New Generation of Data Stores

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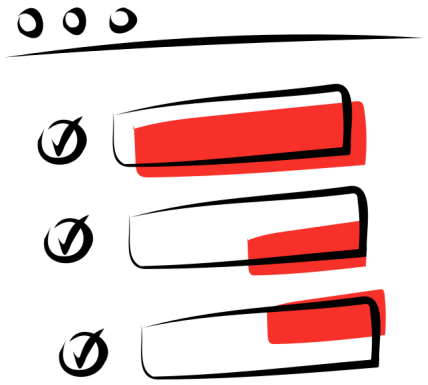
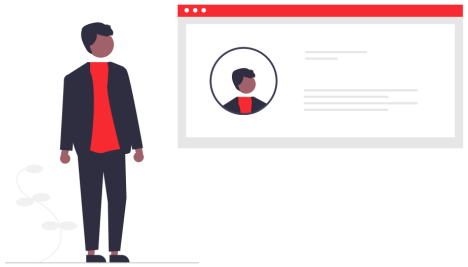
Agenda



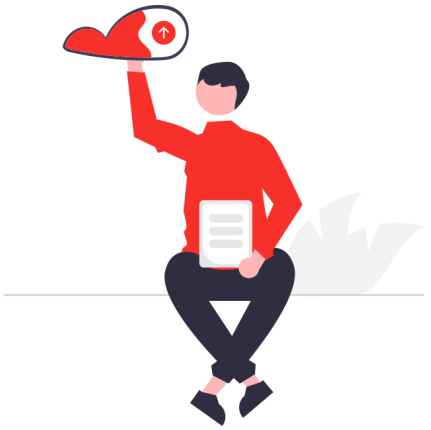
- Cloud native shift
- Splitting Storage & Compute
- Impact for cloud providers
- Impact for your business
- Impact for developers



About me

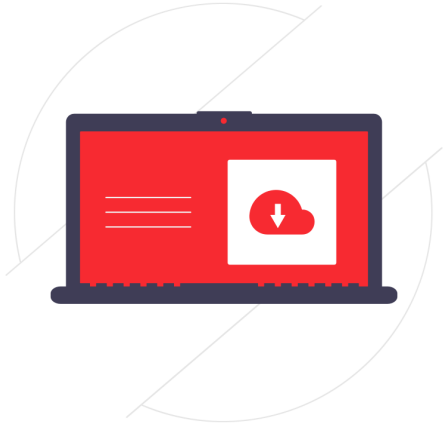
- Databases & Distributed systems
- JVM fan
- Distributed work proponent
- Working at Firebolt, a cloud data warehouse to bring data apps to the masses

Into the cloud: *Lift + shift*

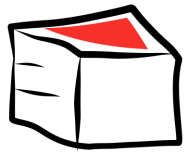


- Your strategy?
- Your strategy **for databases**?
- Consume more cloud services over time?

Data stores in the cloud



- Hosted by the cloud provider
  - Minor modifications & version lock-in
- Hosted by the database provider
  - Version lock-in
- Hosted by yourself
  - Upgrade complexity
  - Maintenance work



Data store architecture - Single system

- ✅ Single system handling reads & writes
- ✅ No coordination required
- ✅ Easy handling of transactions
- ❌ SPOF
- 💰 Scaling strategy: Scale-up
- Example: Postgres

Architecture - Decouple reads and writes

- ✅ Decouple reads from writes
- ✅ Some coordination required
- ✅ Leader/follower architecture
- ❌ SPOF
- ❌ Complexity moves to the client (several endpoints)
- 💰 Scaling strategy: Scale-up for writes, scale-out for reads
- Example: Postgres

Architecture – Sharding & Replication

- ✅ Keep copies of data in cluster, read scalability
- ✅ Split data across cluster, write scalability
- ✅ No SPOF (at the price of coordination), zero-downtime upgrades
- ✅ Scaling strategy: Scale-out
- ❌ Complexity, coordination, maintenance
- 💰 More machines to keep data safe, duplicating writes
- Example: Elasticsearch

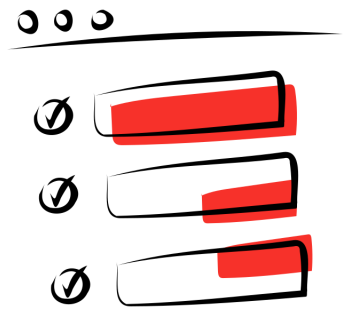
Architecture - Sharding & Replication

- ❌ Reads and writes are not decoupled
- ❌ Performance impact on load shift
- ✅ Heterogenous clusters/Tiering (hot, warm, cold, frozen)

Architecture - Streaming

- 💰 Streaming platforms as buffer
- ✅ Decouples writes
- ❌ Increased cycle time from event generation to storage
- ❌ Increases architecture complexity

What's the goal?



