The Feud Is Over and Everyone Is in the Pool

Michael Hajeck
Senior Vice President
Solid State Storage Business Unit
Western Digital

SSD and HDD

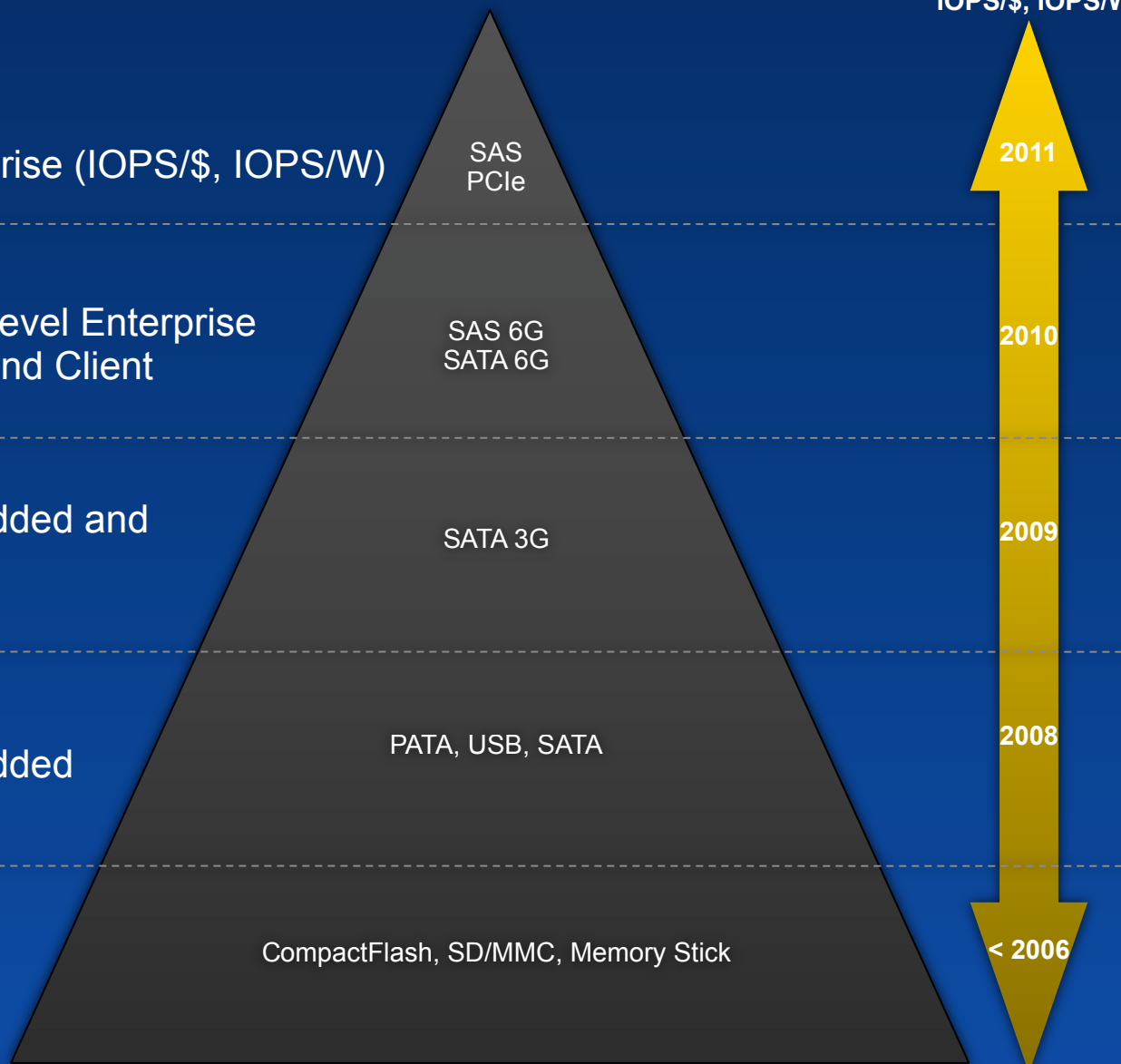
- SSD is system-level enhancement
- Design metrics are different and for the most part mutually exclusive
  - HDD: Capacity per dollar
  - SSD: Performance per dollar and per watt
- It is all about TCO
  - TCO changes from market to market and from application to application

The SSD Challenge

- Quantifying the intangible
  - "Better" experience
  - The value of "Green"
  - Downtime, goodwill and system-level value
- Versus the tangible
  - Cheap capacity

