Ultrastar He^{10} Sales Presentation

December, 2015

Introducing the **Best Capacity Hard Drive** in the Industry

PMR technology works in all Capacity Enterprise environments

Highest Capacity
10TB

25%
More capacity*

Lowest Power
Watts/HDD

44%
Less power*

Most Reliable
2.5M hours MTBF rating

25%
More reliable*

PMR Technology Works Anywhere!

* vs. 8TB air drives

End-to-End Storage

Capacity Enterprise Portfolio

Lower Capacities

Highest IOPS/TB

High Capacity

Highest Reliability

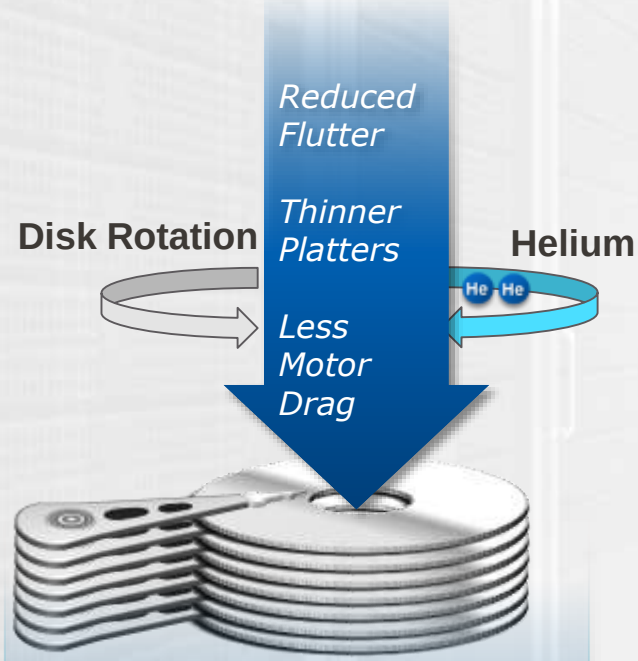
Best TCO

Lowest Power

Active Archive

Lowest $/TB

HelioSeal® HDDs: Two Years Later



Helium – 7 Disk

- 4°C cooler operation
- 44% reduction in watts (idle)*

* He^{10} compared to 8TB air

- >3 million helium HDDs deployed
  - 1st gen He^6 shipped in volume
  - 2nd gen He^8 in mass adoption
  - Ha10 with industry's highest capacity
  - 3rd gen He10 with higher capacity & faster performance
- Mass market acceptance
  - Deployed in world's largest data centers
  - TCO benefits proven
  - Demonstrated reliability
    - 2.5M hrs MTBF rating*
- Demand continues to scale

* 2.5M hours demonstrated through ALORT post-LVM

Quality Drivers

Three Generations of **Best** – Field Proven Reliability

6TB
World's first **helium** hard drive

8TB
2nd Generation **helium** hard drive

10TB
3rd Generation helium hard drive

2013
HelioSeal Technology Patented

2014
1M HelioSeal Units Deployed

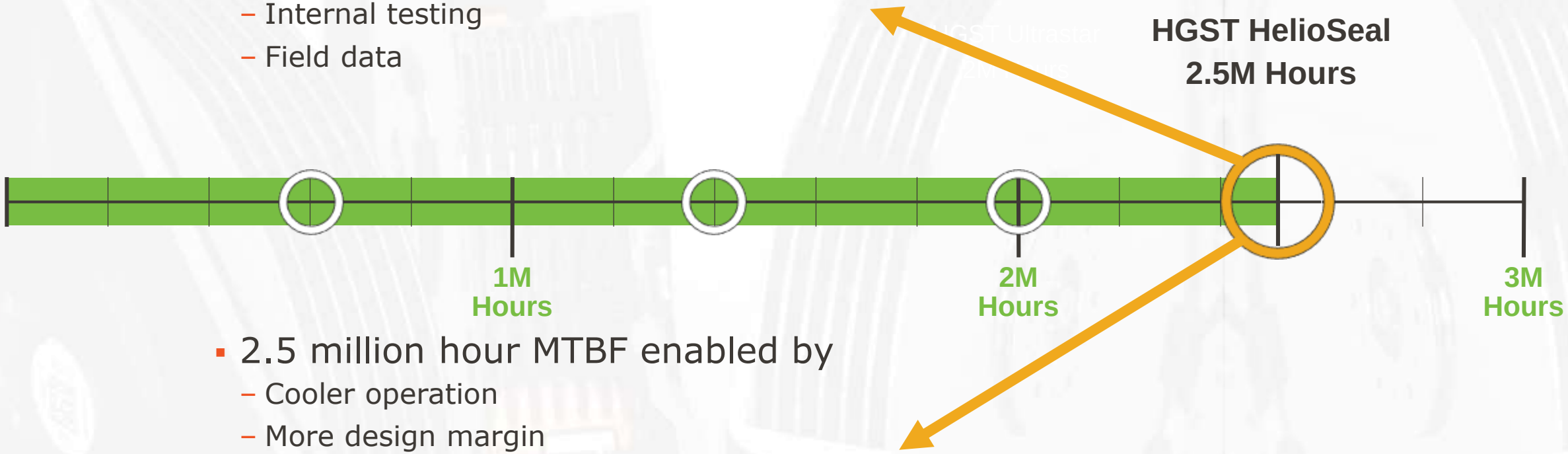
2015
4M HelioSeal Units Deployed

Helium Delivers the **Best** Capacity, Power Efficiency & Reliability (2.5M hour MTBF)

