Chukwa: a scalable log collector
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Why collect logs?

• Many uses
  – Need logs to monitor/debug systems
  – Machine learning is getting increasingly good at detecting anomalies automatically.
  – Web log analysis is key to many businesses

• Easier to process if centralized
Three Bets

1. MapReduce processing is necessary at scale.
2. Reliability matters for log collection
3. Should use Hadoop, not re-write storage and processing layers
Leveraging Hadoop

- Really want to use HDFS for storage and MapReduce for processing.
  + Highly scalable, highly robust
  + Good integrity properties.

- HDFS has quirks
  - Files should be big
  - No concurrent appends
  - Weak synchronization semantics
The architecture

Data
- App1 log
- App2 log
- Metrics...

Agent (seconds)
One Per Node

Collector (seconds)
Per 100 nodes

Data Sink (5 minutes)

Archival Storage (Indefinitely)

Map-Reduce Jobs

HDFS

SQL DB (or HBase)
Design envelope

- Need more aggressive batching or fan-in control
- Need better FS!
- Chukwa not needed – clients should write direct to HDFS
- Don’t need Chukwa: use NFS instead

Number of Hosts vs. Data Rate per host (bytes/sec)
Respecting boundaries

- Architecture captures the boundary between monitoring and production services
  - Important in practice!
  - Particularly nice in cloud context
Comparison

Ganglia

Amazon CloudWatch

UC Berkeley Grid Load last hour

Metrics

Chukwa

Logs
Data sources

- We optimize for the case of logs on disk
  - Supports legacy systems
  - Writes to local disk almost always succeed
  - Kept in memory in practice – fs caching
- Can also handle other data sources – adaptors are pluggable
  - Support syslog, other UDP, JMS messages.
Reliability

- Agents can crash
- Record how much data from each source has been written successfully.
- Resume at that point after crash
- Fix duplicates in the storage layer
• What about collector crashes?
• Want to tolerate asynchronous HDFS writes without blocking agent
• Solution: async. acks
• Tell agent where data will be written if write succeeds.
• Uses single-writer aspect of HDFS
Fast path

Data
- App1 log
- App2 log
- Metrics...

Agent (seconds)
One Per Node

Collector (seconds)
Per 100 nodes

Data Sink (5 minutes)

Fast-path clients (seconds)

HDFS
Cleaned Data Storage (Indefinitely)

Map-Reduce Jobs
Two modes

Robust delivery
• Data visible in minutes
• Collects everything
• Stores to HDFS
• Will resend after a crash
• Facilitates MapReduce
• Used for bulk analysis

Prompt delivery
• Data visible in seconds
• User-specified filter
• Written over a socket
• Delivered at most once
• Facilitates near-real-time monitoring
• Used for real-time graphing
Overhead [with Cloudstone]

Ops per sec

Without Chukwa  With Chukwa
• Tested on EC2
• Able to write 30MB/sec/collector
• Note: data is about 12 months old
• Scales linearly
• Able to saturate underlying FS
Experiences

• Currently in use at:
  • UC Berkeley's RAD Lab, to monitor Cloud experiments
  • CBS Interactive, Selective Media, and Tynt for web log analysis
    – Dozens of machines
    – Gigabytes to Terabytes per day
  • Other sites too...we don't have a census
## Related Work

<table>
<thead>
<tr>
<th></th>
<th>Handles logs</th>
<th>Crash recovery?</th>
<th>Metadata</th>
<th>Interface</th>
<th>Agent-side control</th>
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<tbody>
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<td>No</td>
<td>No</td>
<td>No</td>
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<td>No</td>
<td>RPC</td>
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<td>Flume</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>flexible</td>
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<tr>
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<td>Yes</td>
</tr>
</tbody>
</table>
Next steps

• Tighten security, to make Chukwa suitable for world-facing deployments
• Adjustable durability
  – Should be able to buffer arbitrary non-file data for reliability
• HBase for near-real-time metrics display
• Built-in indexing
• Your idea here: Exploit open source!
Conclusions

• Chukwa is a distributed log collection system that is
  • Practical
    – In use at several sites
  • Scalable
    – Builds on Hadoop for storage and processing
  • Reliable
    – Able to tolerate multiple concurrent failures without losing or mangling data
• Open Source
  – Former Hadoop subproject, currently in Apache incubation, enroute to top level project.
Questions?
vs Splunk

- Significant overlap with Splunk.
  - Splunk uses syslog for transport.
  - Recently shifted towards MapReduce for evaluation.