Digital Storage Is Everywhere

Application Segmentation



	MB/s	IOPS
Read	800+	100K+
Write	800+	100K+

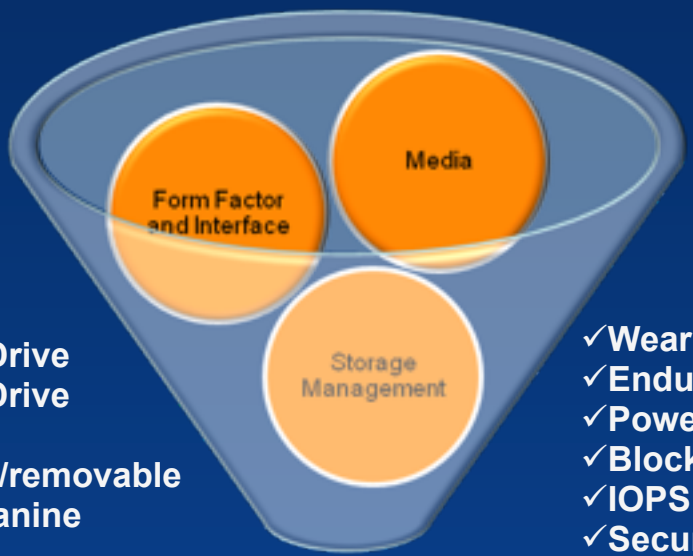
	MB/s	IOPS
Read	400-500	50K+
Write	200-400	20K+

	MB/s	IOPS
Read	200-250	10-15K
Write	80-150	< 3K

	MB/s	IOPS
Read	<100	5K
Write	<80	< 400

	MB/s	IOPS
Read	< 50	N/A
Write	< 40	N/A

SSD Design Variables



- ✓SATA
- ✓SAS
- ✓USB
- ✓PCIe

- ✓NAND
- ✓DRAM
- ✓PCM
- ✓MRAM
- ✓NOR
- ✓Hybrid

- ✓2.5” Drive
- ✓3.5” Drive
- ✓Card
- ✓Fixed/removable
- ✓Mezzanine

- ✓Wear leveling and ECC
- ✓Endurance monitoring and reporting
- ✓Power management
- ✓Block/page management
- ✓IOPS optimization
- ✓Security

- ✓Scalable
- ✓Dollar per unit
- ✓Low power
- ✓Gamer/warrior

Client

SSD

Enterprise

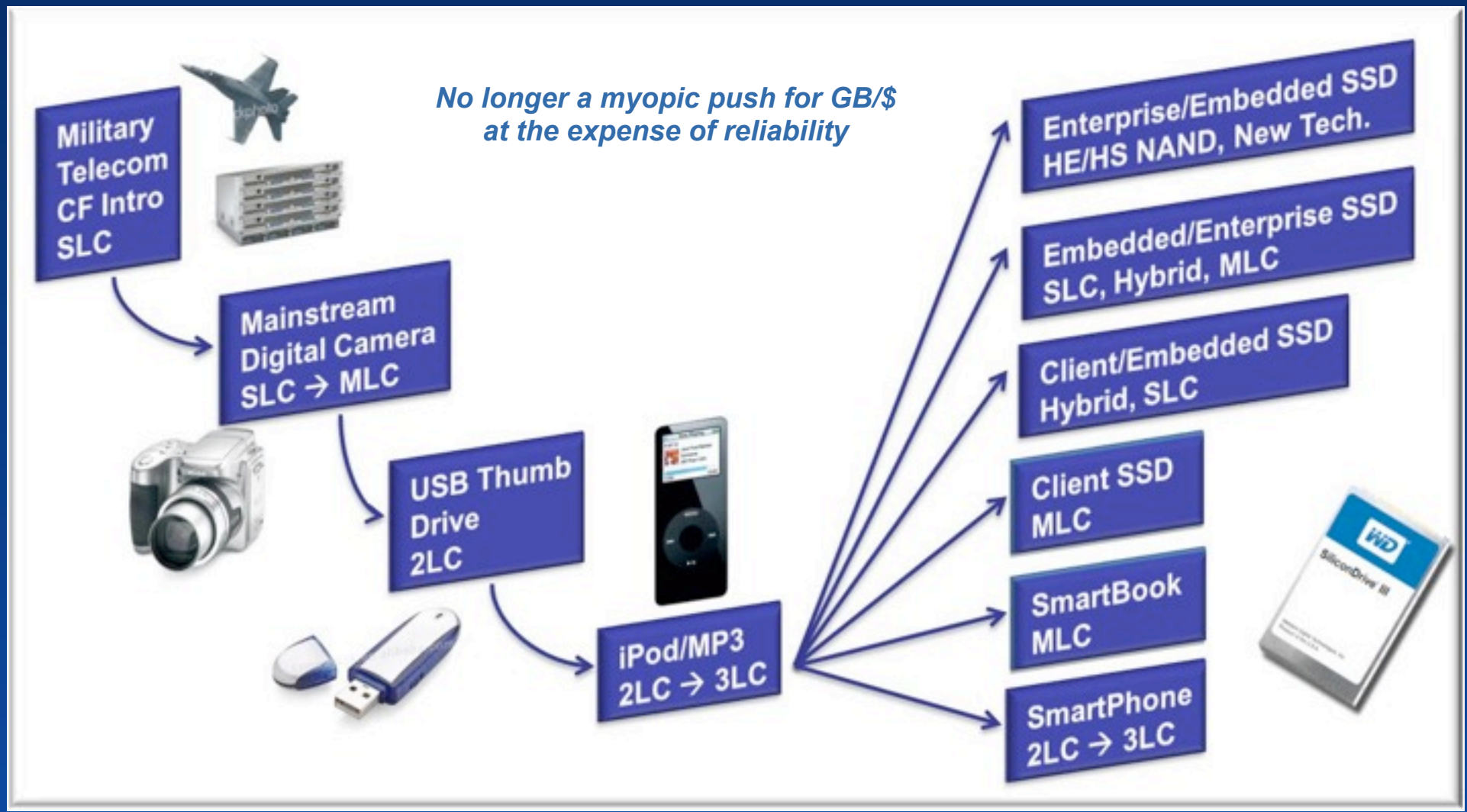
- ✓Performance per watt
- ✓Performance per dollar

