Sweet Storage SLOs with Frosting

Andrew Wang, Shivaram Venkataraman,
Sara Alspaugh, Ion Stoica, Randy Katz

amplab

Exploratory drill-down

Batch analytics

Interactive web-serving

HBase

HDFS

MySQL

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Today's Clusters

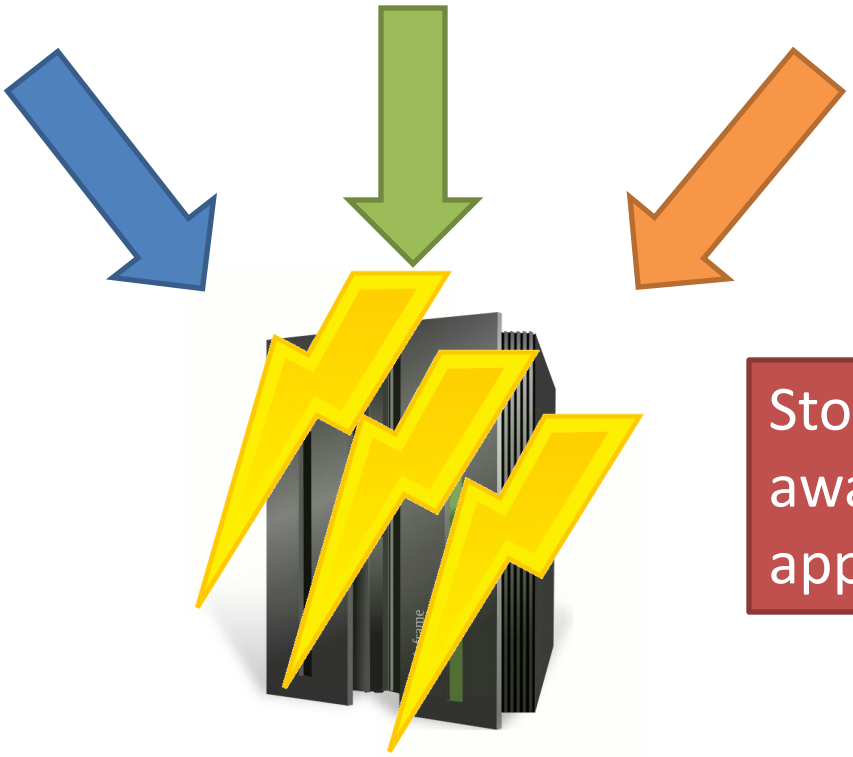
- Segregated storage systems
- Downsides
  - Delayed reaction time from analytics
  - Increased provisioning costs ($$$)
  - Reduced cluster utilization
  - Duplication of data

- Ideally, all apps share a single storage system!