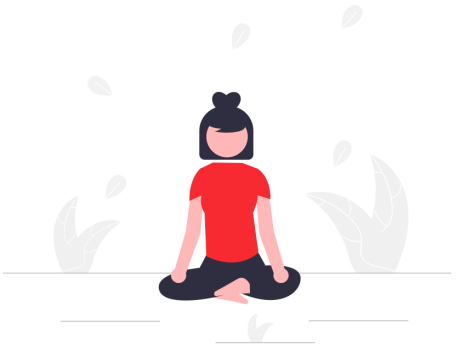
- ✅ Decouple reads & writes => independent scalability
- ✅ Write data once
- ✅ Share storage among readers
- ✅ Minimal coordination
- ✅ Replace tiers with tasks
- ✅ Cross region replication
- ✅ **Cost reduction**

OHAI hyperscalers

- Major advancements in cloud services
- Object storages improved on durability, semantics & speed, reducing the requirement of replication within your application
- **Significant** price drops (1TB S3 $23 a month, Cloudflare $16, Backblaze $5)

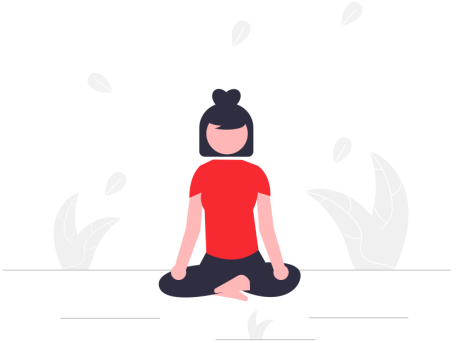
Hyperscalers rule the data world

- ... have the biggest incentive to drive down cost of services
- ... have the biggest incentive to scale down to zero
- ... have always been drivers for data store change
- ... are a couple of years ahead



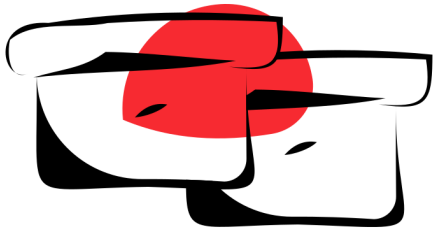
Scale to zero

- Runtime environments: AWS Lambda (2014!), Google Cloud Run
- Databases: AWS Aurora (2018!), GCP AlloyDB, CockroachDB
- Drive-by effect: Pay per use



Scale to zero - data store requirements

- Shut down an instance without losing data
- Quick start-up, single digit seconds
- Split storage & compute



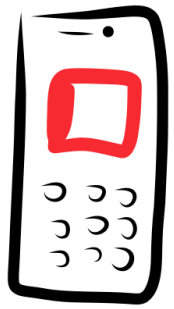
Storage

- Share storage among instances
- Concurrent read access (free!)
- Concurrent write access (locking!)
- Slower than local storage!

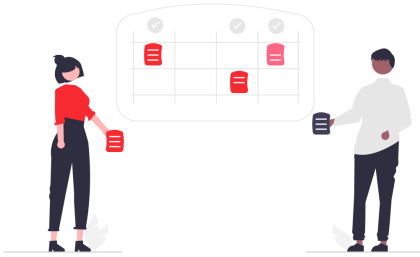
Become object storage smart

- Full table scan? `aaaaaah`
- Optimize for object storage access patterns
- Smarter query plans will not just mean less CPU/IO but lower the bill
- Assign exact costs to queries & inserts

Compute

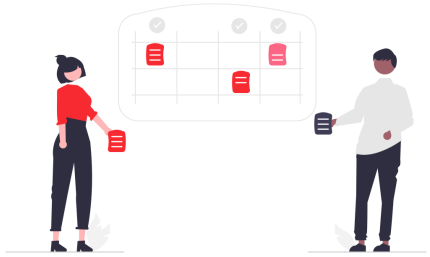


- Indexing and querying can be split
- No activity allows shutting down
- Distributed System with shared storage (consistency/transactions)
- Merging/Vacuuming can now be another compute instance
- Local storage acts as cache, bigger compute means bigger cache