- ✓Capacity per mm^3
- ✓Environmental
- ✓Low power

Embedded

- ✓Long product life
- ✓Five-nines operation
- ✓“No” volatile memory

NVM – Non-Volatile Media



Flash Memory SUMMIT

Standards-Based Storage

1 xSOP/xGA Solutions: <500mm²

xSOP
12x20x1.x
240 mm²

xBGA
14x18x1.x
252 mm²

ONFi 1.x ONFi 2.x MULTIMEDIACARD x1/4/8 SD x1/4

2 xSOP/xGA Solutions: 500-1000 mm²

MiniBlade
24x27x9
650 mm²

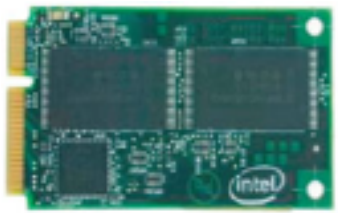
Half-Mini Card
30x27x5
810 mm²

Defacto USB
37x27x8/10
999 mm²

SATA PCI EXPRESS USB USB PCI EXPRESS USB

4 xSOP/xGA Solutions: 1000-2000 mm2

CompactFlash
36x43x3
1,540 mm²



Full-Mini Card
30x51x5
1,530 mm²

1.8" SFF-8156
54x39x5
2,106 mm²

PATA SATA USB PCI EXPRESS SATA SATA

>4 xSOP/xGA Solutions: >2000 mm2

1.8" SFF-8041
54x71x5/8
3,834 mm²

2.5" SFF-8021
70x100x9.5/12.5
7,000 mm²

3.5" SFF-8301
102x143x26
14,586 mm²

SATA SATA Serial Attached SCSI SATA Serial Attached SCSI

Flash Memory SUMMIT

Interface and Form Factor

Converging Server Platforms

Server
Compute + Storage

SAN/NAS
Storage + Compute

ISS
Router + Compute + Storage

Cache | **CPU**

Direct-Attached Storage
(OS, Event/Error Log, System Config, Cache Dump)

