



Making NAND Better

“Stop Wasting Money on \$/GB and Invest in \$/TBW”

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BETTER NAND, LOWER COST, SMARTER SSDs

We live in an “Always-On” world

57% OF ONLINE CONSUMERS
will abandon a site after waiting **3 seconds** for a page to load.



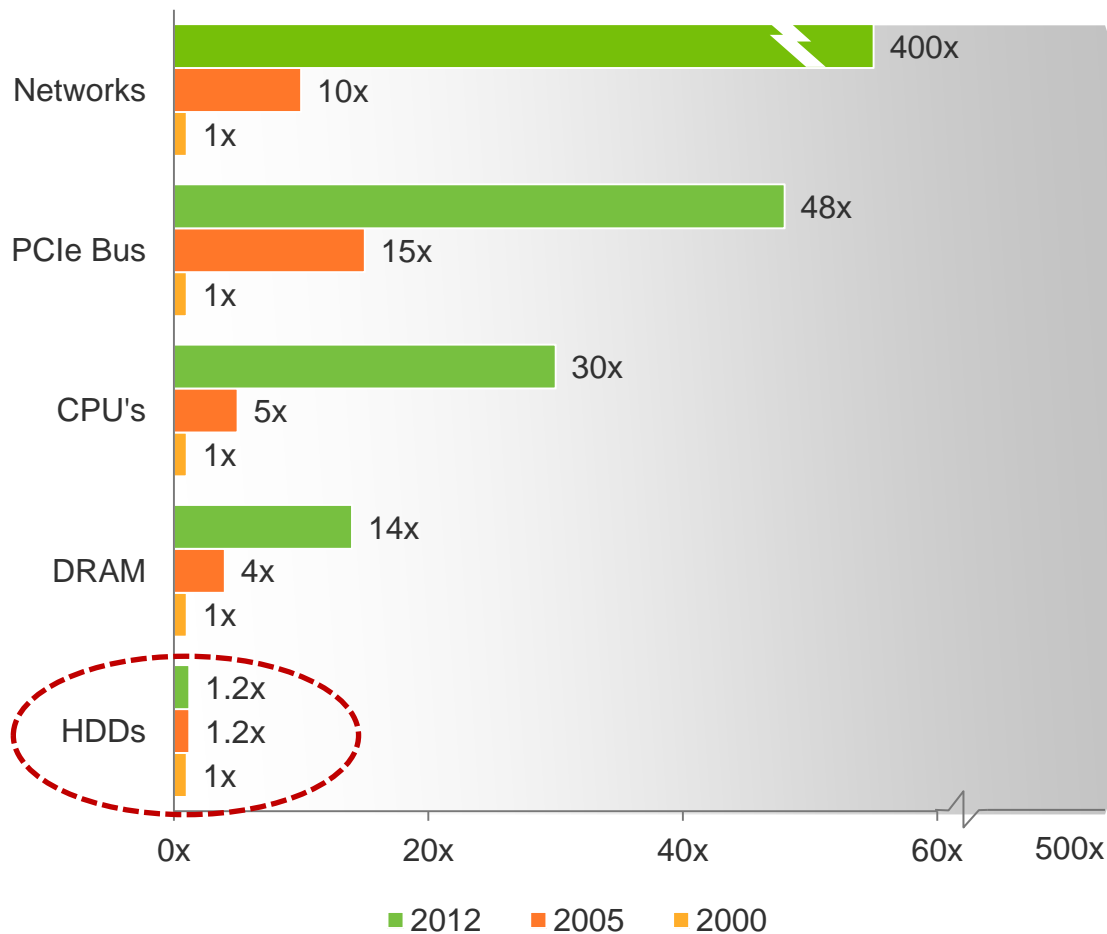
80% of these people **WILL NOT RETURN.**



