How to efficiently manage logs in large-scale Kubernetes clusters

Open Source Observability Day 2024

Aliaksandr Valialkin, CTO at VictoriaMetrics

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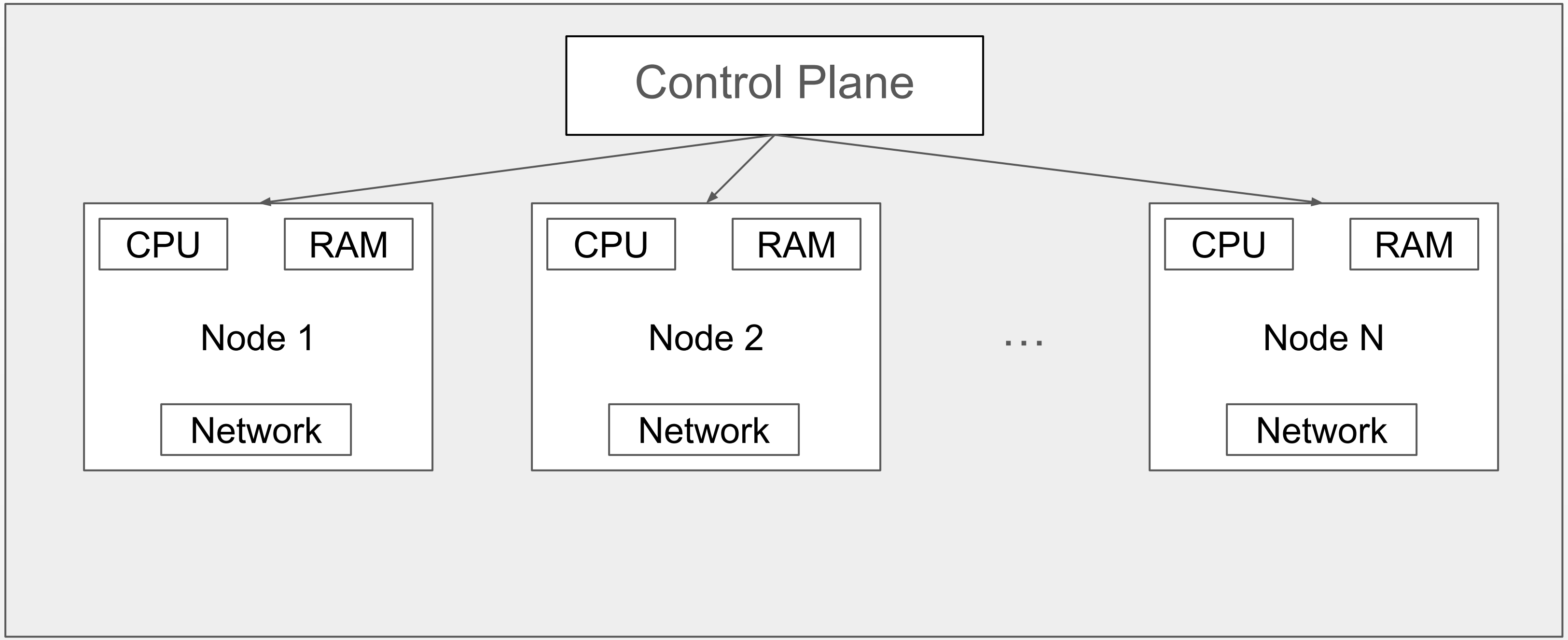
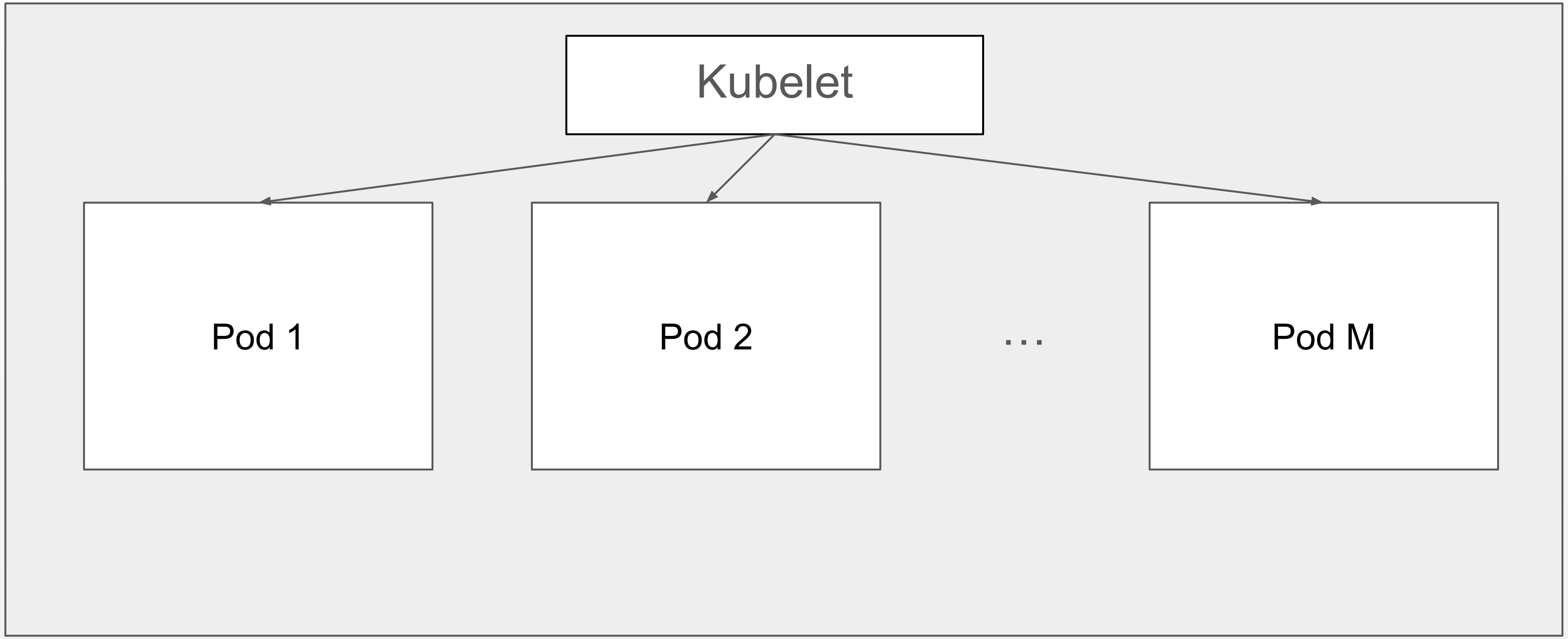
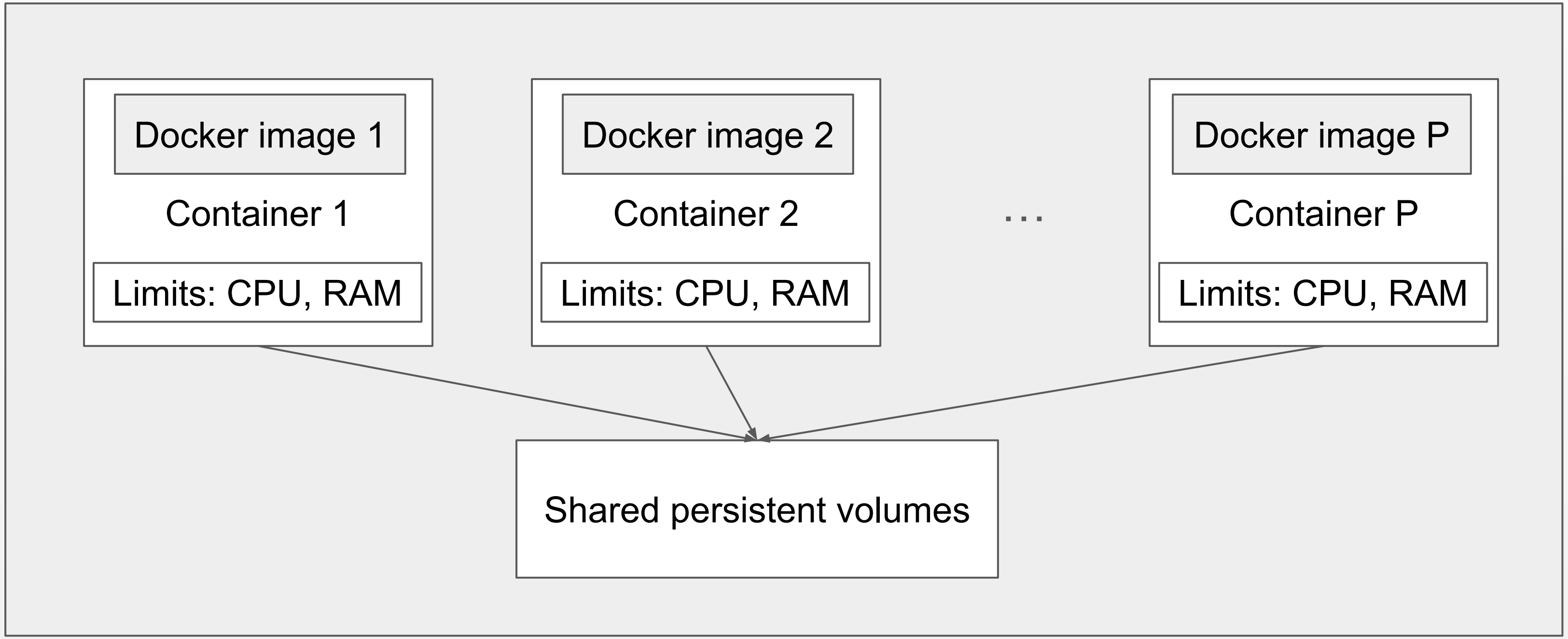