Controller
HBA + RAID

Storage
Device/User Data

Embedded 1:1

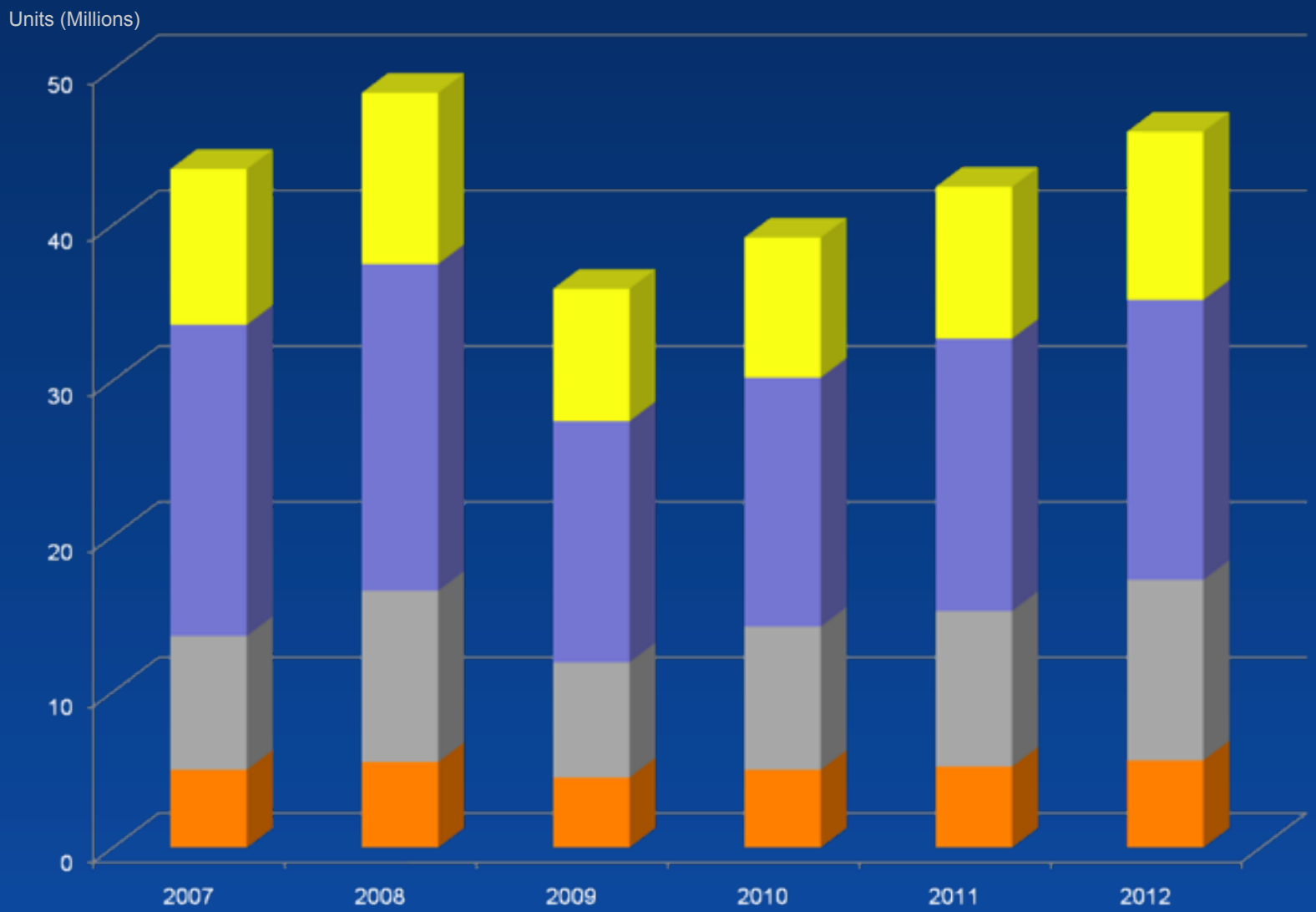
Enterprise 1 : many

Flash Memory SUMMIT

Enterprise Market Segments

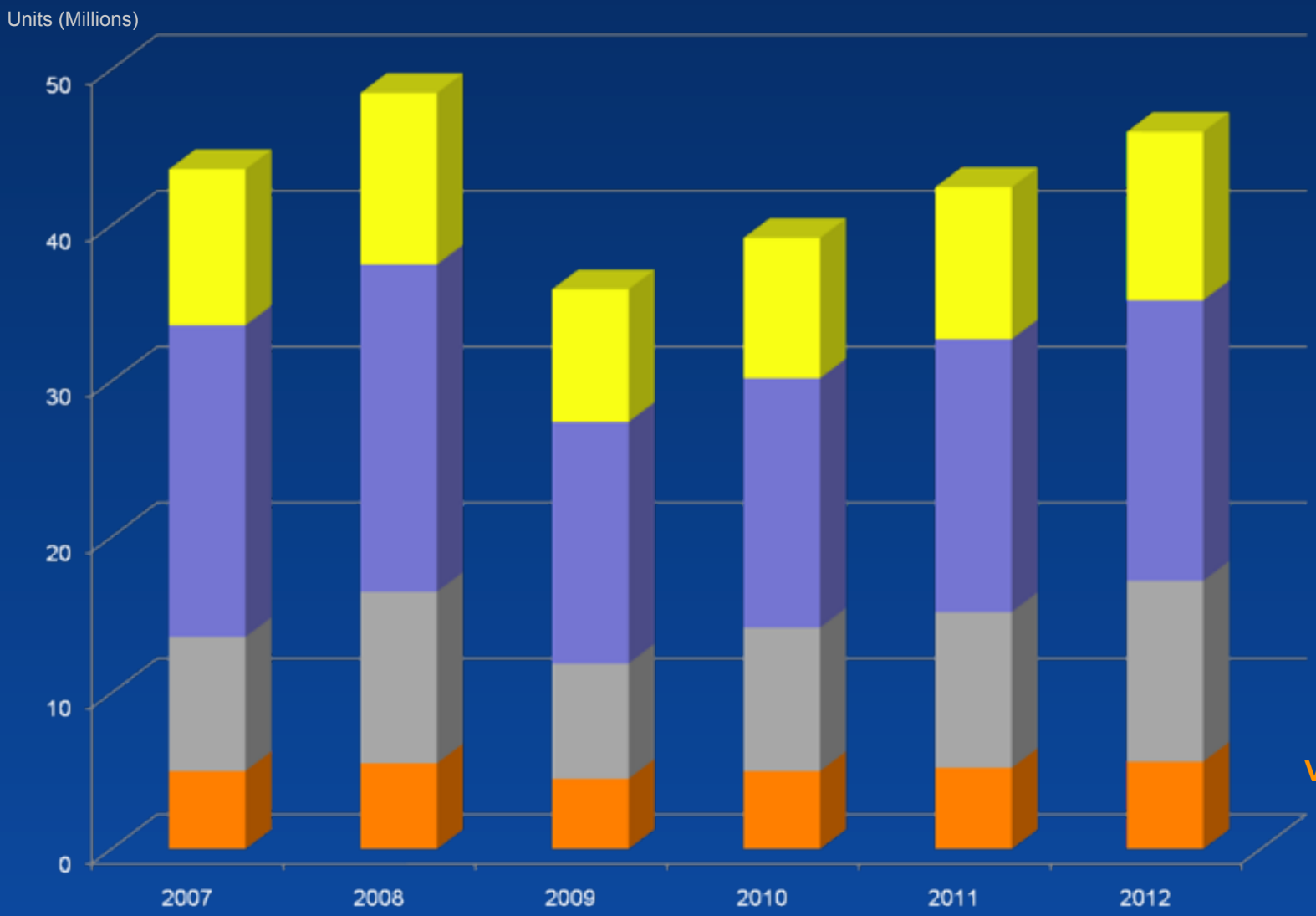
Traditional Enterprise	Enterprise SATA	
Performance Storage High GB, High Perf	**Capacity Storage** Highest GB, Low $/TB	**Storage**
Performance Servers Med GB, High Perf	**Value Servers** Low GB, Low $/unit	**Servers**