Exploratory drill-down

Batch analytics

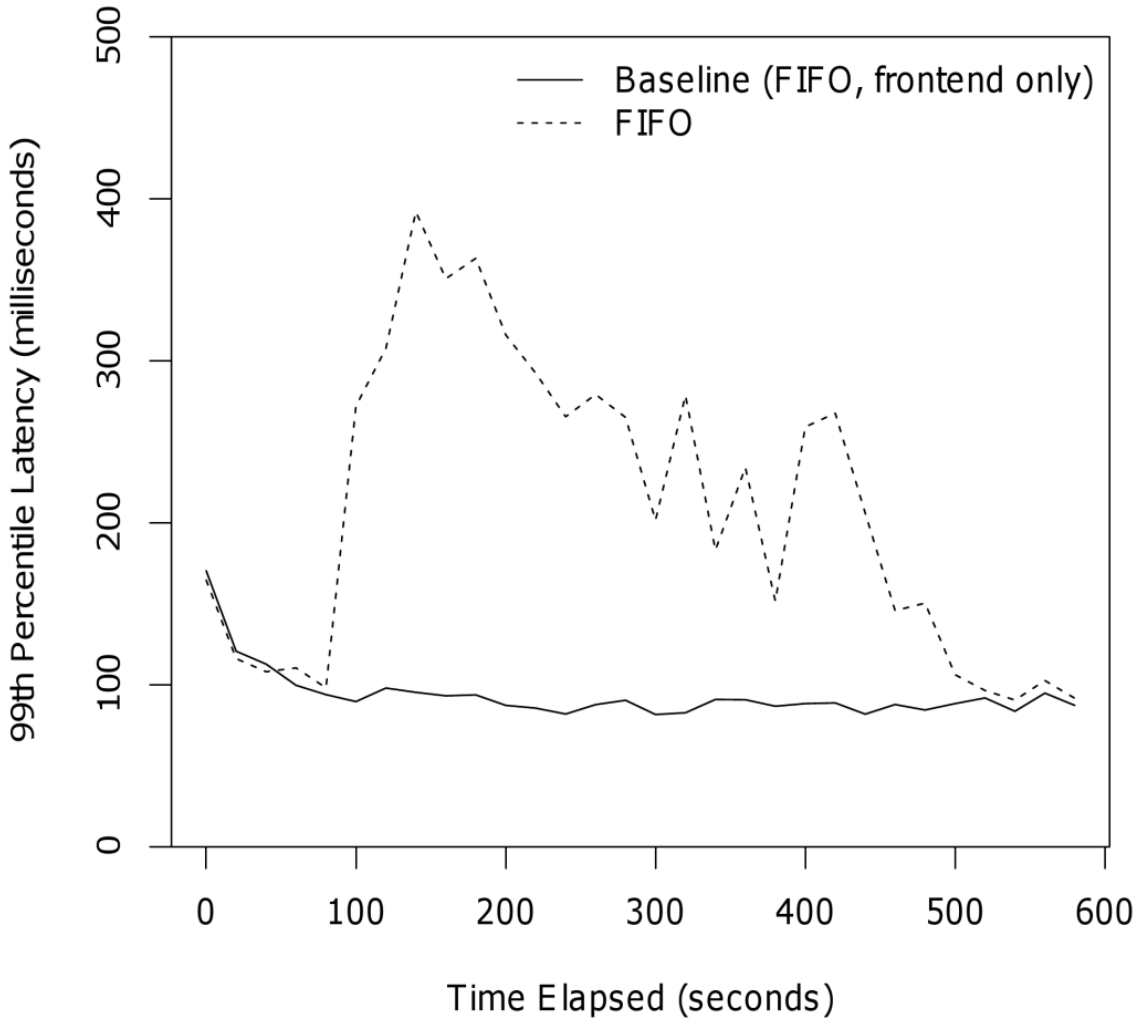
Interactive web-serving



Unified Storage Layer

Storage layer is not aware of each application's SLO!

Mixing Front-end and Batch



High-percentile Latency SLOs

- Metric of merit for latency
  - 95th or 99th percentile
- Important with request fan-out
  - Stragglers affect overall latency
- Growing importance for complex pages
  - Status updates, profile pics, friend requests, etc.

Problem

- Want to multiplex front-end and batch workloads
- Also need 99th percentile latency guarantees for front-end storage system operations

