When the Enterprise Stops Spinning

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Flash Memory Summit

August 2010

SMART® Modular Technologies

Disruptive Innovations

Automobile

MP3 Player

Light Bulb

Flat Panel TV

Airplane

SSD

Laptop

Cell Phone

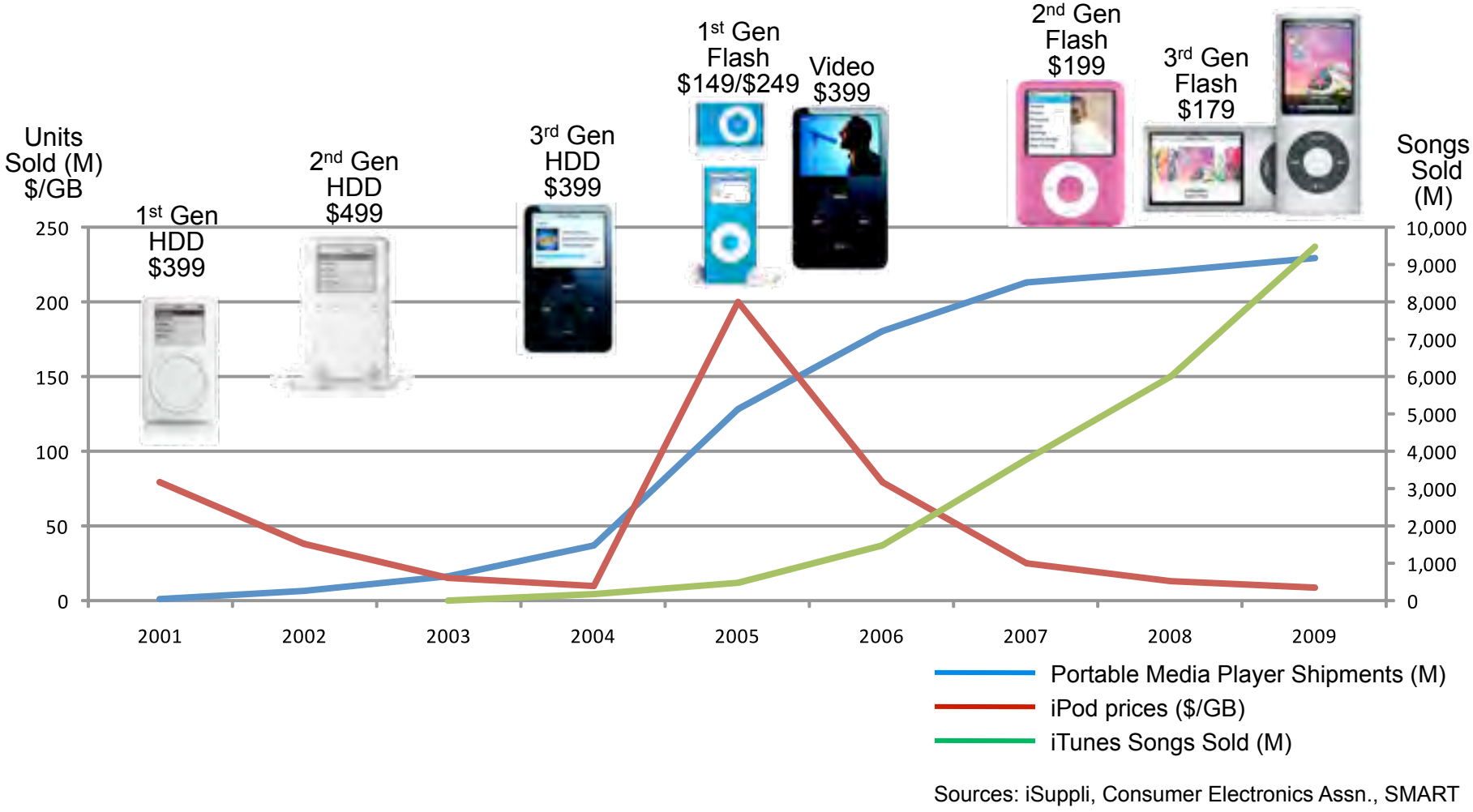
GPS

Digital Photography

Kindle

Disruptive Innovation
iPod/iTunes

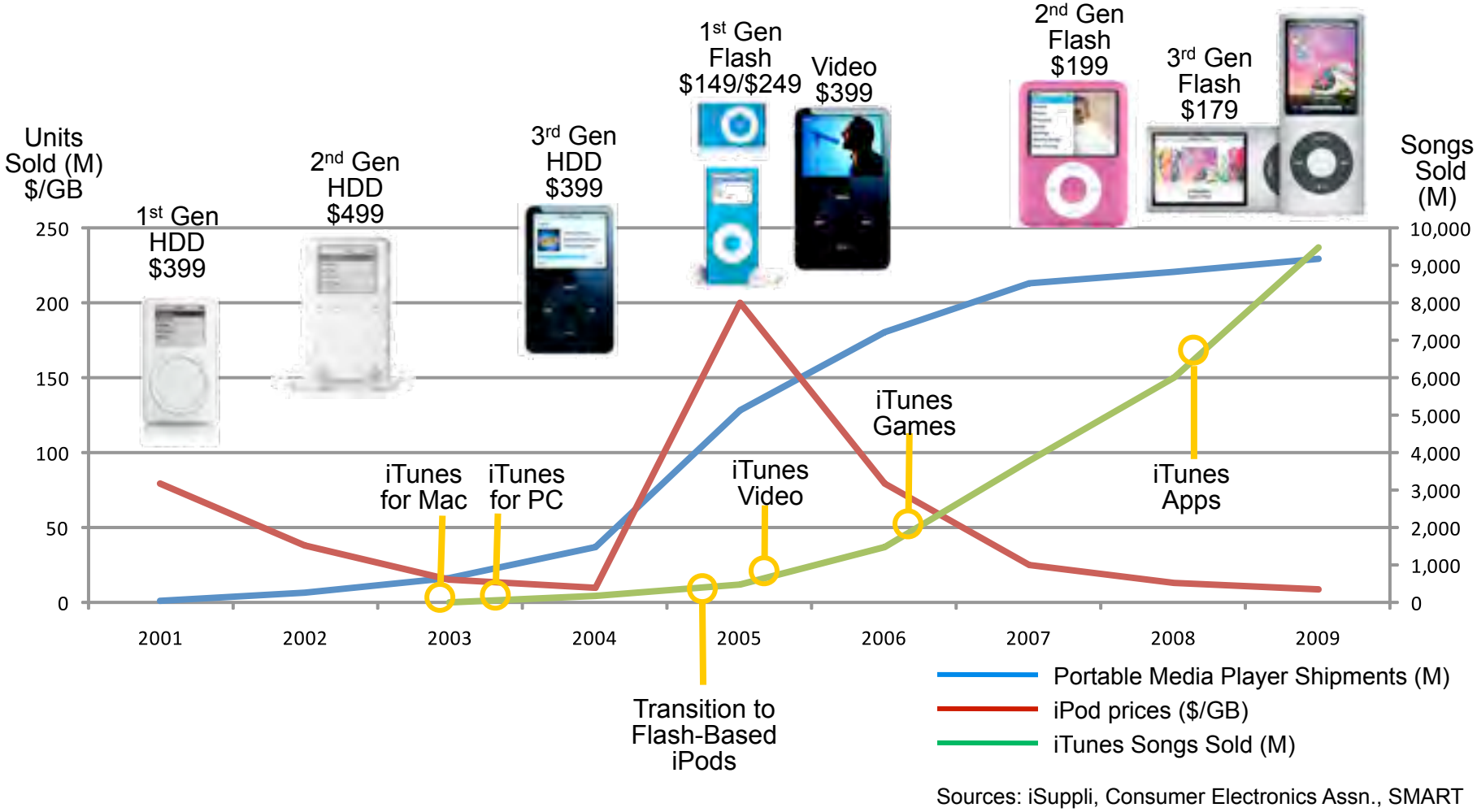
iPod & iTunes



Sources: iSuppli, Consumer Electronics Assn., SMART

Disruptive Innovation
iPod/iTunes

iPod & iTunes



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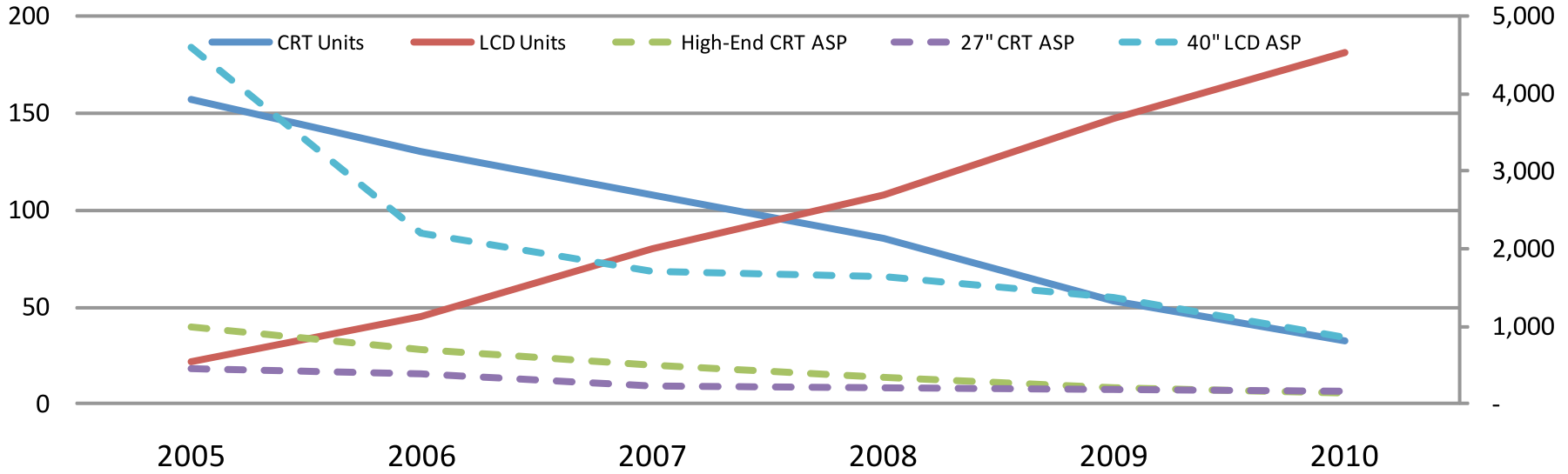
Disruptive Innovations
Flat Panel TVs

Televisions



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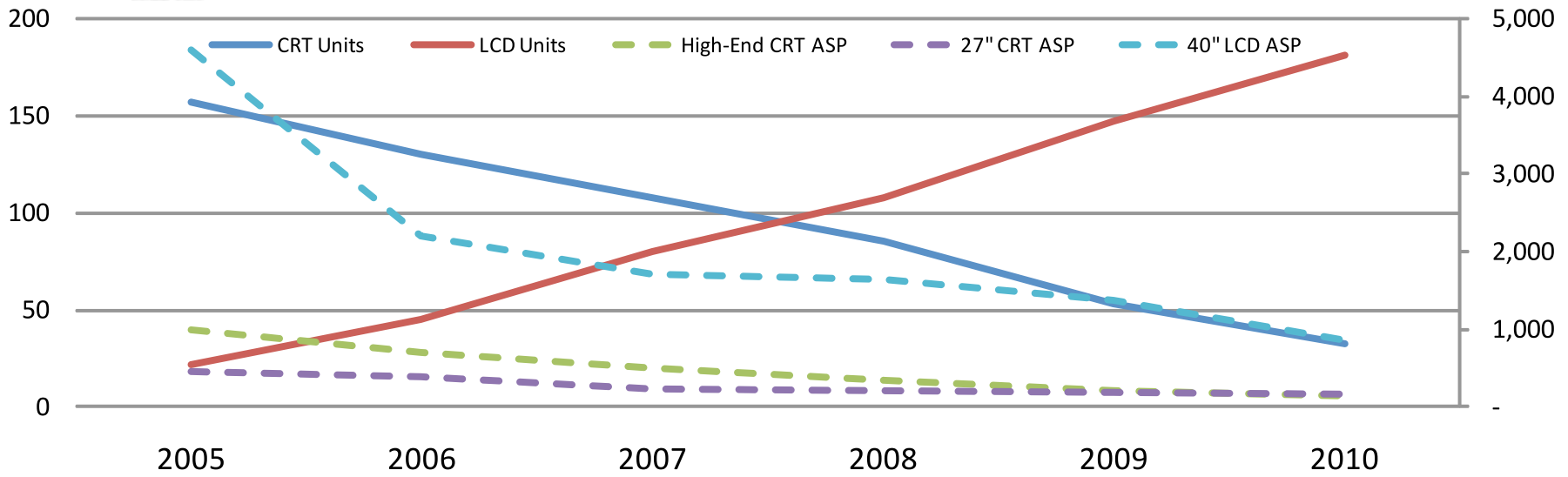
Flat Panel TVs

Televisions

Flat Panel TVs
Price parity not required
for widespread adoption

WW CRT vs LCD TV Shipments (M) and ASP ($)



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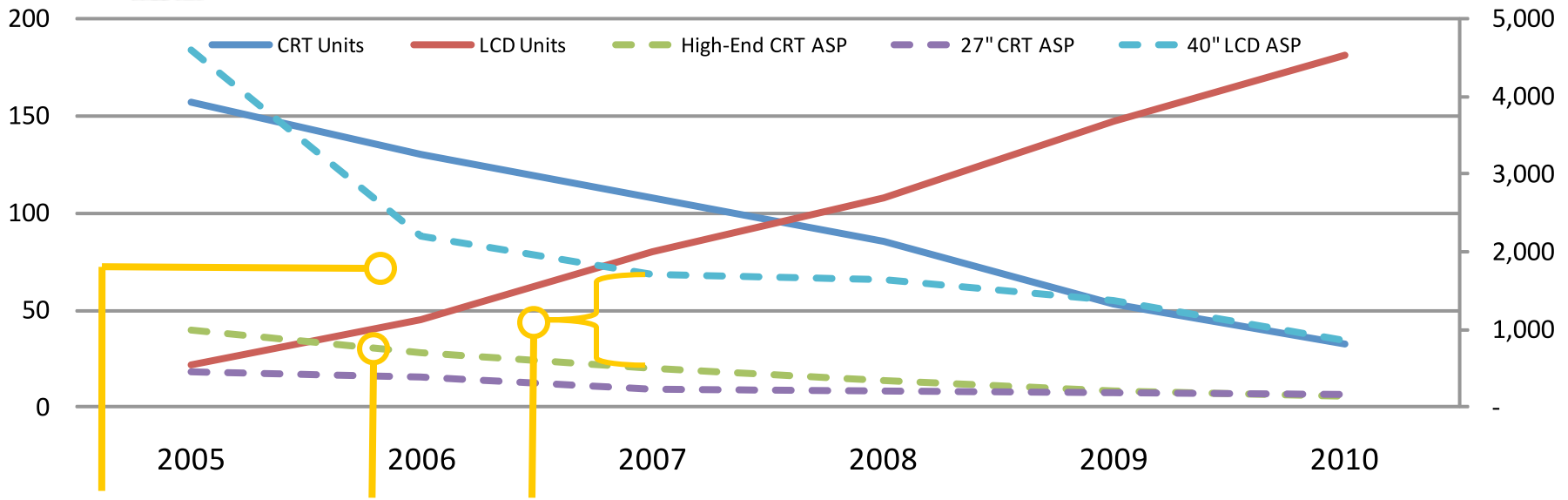

Attempts to create hybrid technologies like Slim CRT at intermediate prices fail to gain market share