Increased latency as an acceptable tradeoff

- Transactional writes need to be duplicated or waited for on the object storage (WAL)
- Batch friendlier
- Not suitable for (milli)second latency

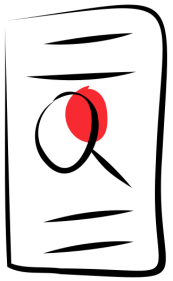


Increased latency as an acceptable tradeoff

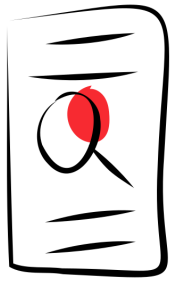
> We ultimately decided that a few hundred milliseconds increase in the median latency was the right decision for our customers to save seconds, tens of seconds, and hundreds of seconds of p95/p99/max latency, respectively.

Richard Artoul about Husky, Datadog Event Storage

Data Stores Splitting Storage & Compute



- ClickHouse (analytics)
- CockroachDB (distributed SQL)
- Firebolt (cloud data warehouse)
- Neon (postgres extension)
- Quickwit (log analytics & search)
- SingleStore (analytics)
- Yellowbrick (data warehouse)
- Yugabyte (distributed SQL)



Data Stores Splitting Storage & Compute

- Amazon RedShift
- Google BigQuery (2012!)
- Snowflake

Elasticsearch

> separate compute from storage to simplify your cluster topology

Stateless — your new state of find with Elasticsearch

Cloud Native Lucene-Based Search Engines

- nrtSearch by Yelp
- KalDB by Slack
  - Kafka, Zookeeper, S3

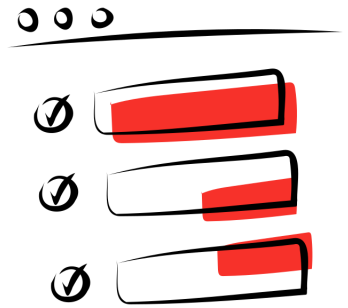
Retrofitting is tough!

> After undertaking a multi-month proof-of-concept and experimental phase

Stateless — your new state of find with Elasticsearch

Why are they doing it?

- Stay competitive in pricing to the hyperscalers
- Provide economically feasible many TB/PB storage engines
- Reduce resource consumption
- Point-in-time recovery
- `Fork your data`, but cheap
- Differentiator in SaaS offering



Downsides of this trend

Hyperscalers — a threat to Open Source?

- Problem: **Hyperscalers & other companies** offer open source software as SaaS without contributing back (to VC backed projects)
- Relicensing: Mongo, Elastic, Confluent, Graylog, Grafana, Redis
- BSL: CockroachDB, Couchbase
- Forks: Opensearch
- Good read: Righteous, Expedient, Wrong

Hyperscalers — a threat to Open Source?

- OSS monetization moves to SaaS monetization (investor driven)
- Open Source vs. Open Code
- Future: Less open source, partial open source, closed source control planes?
- More blackboxed systems?
- Different compatibility guarantees - wire protocol, SQL