HelioSeal Raises the Reliability Bar

Nature of the Platform Provides Higher Reliability

- 2.5 million hour MTBF proven by
  - Internal testing
  - Field data



- 2.5 million hour MTBF enabled by
  - Cooler operation
  - More design margin
  - No possibility of external contamination
  - Less vibration

Product Density & TCO

HelioSeal HDD: TCO Benefits

Deploying 8 Racks

HelioSeal Delivers Clear Density and Power Advantage Compared to Air Drives

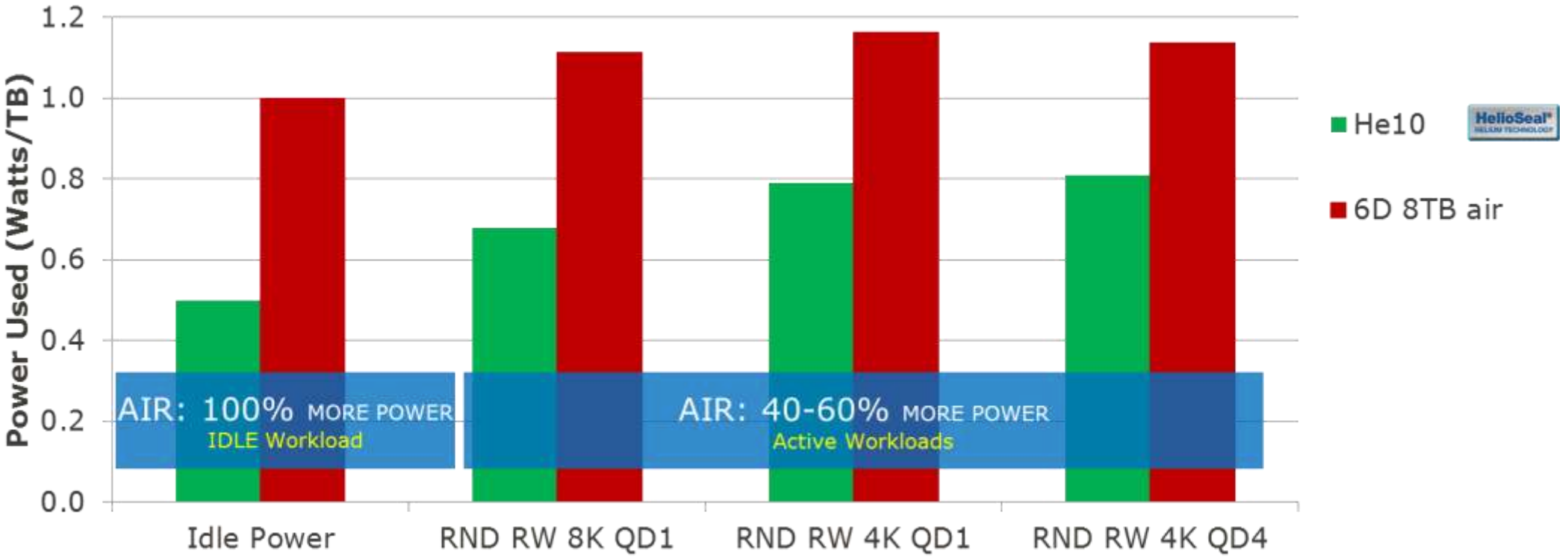
	Capacity % more	Capacity	Power (W)	Watts/TB	W/TB % lower
6TB Air	Baseline	11PB	15.4kW	1.33	Baseline
8TB Air	+33%	15PB	17.3kW	1.13	-15%
10TB Helium	+67% 6TB +25% 8TB	19PB	9.6kW	0.5	-63% 6TB -56% 8TB

Key Rack Components

1920	HDDs
160	Servers
128 sq ft	Space

2Ux12 8-Rack Configuration. Idle Power HDD only.