- Chukwa on its own doesn’t [yet] do indexing or analysis.

- Chukwa helps extract data from systems
  - Reliably
  - Customizably
Assumptions about App

• Processing should happen off-node. (Production hosts are sacrosanct)
• Data should be available within minutes
  – Sub-minute delivery a non-goal.
• Data rates between 1 and 100KB/sec/node
  – Architecture tuned for these cases, but Chukwa could be adapted to handle lower/higher rates.
• No assumptions about data format
• Administrator or app needs to tell Chukwa where logs live.
  – Support for directly streaming logs as well.
On the back end

- Chukwa has a notion of parsed *records*, with complex schemas
  - Can put into structured storage
  - Display with HICC, a portal-style web interface.
• Chukwa is a collection system.
  – Not responsible for storage:
    • Use HDFS.
    • Our model is store-everything, prune late
  – Not responsible for processing
    • Use MapReduce, or custom layer on HDFS

• Responsible for **facilitating** storage and processing

• Framework for processing collected data

• Includes Pig support
Goal: Low Footprint

• Wanted minimal footprint on system and minimal changes to user workflow.
  – Application logging need not change.
  – Local logs stay put, Chukwa just copies them.
  – Can either specify filenames in static config, or else do some dynamic discovery.

• Minimal human-produced metadata
  – We track what data source + host a chunk came from. Can store additional tags.
  – Chunks are numbered; can reconstruct order.
  – No schemas required to collect data
• Major motivation for Chukwa was storing and analyzing Hadoop logs.
  – At Yahoo!, common to dynamically allocate hundreds of nodes for a particular task.
  – This can generate MBs of logs per second.
  – Log analysis becomes difficult
Why Ganglia doesn’t do this

• Many systems for metrics collection
  – Ganglia particularly well-known.
  – Many similar systems, including network management systems like OpenView
  – Focus on collecting and aggregating metrics in scalable low-cost way

• But logs aren’t metrics. Want to archive everything, not summarize aggressively.

• Really want reliable delivery; missing key parts of logs might make rest useless
• Log processing needs to be scalable, since apps can get big quickly
• This used to be a problem for the Microsofts and Googles of the world. Now it affects many more.
• Can’t rely on local storage
  – Nodes are ephemeral
  – Need to move logs off-node
• Can’t do analysis on single host
  – The data is too big
Questions about Goals

• How many nodes? How much data?
• What data sources and delivery semantics?
• Processing expressiveness?
• Storage?
Chukwa goals

• How many nodes? How much data?
  – Scale to thousands of nodes. Hundreds of KB/sec/node on average, bursts above that OK

• What data sources and delivery semantics?
  – Console Logs and Metrics. Reliable delivery (as much as possible.) Minutes of delay are OK.

• Processing expressiveness?
  – MapReduce

• Storage?
  – Should be able to store data indefinitely. Support petabytes of stored data.
In contrast

• Ganglia, Network Management systems, and Amazon’s CloudWatch are all metrics-oriented.
  – Goal is collecting and disseminating numerical metrics data in a scalable way.

• Significantly different problem.
  – Metrics have well defined semantics
  – Can tolerate data loss
  – Easy to aggregate/compress for archiving
  – Often time-critical

• Chukwa can serve these purposes, but isn’t optimized for it.
• Chukwa was originally designed to support batch processing of logs
  – Minutes of latency OK.
• But we can do [best effort] real-time “for free”
  – Watch data go past at the collector
  – Check chunks against a search pattern, forward matching ones to a listener via TCP.
  – Don’t need long-term storage or reliable delivery (do those via the regular data path)
• Director uses this real-time path.
Related work summary

- Ganglia (and traditional NMS) don’t do large data volumes or data rates
- Facebook’s Scribe+Hive
  - Scribe is streaming, not batch
  - Hive is batch, and atop Hadoop
  - Doesn't do collection or visualization.
  - Doesn’t have strong reliability properties
- Flume (from Cloudera)
  - Very similar to Chukwa
  - Emphasis on centralized management