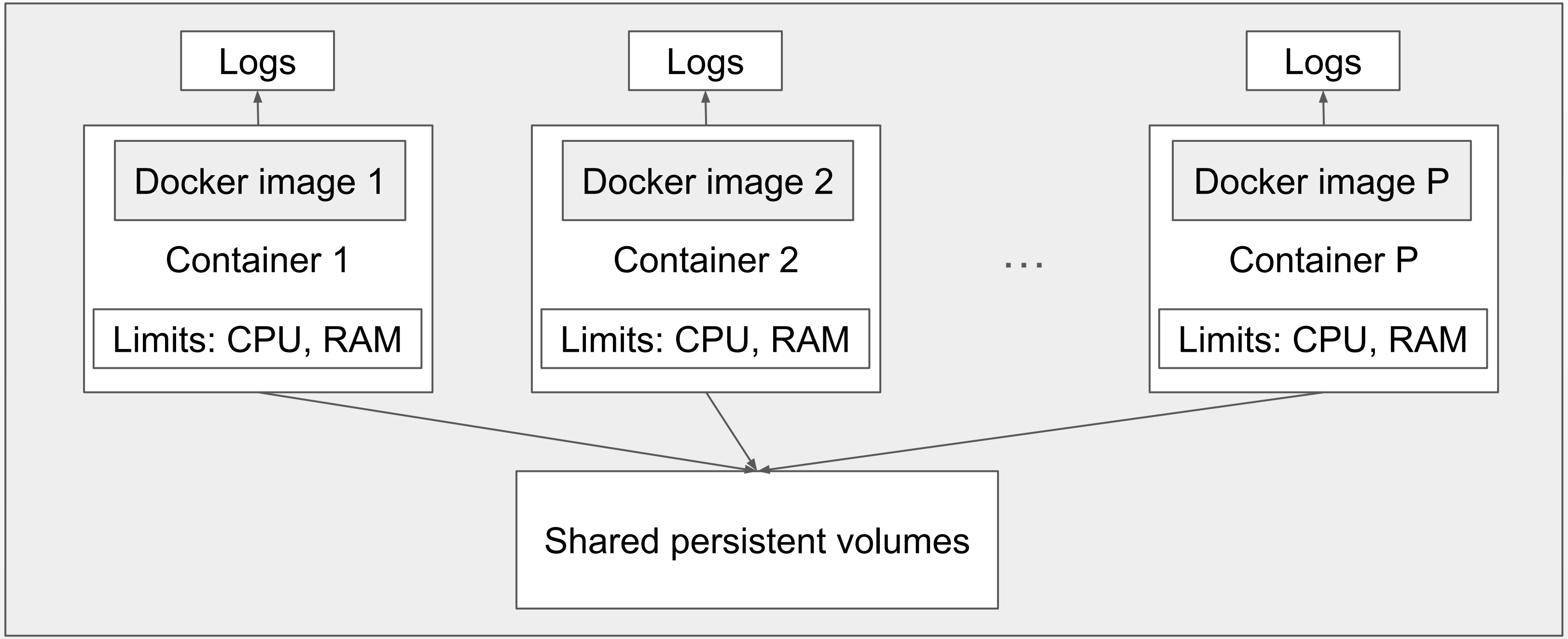
Kubernetes node



Kubernetes pod



Kubernetes logs



Kubernetes log sources

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The most of Kubernetes logs are usually generated by containers deployed by users (aka microservices)

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Kubernetes container logs: destination

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Stdout / stderr is the standard destination for container logs in Kubernetes

Kubernetes container logs: lifecycle

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```
kubectl logs pod_name -c container_name
```

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- Supports “tail -f” functionality
- Good integration with traditional Unix command-line tools (grep, head, tail, etc.)

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- Doesn’t provide tools for log analytics
  - Find top 5 containers with the highest volumes of logs

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  - Fast analytics over the **billions** of ingested logs

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  - Needs **a ton of RAM** for large log volumes

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  - Works perfectly with high-cardinality log fields (user_id, trace_id, ip)

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- Automatically scales to available CPU and RAM - from Raspberry PI to hosts with hundreds of CPU cores and terabytes of RAM
- Supports popular log shipping protocols - syslog, elasticsearch, loki, vector, filebeat, fluentbit, logstash, opentelemetry, telegraf - https://docs.victoriametrics.com/victorialogs/data-ingestion/

VictoriaLogs: querying features

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- Provides rich HTTP querying API for integration with third-party tools - https://docs.victoriametrics.com/victorialogs/querying/#http-api