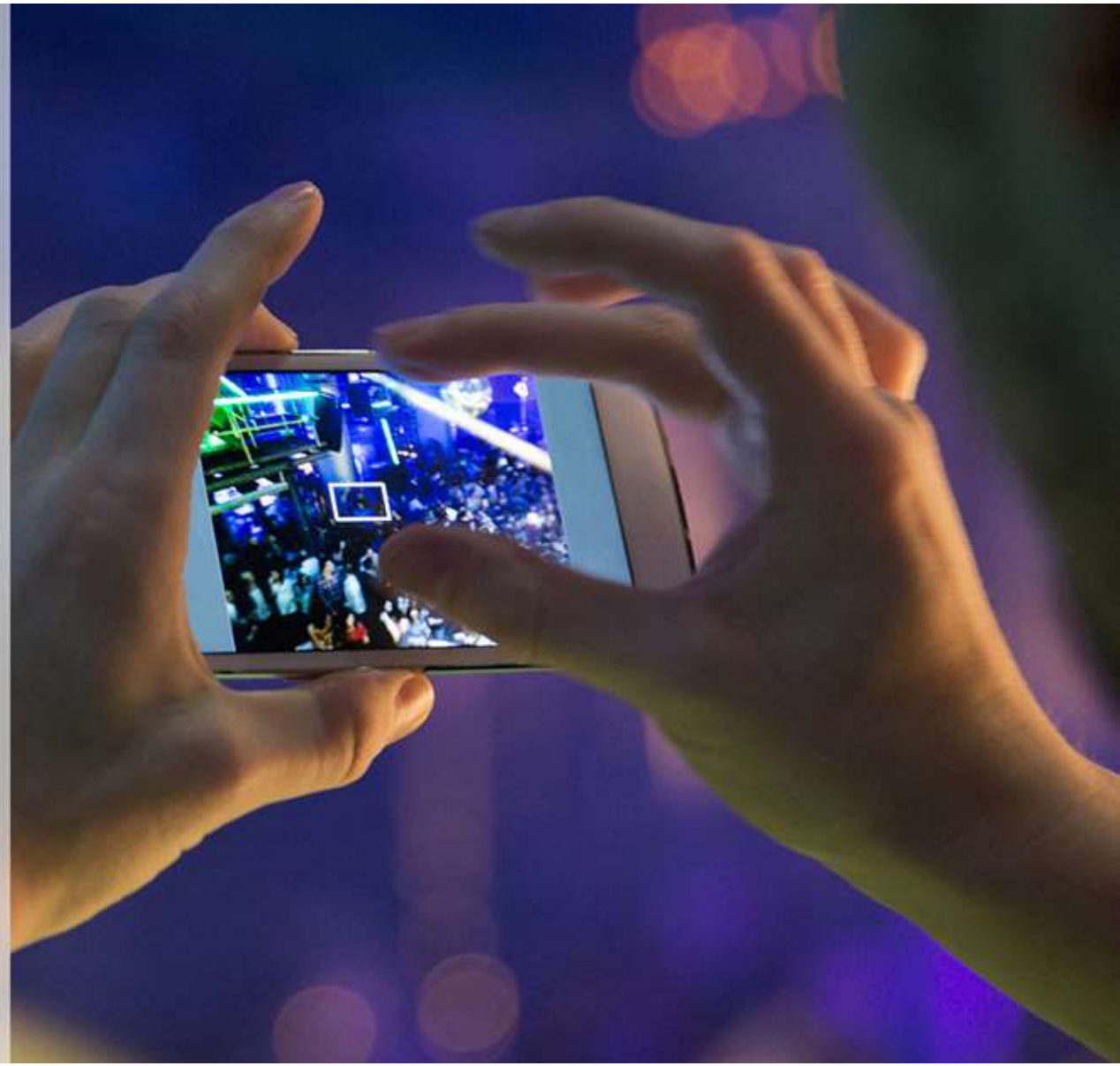
He10. 25% More. Half the Power.



SIT Lab Testing (SATA)