Speed is everything

High Performance Storage Need

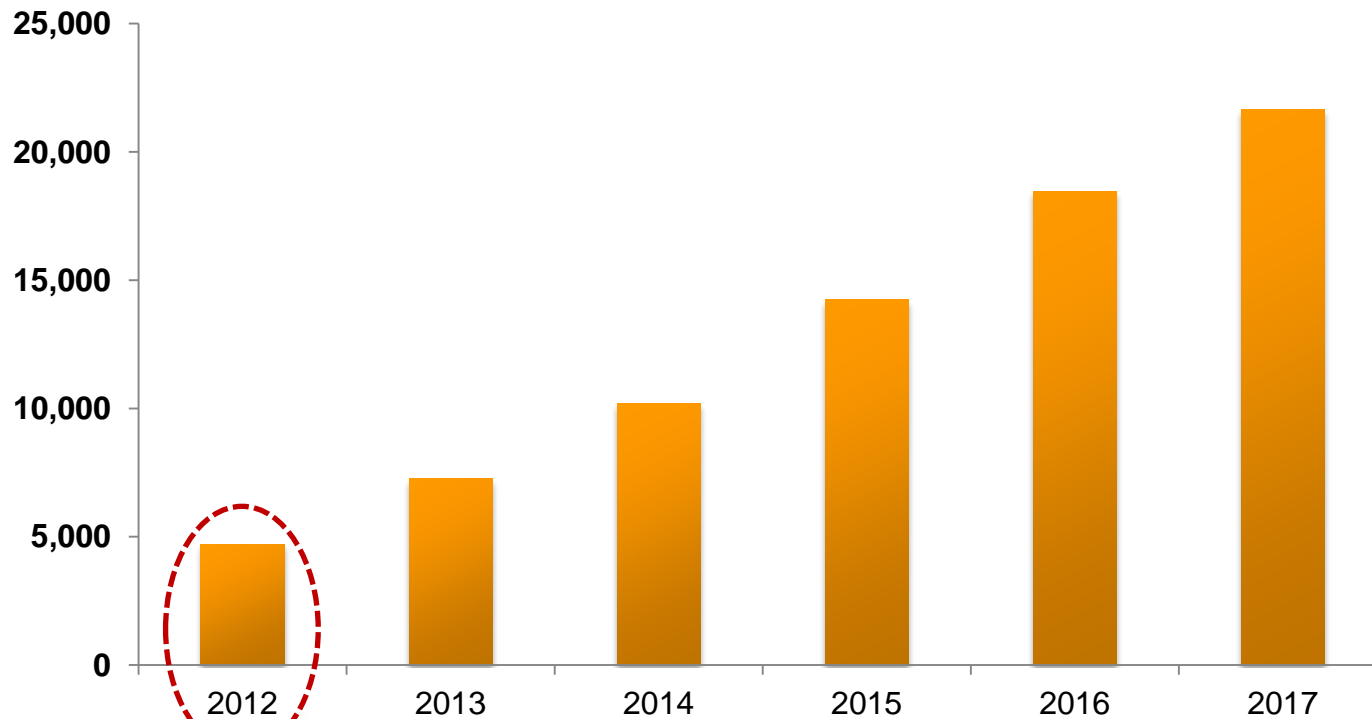
HDD bottleneck – widening performance gap



SSDs provide the high performance needed for current storage infrastructure

SSD Market Growth

Enterprise Server & Storage SSD (K units)



2.4M Client SATA SSD @ <\$1/GB

\$/GB is NOT the right metric to evaluate SSDs

\$/TBW is a BETTER metric to evaluate SSDs

The SSD and Tire Analogy

Buying your first SSD is kind of like
buying your first tires



You only look at the cost of the tires!

The SSD and Tire Analogy

But as you get older...