High-end CRT sizes and capabilities diminish over time

40” LCD ASP delta vs high-end CRTs never <3x

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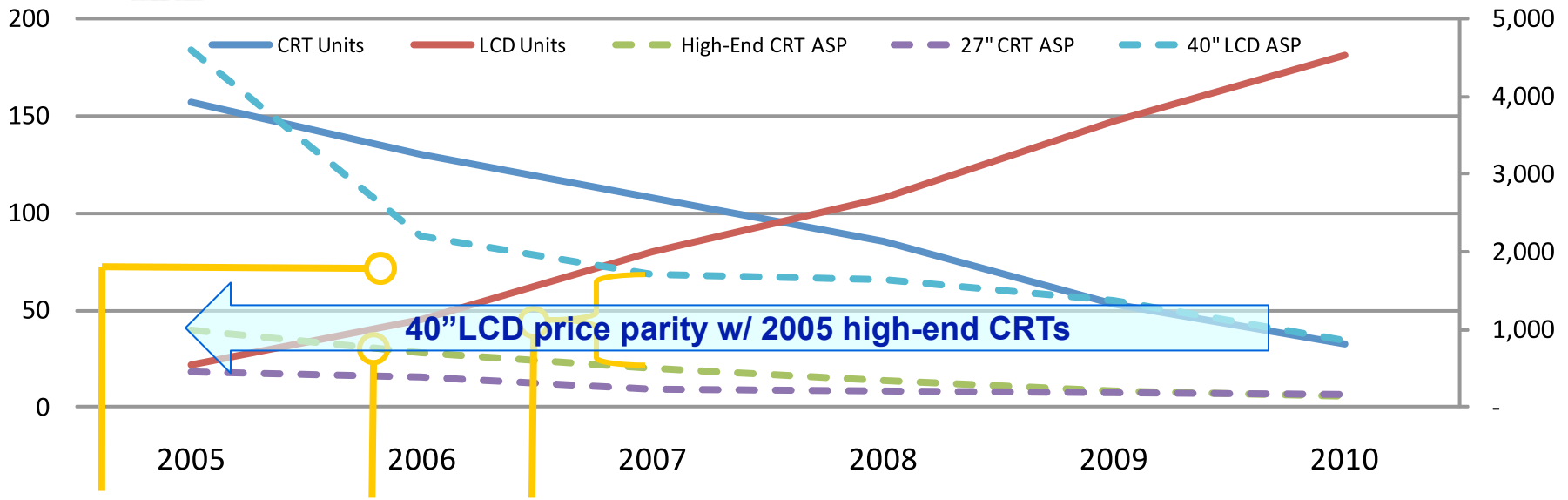

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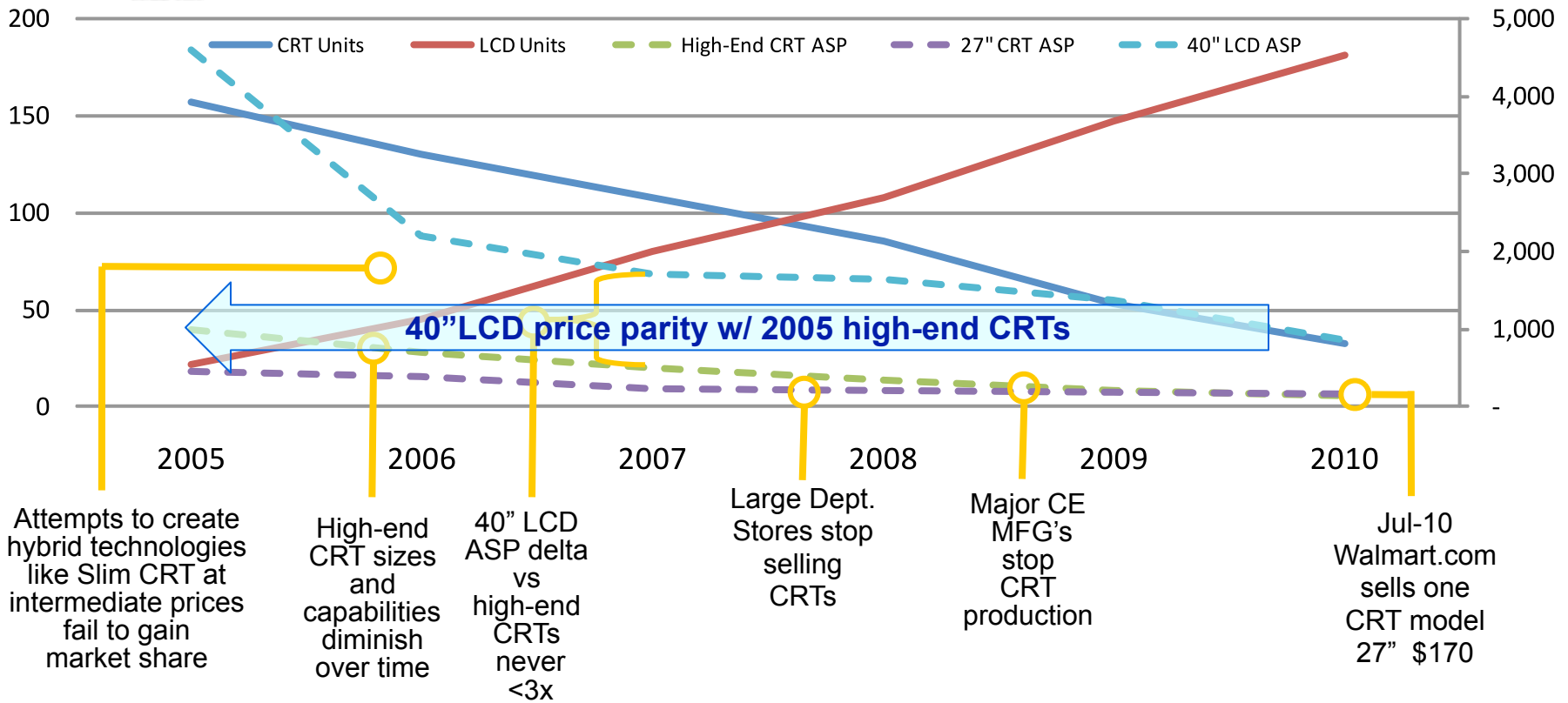

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Enterprise HDD Storage Tiers

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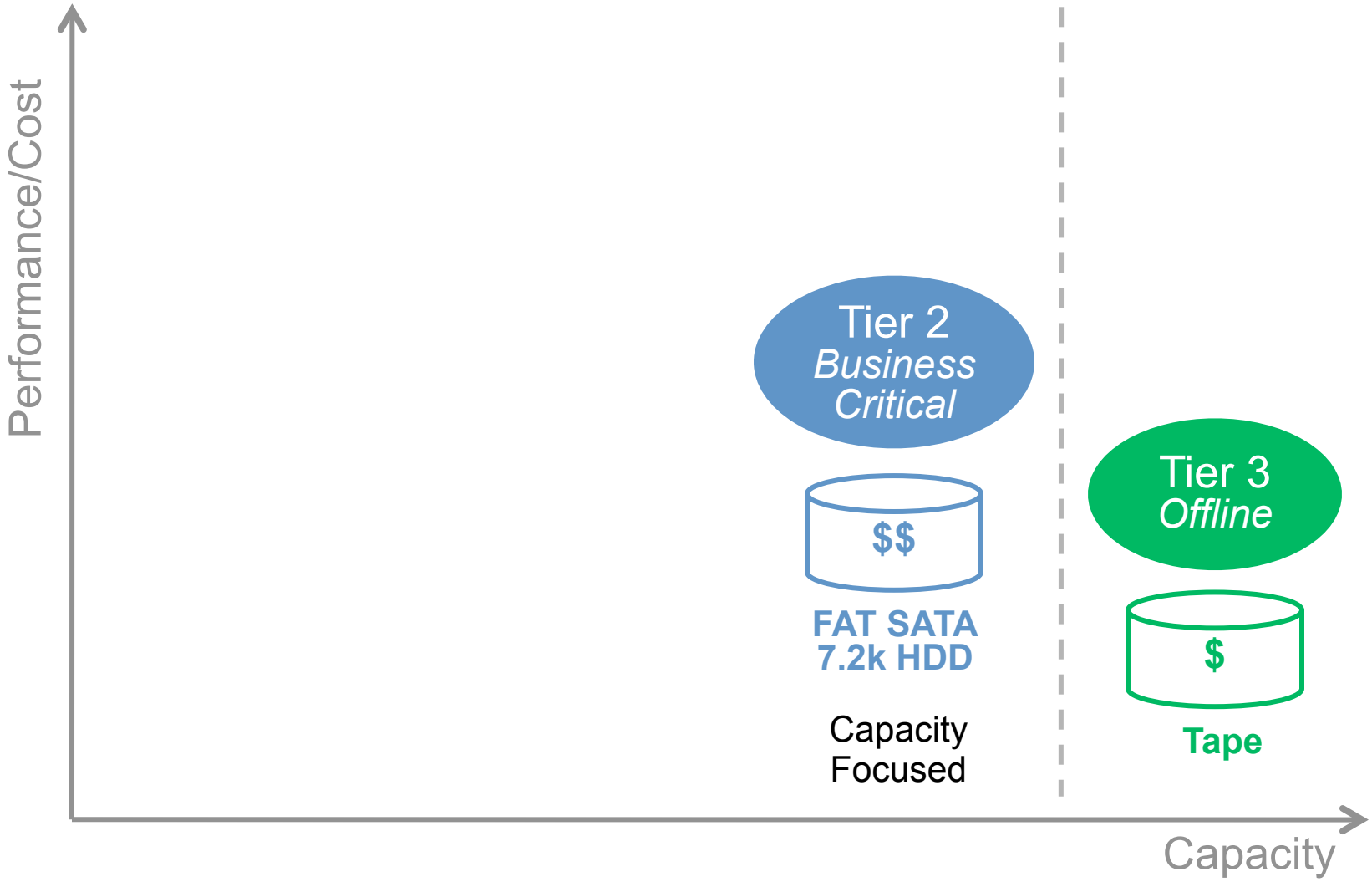

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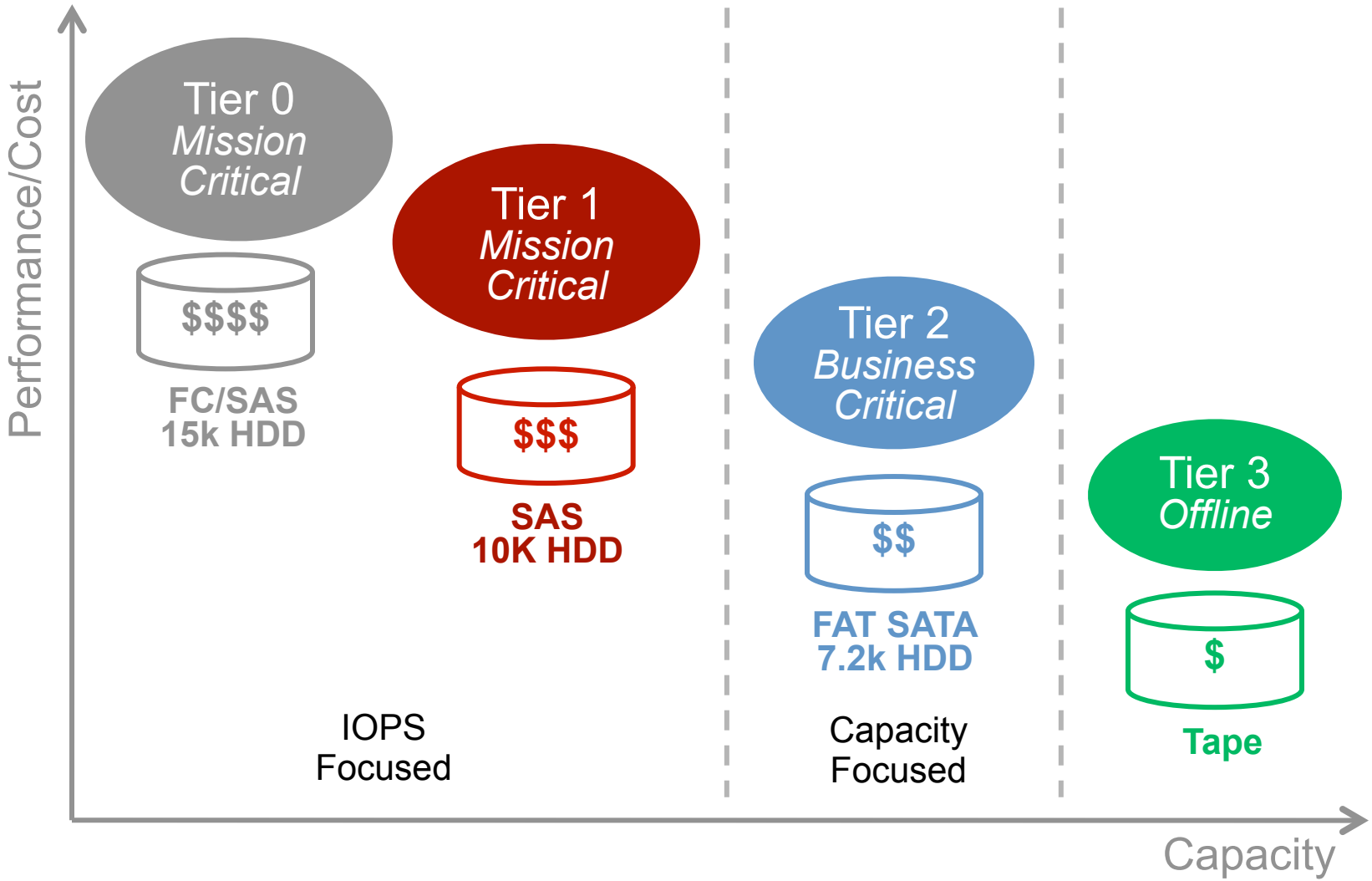
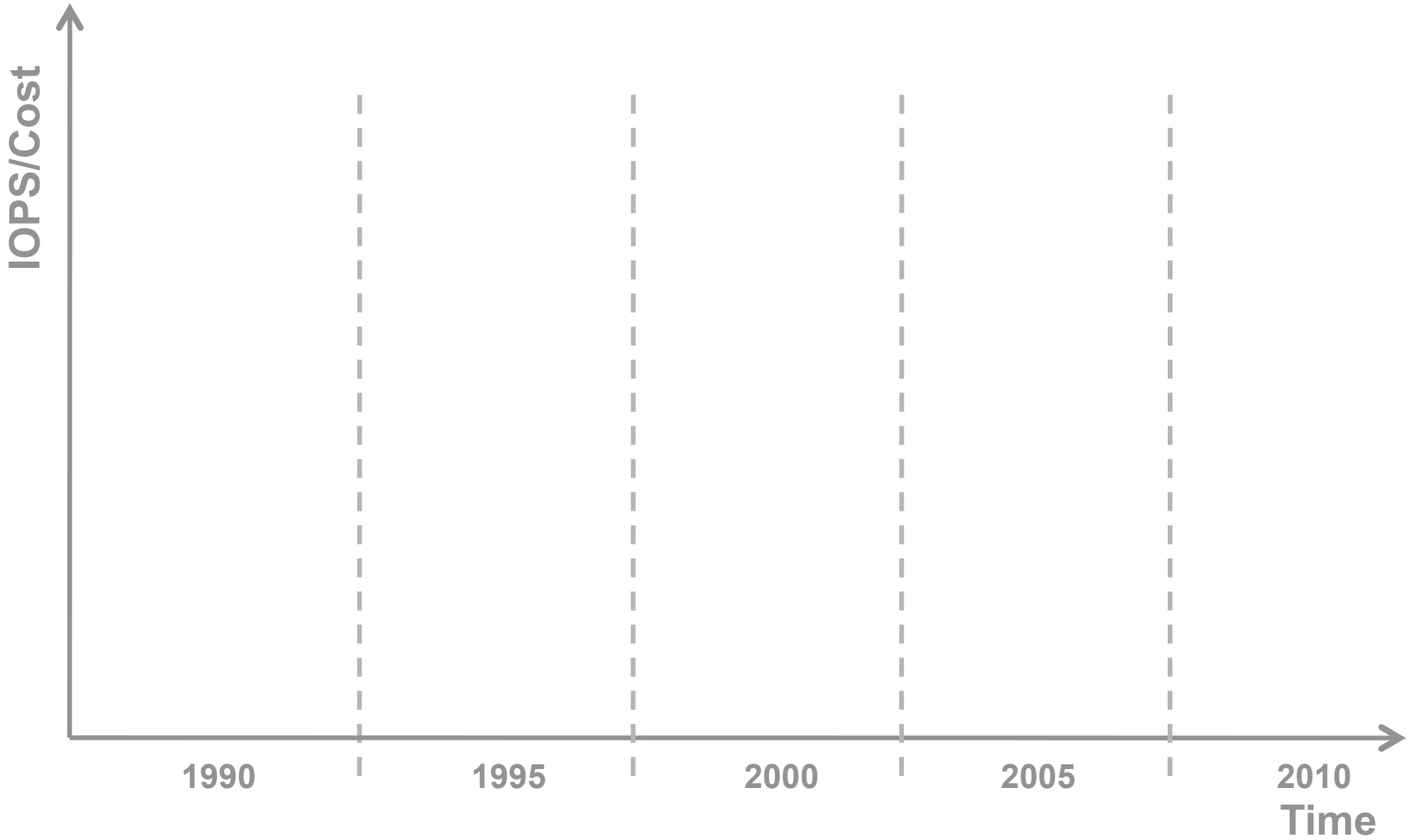