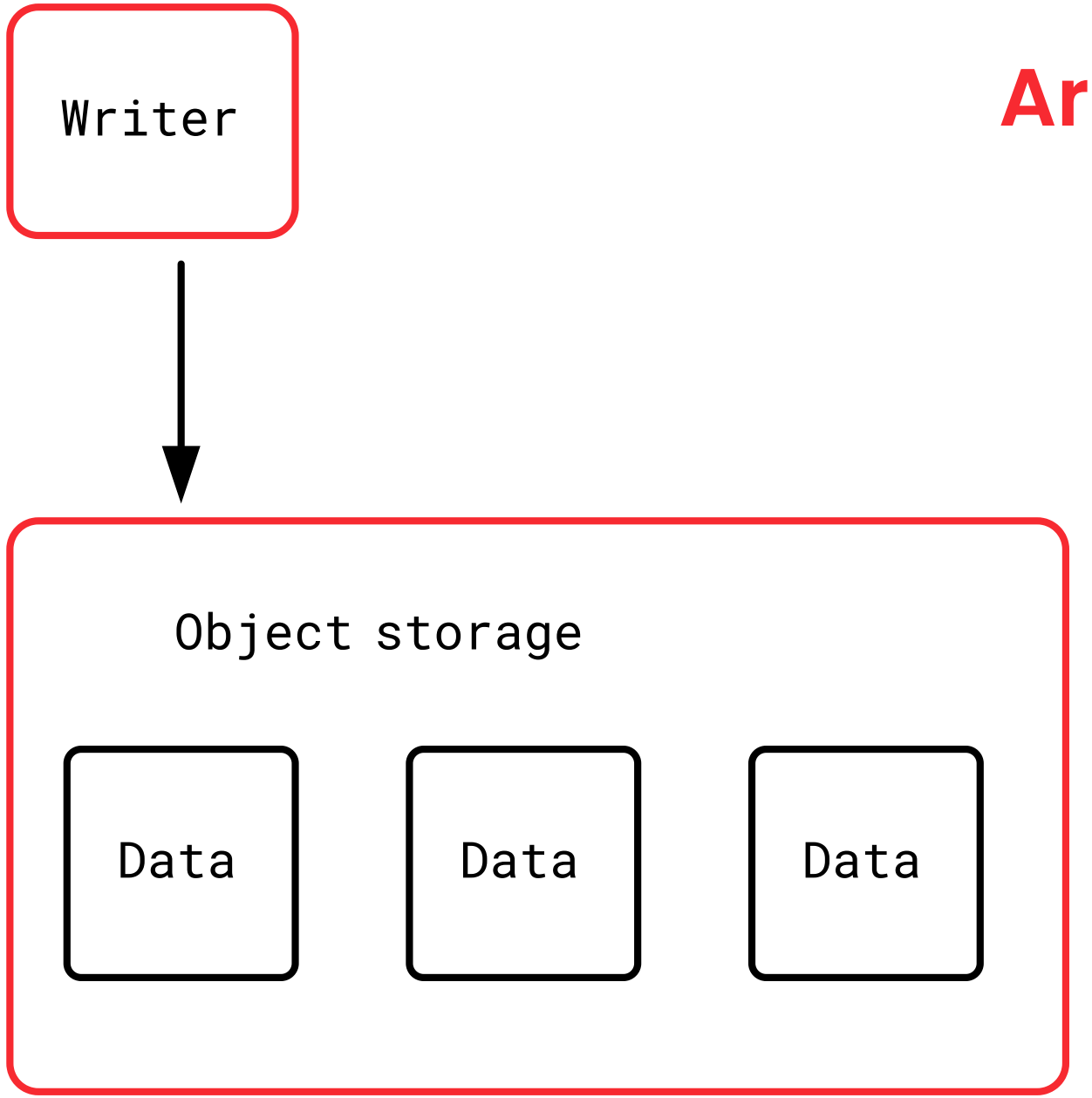
Development becomes more complex

- New generation of data stores will not run on all cloud providers
  - Threat to DigitalOcean, Scaleway, Scalingo, Vultr, OVH
- New generation of data stores will not run locally
  - Testing
  - Fast feedback
  - Offline development
  - Preproduction systems (just kidding!)
  - **Cheap** CI runs