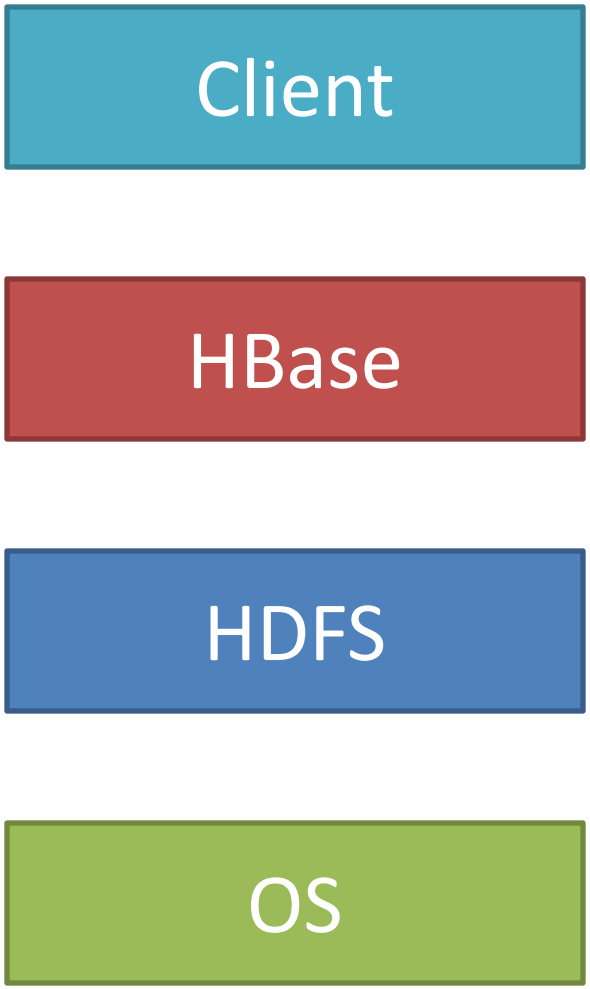
Existing solutions

- Mismatch between apps and storage systems
  - Apps think about key-value or row operations
  - Storage systems think about disks
- Need to manually tune low-level parameters
  - MB/s, IOPS, etc.
- Use average latency, not 99th percentile

Goals of Frosting

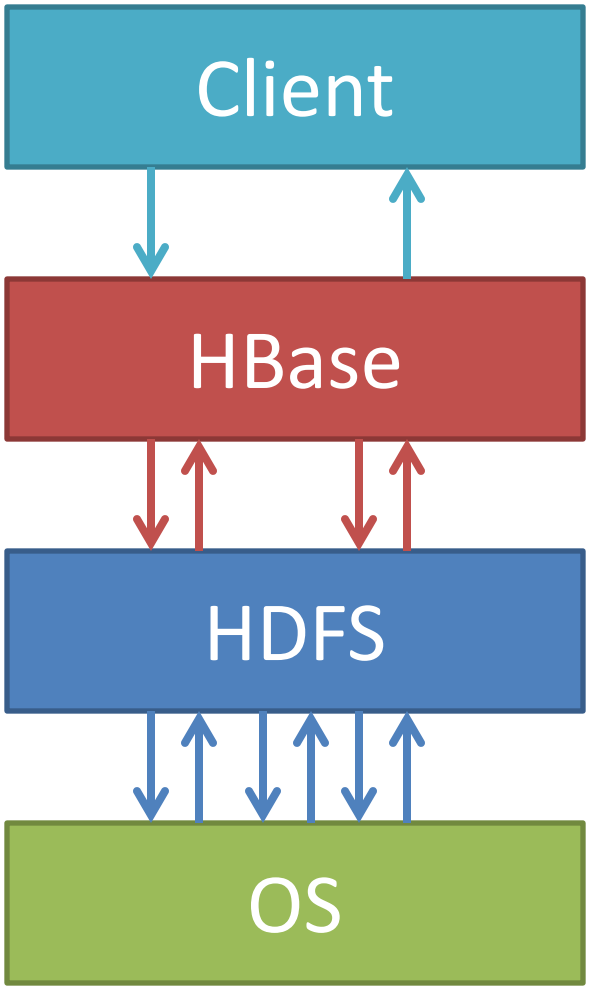
- Enable a single, shared storage layer
- High-level *service-level objectives* (SLOs) specified directly to the storage system
  - *"my gets will finish in 200 ms, 99% of the time"*
- No manual tuning by the app programmer

Deep Software Stacks



- HBase
  - BigTable-like
  - Distributed column store
  - Get, put, scans on rows
- HDFS
  - GFS-like
  - Distributed filesystem
- OS
  - Interfaces with hardware