- Supports “**tail -f**” functionality for query results - https://docs.victoriametrics.com/victorialogs/querying/vlogscli/#live-tailing

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- Optimized for typical log analysis tasks over **structured and unstructured** logs
- Supports data extraction and transformation at query time
- Supports powerful analytics

LogsQL examples

Select all the logs

*

Select all the logs with the “error” word

```
error
```

https://docs.victoriametrics.com/victorialogs/logsql/#word-filter

Select all the logs with the “error” word over the last 5 minutes

```
_time:5m error
```

https://docs.victoriametrics.com/victorialogs/logsql/#time-filter

Select all the logs with the “error” or “warning” word over the last 5 minutes

```
_time:5m (error or warning)
```

https://docs.victoriametrics.com/victorialogs/logsql/#logical-filter

Select all the logs with the “error” word over the last 5 minutes, which do not contain “Failed to process” phrase

```
_time:5m error -"Failed to process"
```

Select all the logs with the “error” word over the last 5 minutes for containers with the name “fluentbit-gke”

```
_time:5m error kubernetes_container_name:fluentbit-gke
```

Select all the logs with the “error” word over the last 5 minutes for containers with the name “fluentbit-gke” using log stream filter (optimized version)

```
_time:5m error {kubernetes_container_name="fluentbit-gke"}
```

https://docs.victoriametrics.com/victorialogs/keyconcepts/#stream-fields

Select all the logs with IP addresses over the last 5 minutes

```
_time:5m ~"([0-9]+[.]){3}[0-9]+"
```

https://docs.victoriametrics.com/victorialogs/logsql/#regexp-filter

Count the number of logs for the last hour

```
_time:1h | count()
```

https://docs.victoriametrics.com/victorialogs/logsql/#count-stats

Select top 10 IP addresses seen in logs over the last week