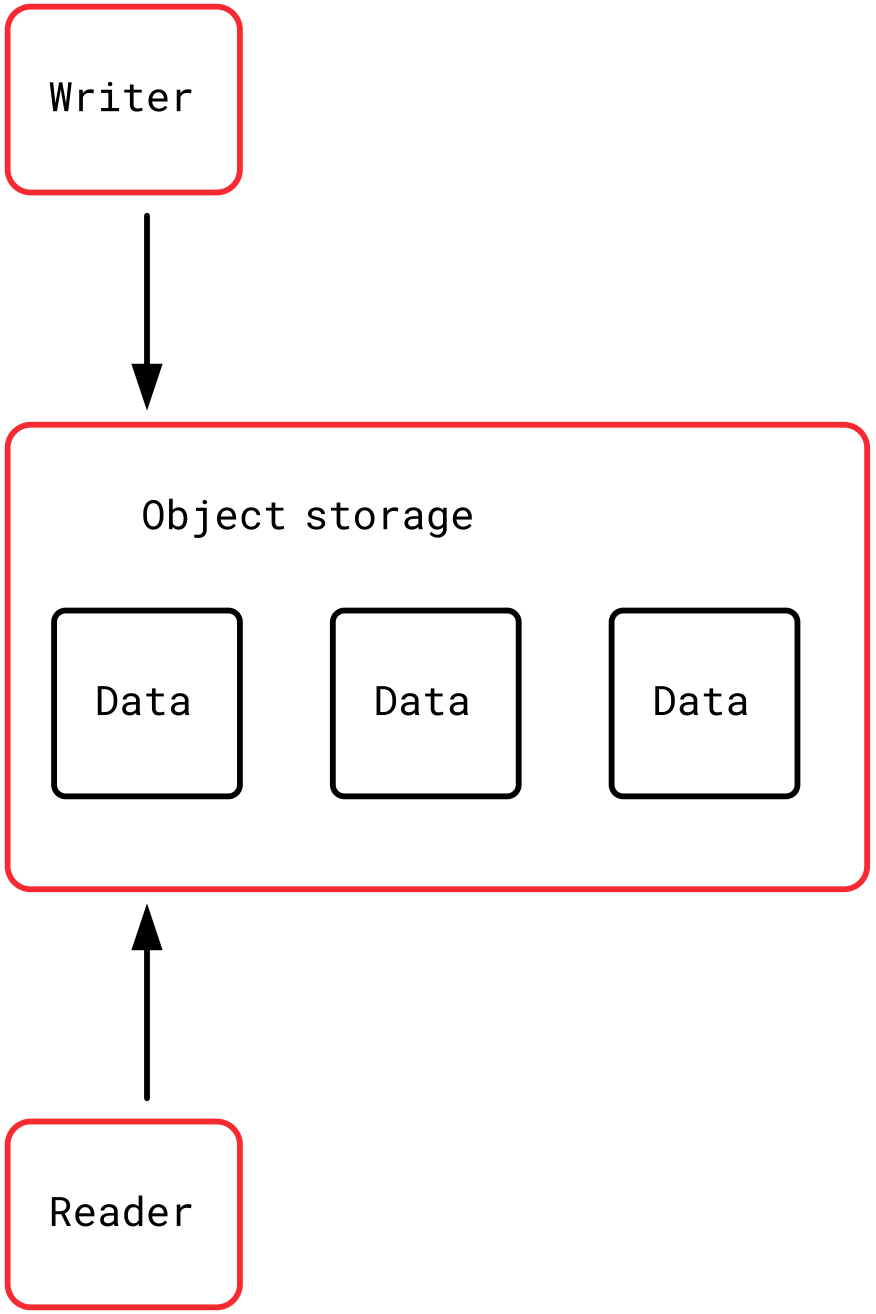
Debugging

- Much more blackbox
- IOPS/bandwidth from remote storage
- Network speed
- Performance stability and predictability

Architecture



Architecture



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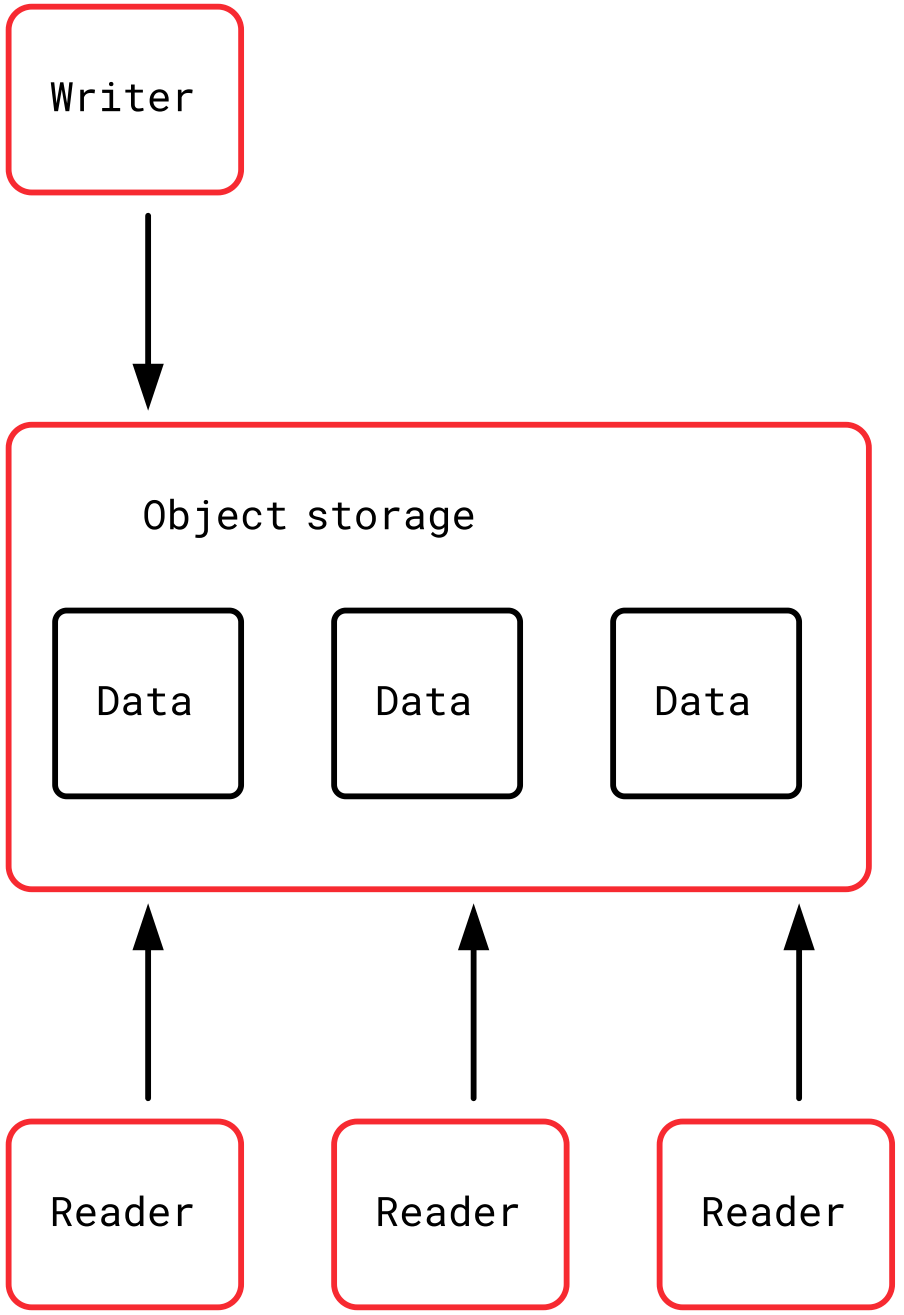

