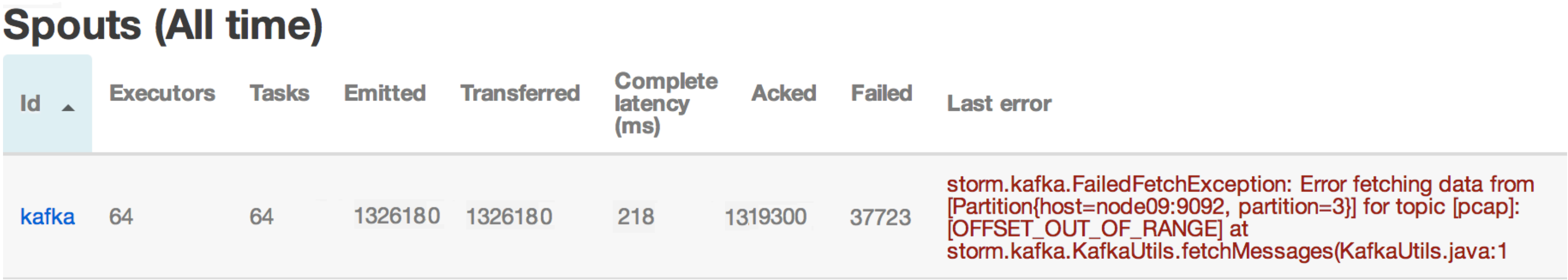
Sheetal Dolas
okay
so just sourcefire

Time in milliseconds to parse 100000 events
Original Transformation : 732
New Transformation - Removal of ':' from keys : 6143
New Transformation - Removal of ':' from keys + trim : 6763

jamsiro .
wow. really?
replaceall takes that long?
instead of trim you can just substring

Storm

- Error handling is critical
  - Poorly handled errors can lead to topology failure and eventually loss of data (or data duplication)



Spouts (All time)

Id	Executors	Tasks	Emitted	Transferred	Complete latency (ms)	Acked	Failed	Last error
kafka	64	64	1326180	1326180	218	1319300	37723	storm.kafka.FailedFetchException: Error fetching data from [Partition{host=node09:9092, partition=3}] for topic [pcap]: [OFFSET_OUT_OF_RANGE] at storm.kafka.KafkaUtils.fetchMessages(KafkaUtils.java:1

Storm

- Tune & Scale individual spout and bolts before performance testing/tuning entire topology
  - Write your own simple data generator spouts and no-op bolts

- Making as many things configurable as possible helps a lot

Lessons Learned

- When it comes to Hadoop…partner up
- Separate the hype from the opportunity
- Start small then scale up
- Design Iteratively
- It doesn’t work unless you have proven it at scale
- Keep an eye on ROI

Looking for Community Partners

Cisco + Hortonworks + Community Support for OpenSOC

How can you contribute?

- Technology Partner Program – contribute developers to join the Cisco and Hortonworks team

Thank you!

We are hiring:

jsirota@cisco.com
sheetal@hortonworks.com