

5

4

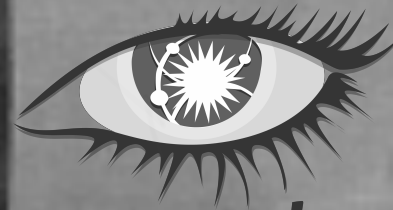
3

2

1



DATASTAX 

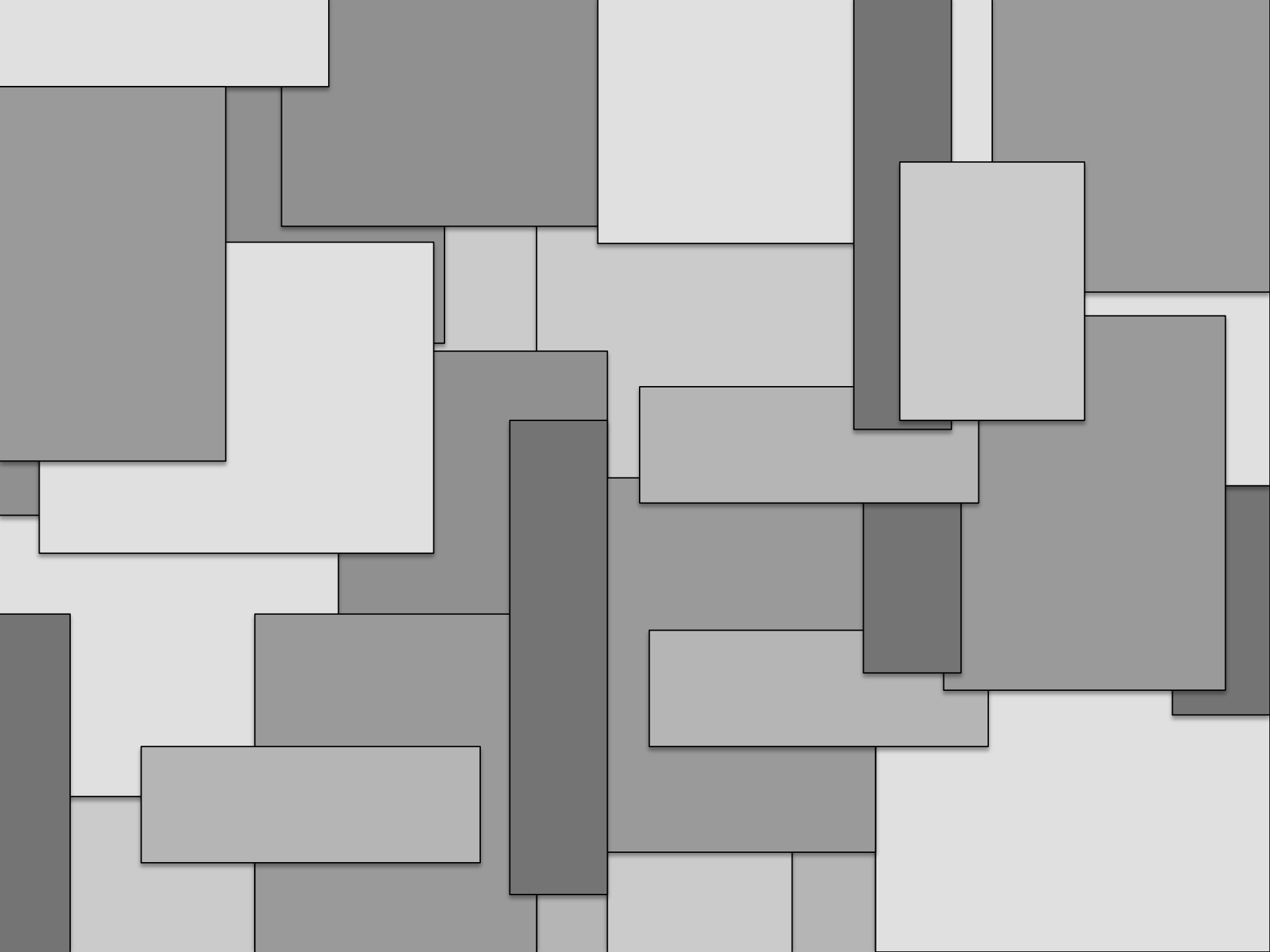


cassandra

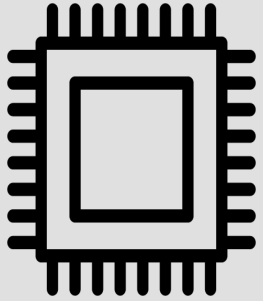
Kathryn
Erickson

Fusion-io

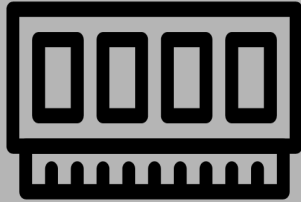




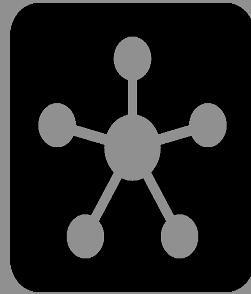
CPU



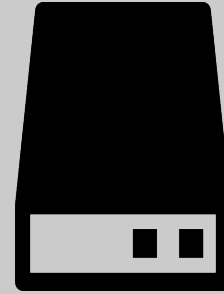
RAM



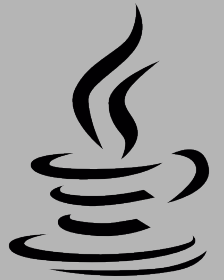
NETWORK



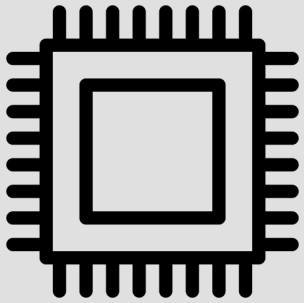
STORAGE



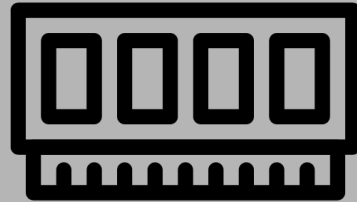
JAVA



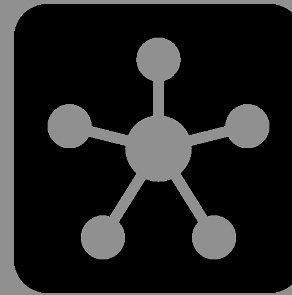
CPU