Mission Critical (Tier 0&1)

The Quest for High IOPS



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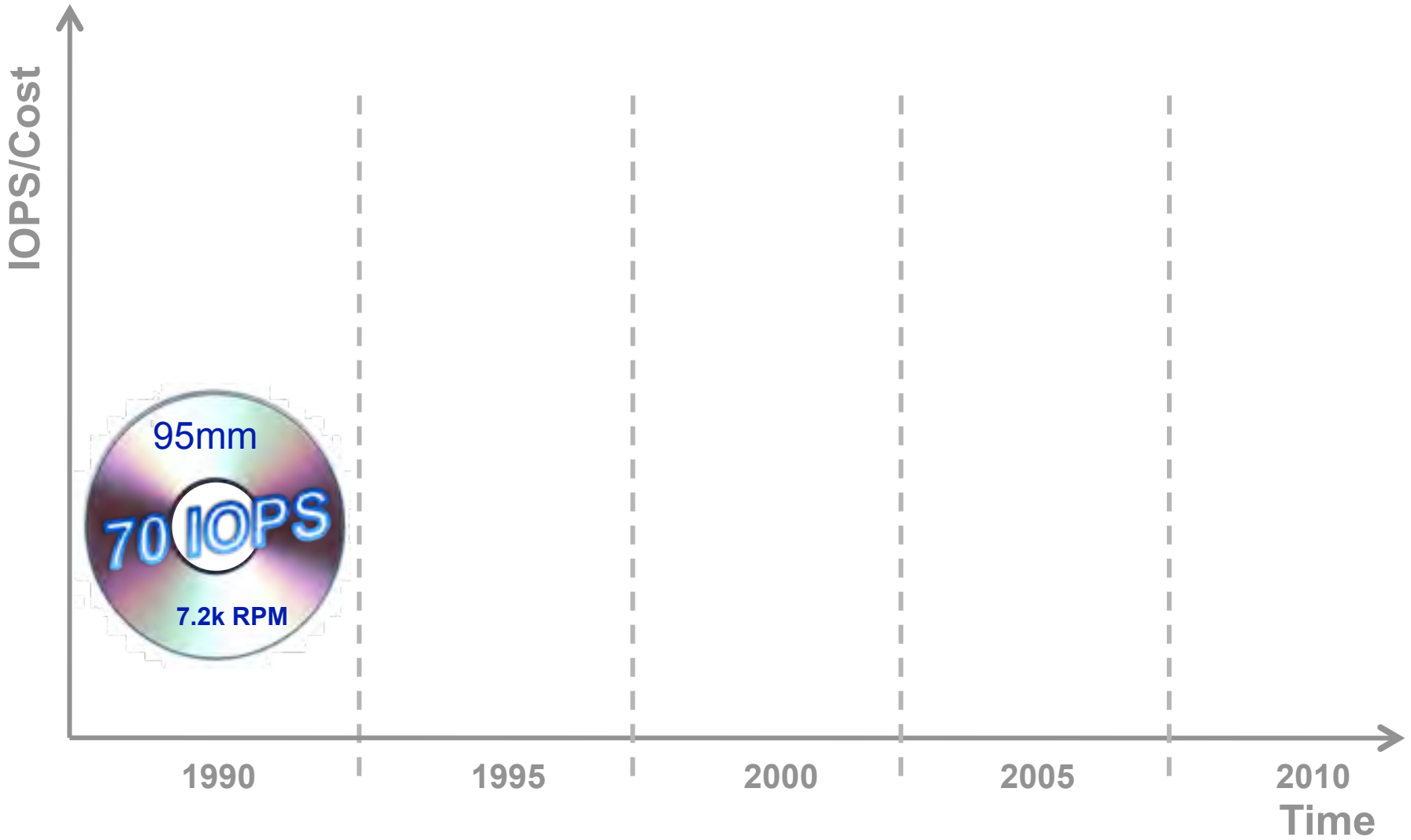

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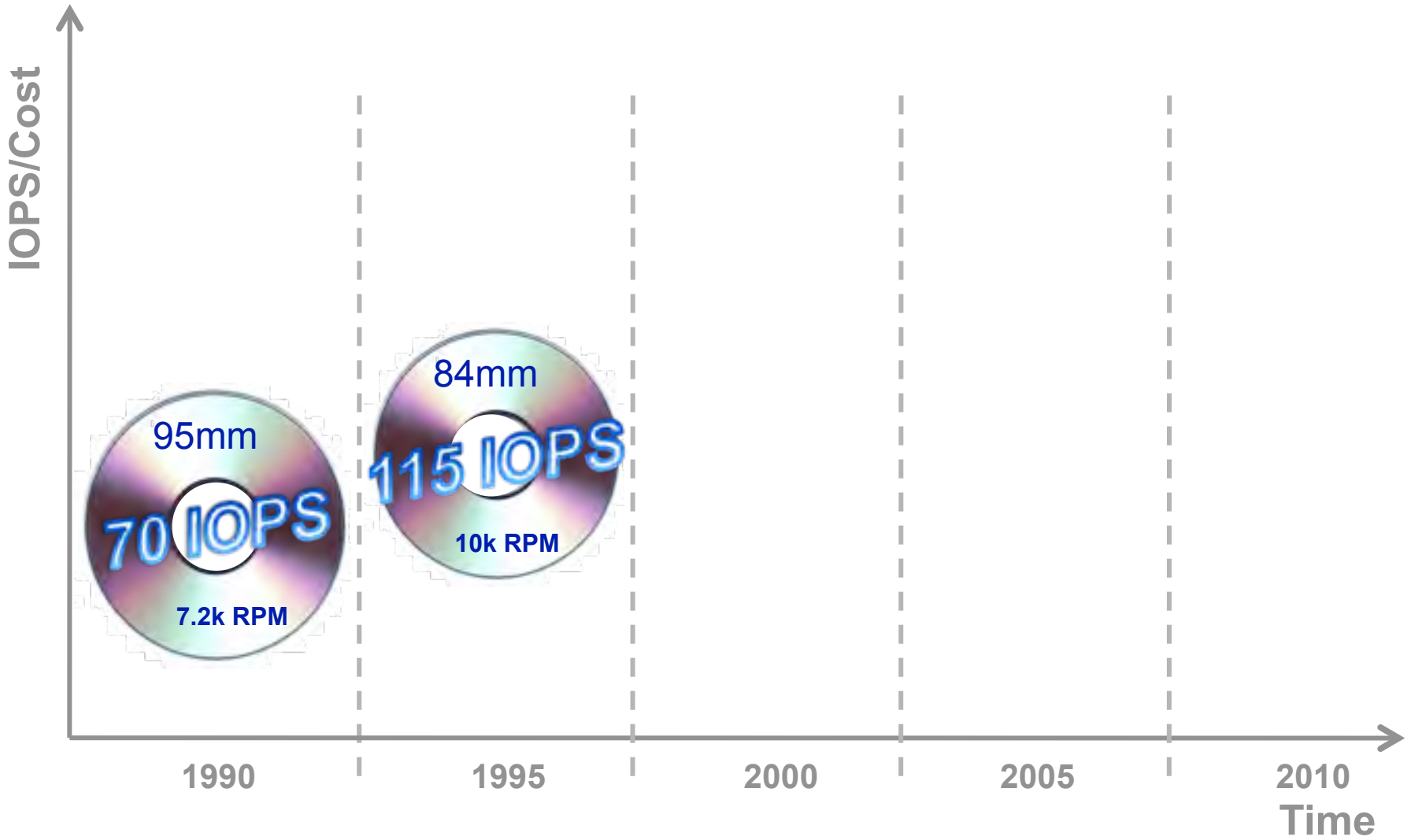

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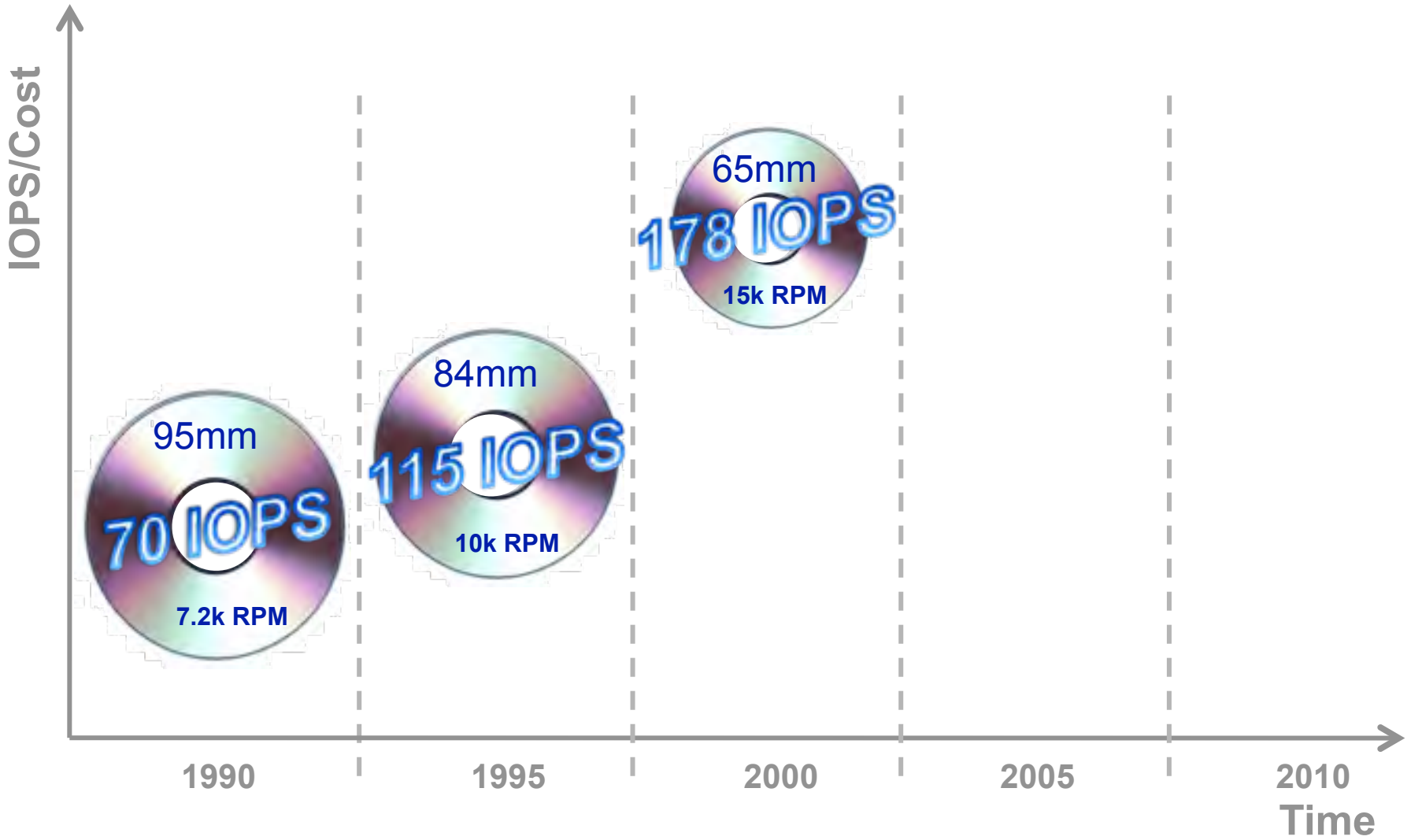

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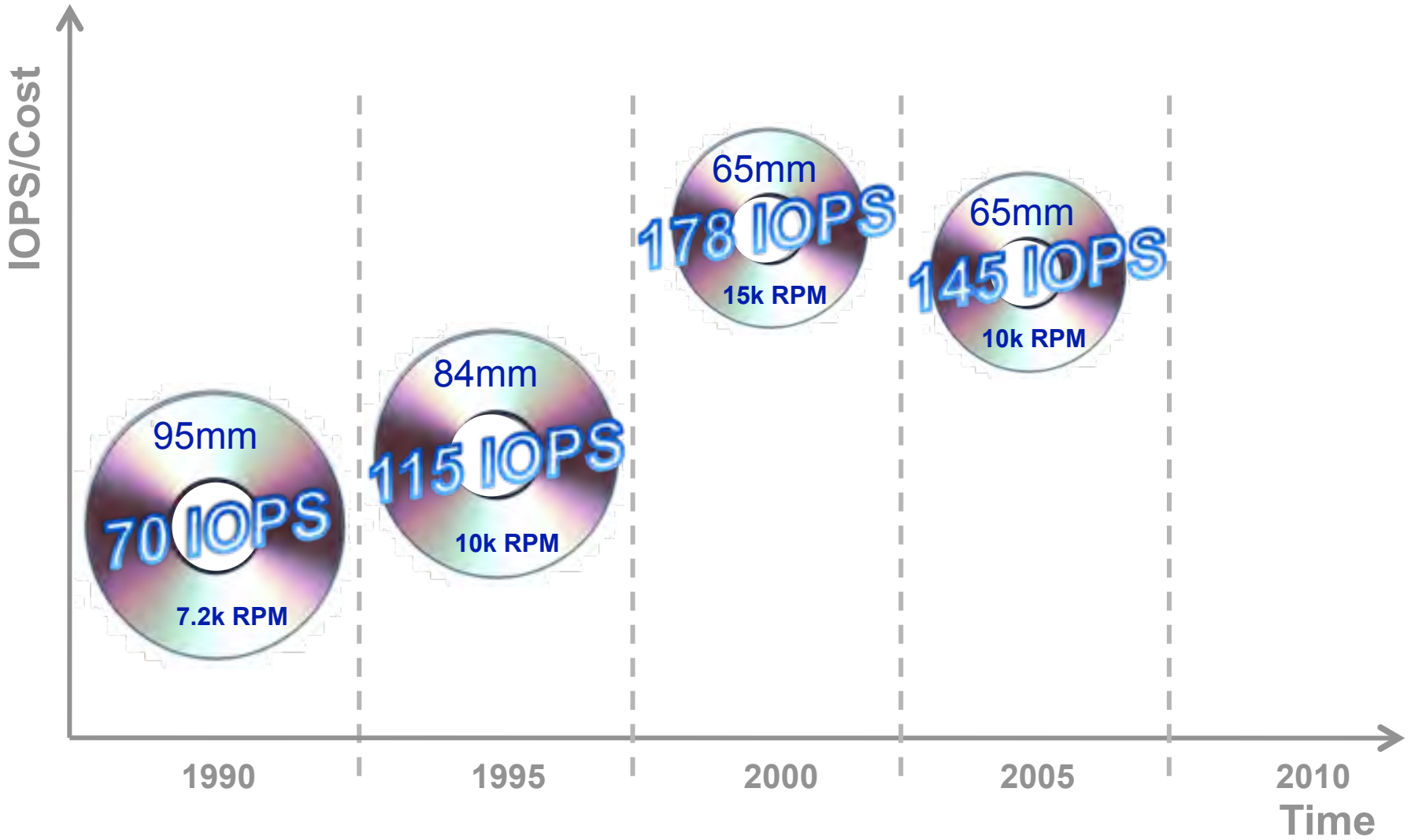