...you also look at the tread wear

\$/GB is the key buying metric

How we bought storage in the past 50 years



15K RPM HDD
\$\$\$ / GB

10K RPM HDD
\$\$ / GB

5400/7200 RPM HDD
\$ / GB

\$/GB vs. \$/TBW

	\$/GB	Endurance	\$/TBW
SSD-A (960GB)	\$0.60/GB	72TBW	\$8
SSD-A (960GB)	\$1.10/GB	1,865TBW	\$0.55

Quick Survey

SATA SSDs from leading **18** SSD vendors on the market today

Only **9** suppliers state Endurance specifications...

Applications Endurance Requirements



Web Server
95/5% Read/Write
4, 8, 64KB transfer size
75% seq/25% random
240GB MLC SATA



Drive Life
1.6 Years

Video on Demand
100% Read
512KB transfer size
100% random
240GB MLC SATA



Drive Life
 ∞ years

Exchange Server
67/33% Read/Write
4KB transfer size
100% random
240GB MLC SATA



Drive Life
0.3 Years

SQL Logging
100% Write
8KB transfer size
100% sequential
240GB MLC SATA



Drive Life
0.08 years

ental

SMART STORAGE S1

Driving NAND cost down....

2012



2017

\$1.90/GB

Enterprise Server SSD

\$0.28/GB

2ynm

1xnm

1ynm

1znm

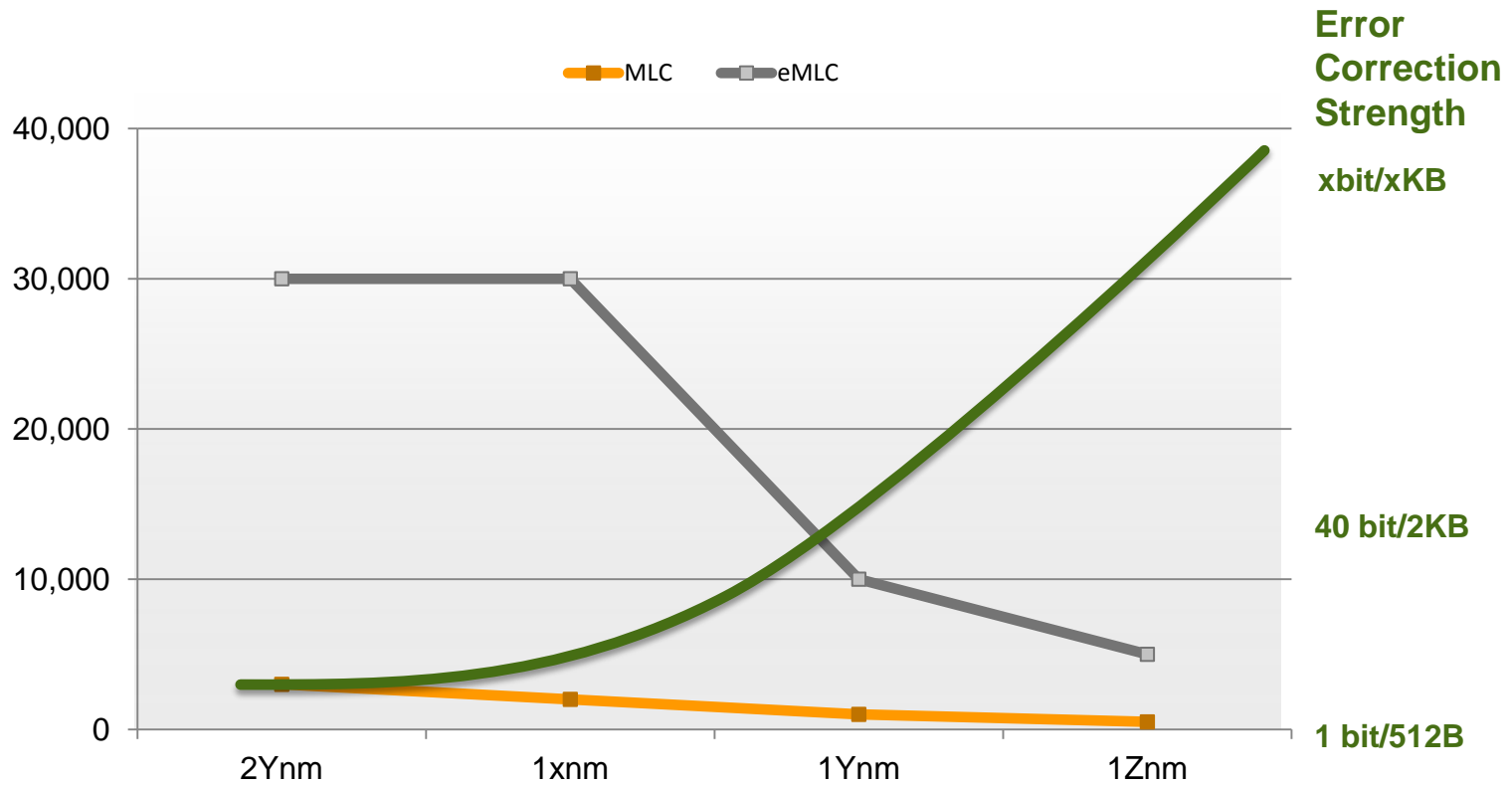
\$4.45/GB

Enterprise Storage SSD

\$0.54/GB

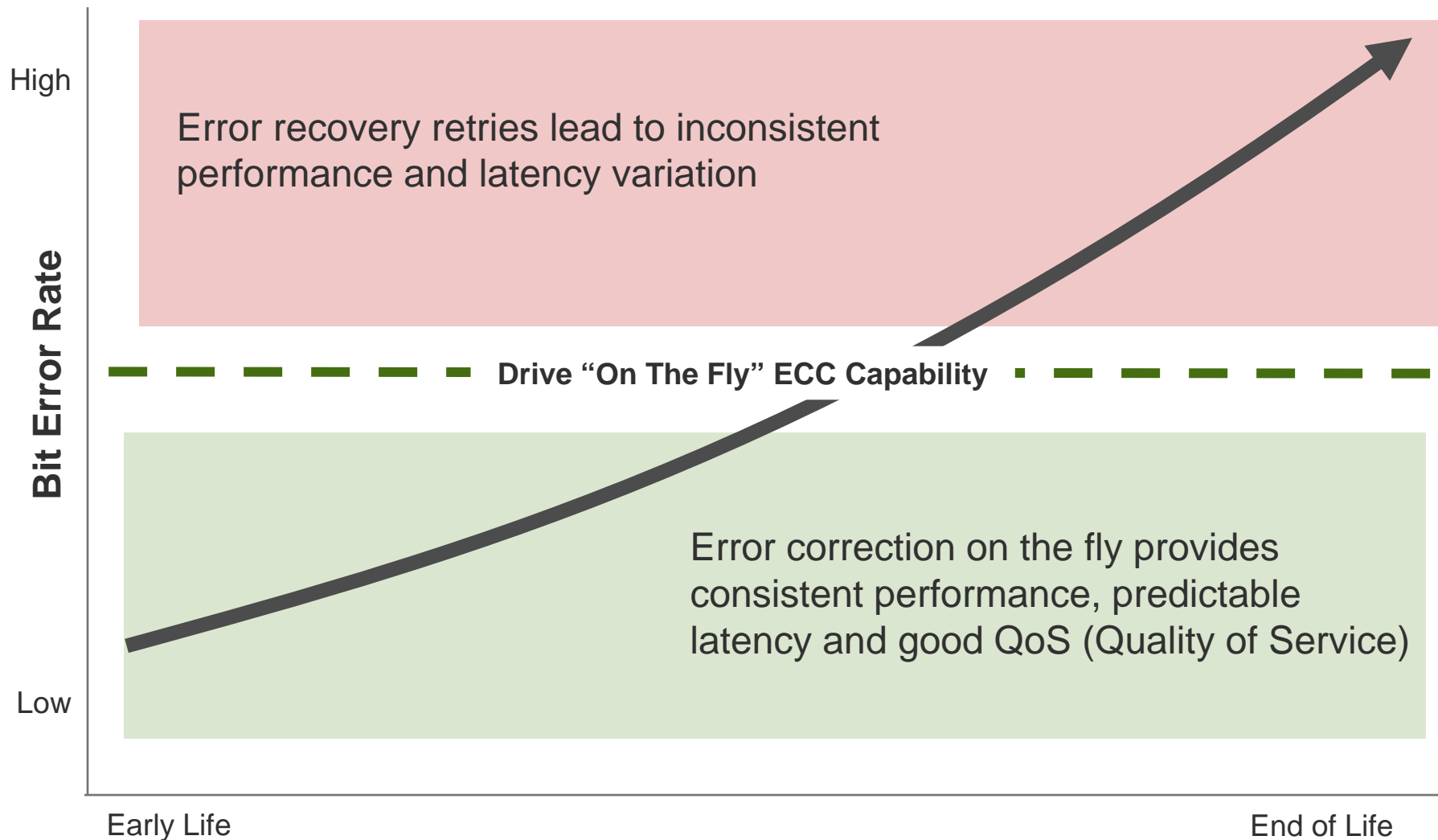


... has consequences



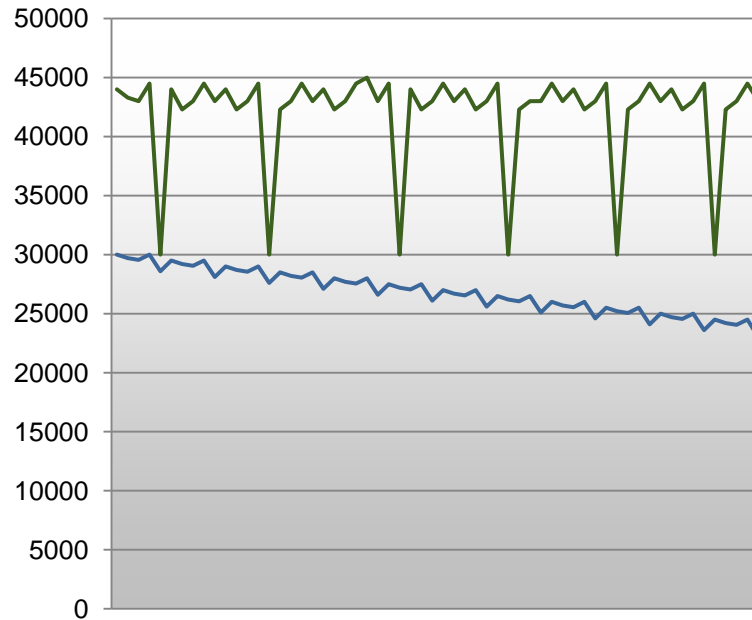
Flash Reliability and Endurance Declining