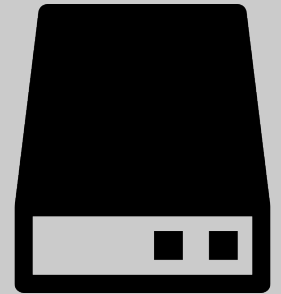
RAM

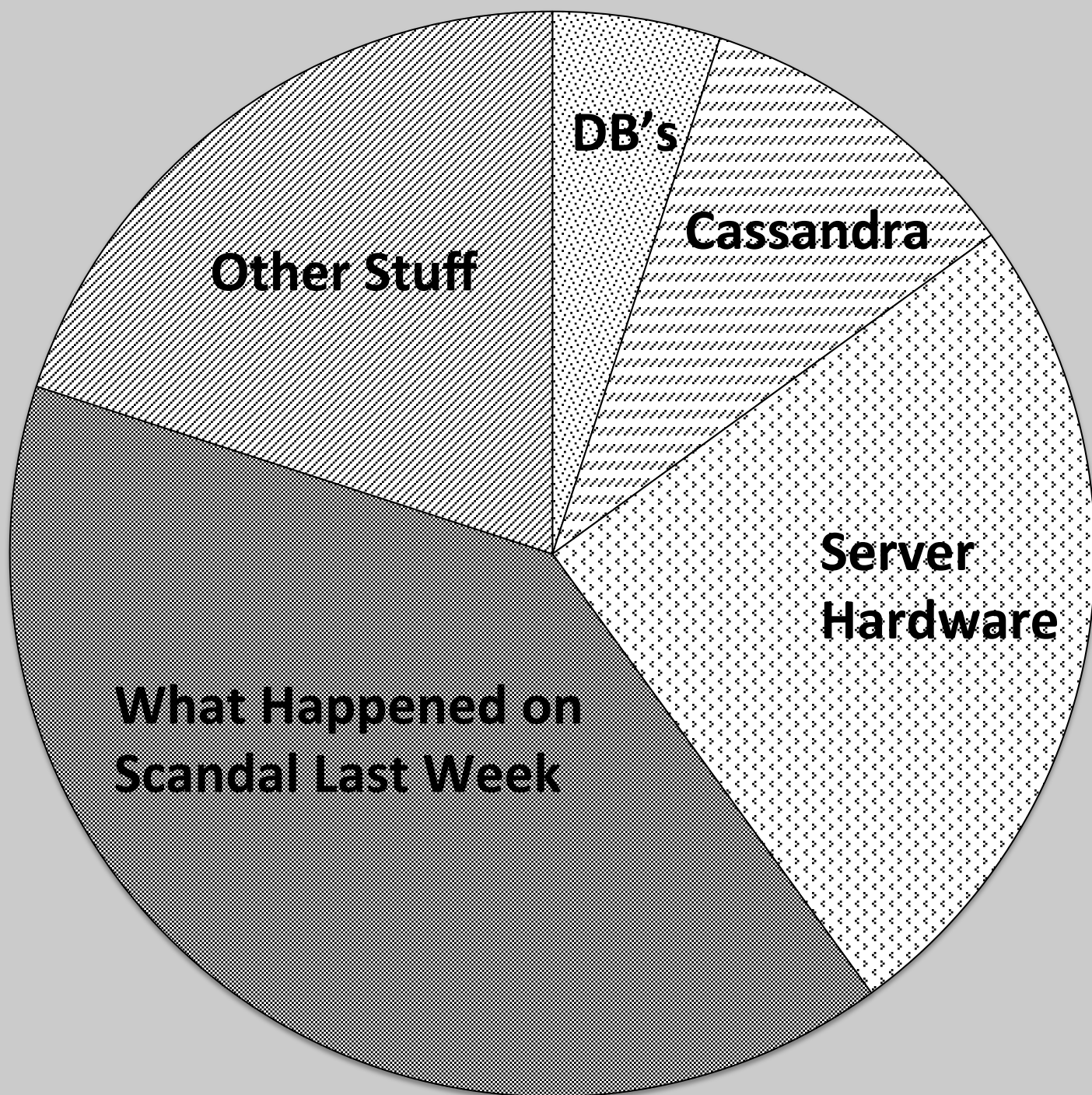


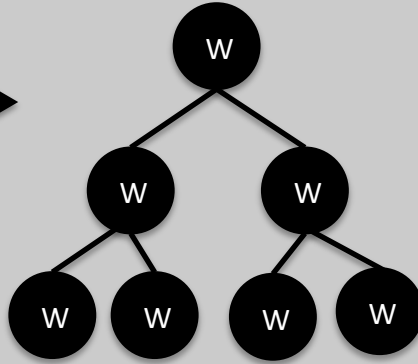
NETWORK

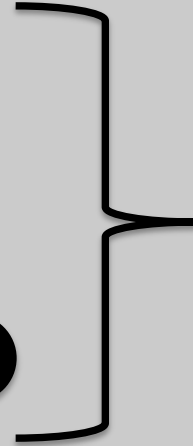
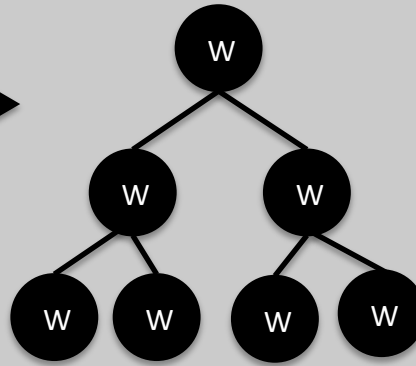


STORAGE



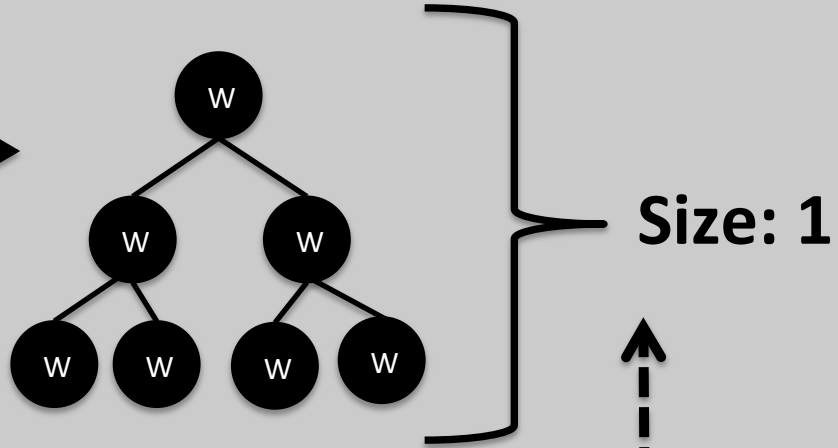


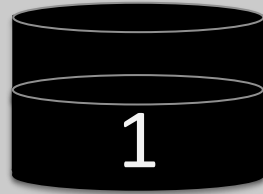
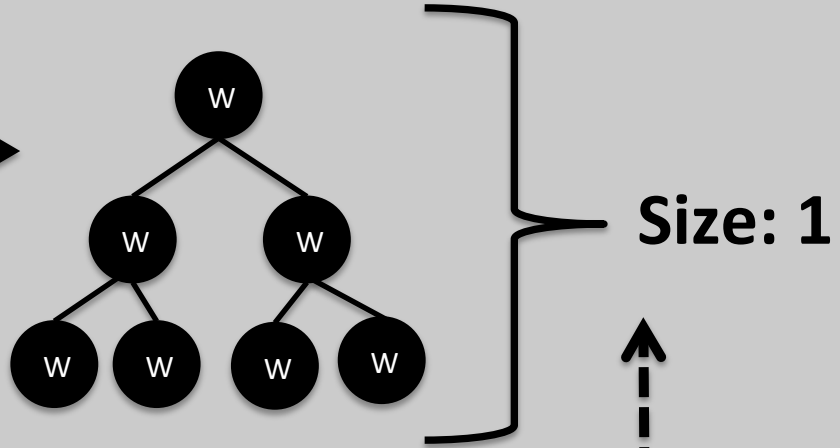
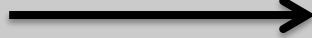


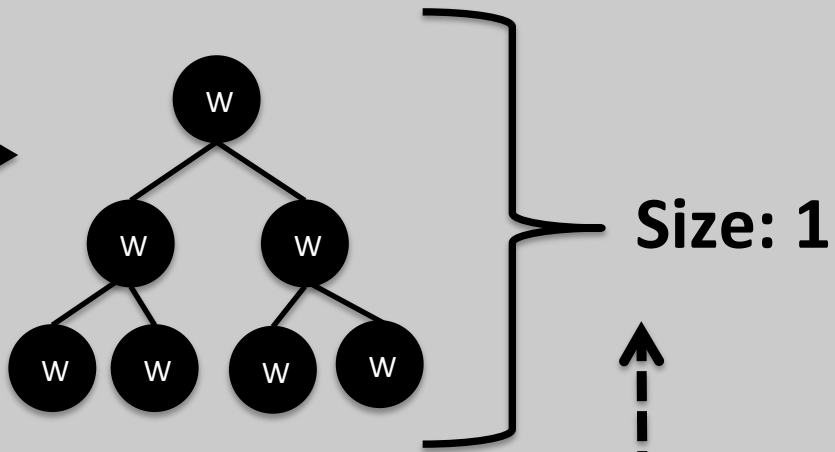


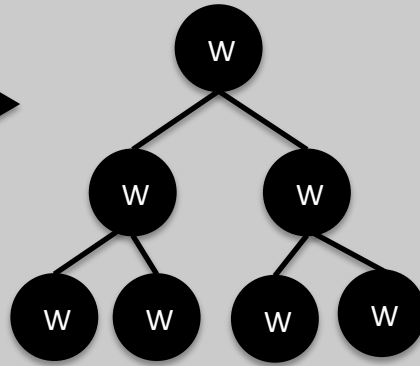
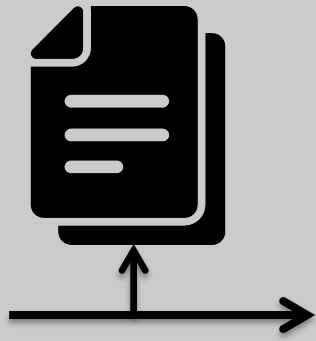
Size: 1