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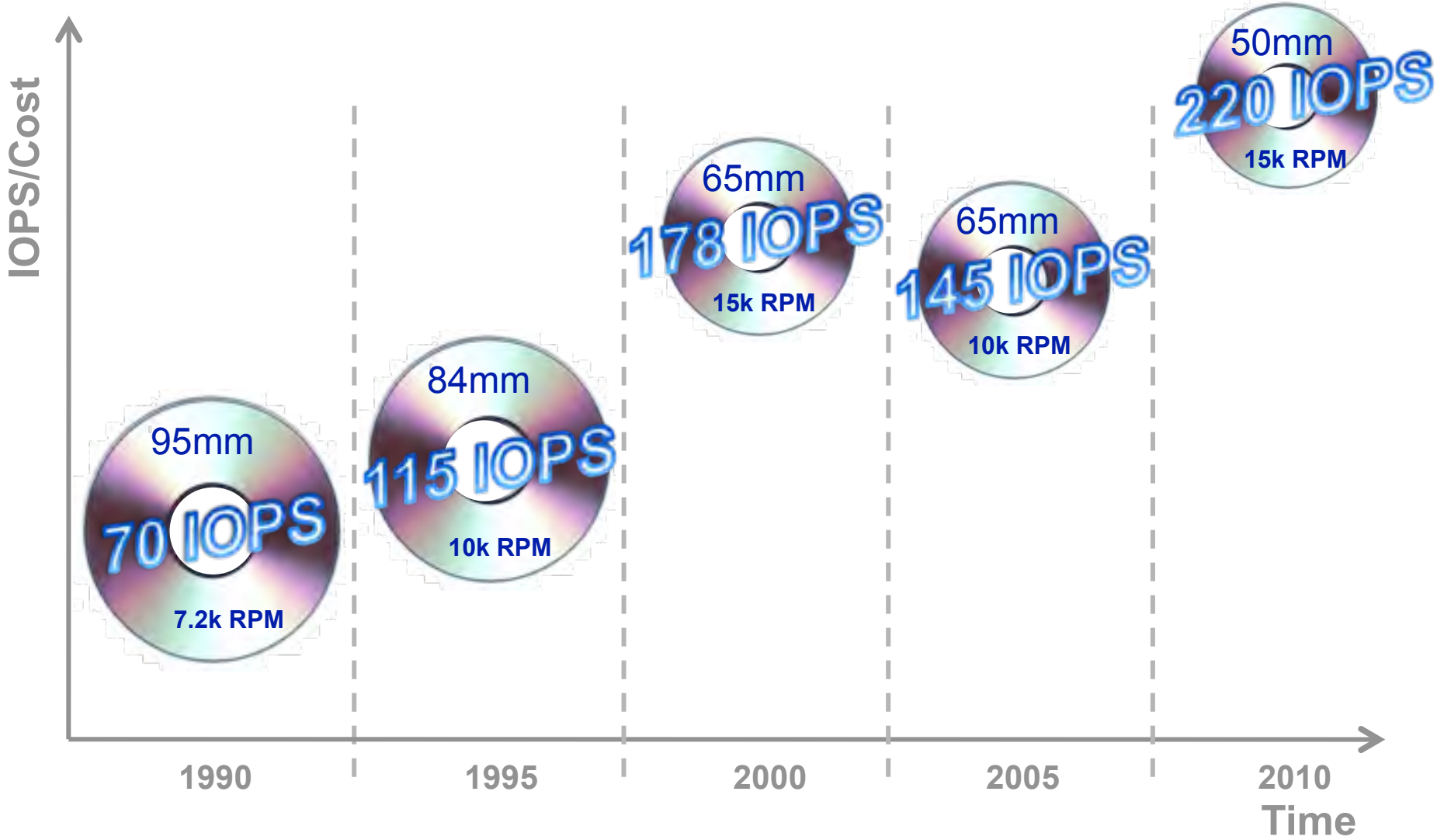

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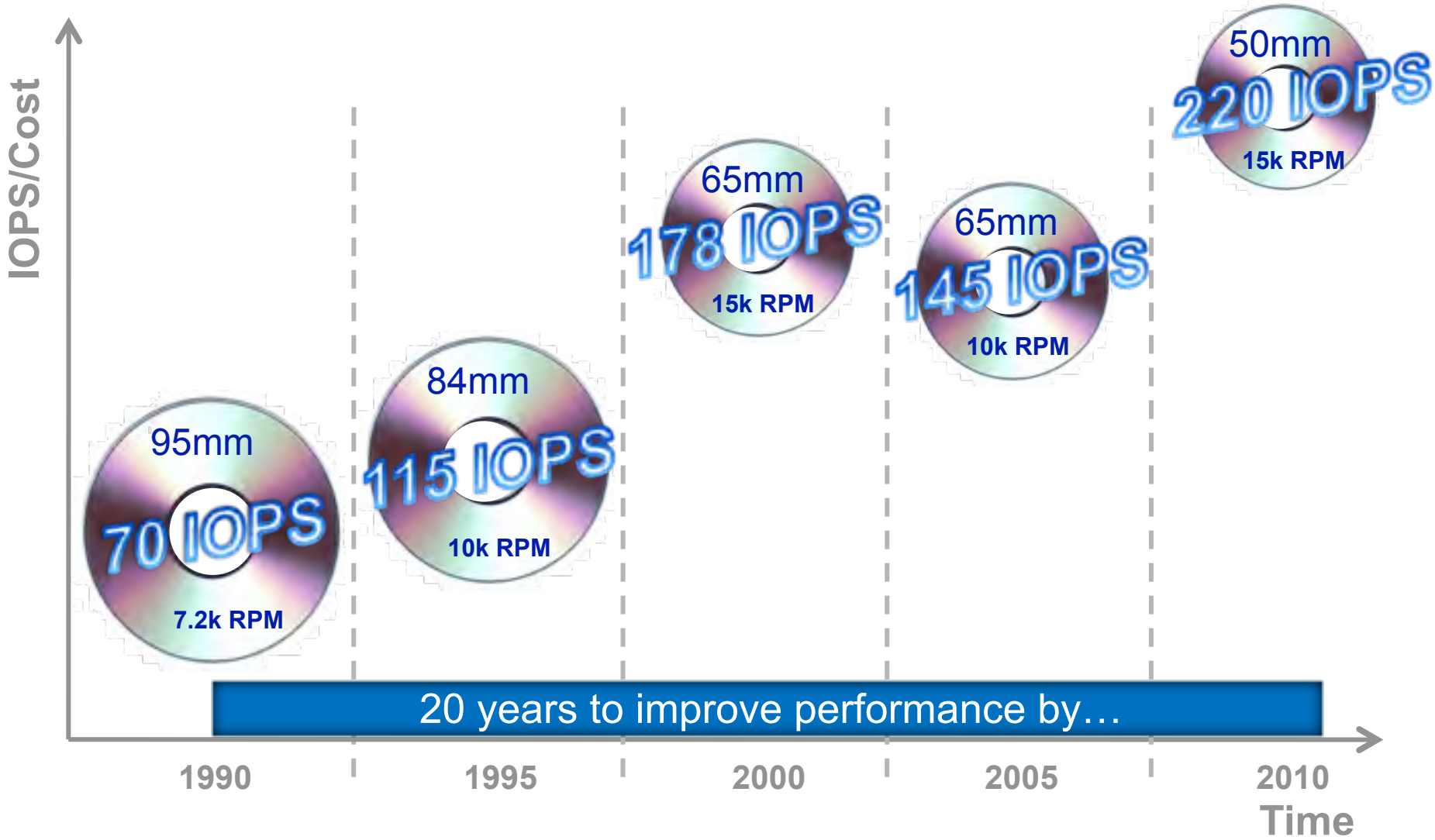

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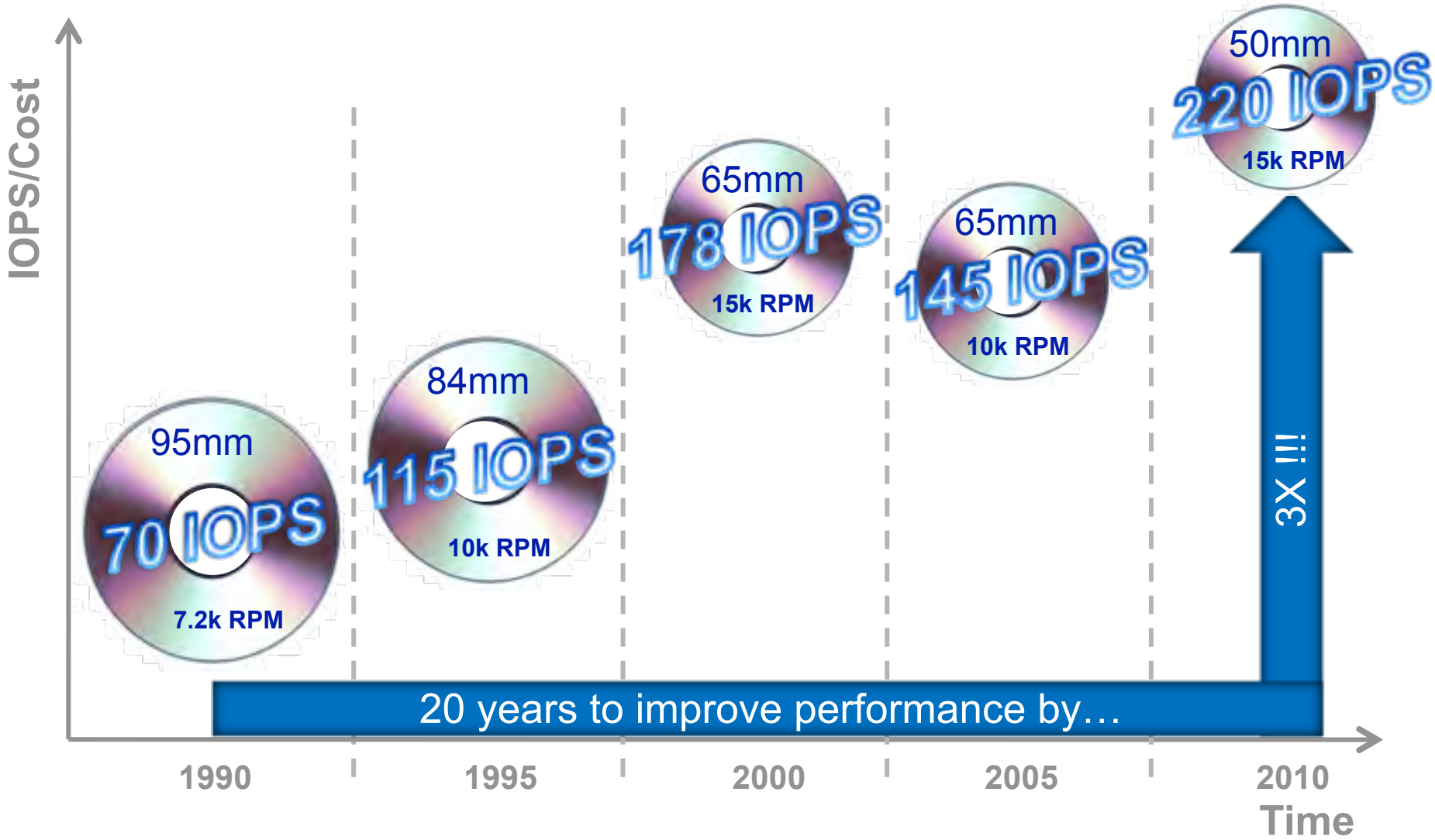
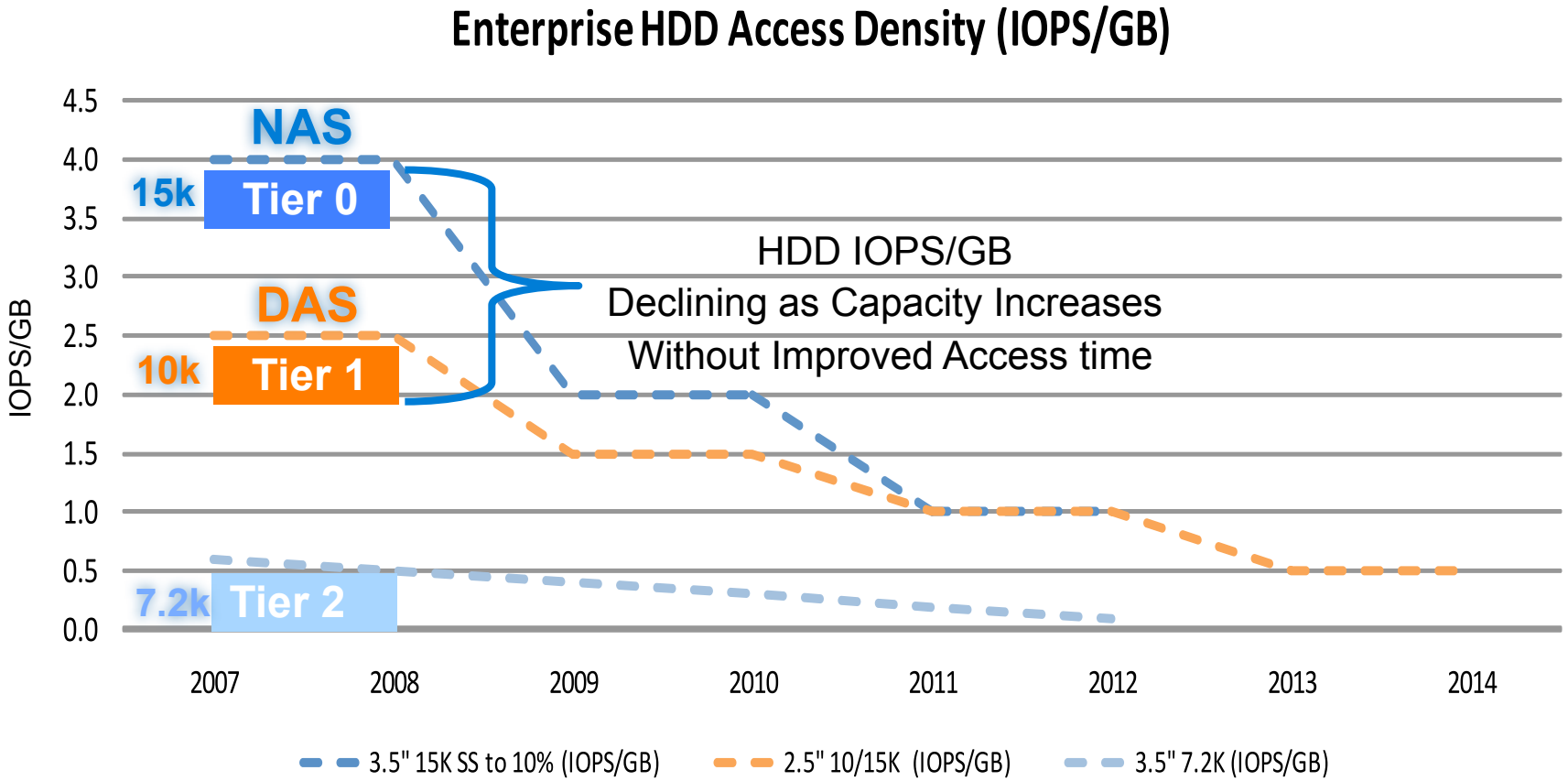