NAND Physics and the Effect on Performance

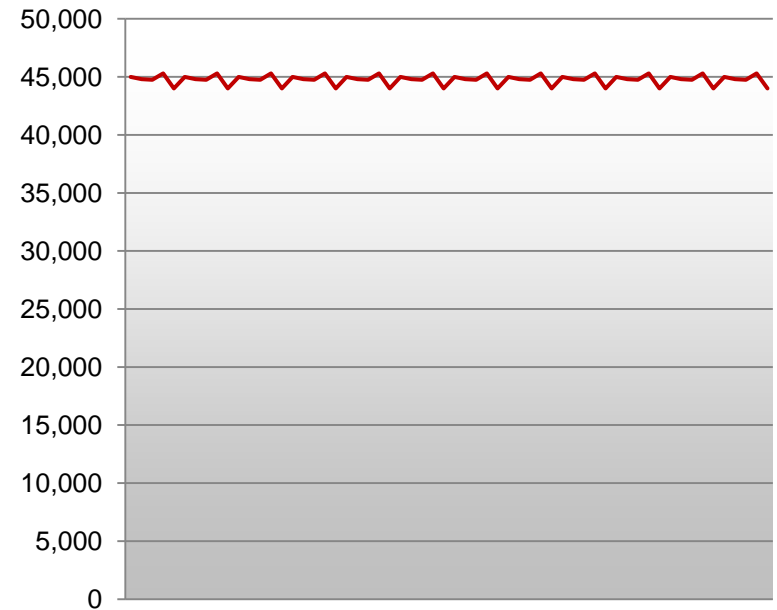


The Result Of Aging Flash

Mixed Workload IOPS

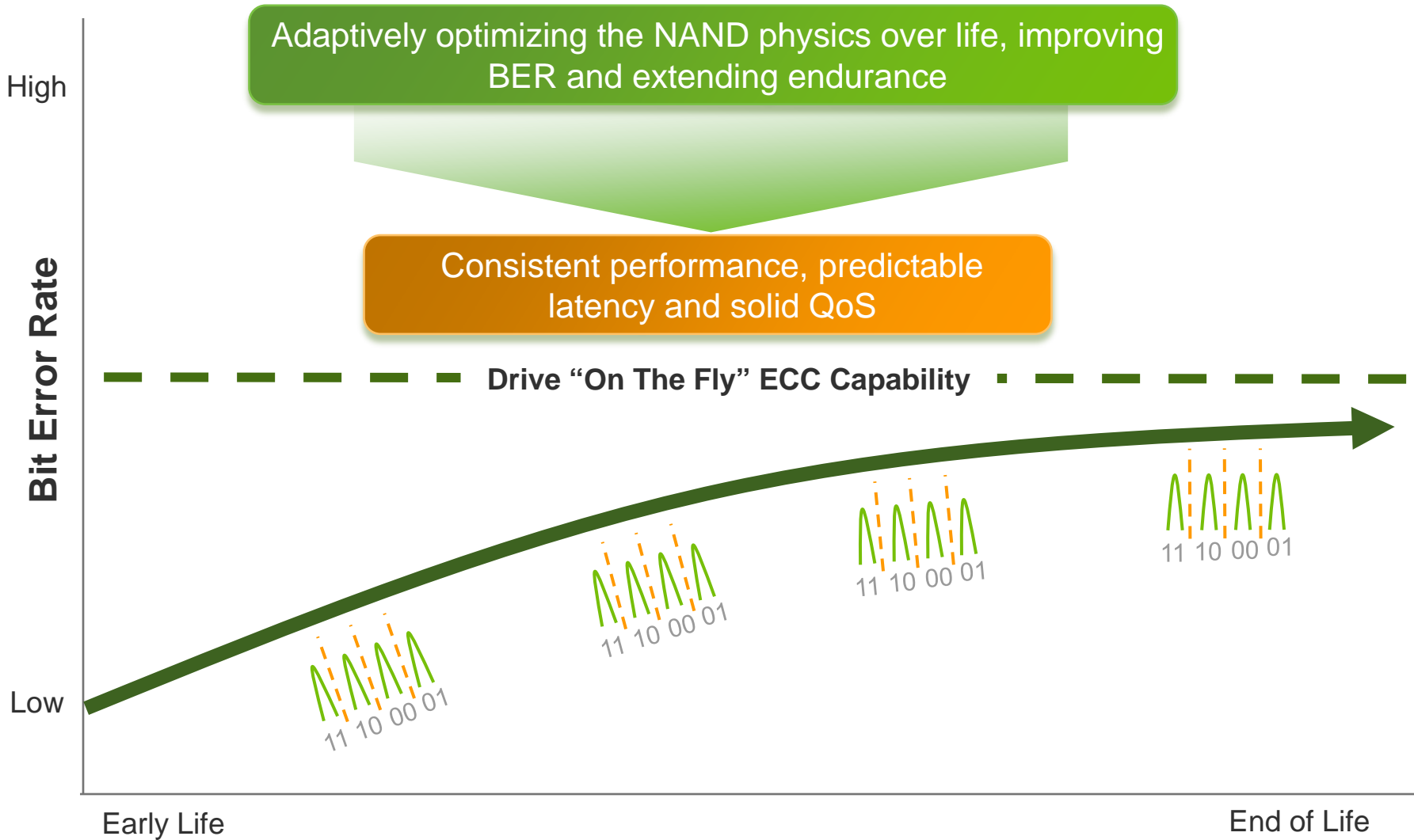