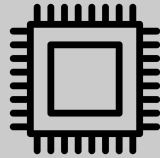




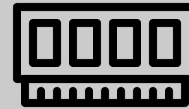


Workload

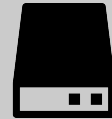
CPU



RAM



STORAGE



C*/DSE – Read
Heavy Capacity
Driven

4-24 cores

32-256GB (128 really
but cache is king)

Local SSD – .5 - 2.5TB

C*/DSE – Write
Heavy – Transaction
Driven

8-32 cores

32-128GB

Local SSD – 1- 3TB /
spinning disk if you must
– .5 – 1TB

DSE + SOLR

12-32 cores

128GB

Separate local SSD for
Lucene and C* - 1 – 3TB

DSE + SPARK

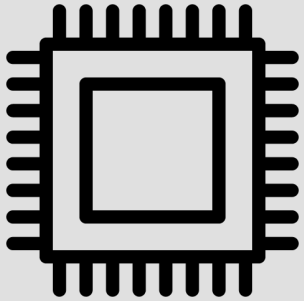
12-32 cores

128GB

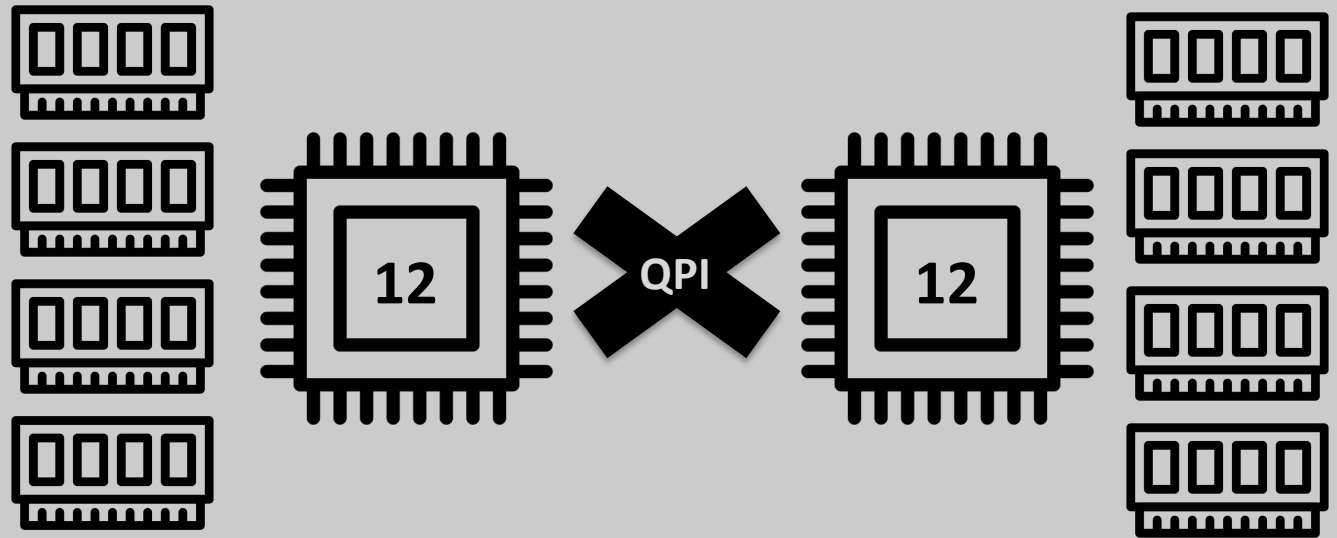
Separate local SSD for
Lucene and C* - 1 – 3TB

*1GbE is sufficient but many are choosing 10GbE for future-proofing

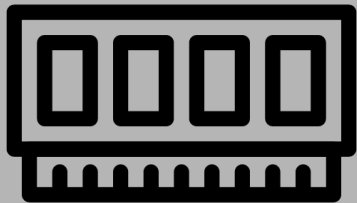
CPU



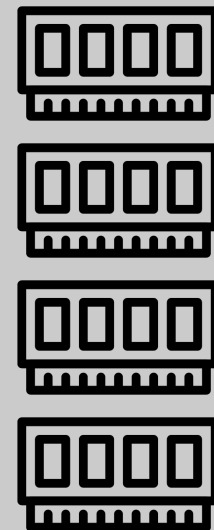
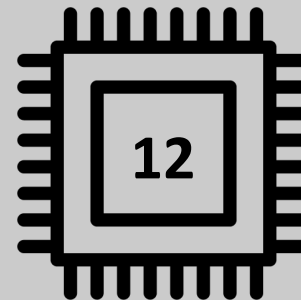
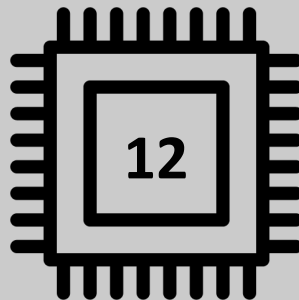
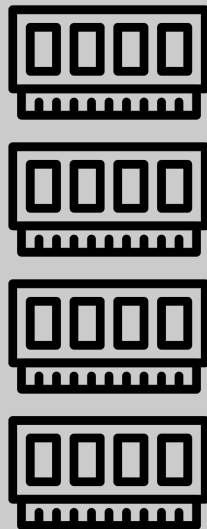
- WWPDD – more cache
- Cache, cache, cache, cache, cache, core-count, megahertz
- $\geq 20\text{MB}$ Cache



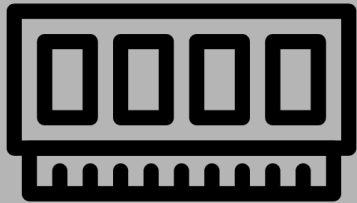
RAM



- 4 DIMMs per socket (maybe 2)
- 8-16 GB DIMMs is the current sweet-spot for \$/GB



RAM

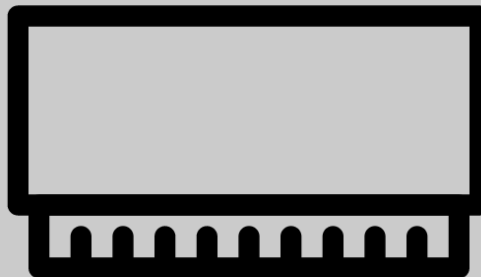
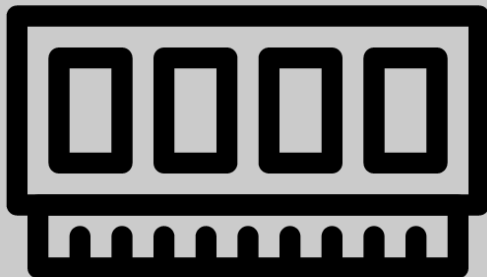