Enterprise HDD Performance
The Problem



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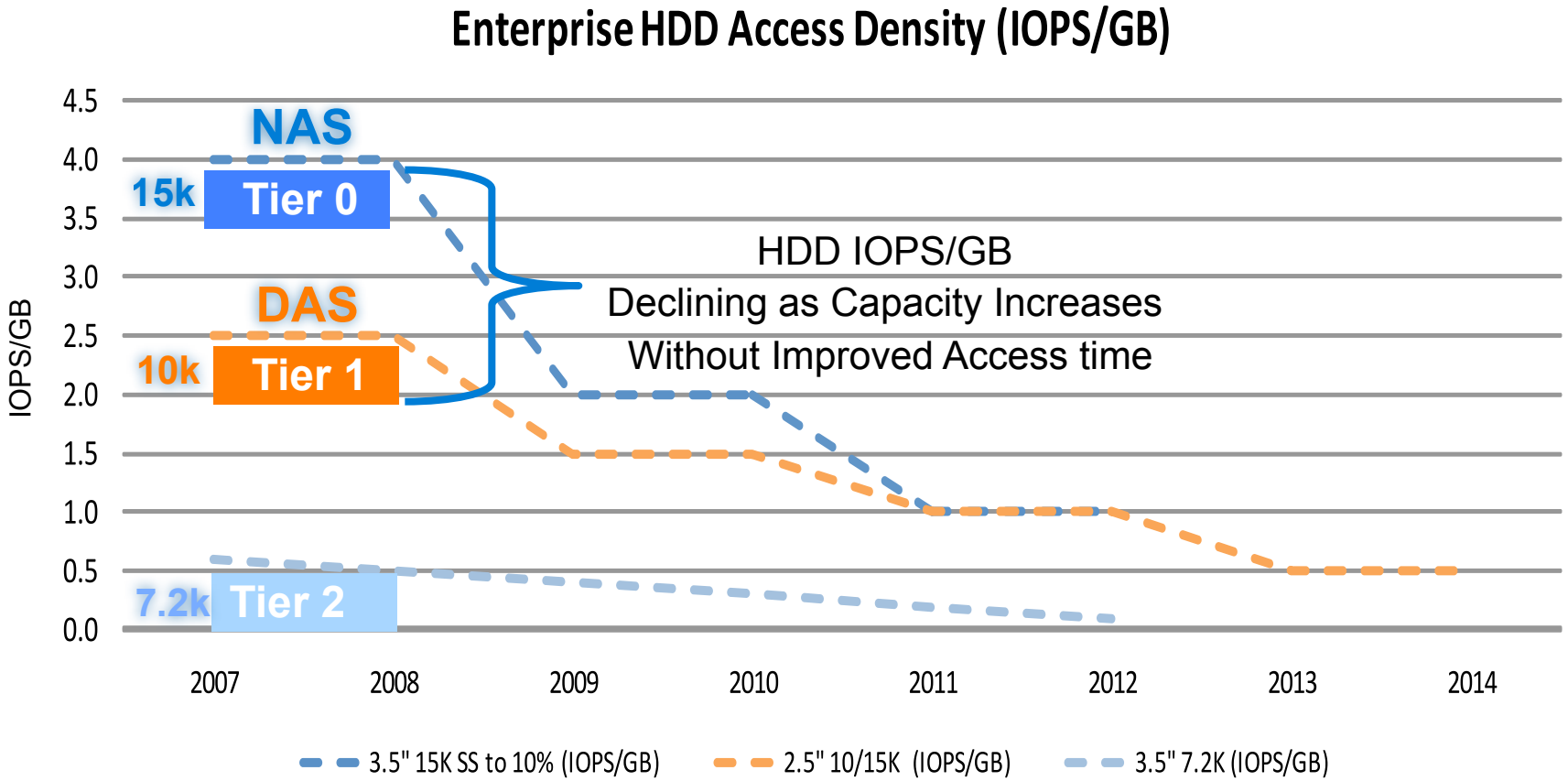
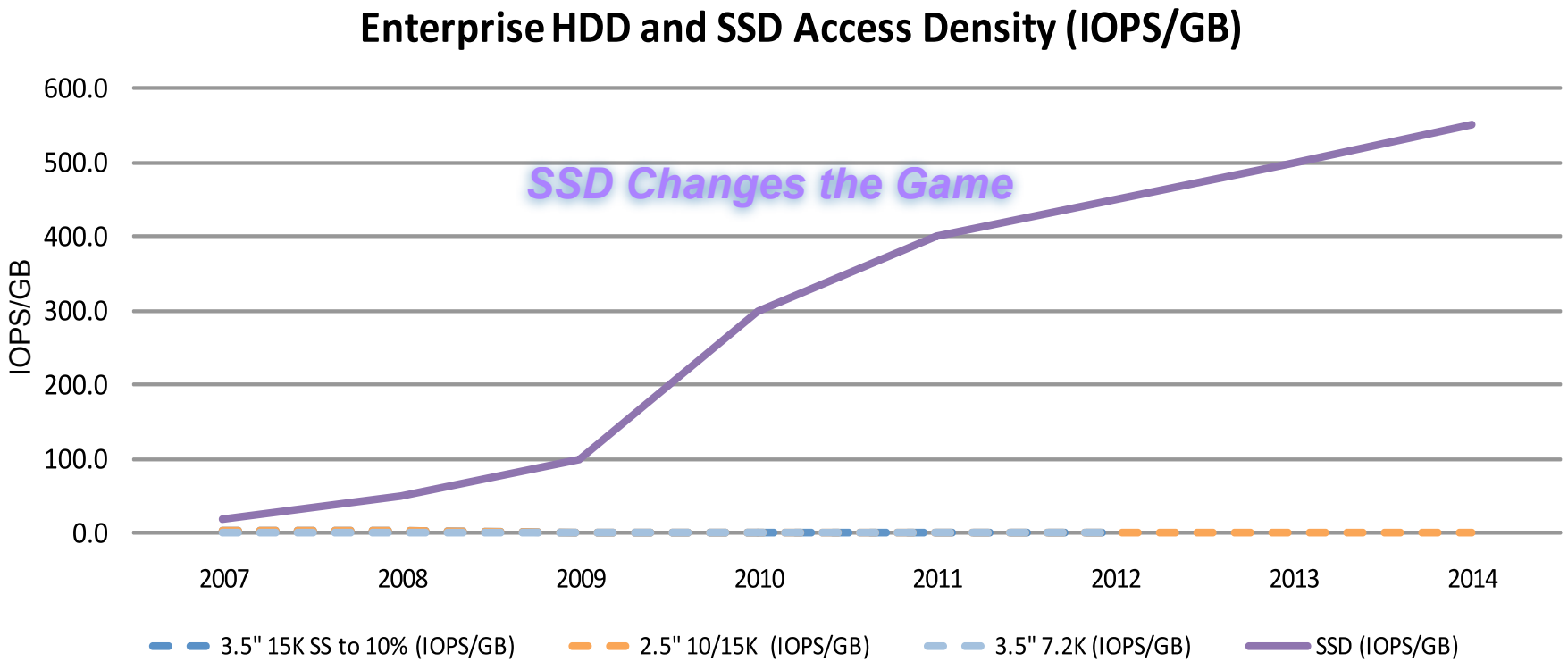


- Enterprise “High IOPS” market served by Tier0 and Tier1 products
- Capacity served by Tier2 HDD

SSD Changes the Game!



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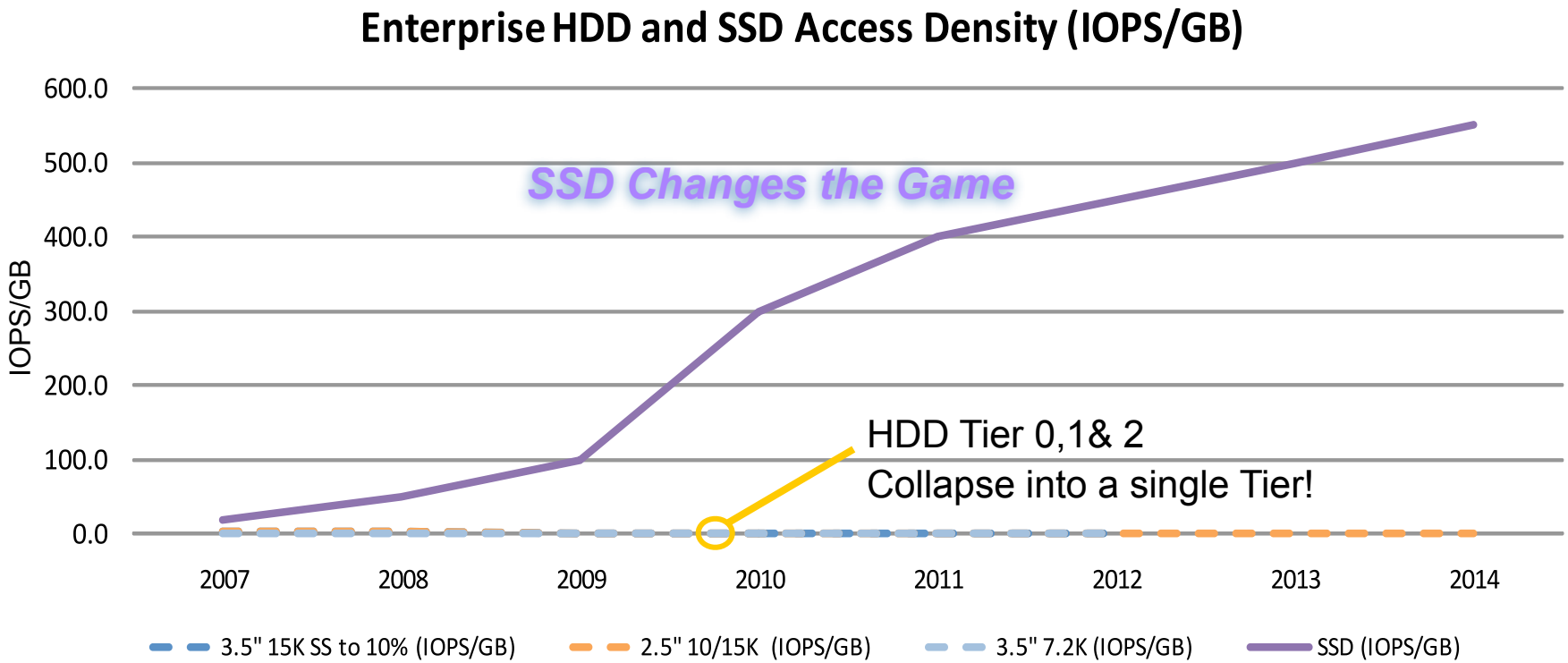

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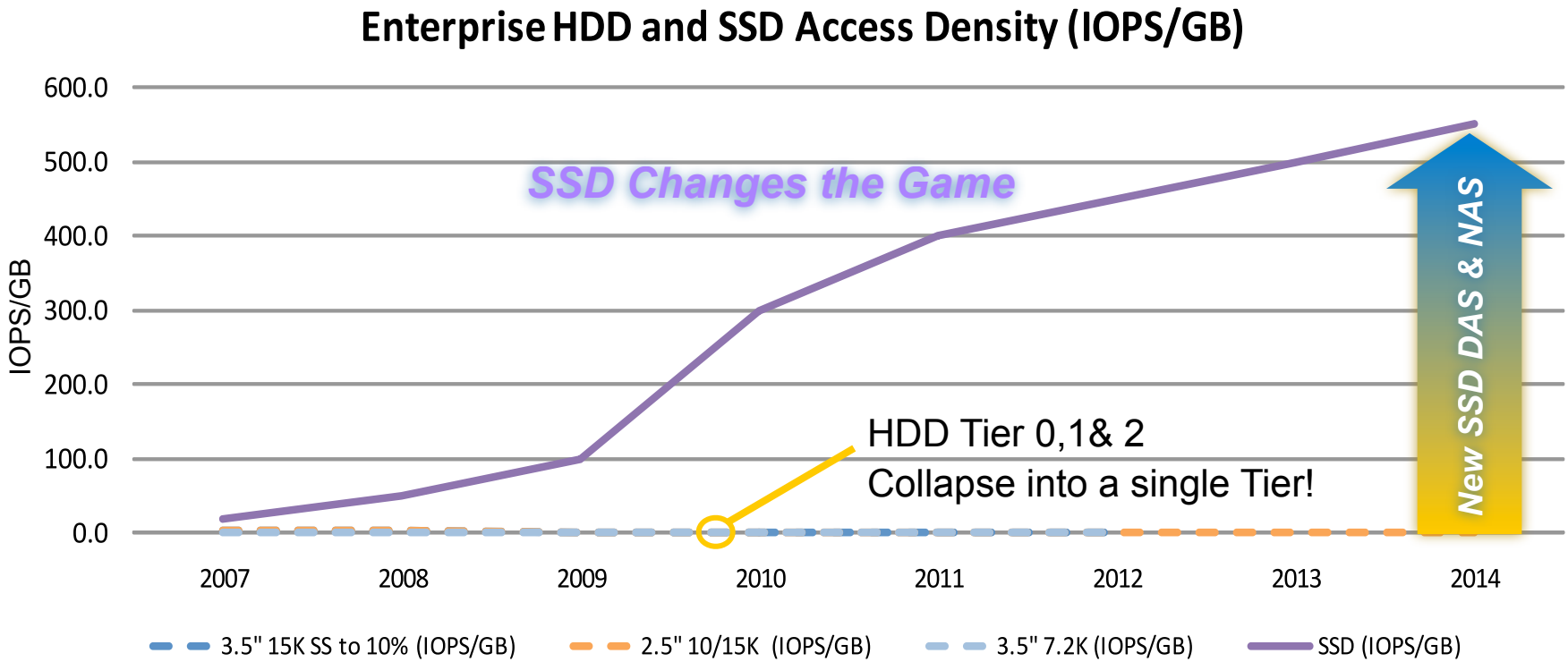