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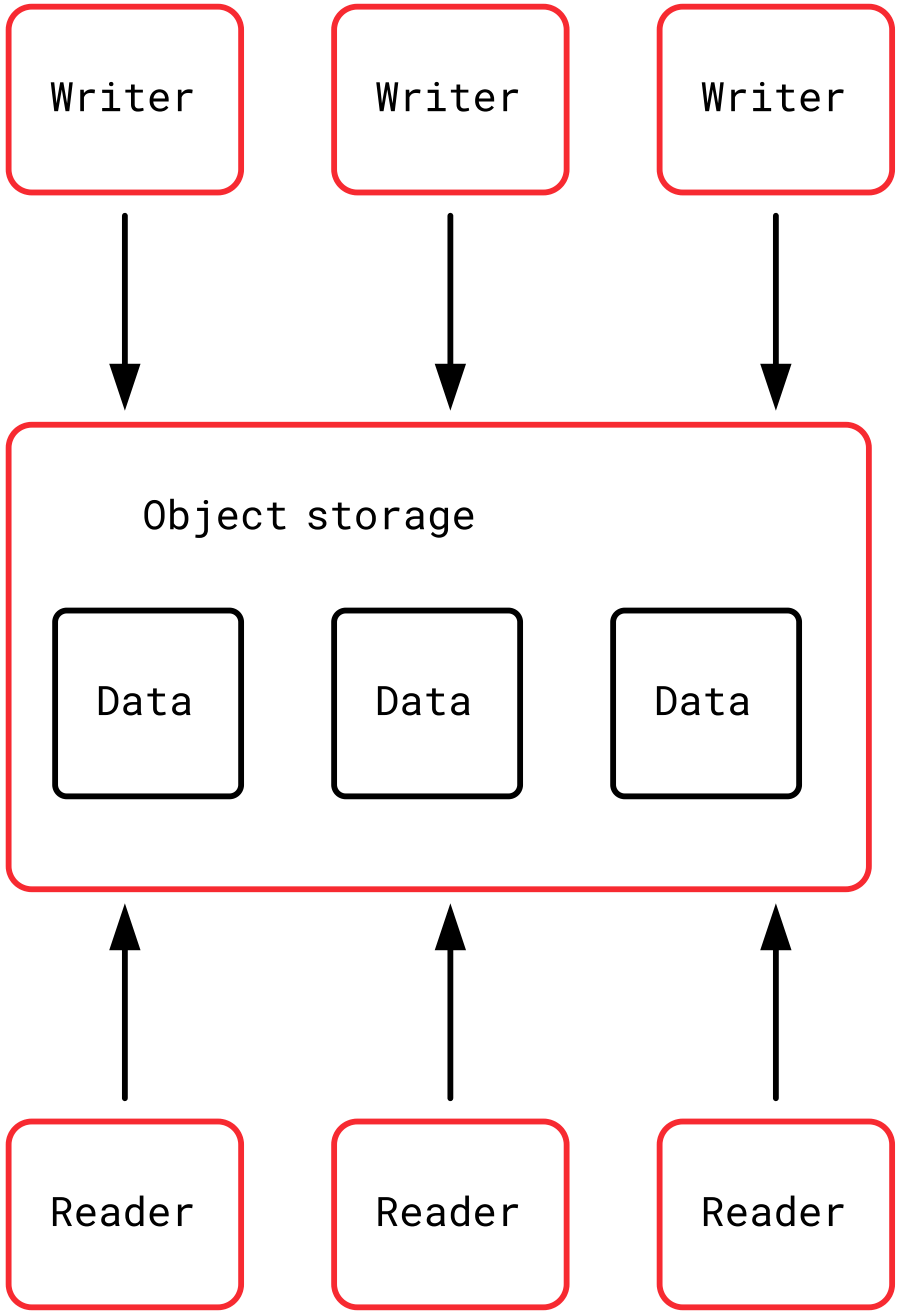