- ✓ HP 8GB (1x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$249.00]
- HP 16GB (2x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$249.00]
- HP 24GB (3x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$498.00]
- HP 32GB (4x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$747.00]
- HP 48GB (6x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,245.00]
- HP 64GB (8x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,743.00]
- HP 80GB (10x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$2,241.00]
- HP 32GB (1x32GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$650.00]
- HP 96GB (12x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$2,739.00]
- HP 64GB (2x32GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,549.00]
- HP 16GB (1x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$150.00]
- HP 32GB (2x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$549.00]
- HP 48GB (3x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$948.00]
- HP 64GB (4x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,347.00]
- HP 96GB (6x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$2,145.00]
- HP 128GB (8x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$2,943.00]
- HP 160GB (10x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$3,741.00]
- HP 64GB (8x8GB) Dual Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,823.00]
- HP 192GB (12x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$4,539.00]
- HP 32GB (1x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$750.00]
- HP 64GB (2x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$1,749.00]
- HP 96GB (3x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$2,748.00]
- HP 128GB (4x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$3,747.00]
- HP 192GB (6x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$5,745.00]
- HP 8GB (1x8GB) Dual Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$10.00]
- HP 256GB (8x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$7,743.00]
- HP 16GB (2x8GB) Dual Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$269.00]
- HP 320GB (10x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$9,741.00]
- HP 384GB (12x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$11,739.00]
- HP 32GB (4x8GB) Dual Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$787.00]
- HP 4GB (1x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Subtract (\$80.00)]
- HP 8GB (2x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$89.00]
- HP 12GB (3x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$258.00]
- HP 16GB (4x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$427.00]
- HP 24GB (6x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$765.00]
- HP 32GB (8x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,103.00]
- HP 40GB (10x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,441.00]
- HP 48GB (12x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,779.00]
- HP 16GB (1x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$250.00]
- HP 32GB (2x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$749.00]
- HP 48GB (3x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$1,248.00]
- HP 64GB (4x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$1,747.00]
- HP 96GB (6x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$2,745.00]
- HP 128GB (8x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$3,743.00]
- HP 160GB (10x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$4,741.00]
- HP 192GB (12x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$5,739.00]

FRONT

Back

64-bit

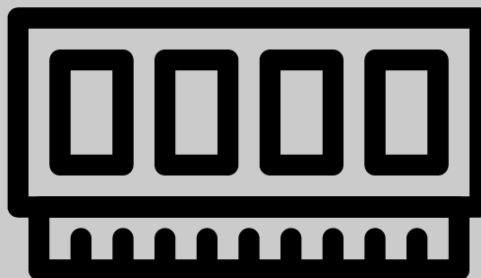
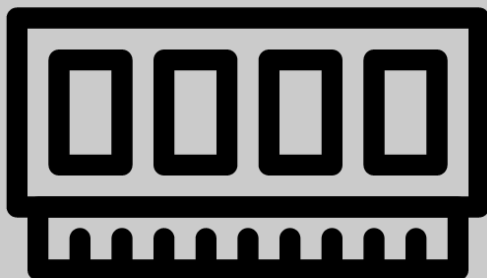


Single Rank

FRONT

Back

64-bit

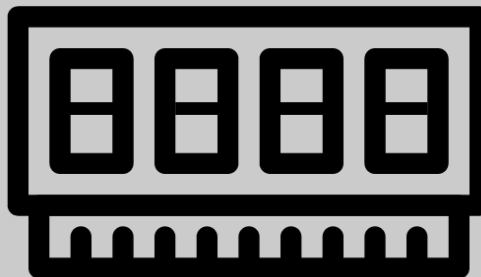
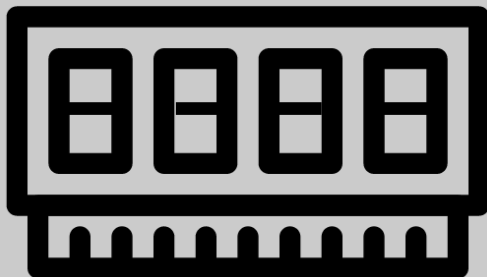


Dual Rank

FRONT

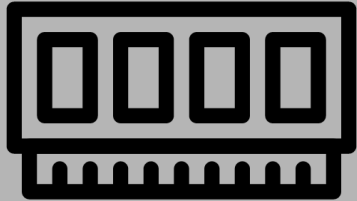
Back

64-bit



Quad Rank

RAM



1 x 32GB (Quad) Module

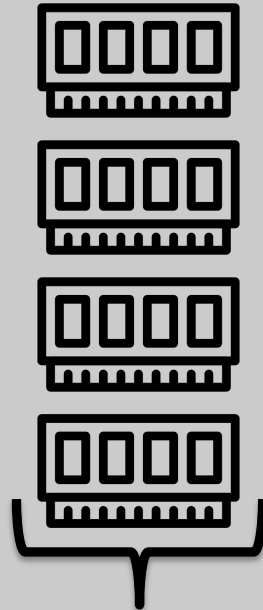
2 x 16GB (Dual) Modules

4 x 8GB (Dual) Modules

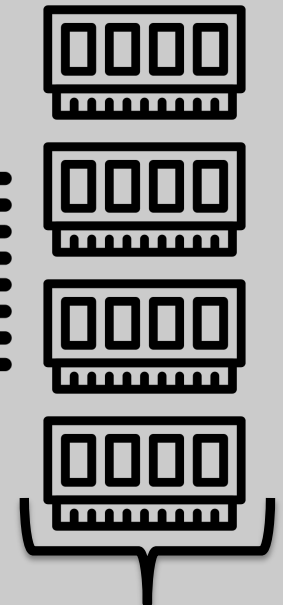
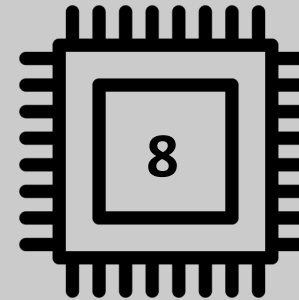
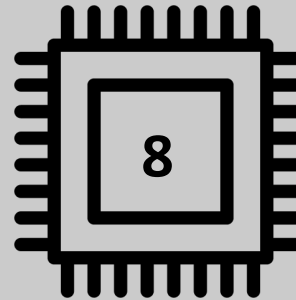
4 x 8GB (Single) Modules

E5-2630L v3

- DDR4
- 4 channels
 - 4 x 64-bit

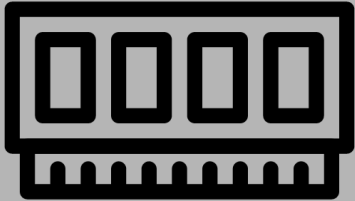


32GB



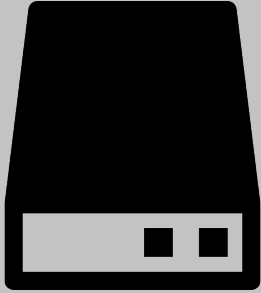
32GB

RAM



- ✓ HP 8GB (1x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$249.00]
- HP 16GB (2x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$498.00]
- HP 32GB (4x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$747.00]**
- HP 48GB (6x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,245.00]
- HP 64GB (8x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,743.00]
- HP 80GB (10x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$2,241.00]
- HP 32GB (1x32GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$650.00]
- HP 96GB (12x8GB) Single Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$2,739.00]
- HP 64GB (2x32GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,549.00]
- HP 16GB (1x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$150.00]
- HP 32GB (2x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$549.00]
- HP 48GB (3x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$948.00]
- HP 64GB (4x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,347.00]
- HP 96GB (6x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$2,145.00]
- HP 128GB (8x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$2,943.00]
- HP 160GB (10x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$3,741.00]
- HP 64GB (8x8GB) Dual Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,823.00]
- HP 192GB (12x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$4,539.00]
- HP 32GB (1x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$750.00]
- HP 64GB (2x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$1,749.00]
- HP 96GB (3x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$2,748.00]
- HP 128GB (4x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$3,747.00]
- HP 192GB (6x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$5,745.00]
- HP 8GB (1x8GB) Dual Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$10.00]
- HP 256GB (8x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$7,743.00]
- HP 16GB (2x8GB) Dual Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$269.00]
- HP 320GB (10x32GB) Quad Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$9,741.00]
- HP 64GB (4x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$1,799.00]
- HP 32GB (4x8GB) Dual Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$787.00]**
- HP 4GB (1x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [subtract \$66.00]
- HP 8GB (2x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$89.00]
- HP 12GB (3x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$258.00]
- HP 16GB (4x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$427.00]
- HP 24GB (6x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$765.00]
- HP 32GB (8x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,103.00]
- HP 40GB (10x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,441.00]
- HP 48GB (12x4GB) Single Rank x8 DDR4-2133 CAS-15-15-15 Registered Memory Kit [Add \$1,779.00]
- HP 16GB (1x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$250.00]
- HP 32GB (2x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$749.00]
- HP 48GB (3x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$1,248.00]
- HP 64GB (4x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$1,747.00]
- HP 96GB (6x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$2,745.00]
- HP 128GB (8x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$3,743.00]
- HP 160GB (10x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$4,741.00]
- HP 192GB (12x16GB) Dual Rank x4 DDR4-2133 CAS-15-15-15 Load Reduced Memory Kit [Add \$5,739.00]