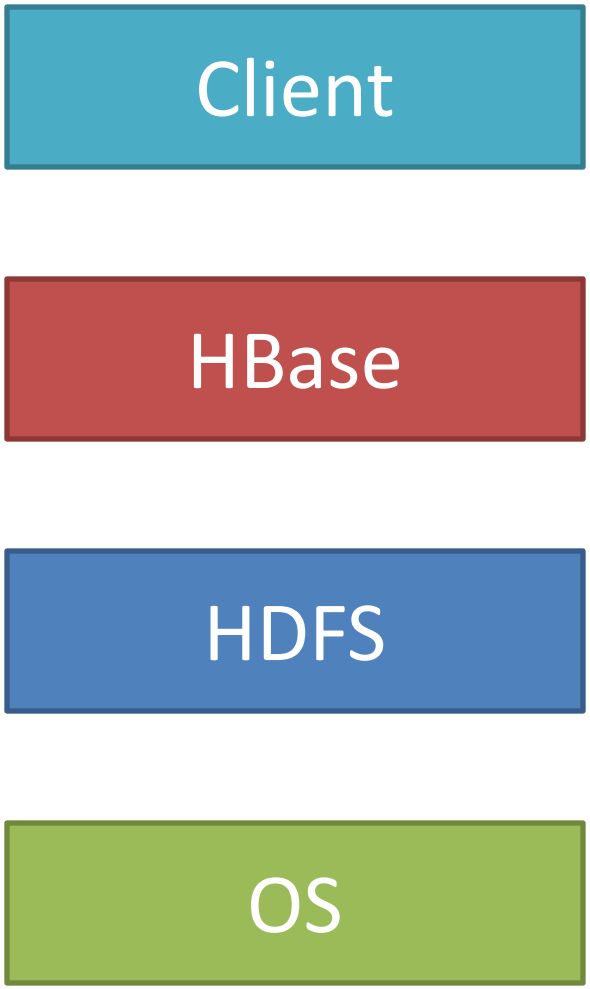
Deep Software Stacks



- Clean layered architecture
- Request processing traverses software stack

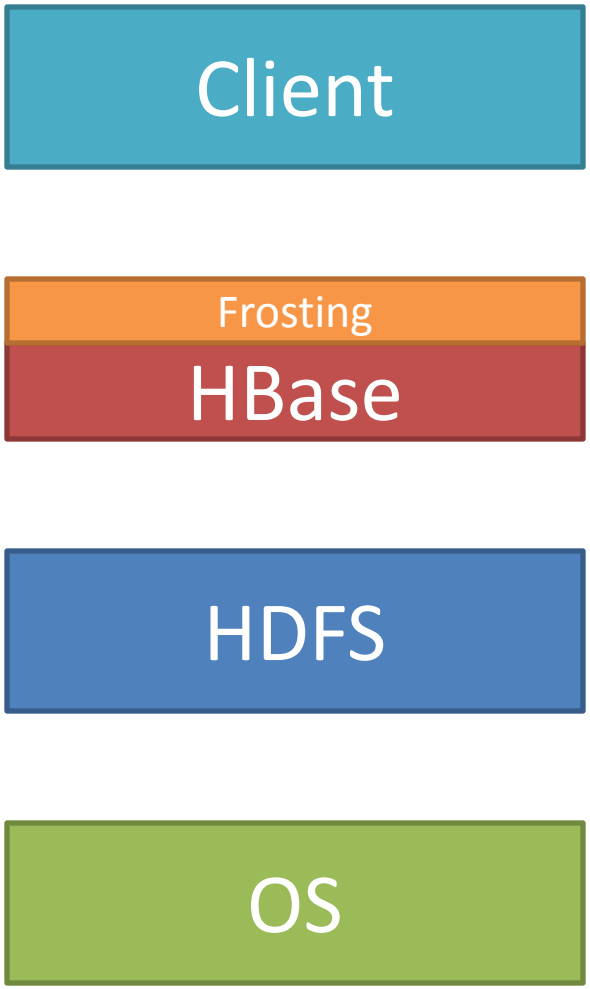
- Hard to debug latency!
- Lots of code
- Complex interactions

