Log Based Storage

Mark O’Connell
mark@mkoconnell.com
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While the concept of a log is certainly not a new concept in computer science, until recently logs have been used as a part of an application, typically for crash recovery purposes or sometimes for auditing/debugging purposes. More recently, logs have been emerging as a first class storage concept in and of themselves, being used in distributed environments as a mechanism for communication, as a mechanism of persistence and recovery for services, and as an enabler for query optimized data structures in complex systems. This tutorial will cover the history of log storage, starting with its use in databases and transaction logs, will contrast log storage vs block, file, and object storage, and then will examine the role of log storage in distributed systems and microservice environments via event logs and CQRS patterns (Command Query Responsibility Separation).
What is a log?

Many real world examples
- Visitor log, access log, arrival log, system log

Characteristics
- Ordered set of events
- Readable by many
- Append only
- Reads from anywhere, though characteristics differ
Traditional uses

- **Audit log** – what happened?
- **Debugging logs** – what went wrong?
- **Recovery log**
  - DB
  - FS
- **Source code control change log** – who broke it?
What’s changing?

- Analytics
- Real time streams
- Replayability
- Distributed / Decoupled Systems
- Microservices
Consequences

Logs become a communication mechanism
Consequences

 Logs become a persistence mechanism
Consequences

- Logs become a recovery / replay mechanism
Multiple readers allow “what if”
CQRS pattern

- Split out data generation from data querying
- Reads and writes optimized differently
- Can have many read models for one event log
How would this work?

1. Microservice A

Changes are written to a log

Processed by a specialized microservice to provide query services

An in memory data structure, optimized for the expected queries
Resiliency is automatic

1. Microservice A

Changes are written to a log

Start from beginning or from a checkpoint

Query microservice

Restart on same or different node

Query microservice

Changes are reapplied from the log

Service crash!!
Elastic scaling

Changes are written to a log

Microservice A — Query microservice

Load grows
Elastic scaling – clone service

1. Microservice A

Changes are written to a log

Load grows
Elastic scaling – partitioned clones

1. Microservice A

Changes are written to a log

Load grows

Query microservice

Requests A-M

Requests N-Z
Elastic scaling – clones take over

- Changes are written to a log

1. Microservice A

Each reads independently from the log

Query microservice

Handle requests A-M

Handle requests N-Z
More than just query

1. Microservice A

Changes are written to a log

Partitioned for throughput

Partition 1 \(\cdots\) Partition N

Real time analytics results
Is log storage truly different?

**Block**
- Fast - IOPS
- Low overhead
- Application determines data layout
- Inflexible
- Hard to share

**File**
- Human accessible
- Application suggests data layout
- Sharing locally, via NAS
- Built on block

**Object**
- Human accessible
- Sharing at web scale
- Infinite scale
- BW oriented
- Built on file normally

**Log**
- Human accessible
- Sharing amongst local apps
- Infinite scale
- Recent data: fast
- Older data: BW
- Build by tiering
Summary: Logs

- Decoupled from applications
- Source data for multiple applications
- Allow app transparent HA, recovery, replication
- Source data for streaming analytics
- Different characteristics from Block / File / Object
  - Low latency for tail (IOPS) – read and write
  - High bandwidth for others – read only (immutable)
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Authorship History
Mark O’Connell
Updates:

Additional Contributors

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