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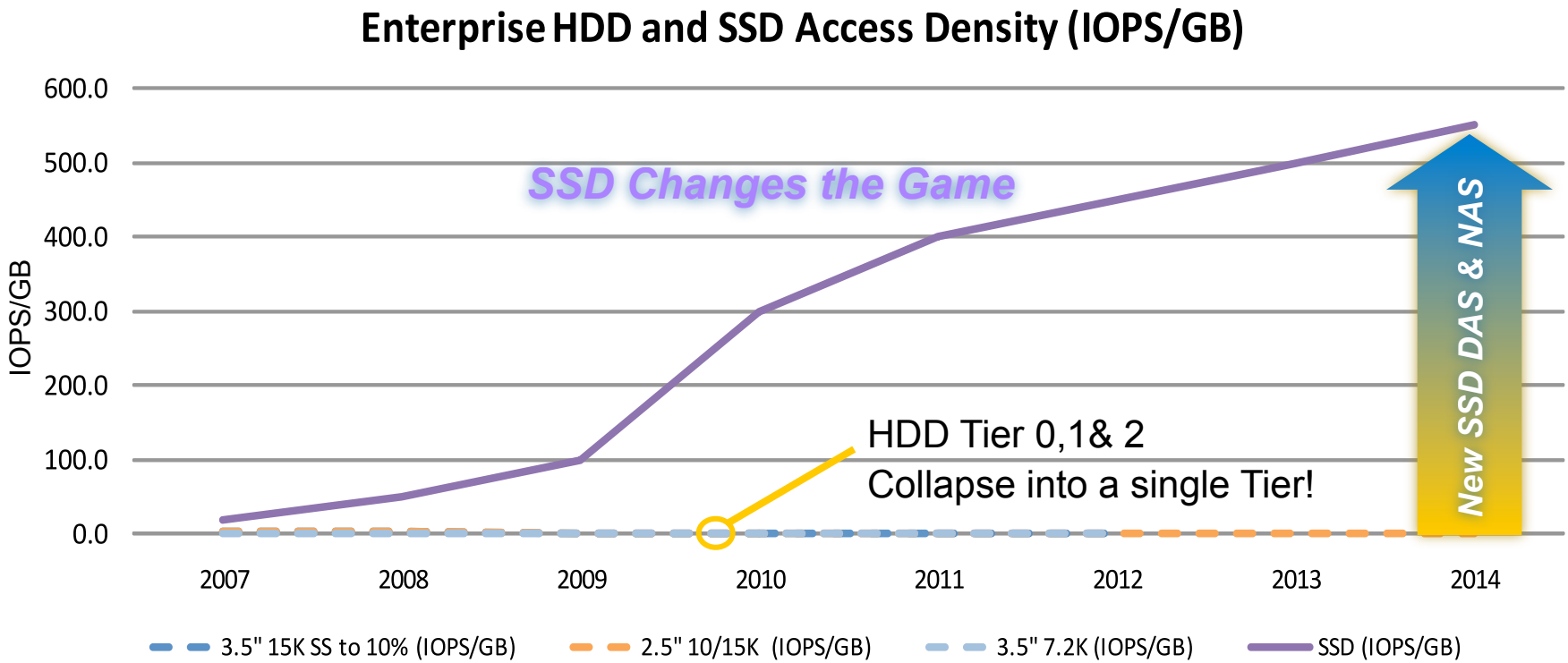

- Enterprise “High IOPS” Mission Crittical market shifts to SSD
- Capacity will be served by a single HDD Tier

Game Changing Technology

2011 Assumptions

- 2U storage rack
- 2.5” HDD max cap = 400GB / 24 HDDs, destroked to 20%
- 2.5” SSD max cap = 800GB / 36 SSDs

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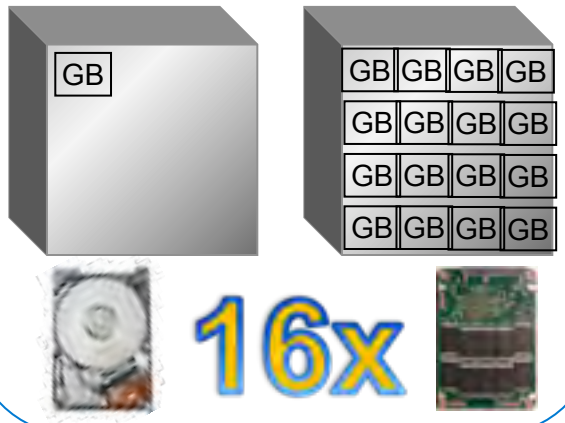
Game Changing Technology

Storage Density

1 GB/in^3 16 GB/in^3



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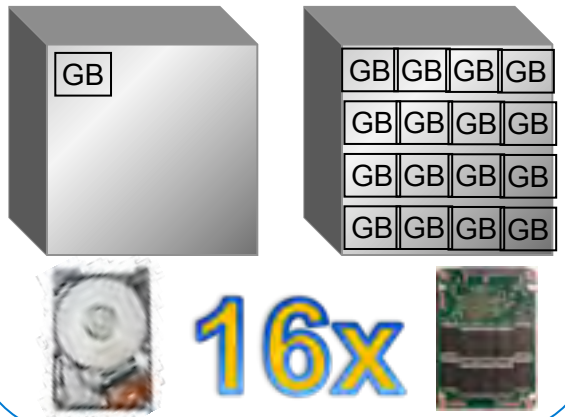

16x

Performance Density

4.2 IOPS/in^3 1,250 IOPS/in^3

300x

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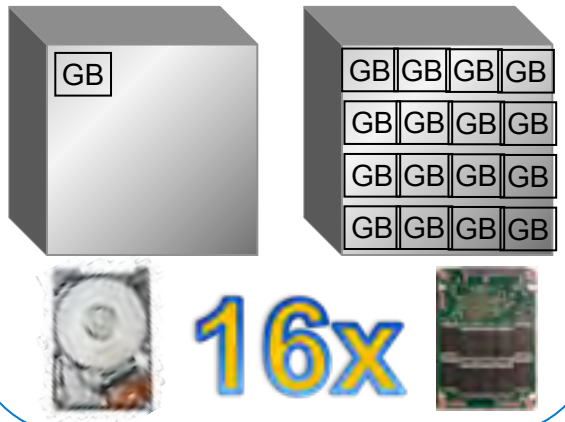

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4.2 IOPS/in^3 1,250 IOPS/in^3

Power Metrics

11.4 GB/W

570 GB/W

Game Changing Technology

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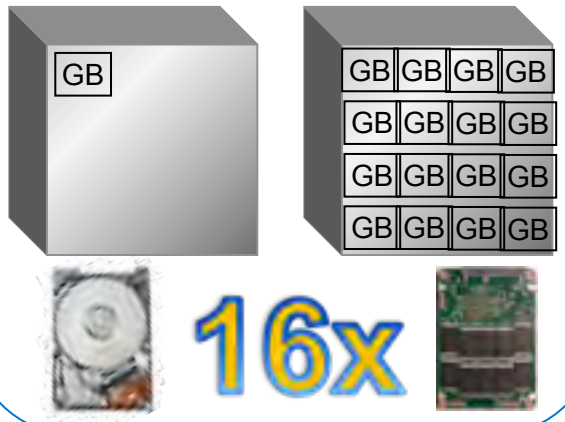

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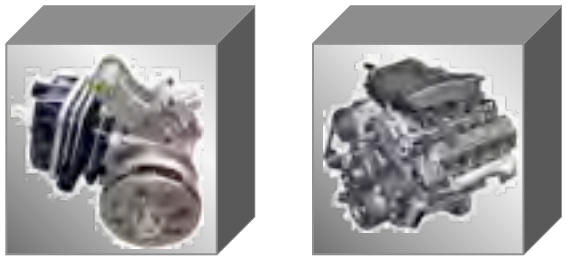


300x

Power Metrics

11.4 GB/W	570 GB/W
43 IOPS/W	42,850 IOPS/W

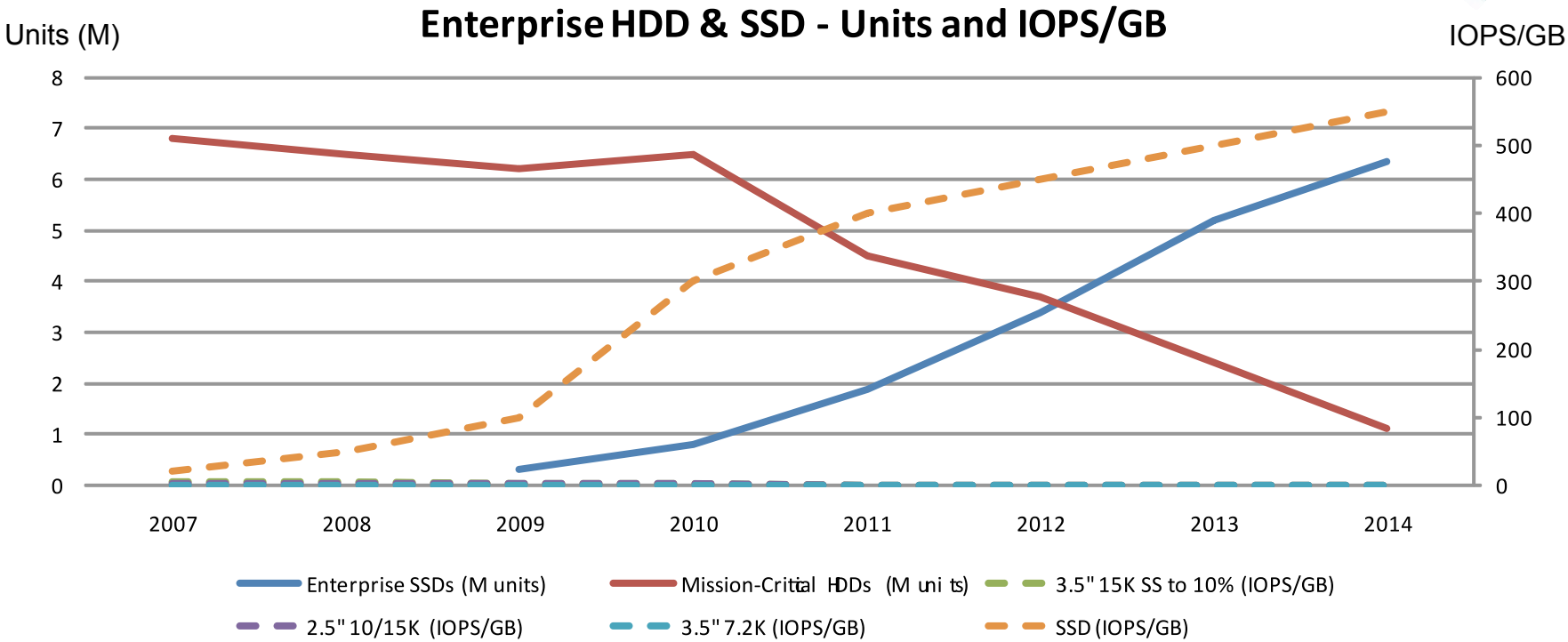
50x

1000x

Disruptive Innovations
Enterprise SSDs

HDD

SSD



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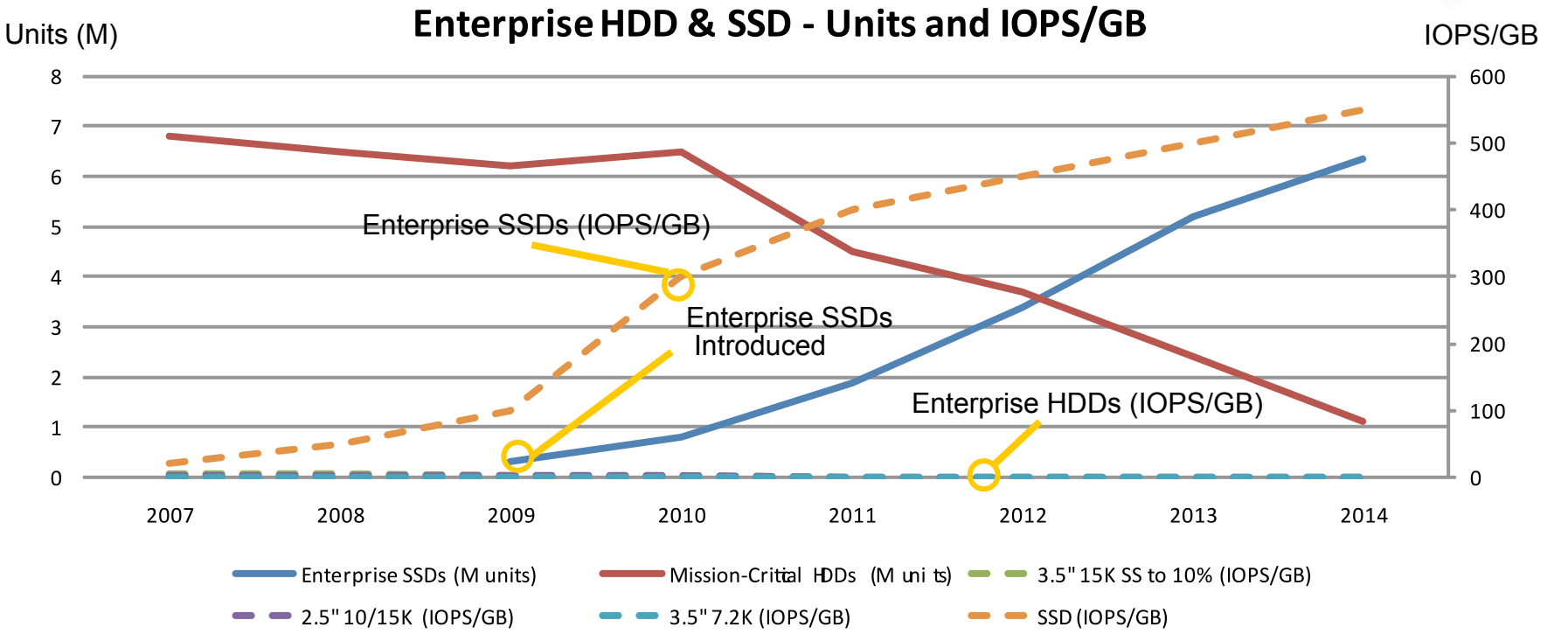
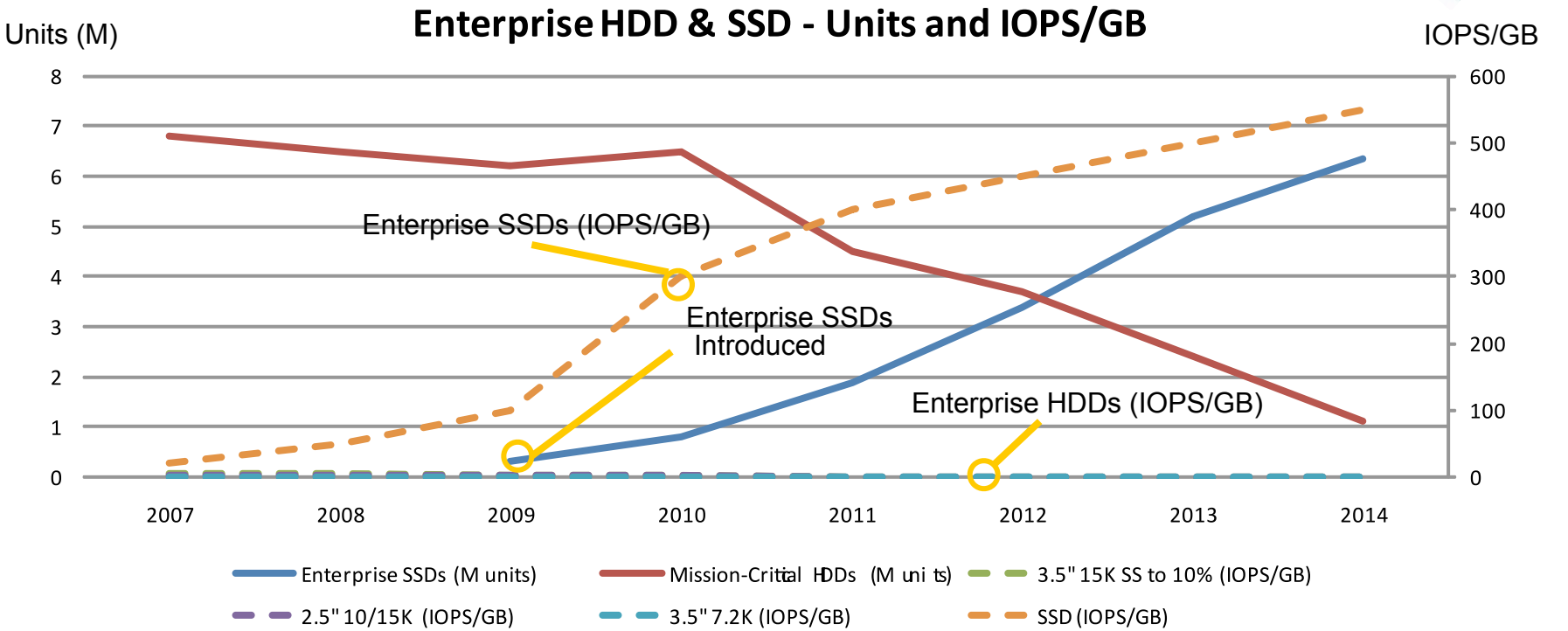