10TB vs 8TB 6 Disk Comparison

Key Specs



Ultrastar® He10 Key Specs & Features

Capacity

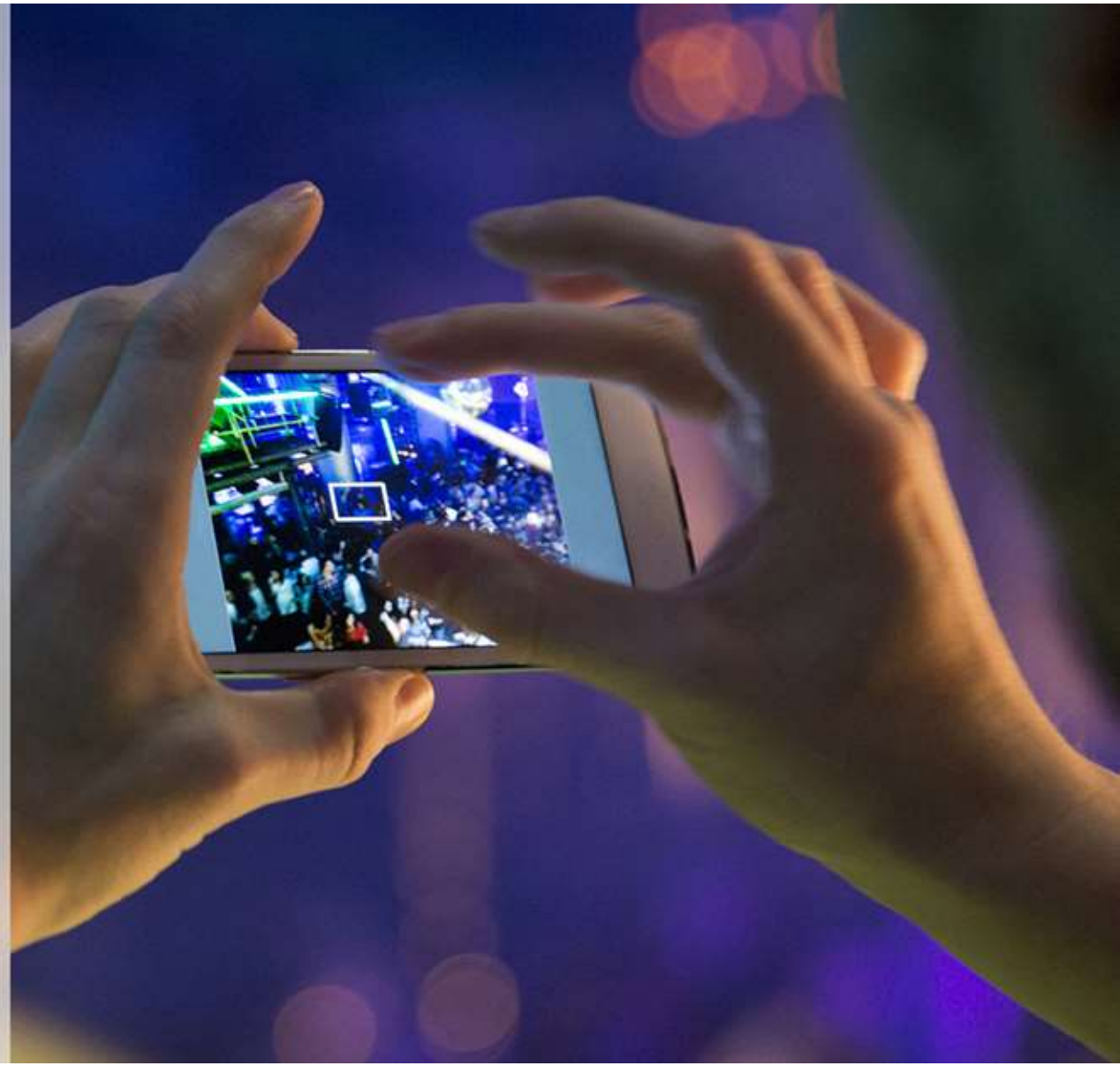
		Ultrastar He10	
Drive	Capacity / RPM	10/8TB / 7200	
	Interface	SATA 6Gb/s	SAS 12Gb/s
	Sector Format	512e, 4Kn (PMR)	
Power	Idle+/ Random++(R/W)	5.0 / 6.8 Watts	5.8 / 9.5 Watts
Performance	Sustained Data Rate	10TB: 249 MB/s, 237 MiB/s 8TB: 225 MB/s, 215 MiB/s	
	Cache	256 MB	
Reliability	MTBF / Warranty	2.5 M* Hours / 5 Years	
	Error Rate / Workload	1 in 10^{15} / 550 TB/yr	
Key Features	Media Cache	Faster random write	
	NVC	Improves SAS Write performance	
	Logical Depop (optional)	Extends drive availability	
	Dual Safe Firmware	Non-destructive FW update	
	RAID "Rebuild Assist"	Reduces Rebuild Time	
	Security	ISE BDE, TCG	ISE TCG, TCG w/FIPS

New features over prior gen shown in **orange**

+Idle_A. ++Power RND RW: SATA 8K QD1 | SAS 4K, *2.5 M Hours to be demonstrated through ALORT after LVM