Enterprise Storage



Source: WD Internal Research

Enterprise Storage

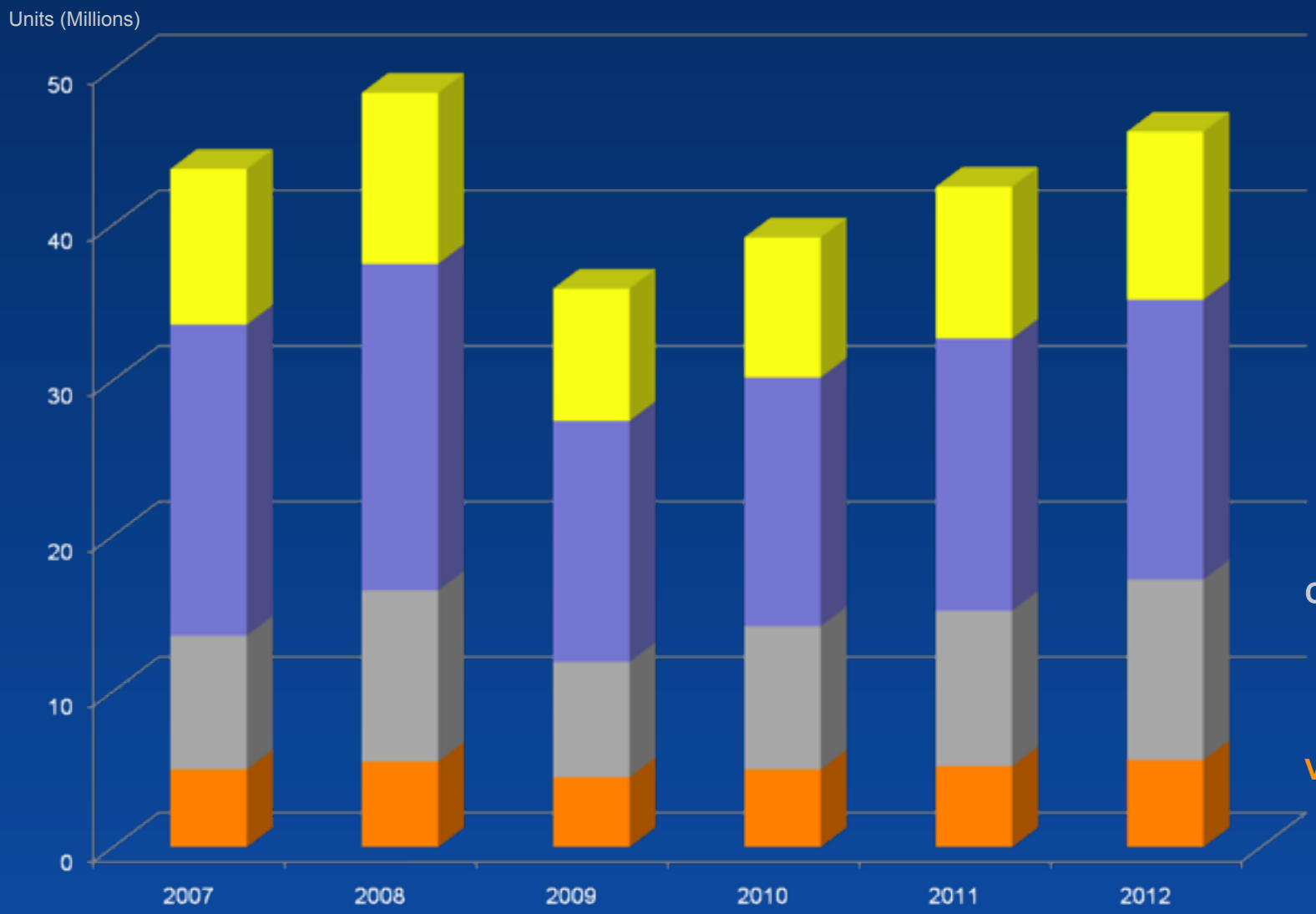


Value Server

- 3.5" → 2.5" 7200 HDD + eSSD
- SATA 3G
- 2x PB Growth

Source: WD Internal Research

Enterprise Storage

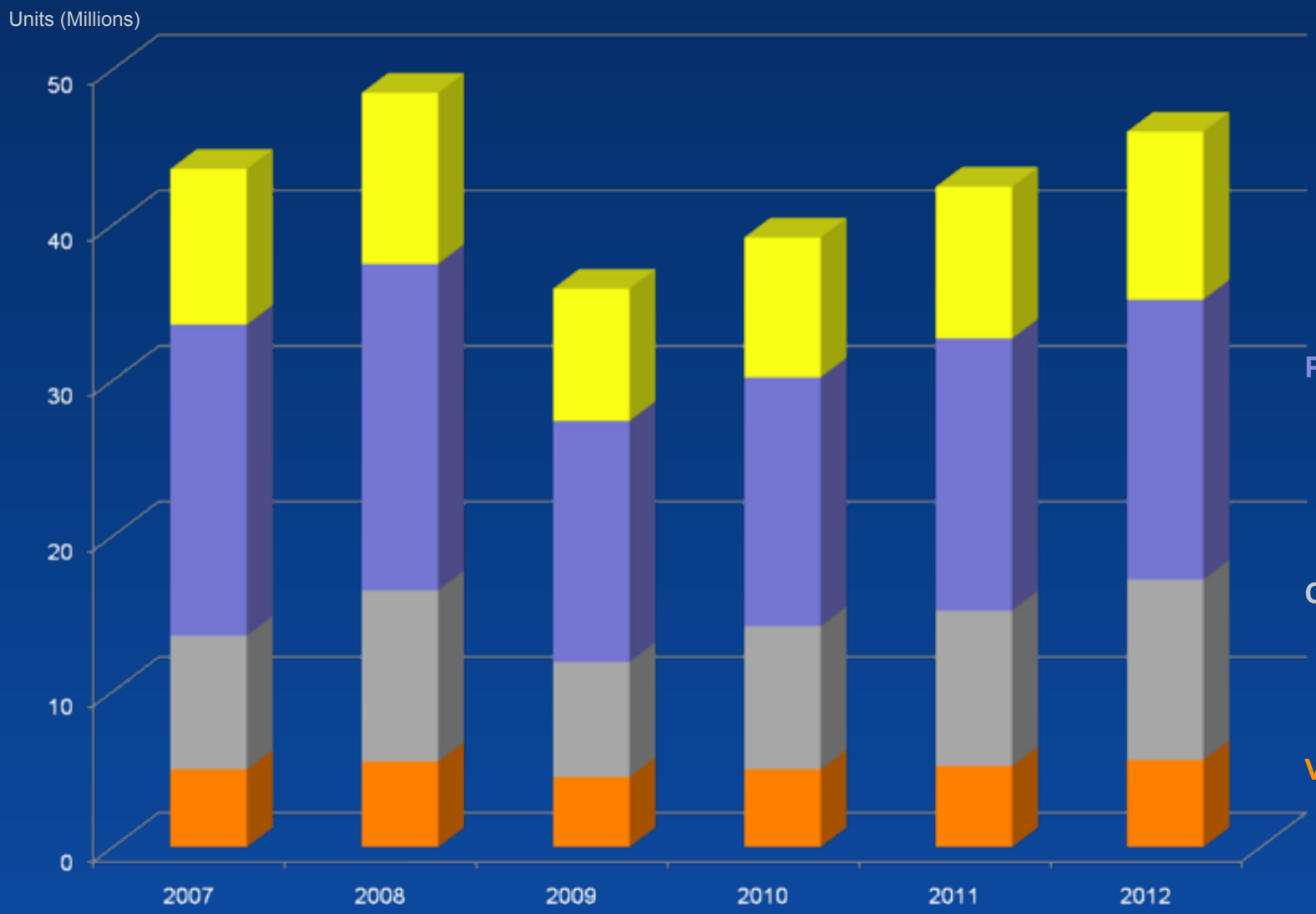


Capacity Storage
- 3.5” 7200 HDD
- SATA 3G → SATA/SAS 6G
- 4x PB Growth

Value Server
- 3.5” → 2.5” 7200 HDD + eSSD
- SATA 3G
- 2x PB Growth

Source: WD Internal Research

Enterprise Storage



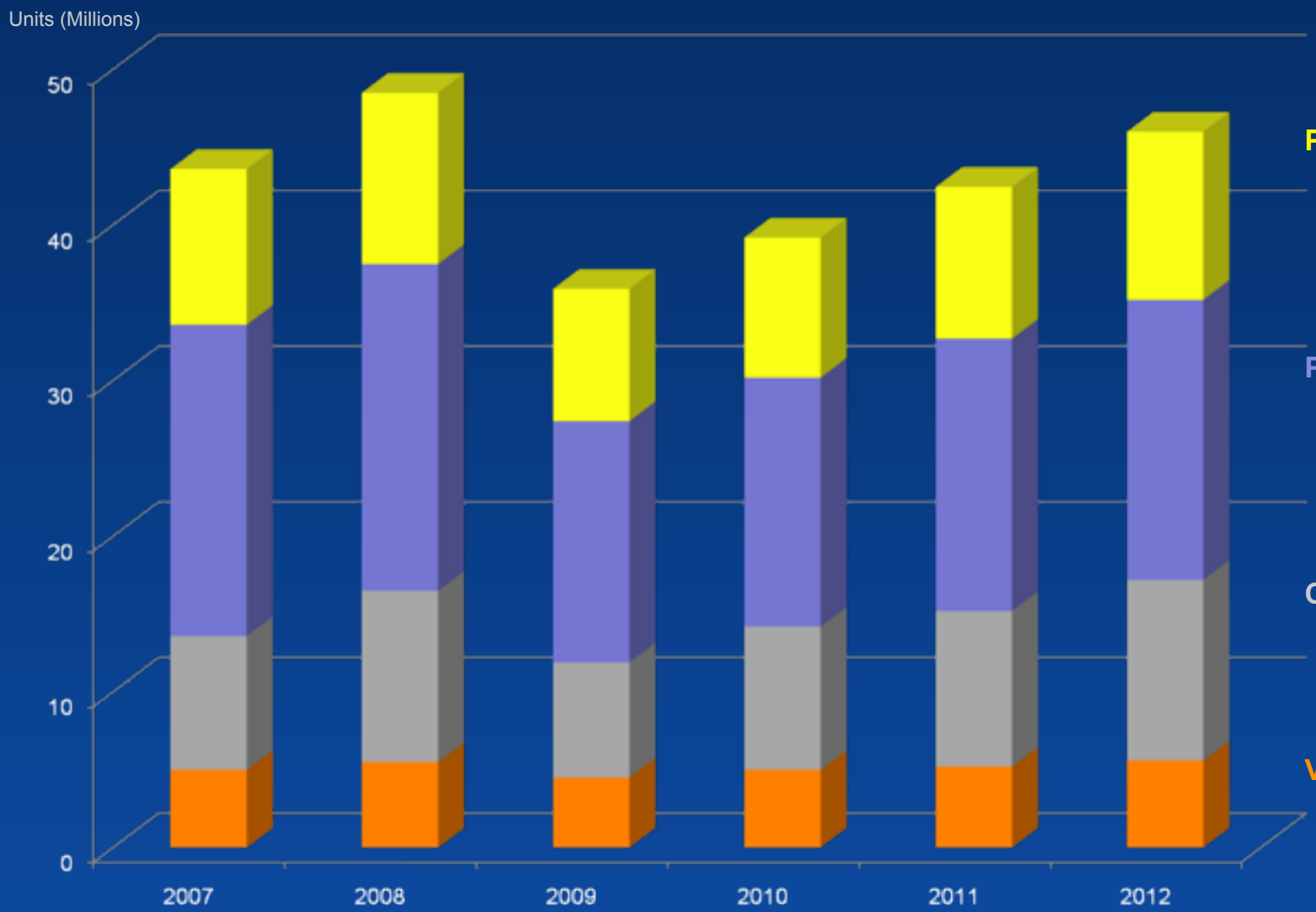
Performance Server
- 3.5” 15K HDD → SSD + 2.5” 10K HDD
- SAS 3G → SAS 6G, PCIe
- 2x PB Growth

Capacity Storage
- 3.5” 7200 HDD
- SATA 3G → SATA/SAS 6G
- 4x PB Growth

Value Server
- 3.5” → 2.5” 7200 HDD + eSSD
- SATA 3G
- 2x PB Growth

Source: WD Internal Research

Enterprise Storage



Performance Storage
- 3.5” 15K HDD → SSD + 2.5” 10K HDD
- FCAL → SAS and PCIe
- 2-3x PB Growth

Performance Server
- 3.5” 15K HDD → SSD + 2.5” 10K HDD
- SAS 3G → SAS 6G, PCIe
- 2x PB Growth