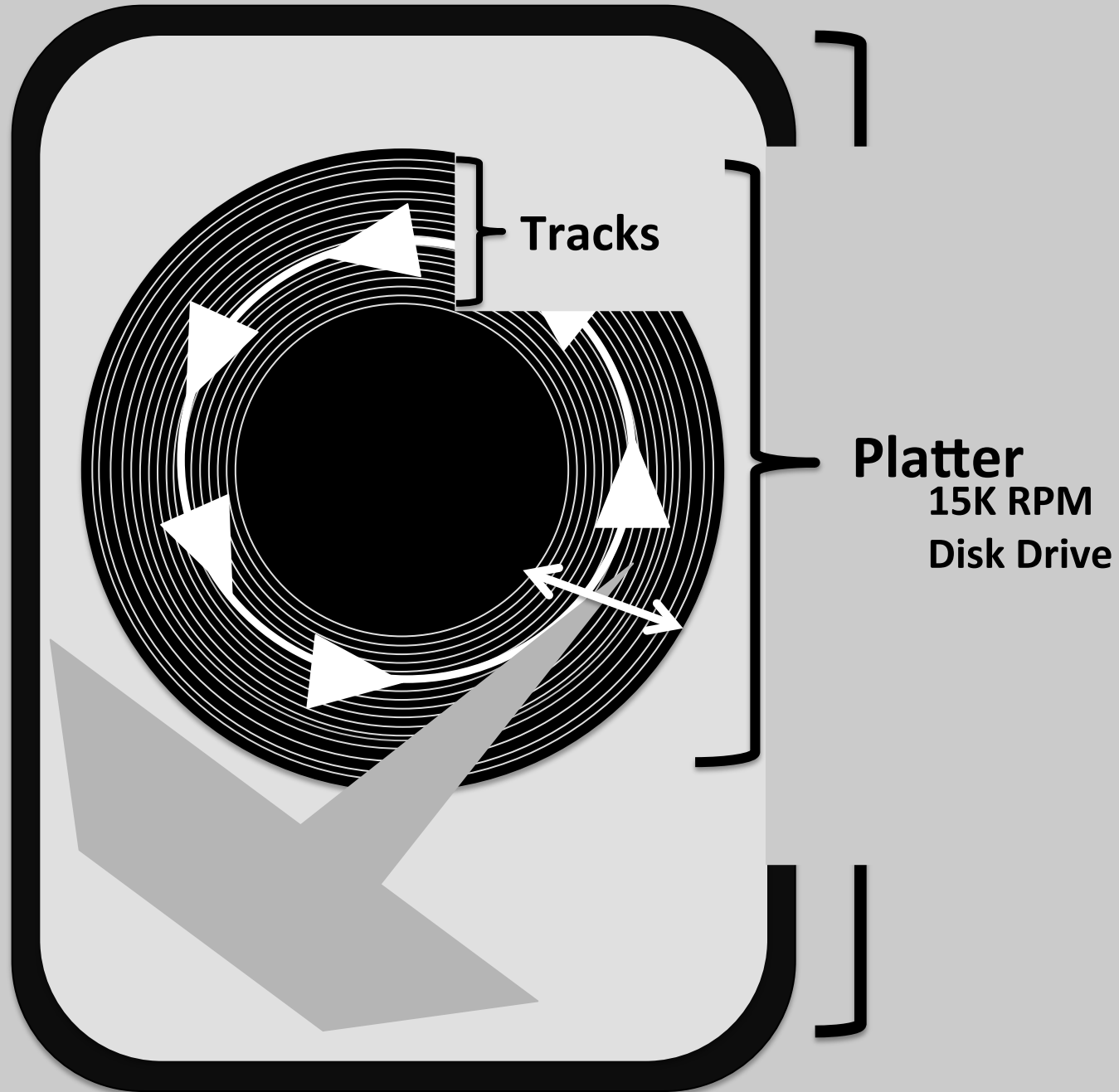
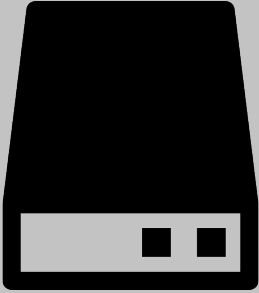
STORAGE



Metrics

- How Spinning Drives Work
- How Flash Works
- Local Storage Interfaces
- Graph It