Preliminary

HGST Technology Innovations

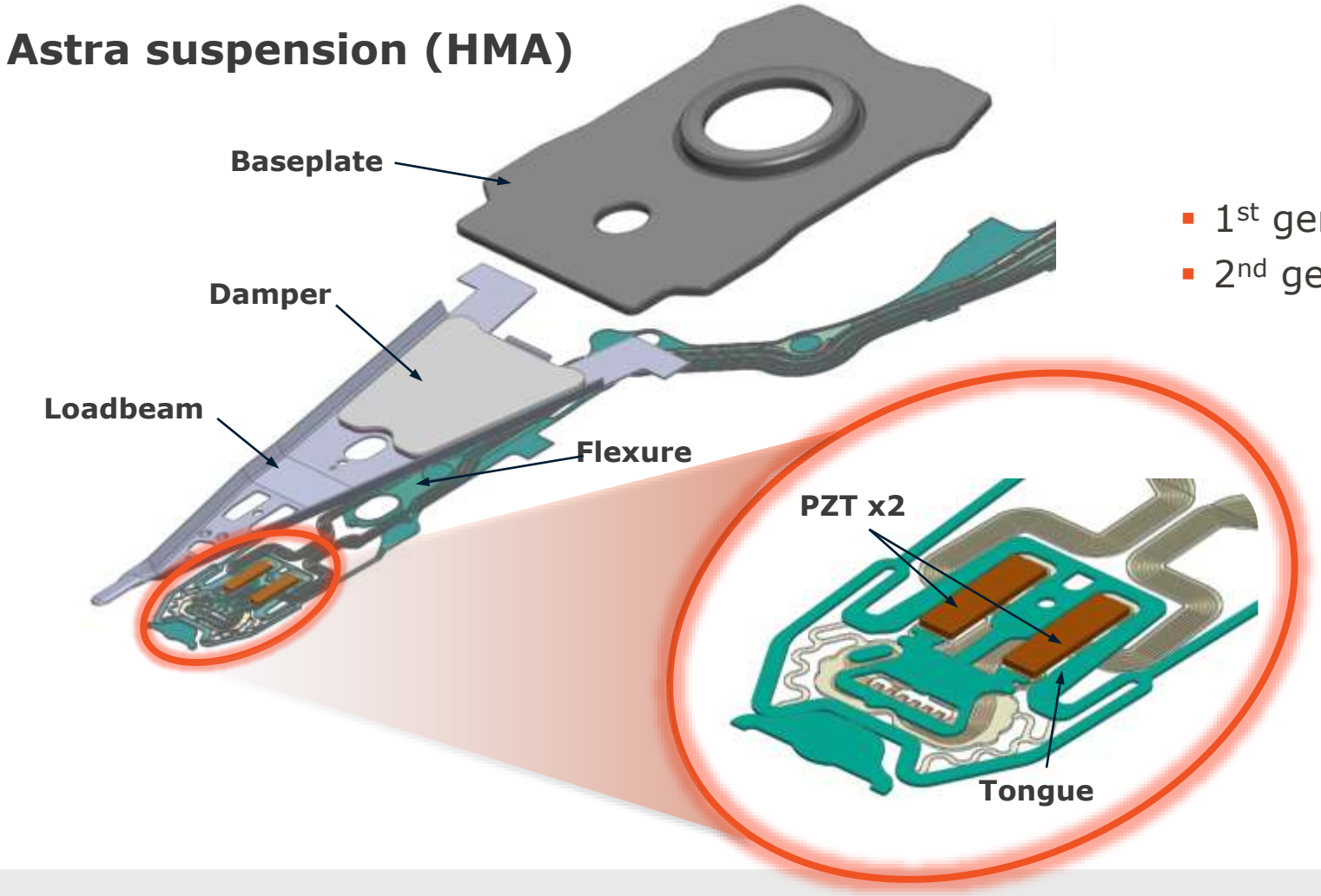


Technology Innovations (He10)

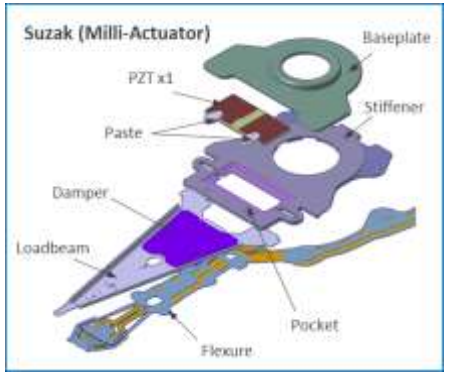
- **DSA Gen 2** — HGST Micro Actuator (HMA) Better head positioning and RV robustness
- **NVC** — Improves SAS Write Performance
- **Dual Safe** — Dual Safe Firmware Updates
- **Media Cache** — Vastly improved write performance and 100% data integrity
- **Logical Depop** — (Optional) Keep HDD in service longer
- **Rebuild Assist** — Rebuild Assist for RAID – faster recovery time
-  — Full Suite of Security Options SATA BDE and TCG model
-  — Improved format efficiency (4Kn/512e) while providing legacy compatibility

Improved Rotational Vibration Support

HGST Micro Actuator (HMA) / 2nd Generation Dual Stage Actuator (DSA)



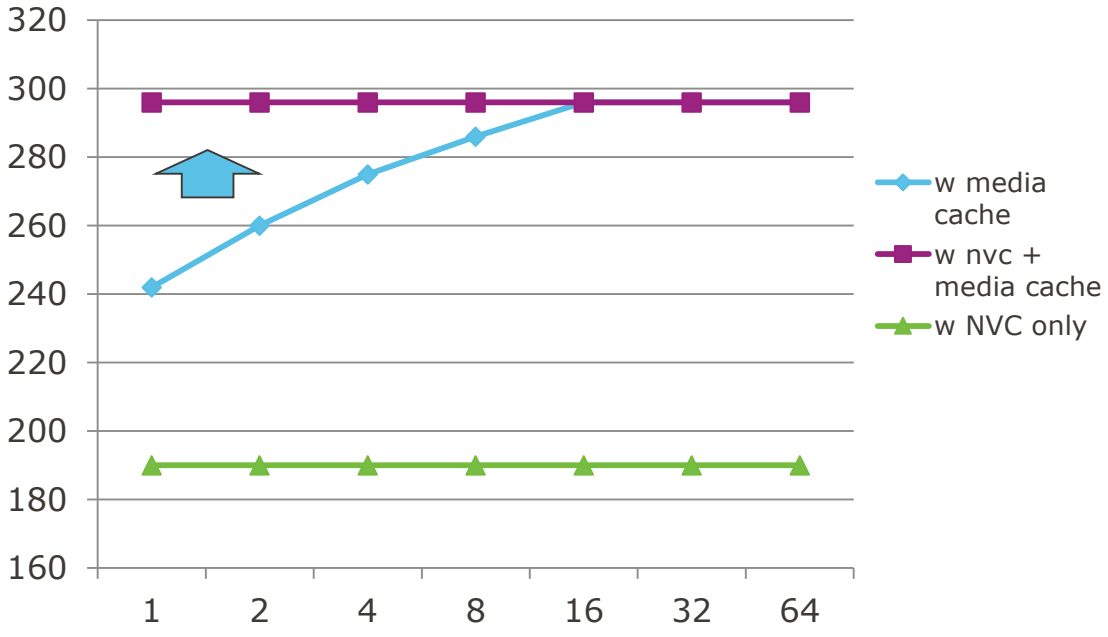
- 1st gen "Loadbeam" DSA
- 2nd gen "Slider" DSA, HMA