Frosting Architecture



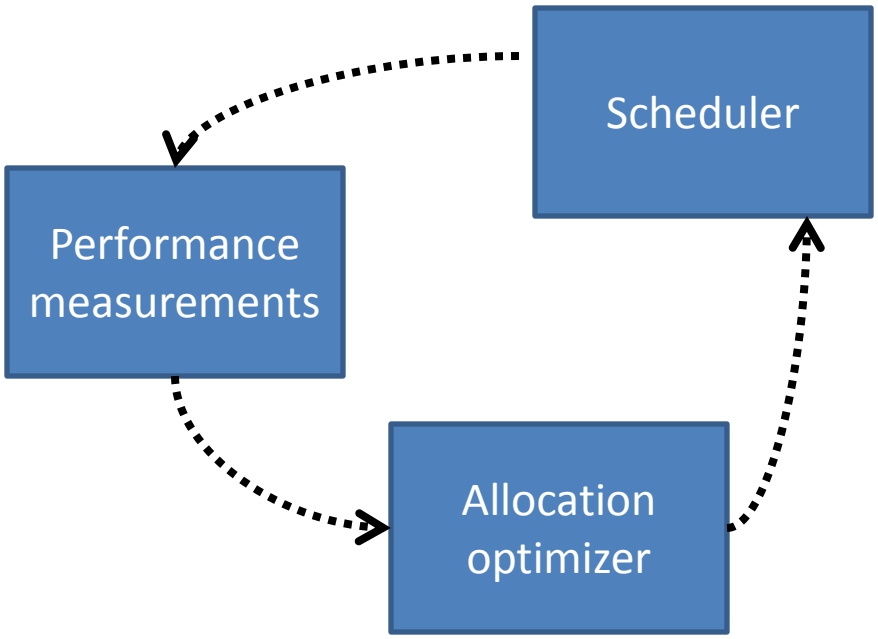
- Try the simple approach

Frosting Architecture



- Try the simple approach
- Insert scheduling at the top layer (HBase)
- Proportional share among HBase clients
- Dynamically adjust shares to enforce client SLOs