HDD STORAGE



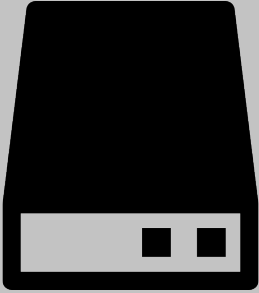
15K RPM HDD

~200 IOPS

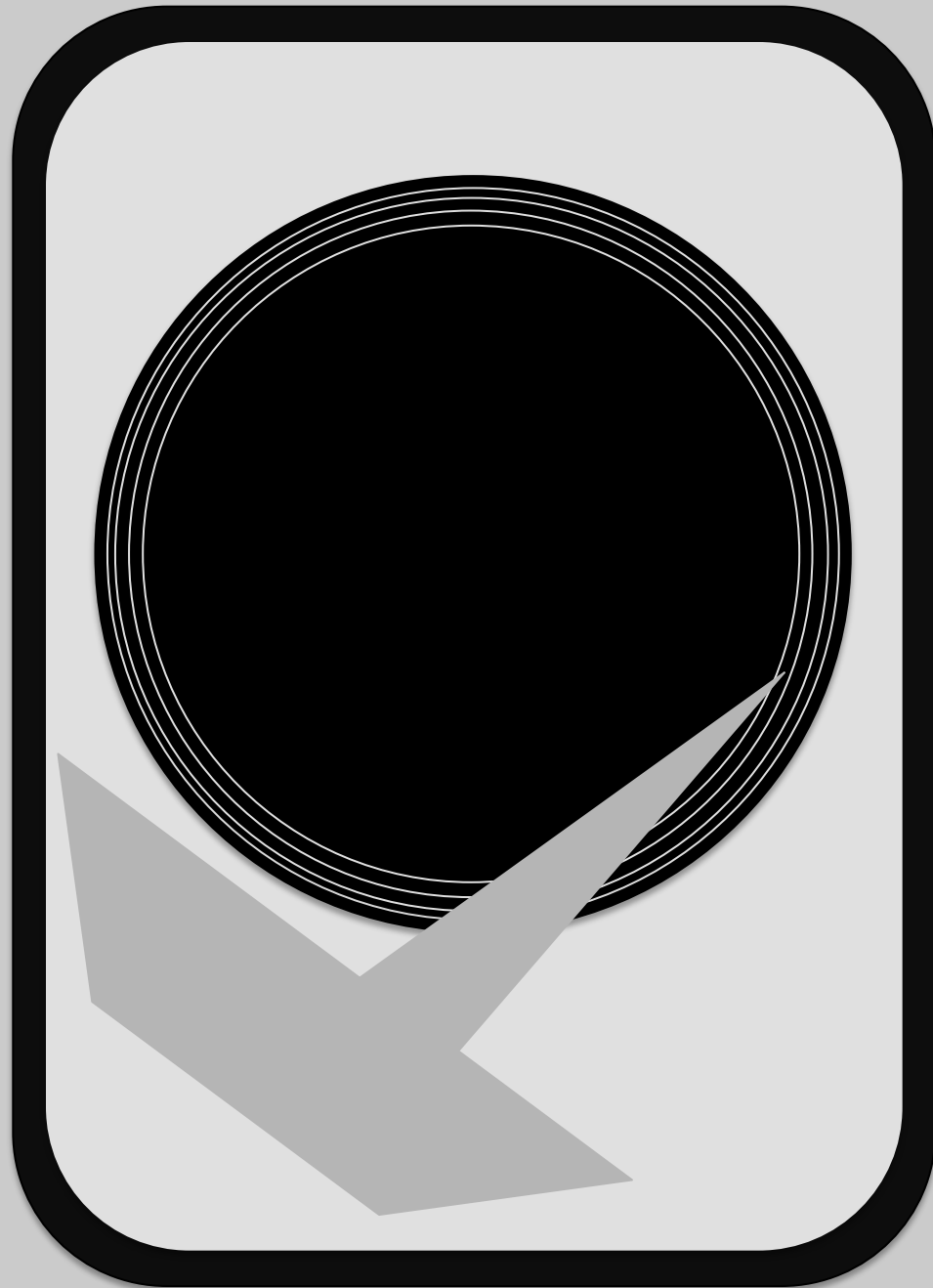
~160MB BW

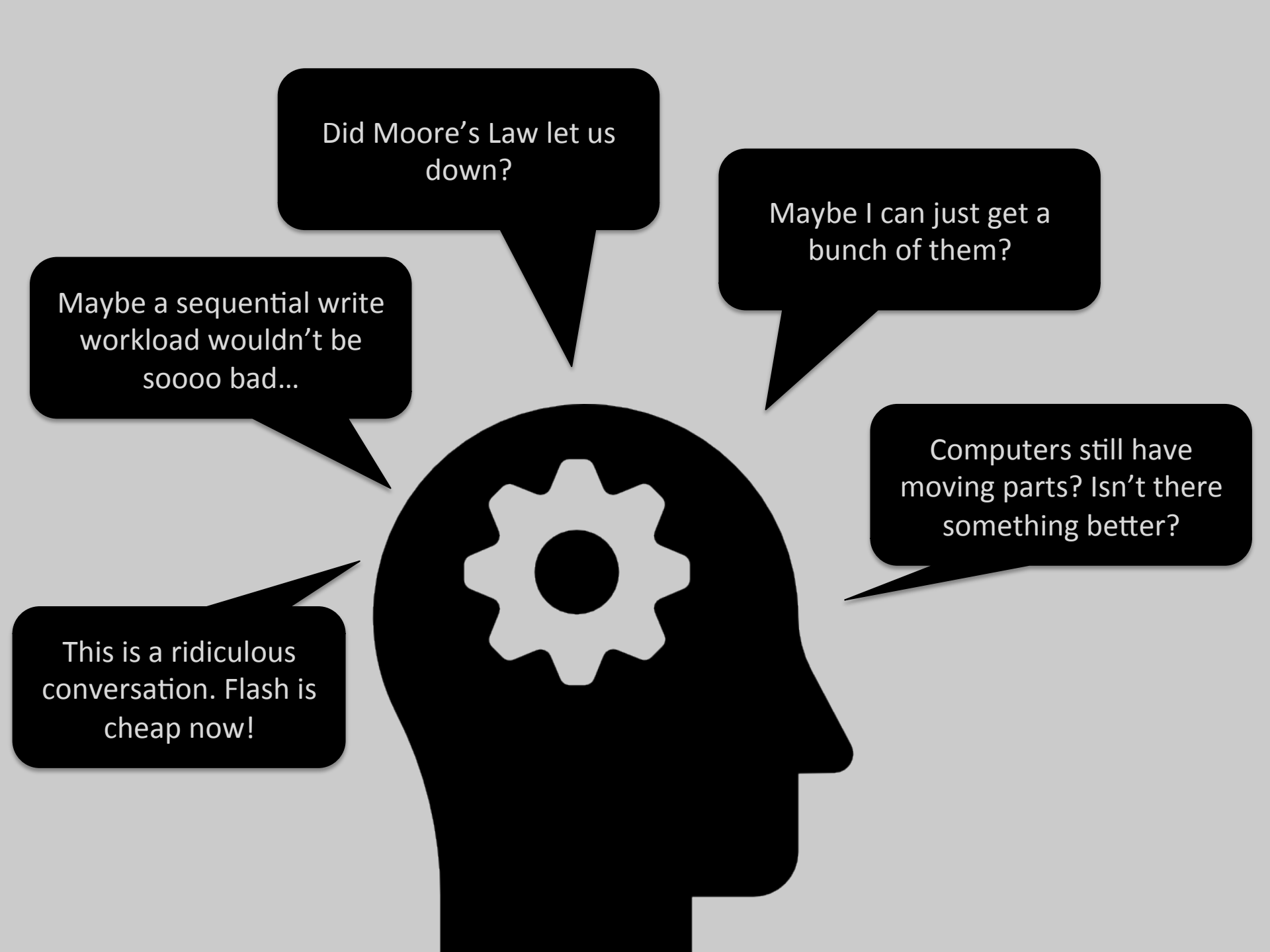
5ms Latency

HDD STORAGE



Short- Stroking





Did Moore's Law let us
down?

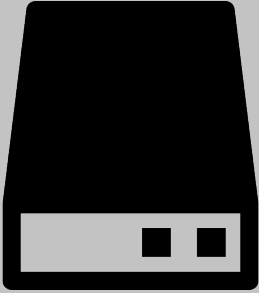
Maybe I can just get a
bunch of them?

Maybe a sequential write
workload wouldn't be
soooo bad...

Computers still have
moving parts? Isn't there
something better?

This is a ridiculous
conversation. Flash is
cheap now!

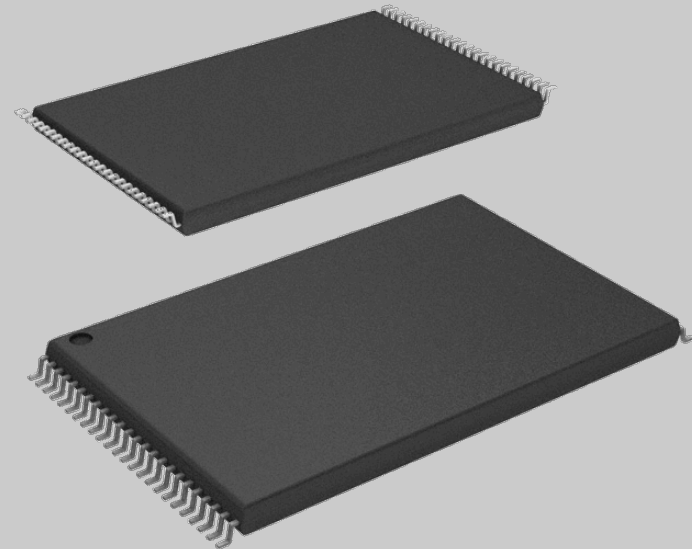
FLASH STORAGE



- No Moving Parts (Better parallelism thus better BW/IOPS)
- No Seek Times (Low Latency)
- Lower Power
- Less Heat Produced (reduced cooling cost)