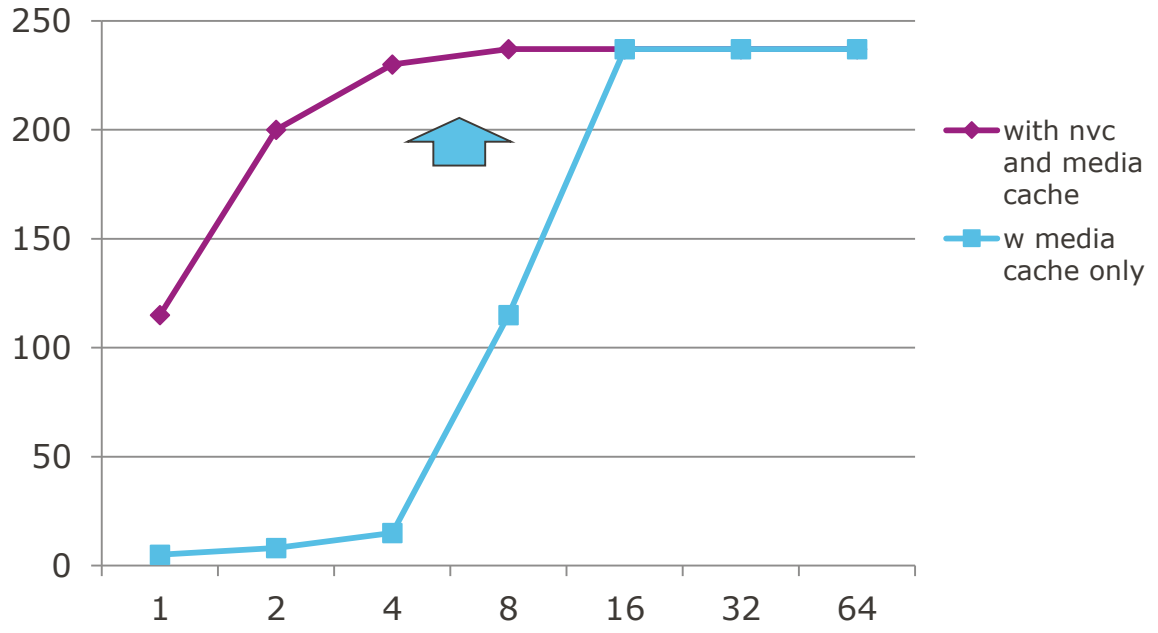
Improved SAS Performance

4MB NVC improves WCD write performance

- 4KB Random Write
  - WCD: Low QD performance now equivalent to deep QD performance
  - WCE: No contribution



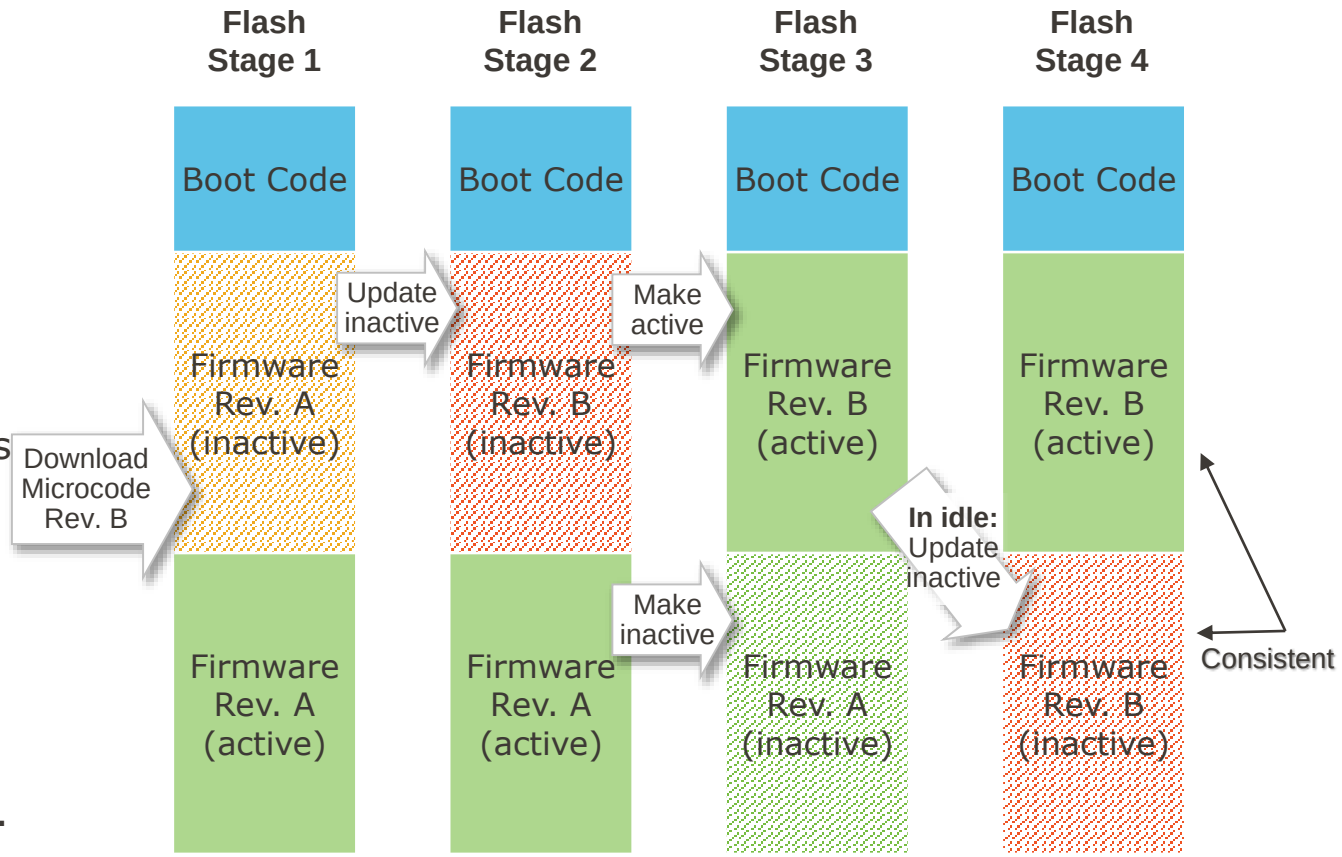
- 4KB Sequential Write
  - WCD : QD4 can reach to the max sustain
  - WCE : No contribution