What application sees

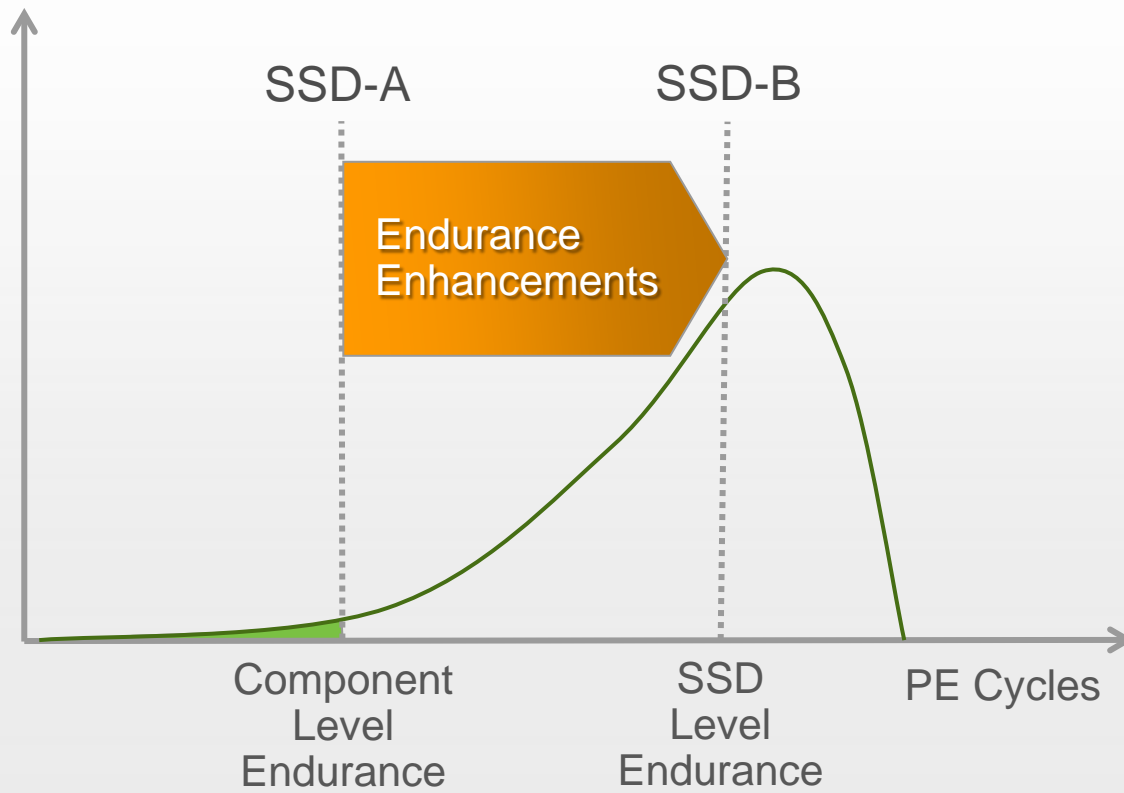


What application wants

Endurance Enhancement Technologies



Why the Difference?