SSDs

10K – 1M IOPS
400MB-3GB BW
<200us Latency



MLC
≥1 DWPD

- DWPD –
Overwrites per
day over 5

years

W – Total

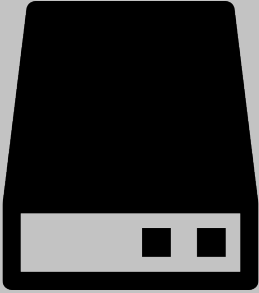
bytes you

write to the

drive before

wear out

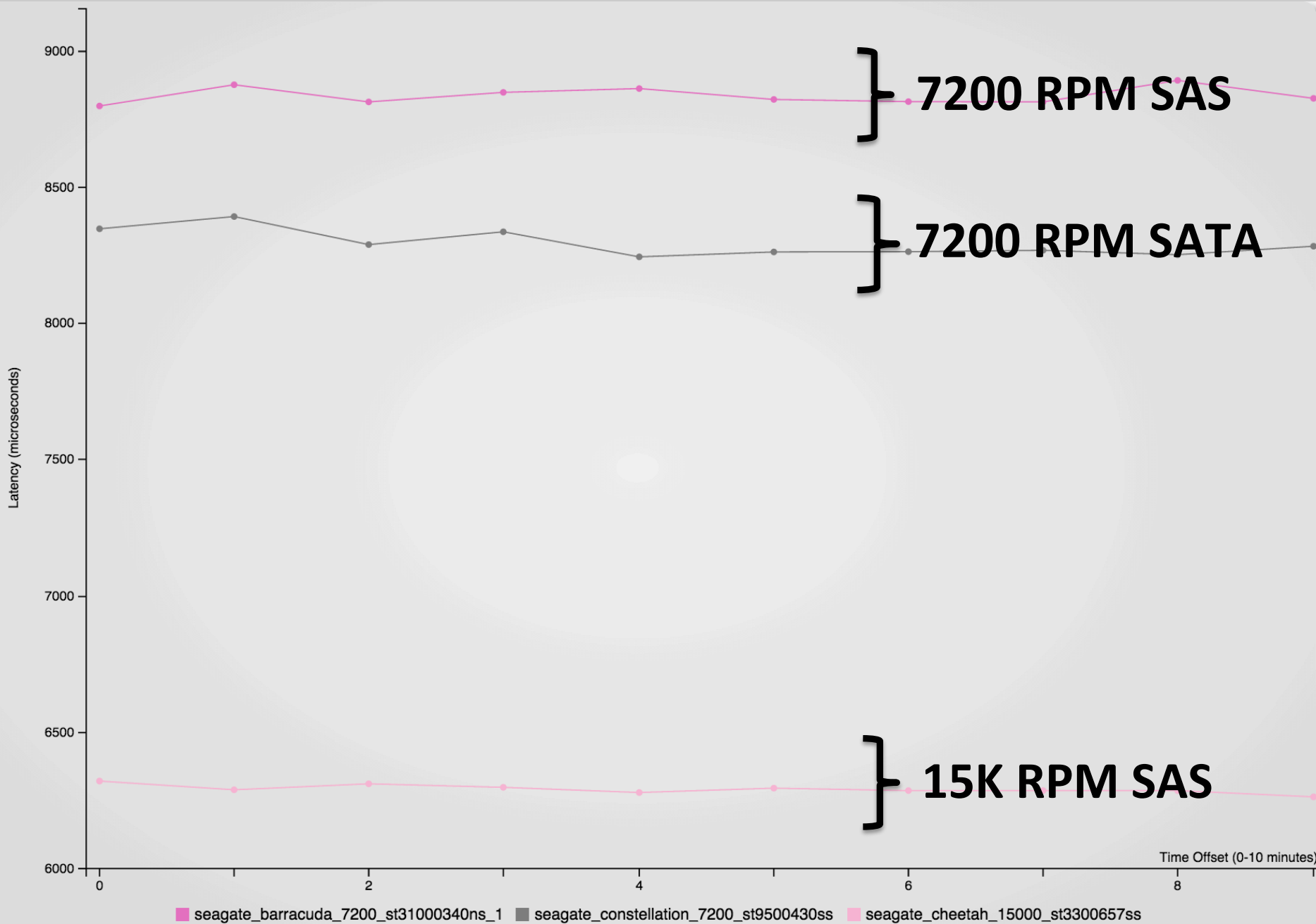
Storage Interfaces



Interface	Speed
SATA III	.75 Gigabyte
SAS II	.75 Gigabyte
SAS III	1.5 Gigabytes
PCIe Gen 2 x8	4 Gigabytes