Dual Safe Firmware Updates

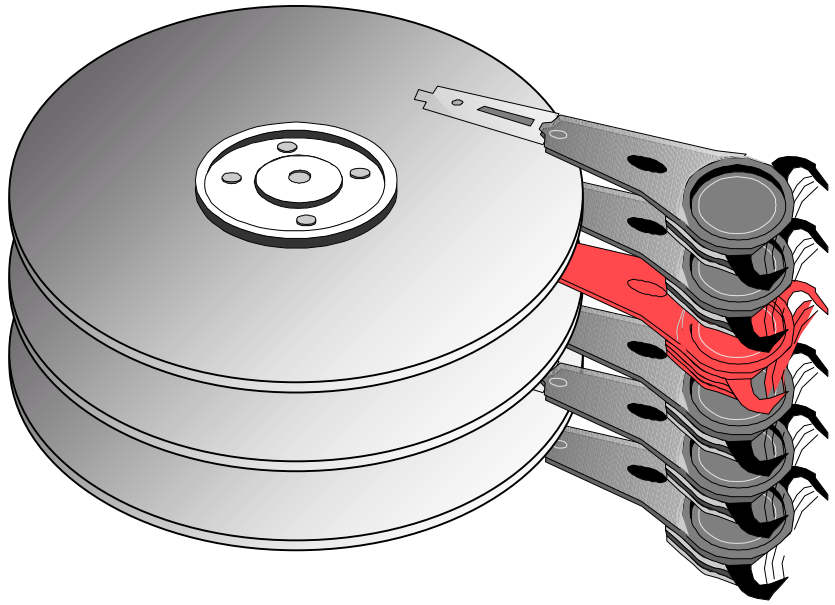
Non-Destructive Firmware Updates

- Protects HDD from becoming non-functional if power is interrupted during a firmware download to flash memory
  - HDD maintains two copies of firmware. The inactive copy is updated during the download, leaving the active version intact.
  - If power off occurs during update, the active copy is used upon power on.
  - Upon download completion and firmware verification, the new firmware code becomes active. The previous version of firmware becomes inactive.
  - During idle cycles, the HDD updates the previous version of firmware with the new active version.
  - If an uncorrectable error occurs during boot of the active image, the inactive firmware copy will be used.



Logical Depop (Optional Capability)

- Logical Depop is an exclusive HGST technology that allows customers to remotely restore drive functionality
- **Reduces** maintenance cost, **reduces** security/service-related risk, **accelerates** return to service, **extends** resource utilization, **decreases** spare inventory, **gains** operational flexibility