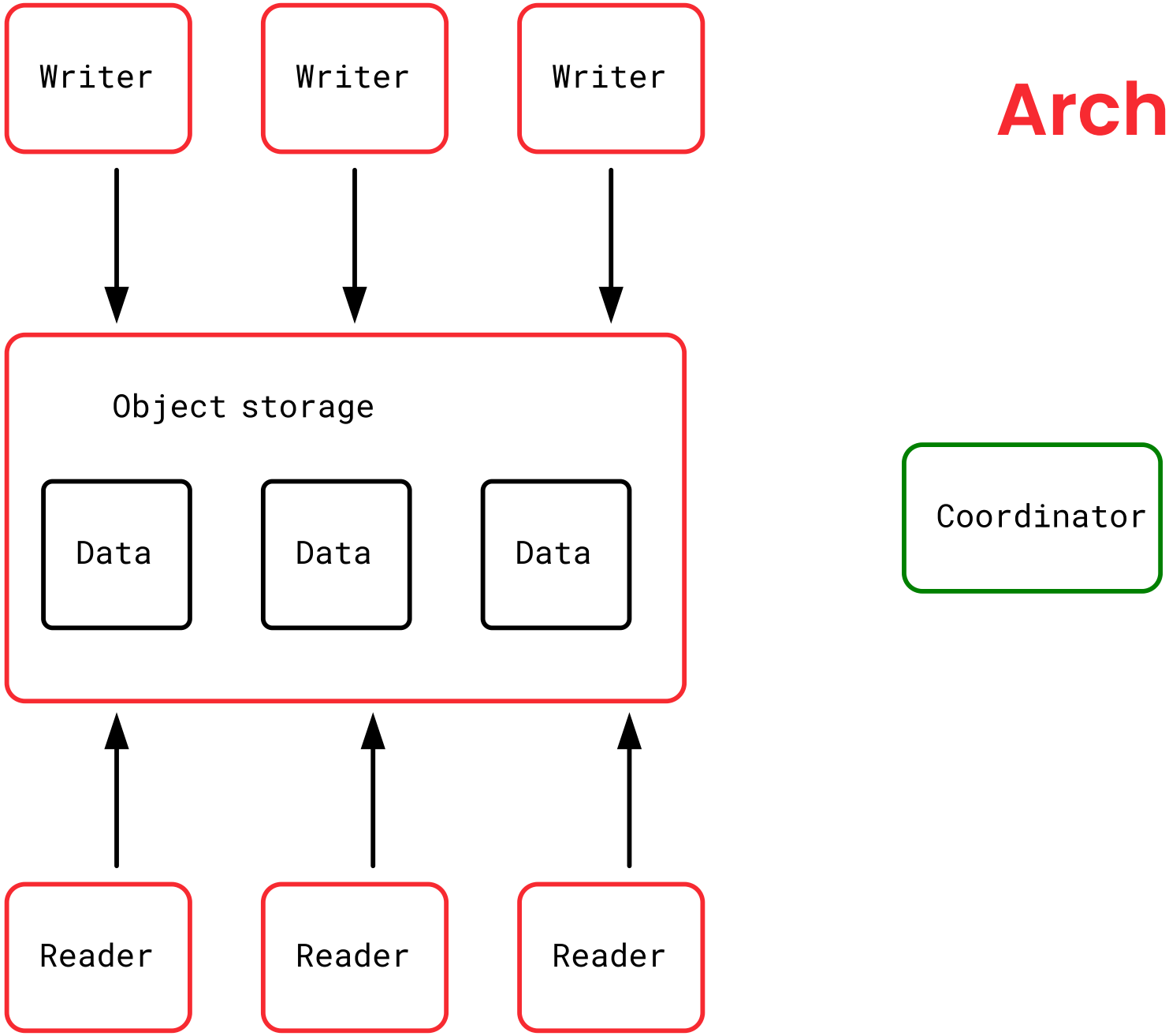
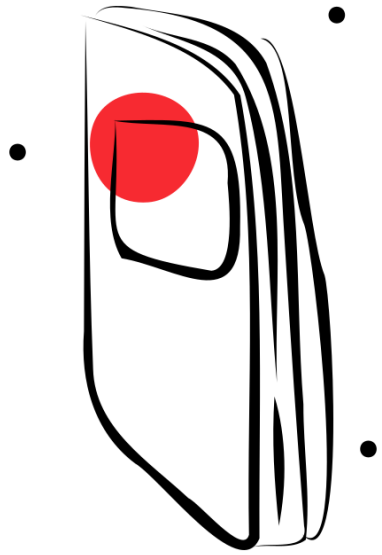