High-level SLO Enforcement

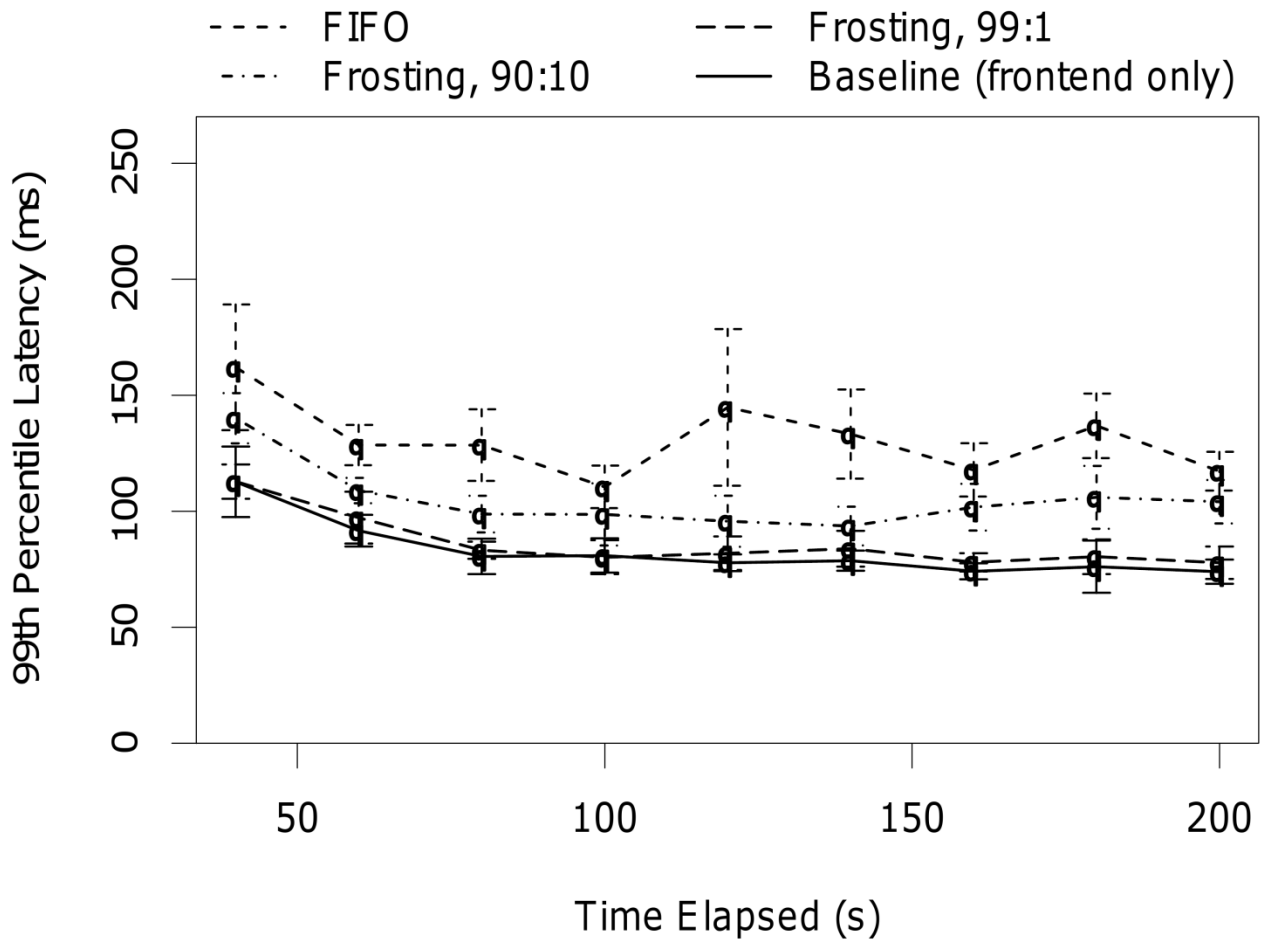


- Feedback loop
- Measure each client's performance
- Compare with SLO
- Increase or decrease allocation accordingly

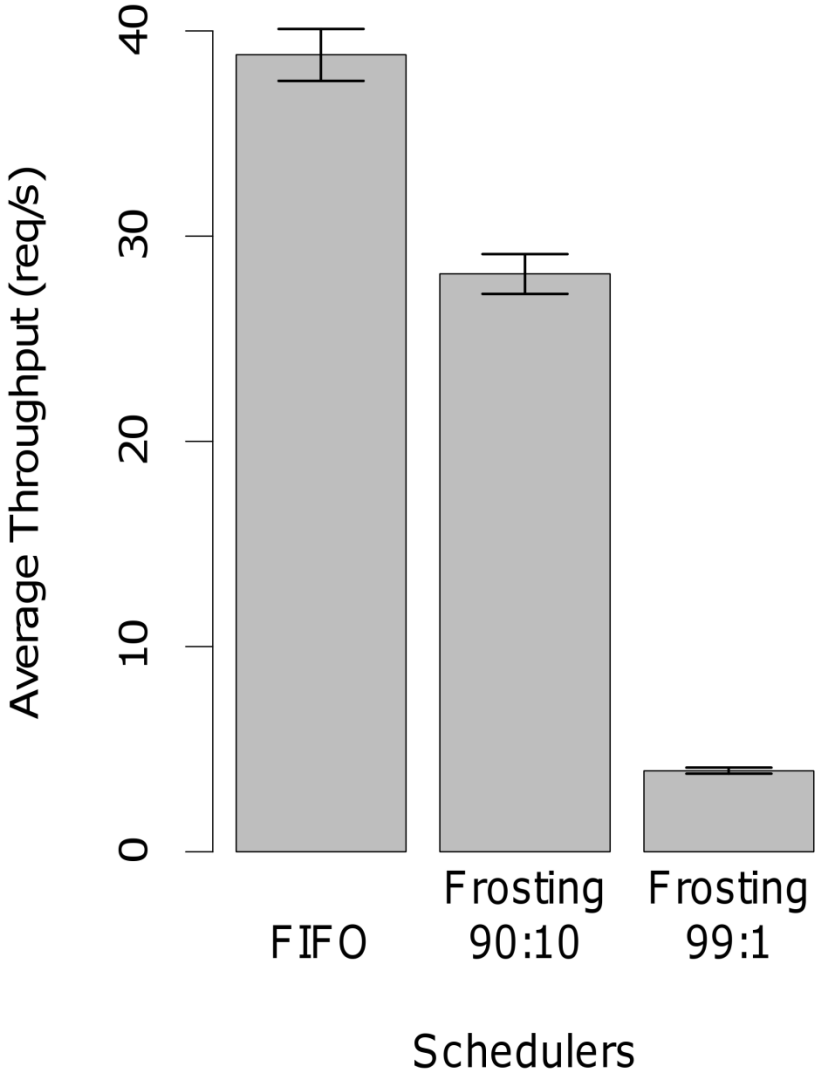
Evaluation

- HBase cluster on c1.xlarge EC2 nodes
  - 8 CPU cores
  - 4 local disks
- Yahoo! Cloud Serving Benchmark clients
  - Frontend: 1-row gets, high priority
  - Batch: 500-row scans, low priority