Disruptive Innovations
Enterprise SSDs

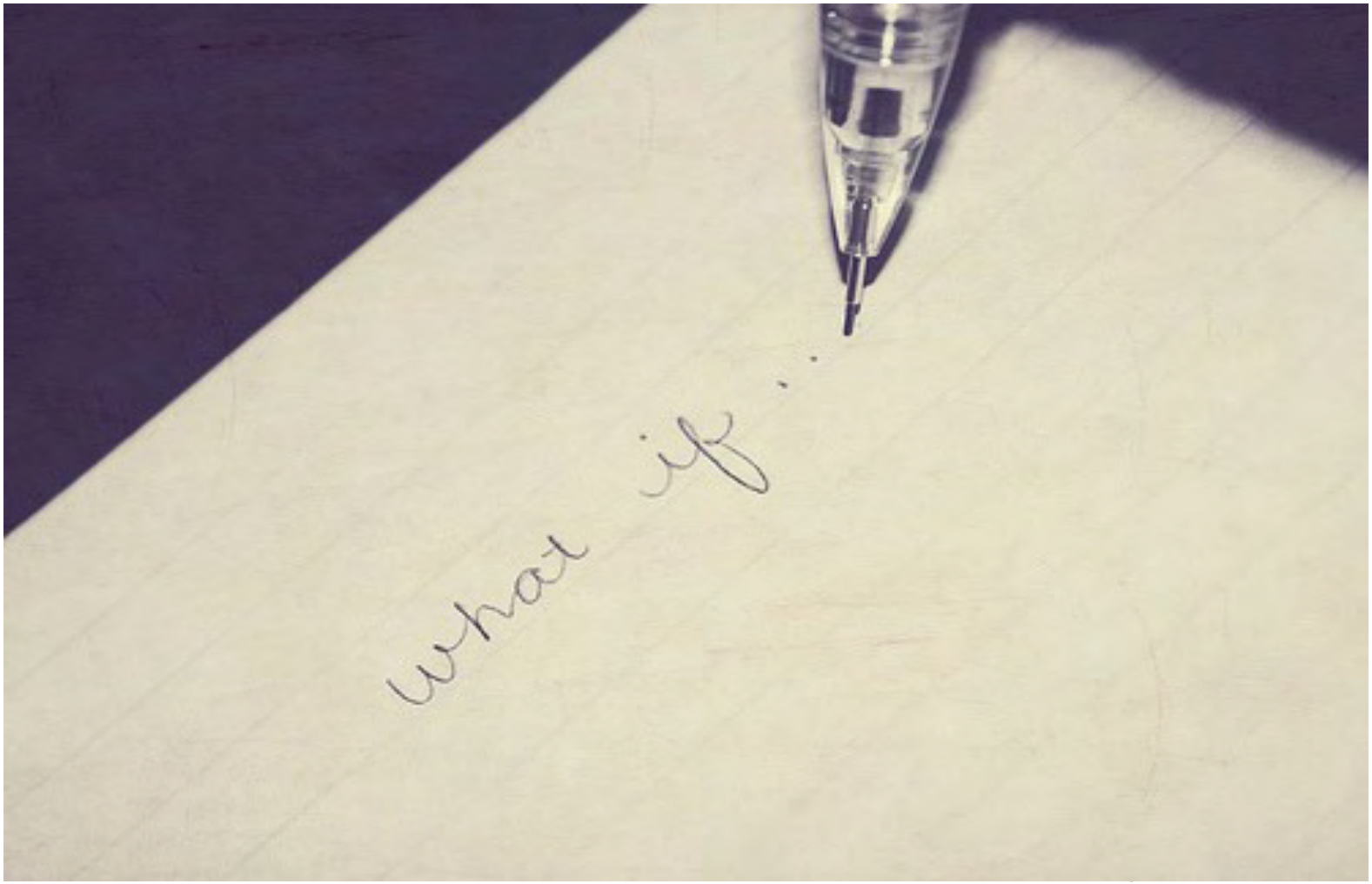
HDD

Enterprise SSDs >> HDDs
TCO and Infrastructure Fuel Volume Explosion!

SSD



What if…
The Enterprise Stopped Spinning?



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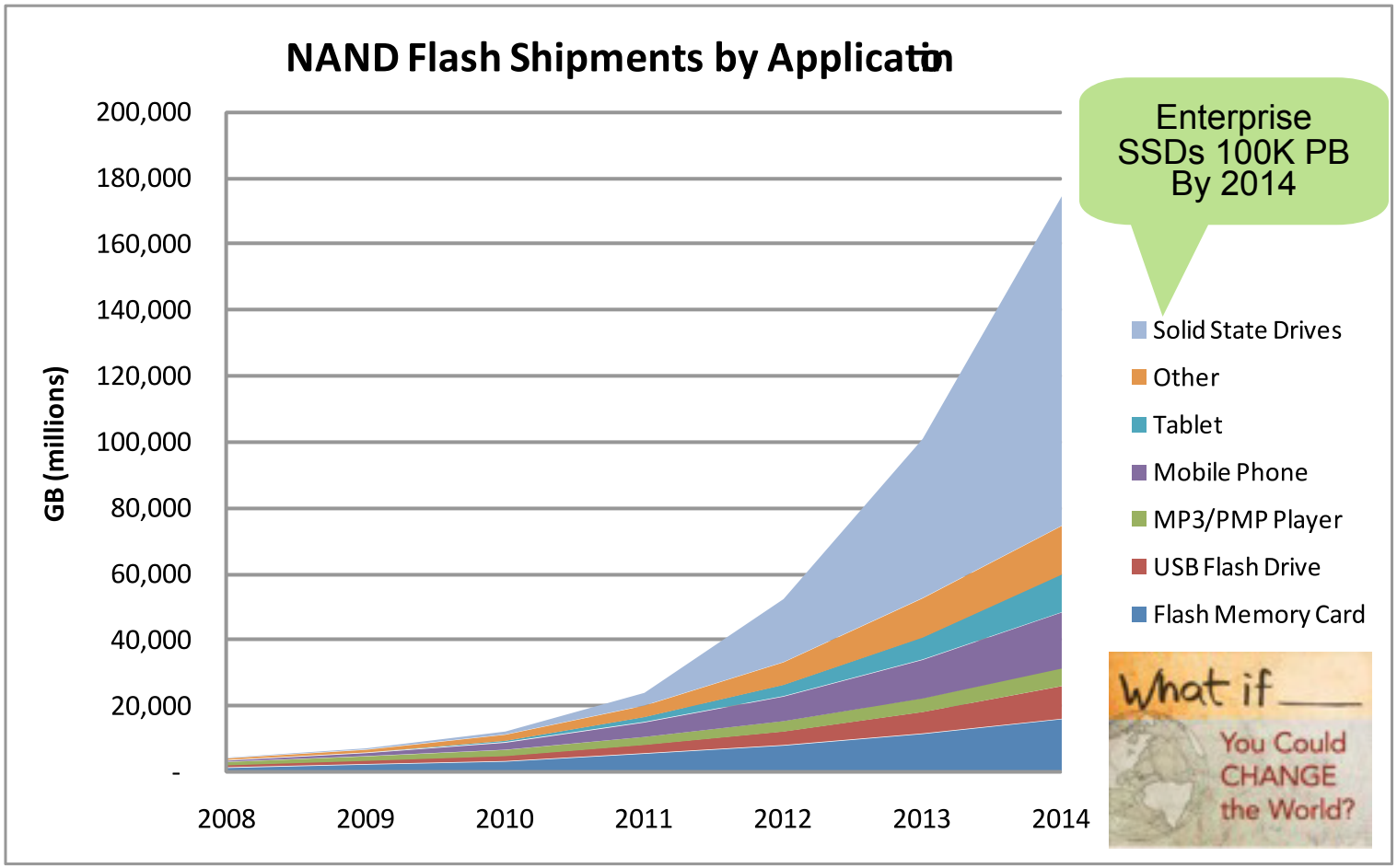

Source: Forward Insights, SMART

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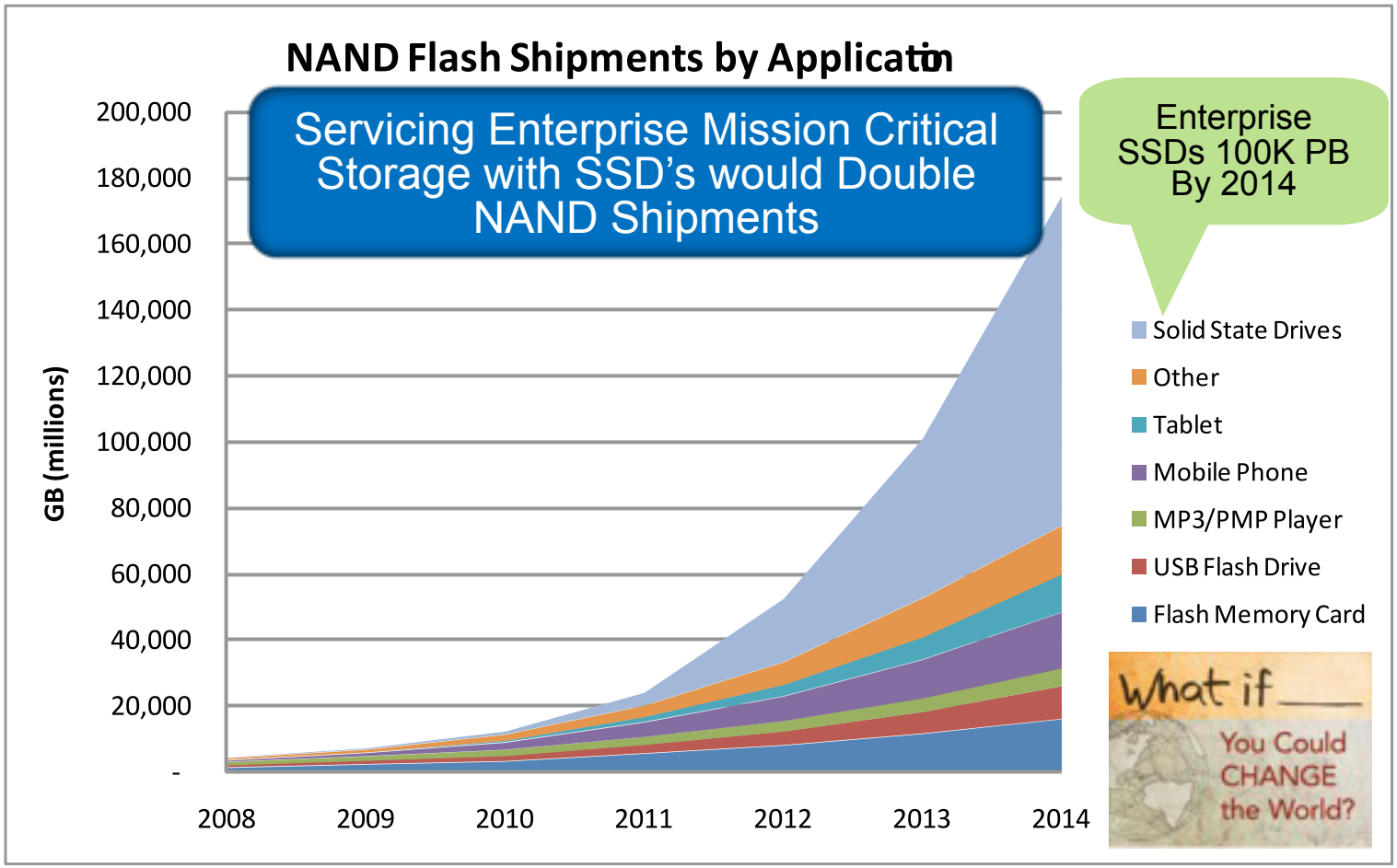

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How Can We Enable Such Growth?

Solid State Storage technology
is already a game changer in
Performance, *Power* and *Storage Density*

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The key to massive adoption is continued cost reduction

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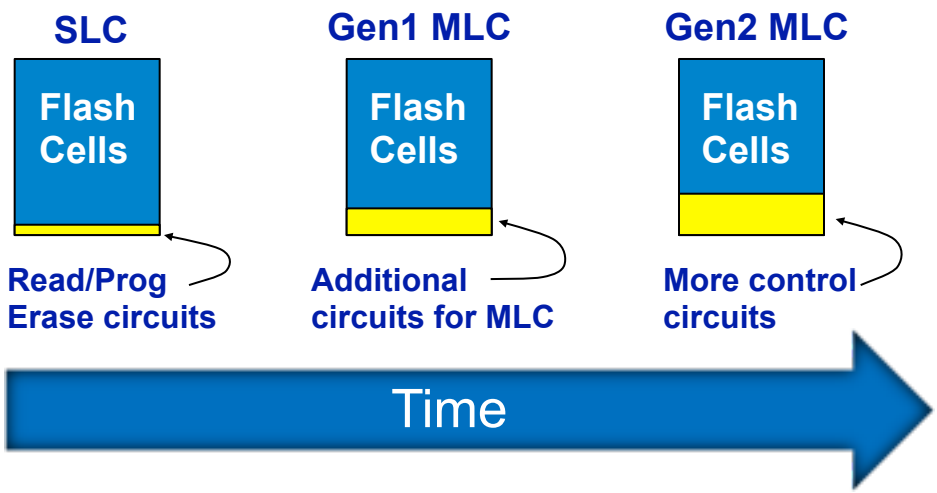
The key to massive adoption is continued cost reduction

Working together
to create the best value for our customers
will benefit the entire industry