When HDD fails, reconstruction or rebuild will be done as system level recovery

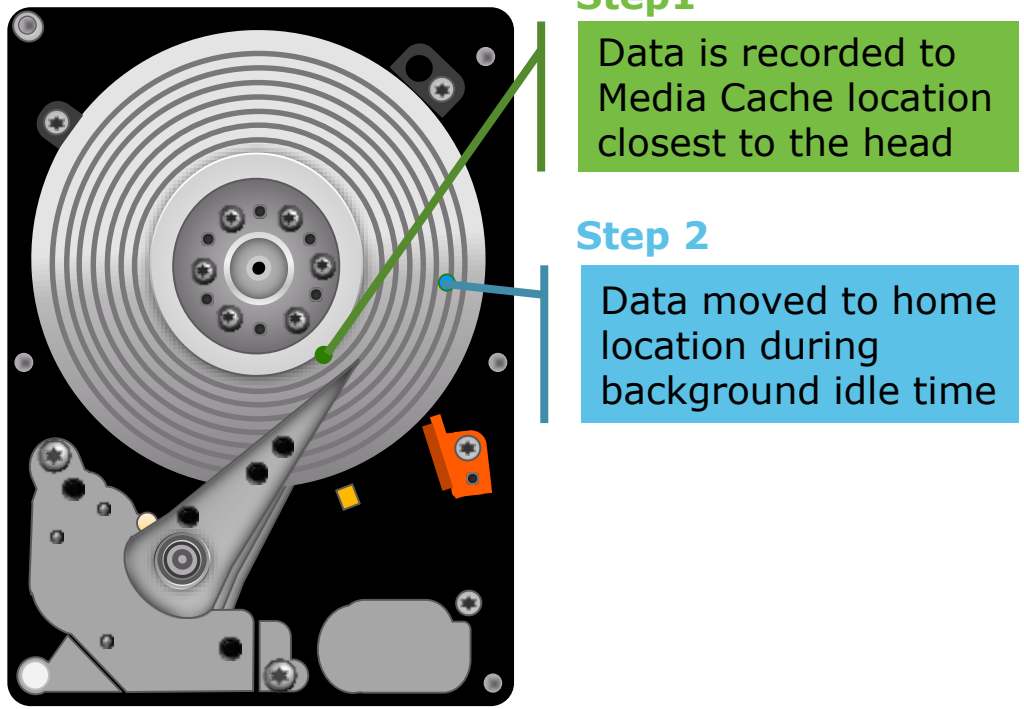
Process

- Run new device diagnostic command to failed HDD
- If head failure is detected and HDI is not affected:
  - Offline HDD
  - Run format (Data on HDD lost during format)
  - Run test – Return reduced capacity HDD to the fleet

Media Cache

HGST's disk-based caching technology provides a large Non-Volatile Cache (NVC) on the media that results in improved reliability and data integrity during unexpected power loss along with a significant improvement in write performance (even at high workloads compared to solutions with limited NAND or flash-based NVC)

- Enhanced Write Performance
  - Improvement in Random Write performance for aligned 4Kn/512e workloads
- Improved Reliability
  - 100% data integrity during unexpected power loss
- Firmware-Based Implementation
  - Sophisticated firmware algorithm implements caching mechanism without additional flash or NVC

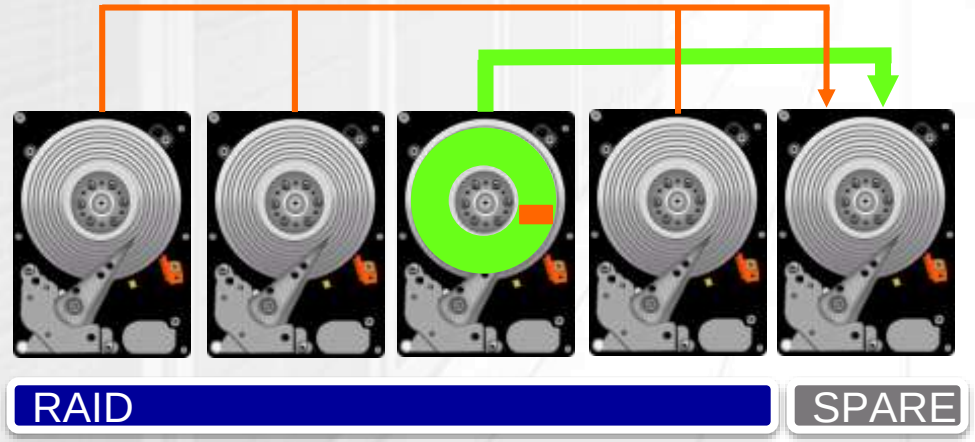


Rebuild Assist for RAID

Traditional RAID Recovery

- Time consuming
- Performance hit
- Increased risk

Rebuild Assist for RAID



- Faster
- Minimizes performance hit

Advanced Format

Enabling Larger Capacities. Providing Legacy Compatibility.

- He10 is Advanced Format only
  - In general, >6TB will be offered in AF only
- Benefits
  - Higher capacity points sooner
  - Lower sector overhead improves format efficiency
  - Provides a larger, more powerful error correction code (ECC)
- AF Transition
  - Hyperscale already using 512e
  - 512n customers can migrate to 512e
  - Some customers will migrate to 4Kn

Security and Encryption

	ISE Instant Secure Erase	Encryption SATA: TCG	 SATA: BDE, SAS: TCG	FIPS 140-2 SAS: TCG Only
Ultrastar He10	☑ YES*	☑ YES*	☑ YES	☑ YES
Ultrastar He8 Aries-HC8 8TB	☑ YES*	--	☑ YES	☑ YES
Ultrastar 7K6000 Aries-KP 6TB	☑ YES*	--	☑ YES	☑ YES
Ultrastar He6 Aries-HC6 6TB	☑ YES (SAS)	--	☑ YES	--
Ultrastar 7K4000 Mars-KP 4TB	--	--	☑ YES	--

*** Secure Erase (Overwrite Only) option is available (i.e. Crypto Disabled)**

Thank you