Capacity Storage
- 3.5” 7200 HDD
- SATA 3G → SATA/SAS 6G
- 4x PB Growth

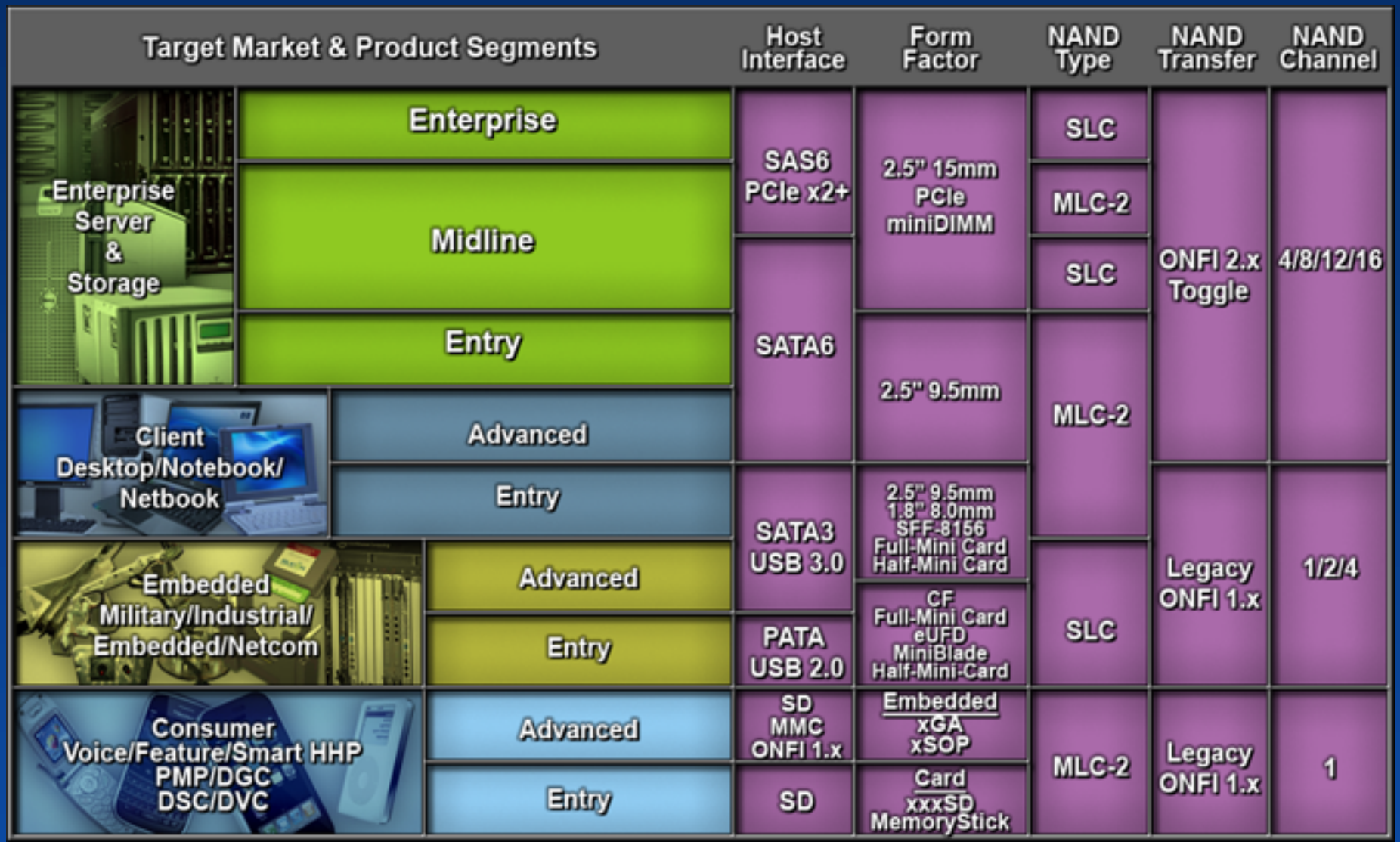
Value Server
- 3.5” → 2.5” 7200 HDD + eSSD
- SATA 3G
- 2x PB Growth

Source: WD Internal Research

SSD Opportunities

- Today
  - Rugged, harsh environments
  - Long deployment cycle
  - Enterprise high IOPS
- Tomorrow
  - New enterprise storage tiers
  - Business computing
  - Performance notebooks

Multiple SSD Market Segments



What is Needed?

- Positive, tangible user experience improvements
- End users re-thinking how they are going to use storage
- Ecosystem re-design
- Non-volatile media hybrids
- System-level compatibility
- Standardization

Summary

- In the battle of capacity versus performance, capacity has won most of the time
  - Moving from 1,000x to 4x is great, but it's still 4x
- SSD is more enhancement than replacement
- Use SSD for performance and HDD for capacity
- It is always about standardization and TCO

Thank you