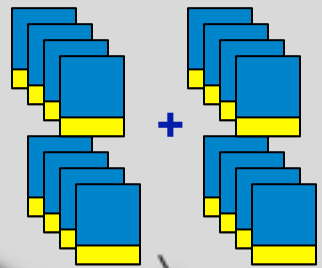
Flash Evolution

Flash Evolution

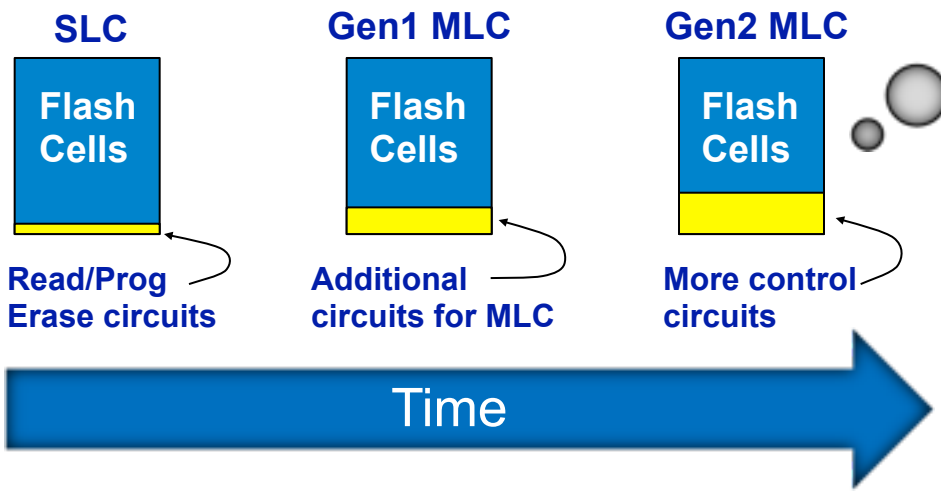


Flash Evolution

SSDs aggregate lots of complex flash chips…



= $$$



Storage Class Flash (SCF)

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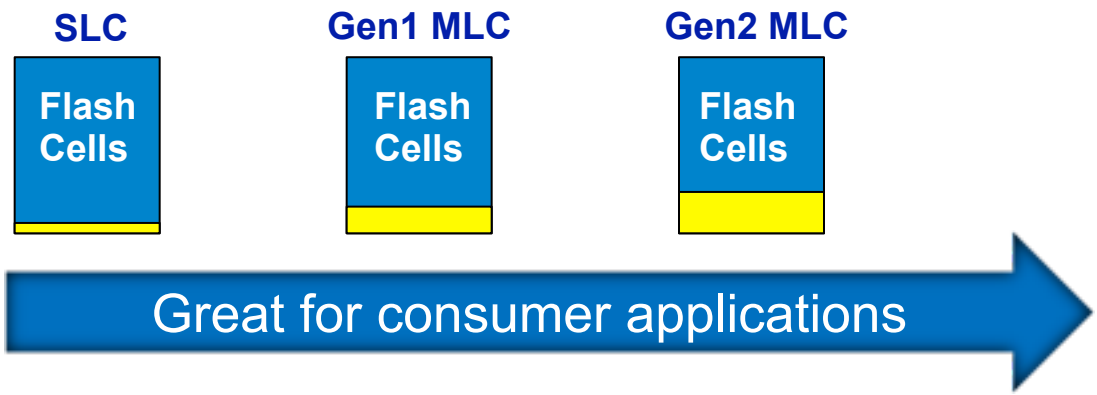

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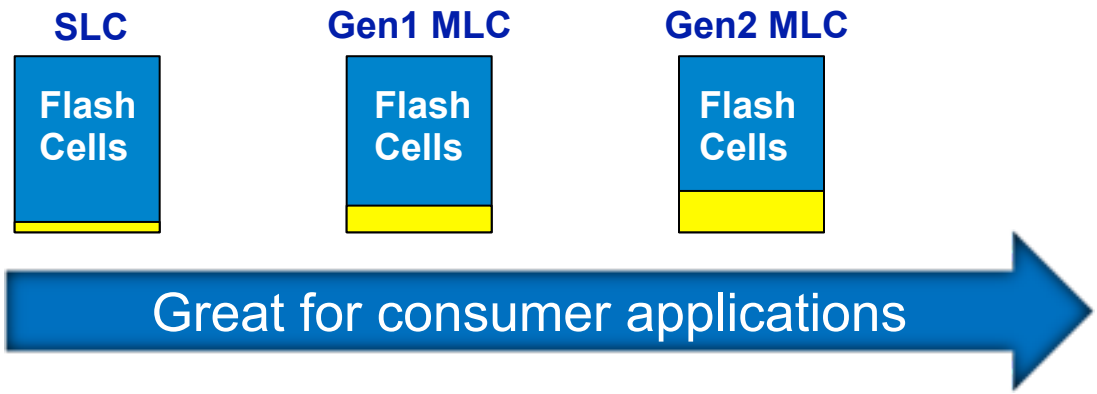
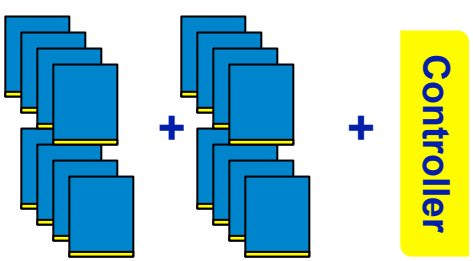
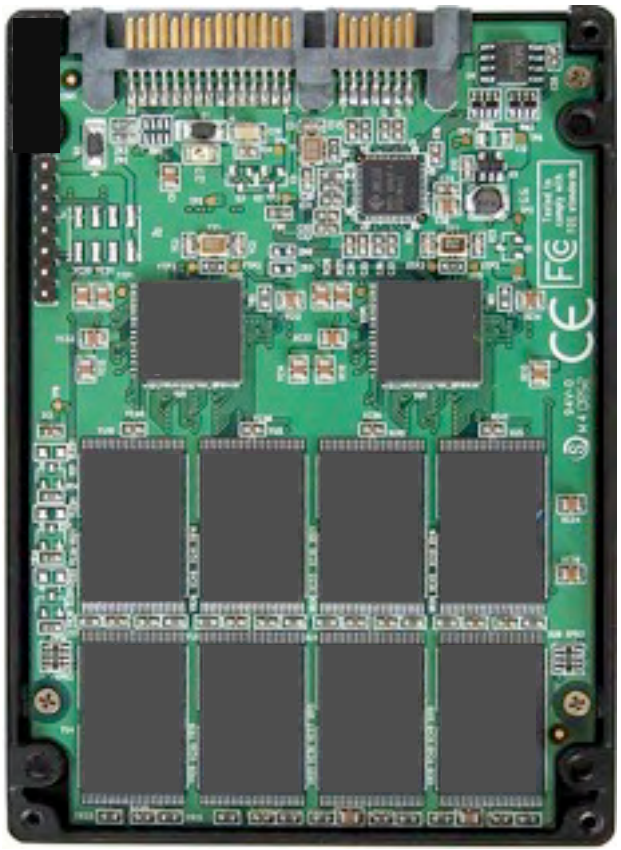


SSD Solution:
Simplify the flash and
Use intelligent
controllers



NAND Flash Aggregation in SSDs

Host Interface

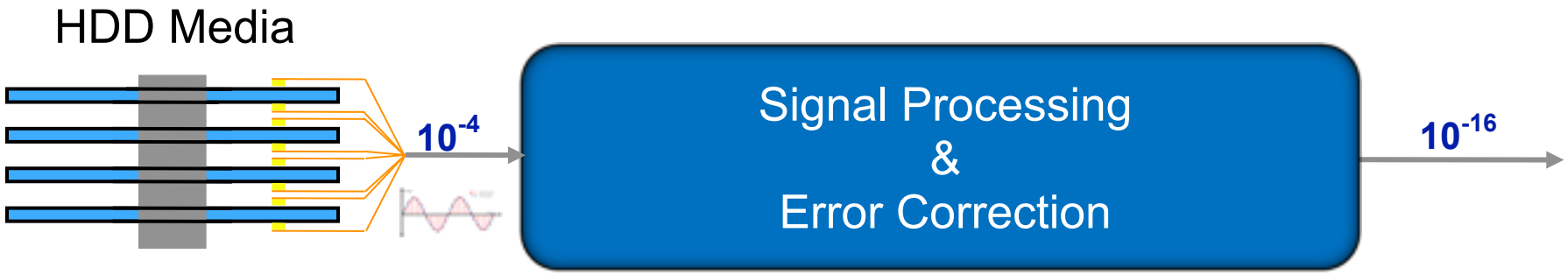


16 Flash / SSD!

Objectives:

1. Minimize the cost of each flash chip
2. Allow variability across the population of flash
3. Concentrate complex circuitry in the controller
4. Manage variations in flash performance from the controller
5. Optimize the flash/controller interface

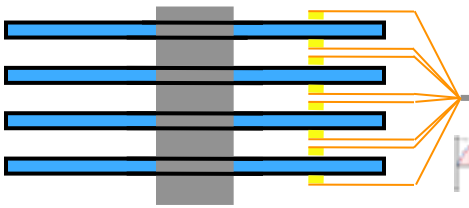
Aggregated Media Strategy
Powerful signal integrity boost



Long history of managing
high error rates and imperfect media

Aggregated Media Strategy
Powerful signal integrity boost

HDD Media



10^{-4}

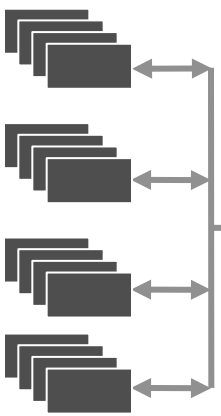
Signal Processing
&
Error Correction

10^{-16}

Long history of managing
high error rates and imperfect media

Leveraging these concepts will lead to the most
cost effective SSD solutions

Flash



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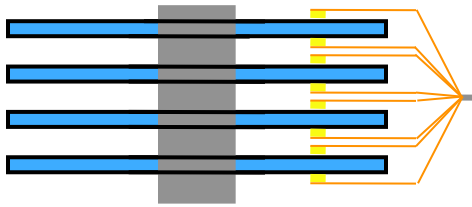
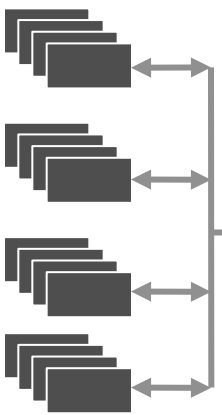


Programmable Write driver and Read circuit → Adaptive Programmable Bit Detector → Sophisticated Error Correction Code

- Characterize the quality and capability of the media
- Allocate data based on quality of media

Flash



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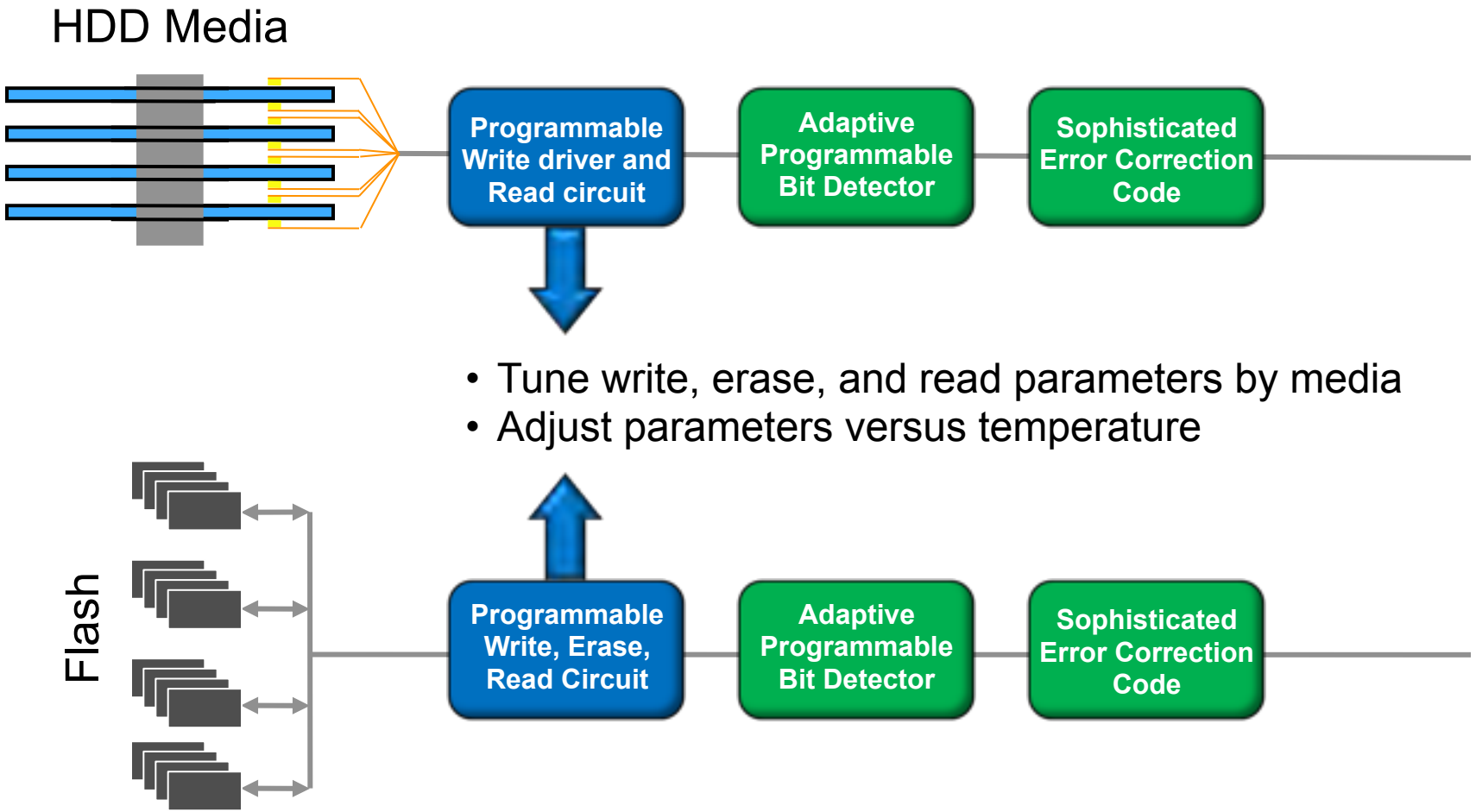

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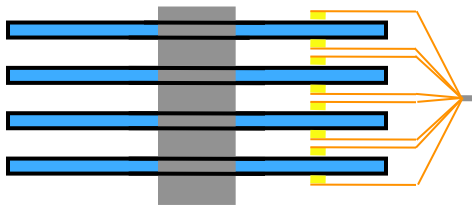
Powerful signal integrity boost

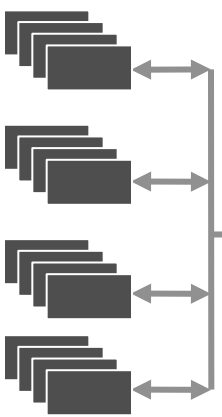
HDD Media



Programmable Write driver and Read circuit → Adaptive Programmable Bit Detector → Sophisticated Error Correction Code

- Programmable detector tuned by operating conditions

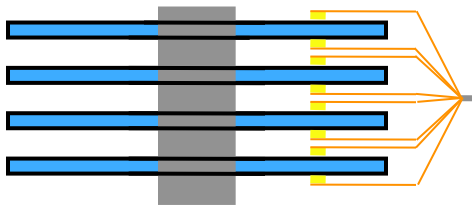
Flash



Programmable Write, Erase, Read Circuit → Adaptive Programmable Bit Detector → Sophisticated Error Correction Code

Aggregated Media Strategy
Powerful signal integrity boost

HDD Media



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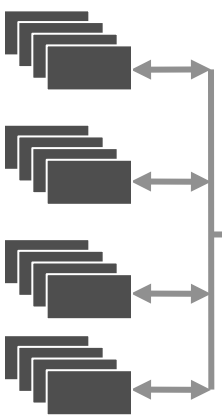
- Strong error correction code and defect management schemes to ensure error free performance

Flash



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Working together
we can
Stop the Enterprise from Spinning!

Q&A

Thank you