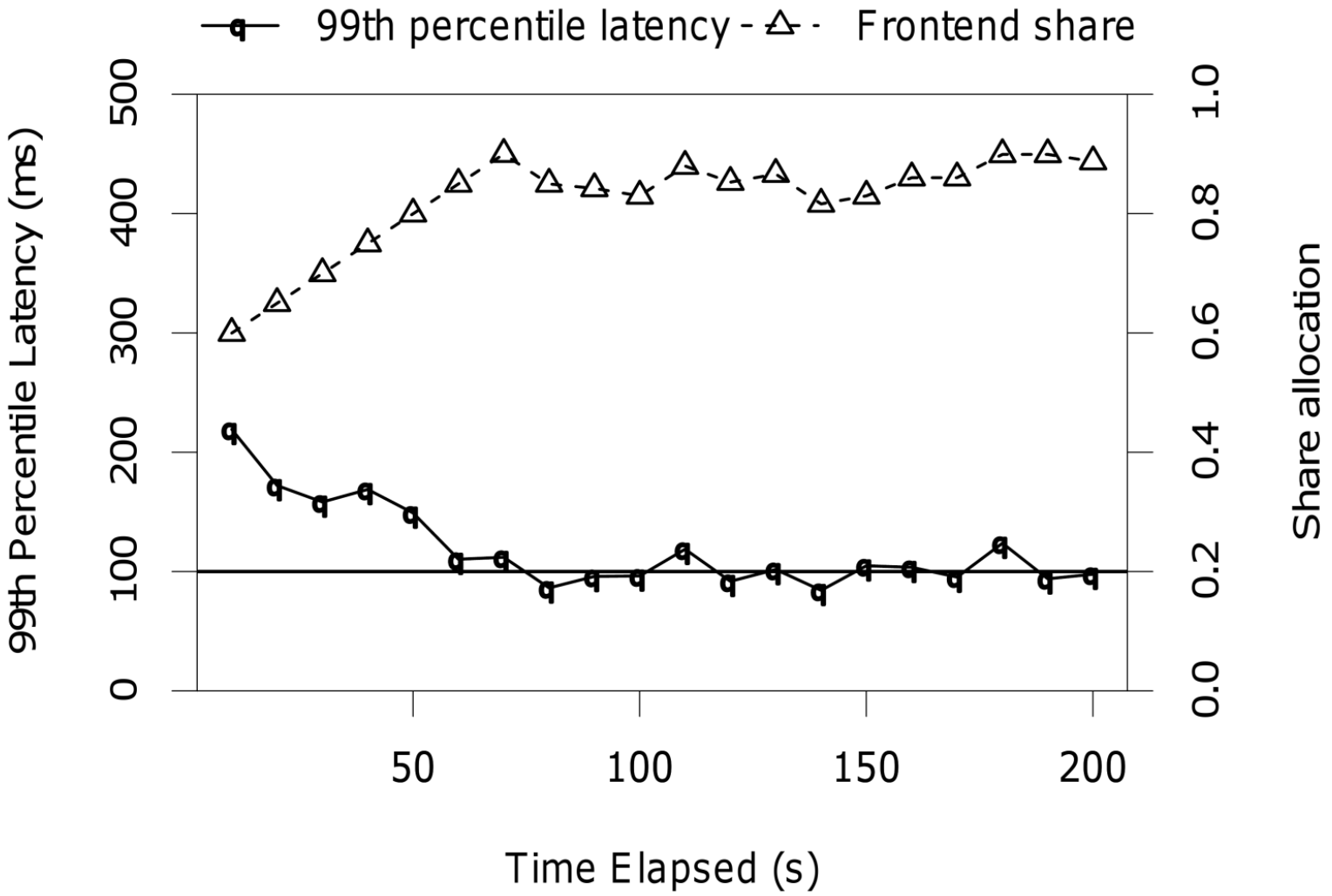
Evaluation


FIFO
Frosting, 99:1
Frosting, 90:10
Baseline (frontend only)
99th Percentile Latency (ms)
0
50
100
150
200
250
50
100
150
200
Time Elapsed (s)

Evaluation


Average Throughput (req/s)
0
10
20
30
40
FIFO
Frosting 90:10
Frosting 99:1
Schedulers

Evaluation


99th percentile latency
Frontend share
99th Percentile Latency (ms)
0
100
200
300
400
500
Share allocation
0.0
0.2
0.4
0.6
0.8
1.0
50
100
150
200
Time Elapsed (s)

Conclusion

- Fundamental latency vs. throughput tradeoff
- High-level SLOs can be enforced directly and automatically by the storage system
- Ideas can be applied to existing systems