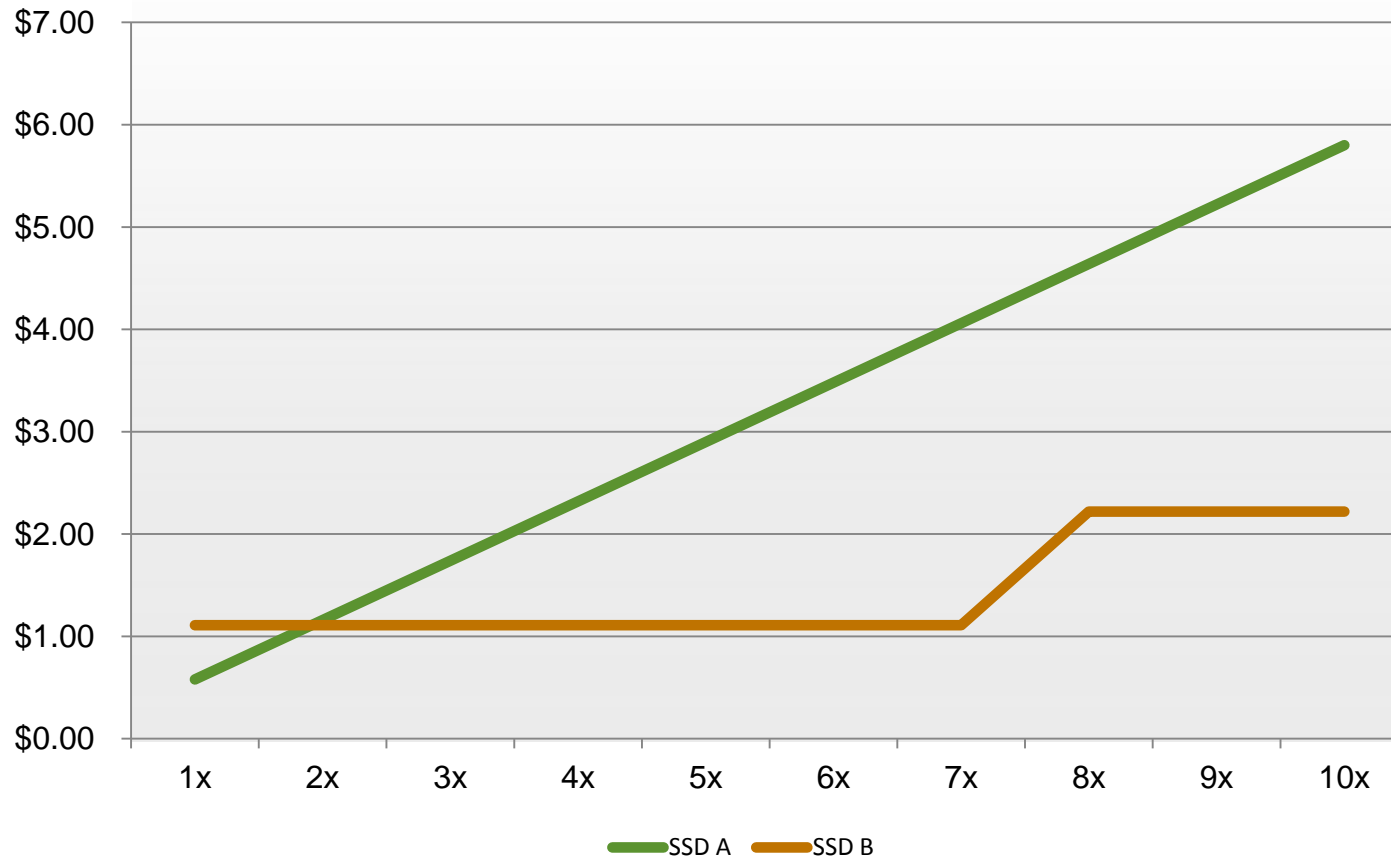


The Cost of Endurance

Acquisition Cost Per GB

SSD-A: \$0.60/GB

SSD-B: \$1.10/GB



Conclusion

- Insatiable appetite for low cost SSDs
- \$/GB is not providing full picture
- Smaller geometries drive NAND cost down, but also endurance!
- \$/TBW is becoming a far more important metric for storage TCO





Thank You!