```
_time:7d `remoteAddr="`
  | extract `remoteAddr="<ip>:`
  | stats by (ip) count() as rows
  | sort by (rows desc) limit 10
```

https://docs.victoriametrics.com/victorialogs/logsql/#extract-pipe
https://docs.victoriametrics.com/victorialogs/logsql/#stats-pipe
https://docs.victoriametrics.com/victorialogs/logsql/#sort-pipe

Select top 10 IP addresses seen in logs over the last week (simplified version)

```
_time:7d `remoteAddr="`
  | extract `remoteAddr="<ip>:`
  | top 10 by (ip)
```

https://docs.victoriametrics.com/victorialogs/logsql/#top-pipe

Select top 5 container names with the biggest number of logs with the “error” word over the last hour

```
_time:1h error | top 5 by (kubernetes_container_name)
```

Select top 5 container names with the biggest errors rate over the last hour

```
_time:1h
  | stats by (kubernetes_container_name)
    count() as total,
    count() if (error) as errors
  | math errors / total as error_rate
  | filter error_rate:(>0 <1)
  | sort by (error_rate desc) limit 5
```

https://docs.victoriametrics.com/victorialogs/logsql/#math-pipe
https://docs.victoriametrics.com/victorialogs/logsql/#filter-pipe

Read LogsQL docs!

https://docs.victoriametrics.com/victorialogs/logsql/

VictoriaLogs: real production case numbers

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- Logs for the last year from our internal Kubernetes staging cluster
  - Rows: 1.9 billion (vl_storage_rows)

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- Logs for the last year from our internal Kubernetes staging cluster
  - Rows: 1.9 billion (vl_storage_rows)
  - Disk space usage: 45GiB (vl_data_size_bytes)

VictoriaLogs: real production case numbers

- Logs for the last year from our internal Kubernetes staging cluster
  - Rows: 1.9 billion (vl_storage_rows)
  - Disk space usage: 45GiB (vl_data_size_bytes)
  - Uncompressed size of logs: 2.5TB (compression ratio: **55x**) (vl_uncompressed_data_size_bytes)

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- Logs for the last year from our internal Kubernetes staging cluster
  - Rows: 1.9 billion (vl_storage_rows)
  - Disk space usage: 45GiB (vl_data_size_bytes)
  - Uncompressed size of logs: 2.5TB (compression ratio: **55x**) (vl_uncompressed_data_size_bytes)
  - RAM usage: 250MB (process_resident_memory_anon_bytes)

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  - Disk space usage: 45GiB (vl_data_size_bytes)
  - Uncompressed size of logs: 2.5TB (compression ratio: **55x**) (vl_uncompressed_data_size_bytes)
  - RAM usage: 250MB (process_resident_memory_anon_bytes)
  - CPU usage: 5% of a single CPU core (process_cpu_seconds_total)

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    - CPU limits: 4

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  - Persistent volume: 100GB standard (HDD-based Google Cloud disk)

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- Single-node VictoriaLogs container
  - CPU limits: 4
  - Memory limits: 14GiB
  - Persistent volume: 100GB standard (HDD-based Google Cloud disk)
    - 75 read IOPS
    - 150 write IOPS
    - 12 MB/s read/write throughput

VictoriaLogs: real production case numbers

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  - Top 5 apps with the highest log volume over the last 100 days: **500ms**

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  - The last 100 logs with the ‘error’ word: **100ms**
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  - Count the number of logs over the last 100 days: **300ms (found ~500M logs)**
  - Top 5 apps with the highest log volume over the last 100 days: **500ms**
  - Count the number of logs with “foobar” word across 1.9 billions of logs: **3s (found ~350 entries)**

Useful links

VictoriaLogs - https://docs.victoriametrics.com/victorialogs/

LogsQL - https://docs.victoriametrics.com/victorialogs/logsql/

How collect Kubernetes logs - https://github.com/VictoriaMetrics/helm-charts/blob/master/charts/victoria-logs-single/README.md

Ingest other logs - https://docs.victoriametrics.com/victorialogs/data-ingestion/

Interactive command-line tool for querying VictoriaLogs - https://docs.victoriametrics.com/victorialogs/querying/vlogscli/