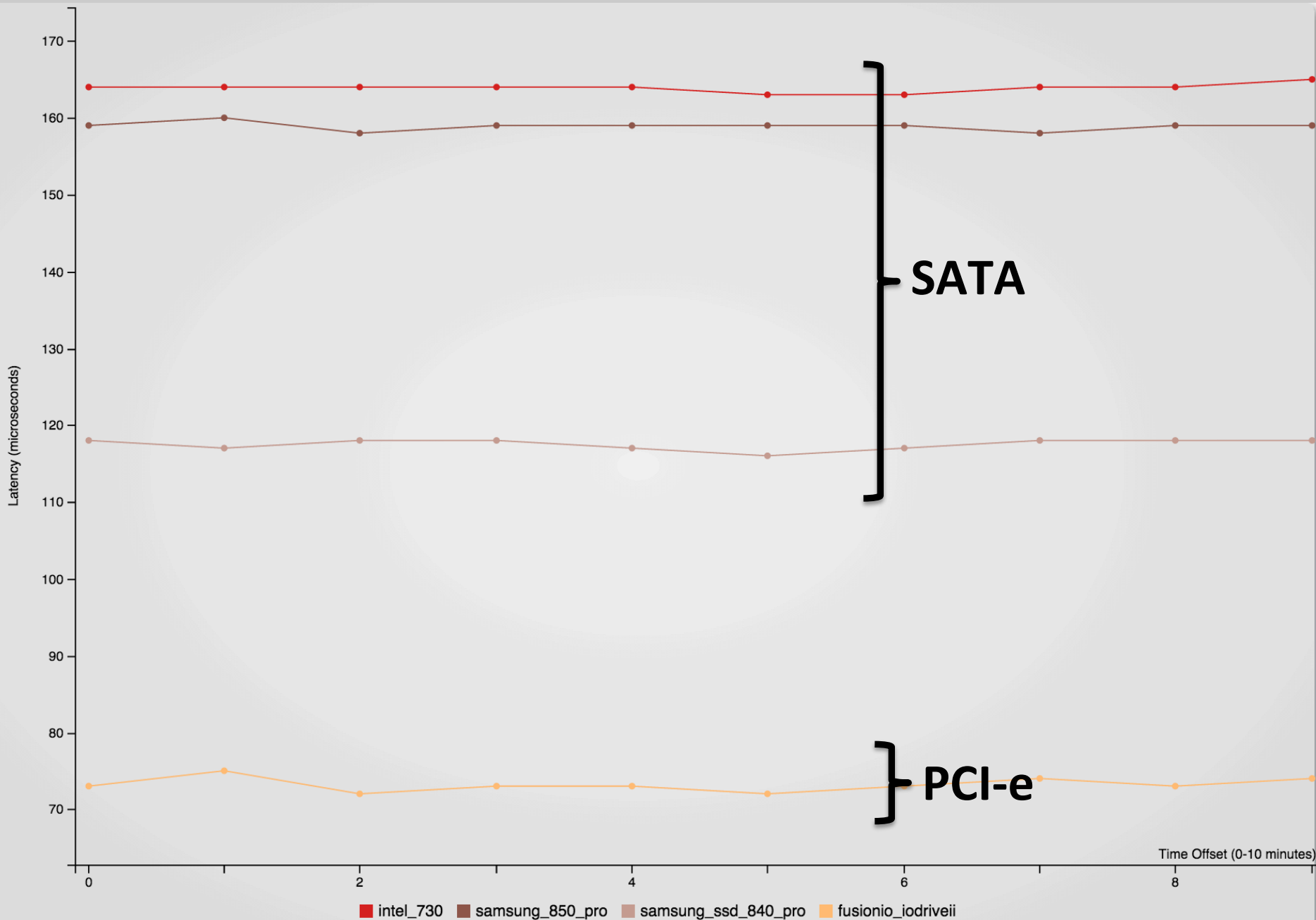


HDD STORAGE – Average SATA Latency



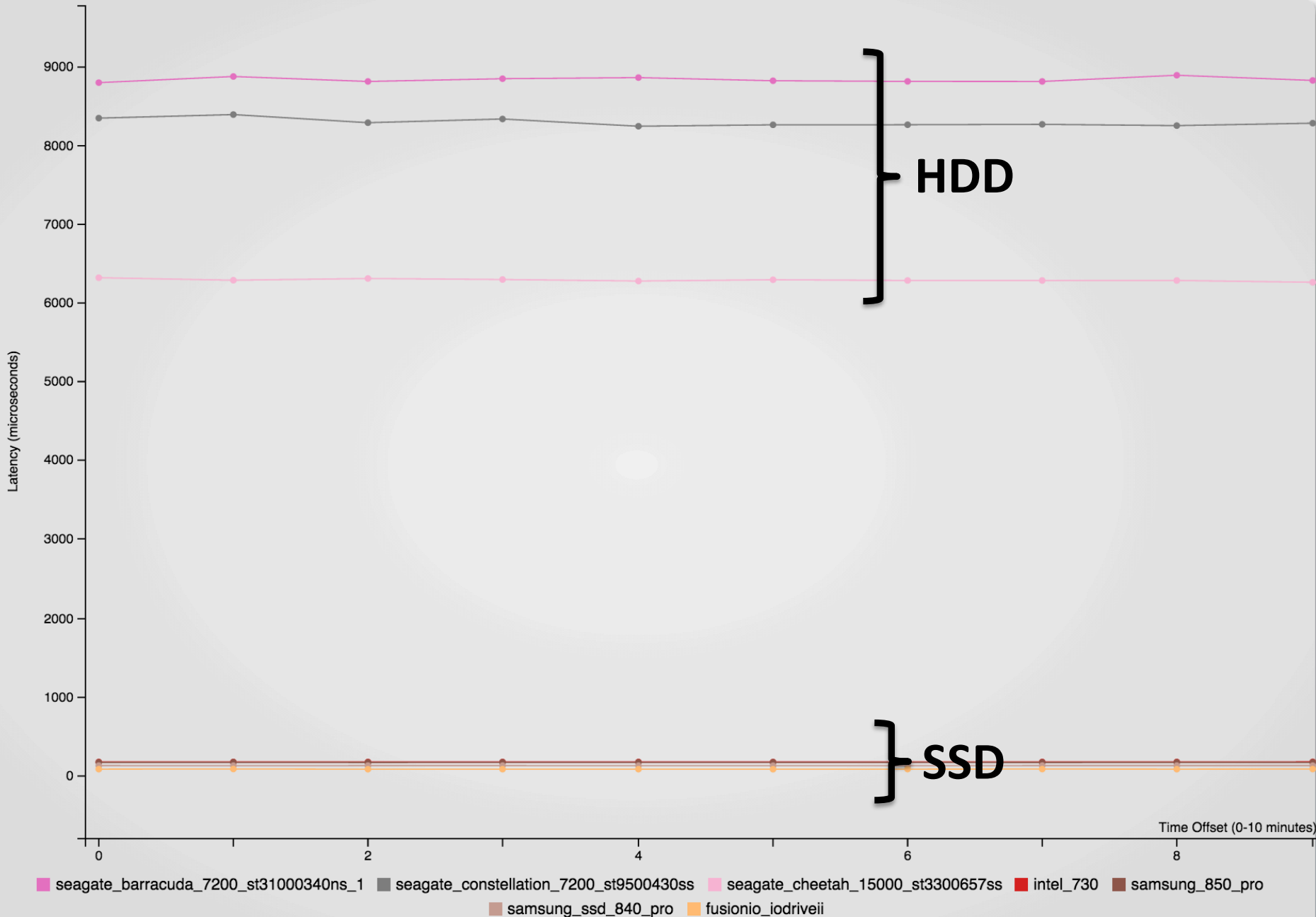


FLASH STORAGE – SSD Average Latency



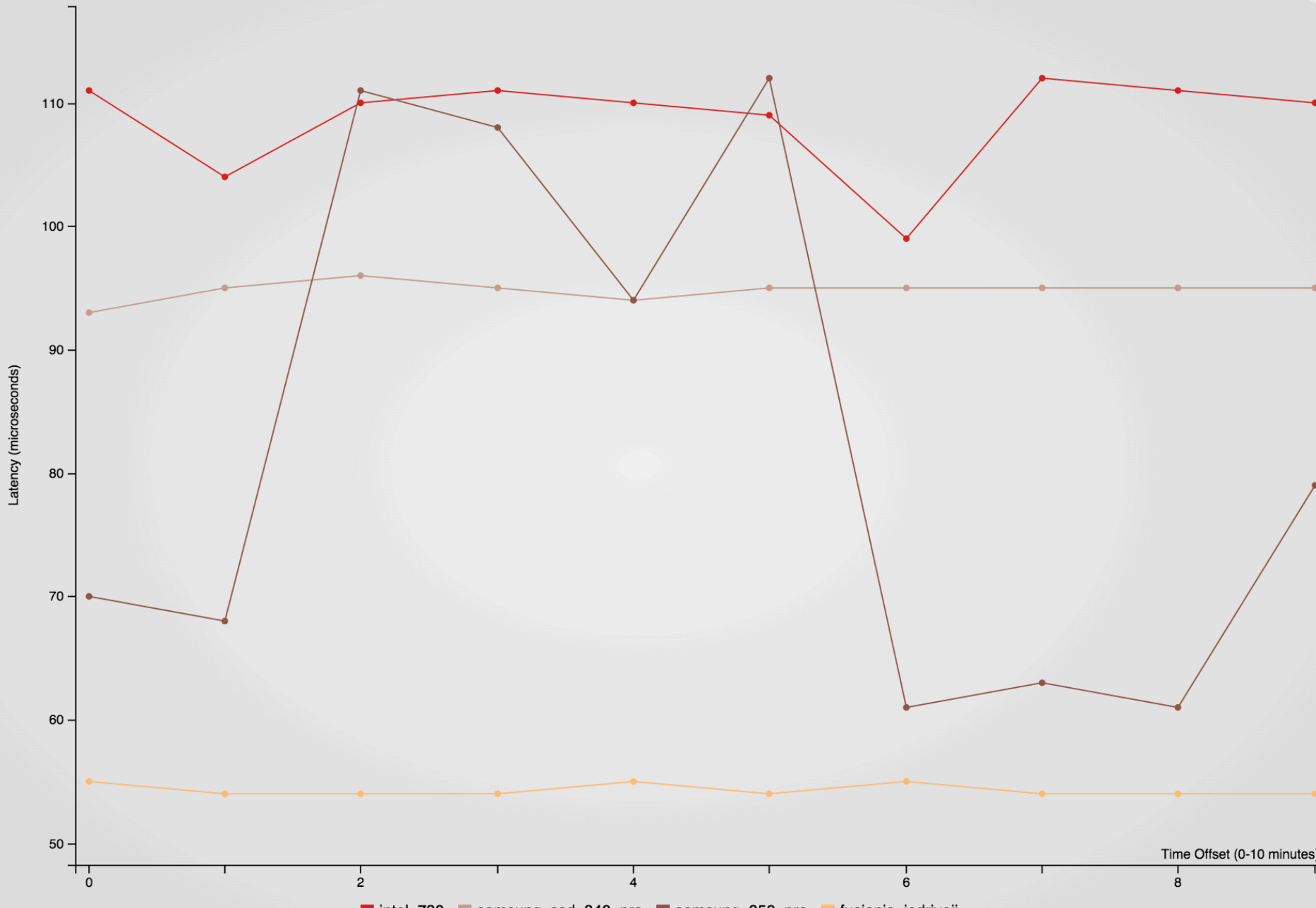


STORAGE – Average Latency

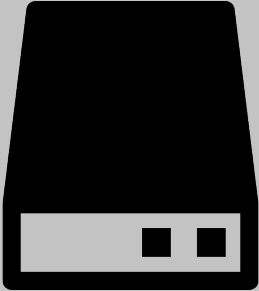




STORAGE – Consistent Latency



Storage Sizing



- CQL Sizer - <http://www.sestevez.com/sestevez/CASTableSizer/>
- Use Opscenter Capacity Planner

Conclusions

- CPU - Get the most Cache for your Cash
- RAM – 4 DIMMs/CPU 32GB-256GB Total
- Storage – MLC SSD – PCIe is Gold Standard

Acknowledgements

- Al Tobey, Matt Kennedy, Jon Erickson