Architecture



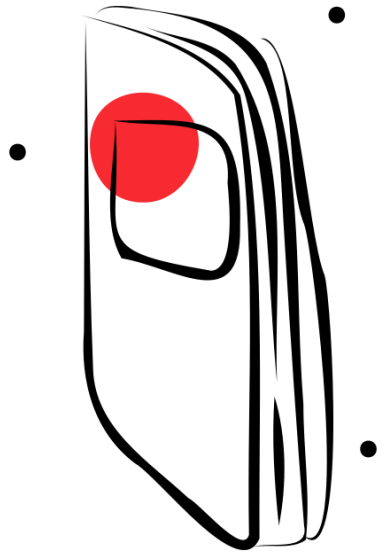
Coordinator

Coordination - Append only



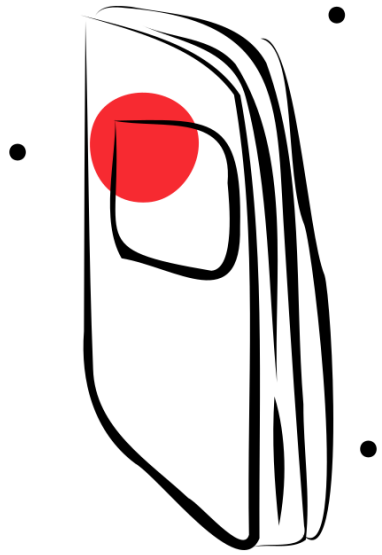
- When is a write `done`?
- Multi file moves are not atomic
- Notify readers of new data

Coordination - Updates & Deletes



- No `in place` updates
- Append + Mark as deleted
- Notify readers of new data
- Local storage cache invalidation

Coordination - Cleanup/Vacuum



- Remove unused data
- Remove data marked as deleted
- Compact to bigger segments supporting better compression
- How to remove data, that is `in use`? No notion if inodes

Coordinator

- Gets notified when data is ready to be queried
- Notifices about new data to query
- Triggers Merging/Vacuuming
- Needs to persist its state in case of crash?
- Coordinator might be embedded into another role

Summary

- Cloud only data store trend will continue
- System will be able to store more data, PBs as commodity
- Resource consumption for CI & development is an unsolved problem
- Offline development will cease to exist (cloud IDEs on the rise)

Discuss!

Thanks for listening!

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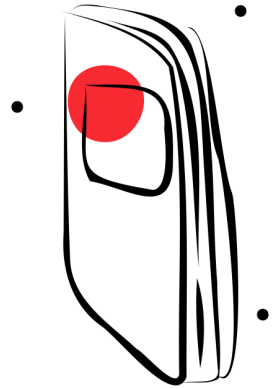
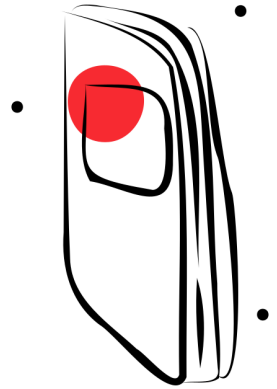
Where can I learn more?



- CMU Database Talks
- Book: Understanding Distributed Systems
- Book: Designing Data Intensive Applications
- The Firebolt Cloud Data Warehouse Whitepaper
- Article: Separating compute and storage, from **2019**
- BigQuery under the hood, from 2016



Where can I learn more?

- This talk as a blog post
- spinscale.de - my blog

Discuss!

Thanks for listening!

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