



Are Two Drives Better than One?

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HGST

Form Factors Driving Proliferation of Storage Options



Must balance FF,
Performance &
Cost

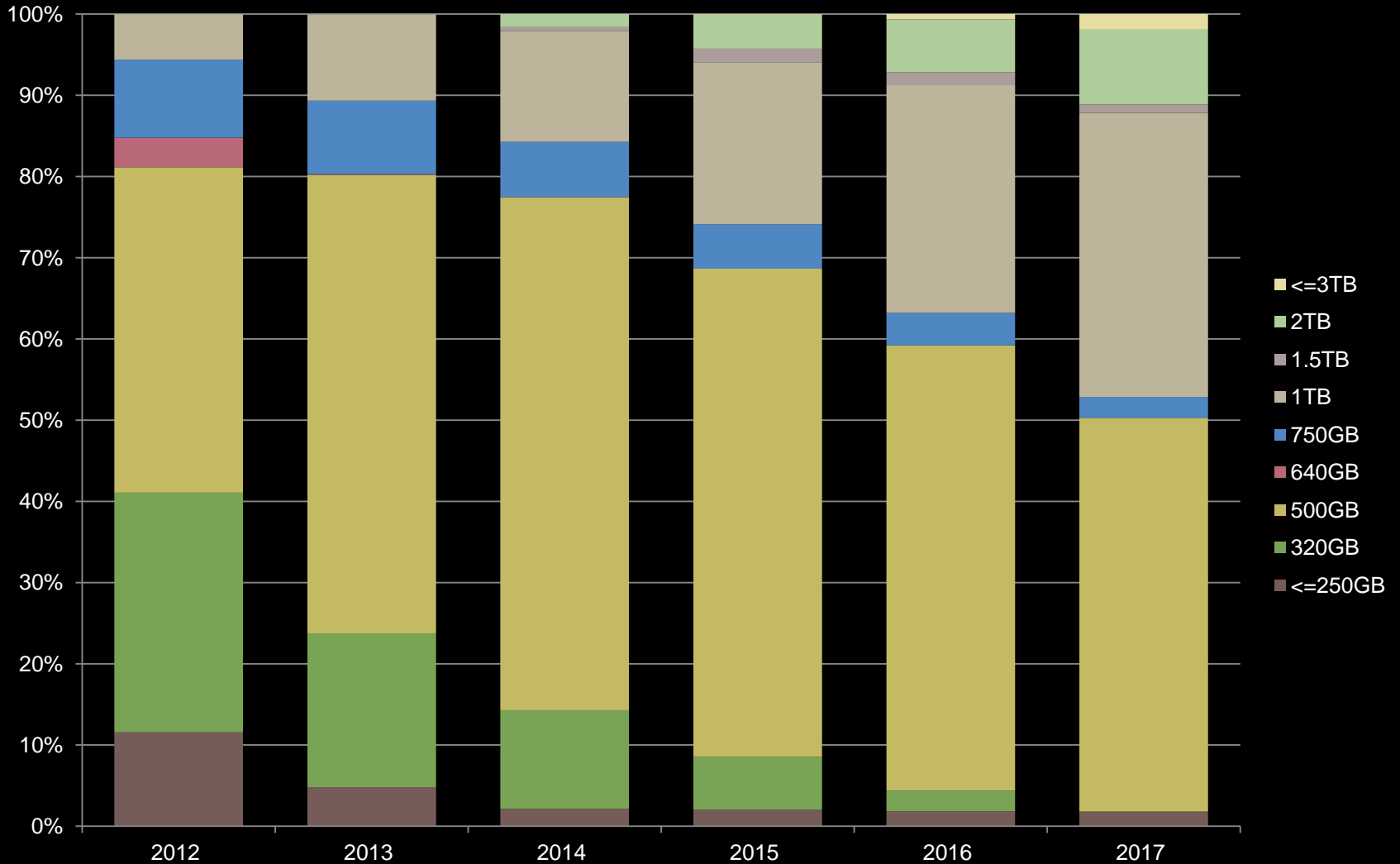
Mobile Storage Options (2H 2013)

	mSATA	M.2	5mm 2.5"	7mm 2.5"	9.5mm 2.5"
Cache SSD	8-32GB	8-32GB			
SSD	128-512GB	128-512GB		128-960GB	
SSHD			500GB	500GB – 1TB	750GB – 1TB
HDD			320-500GB	250GB – 1TB	500GB – 1.5TB

One Size Does NOT Fit All



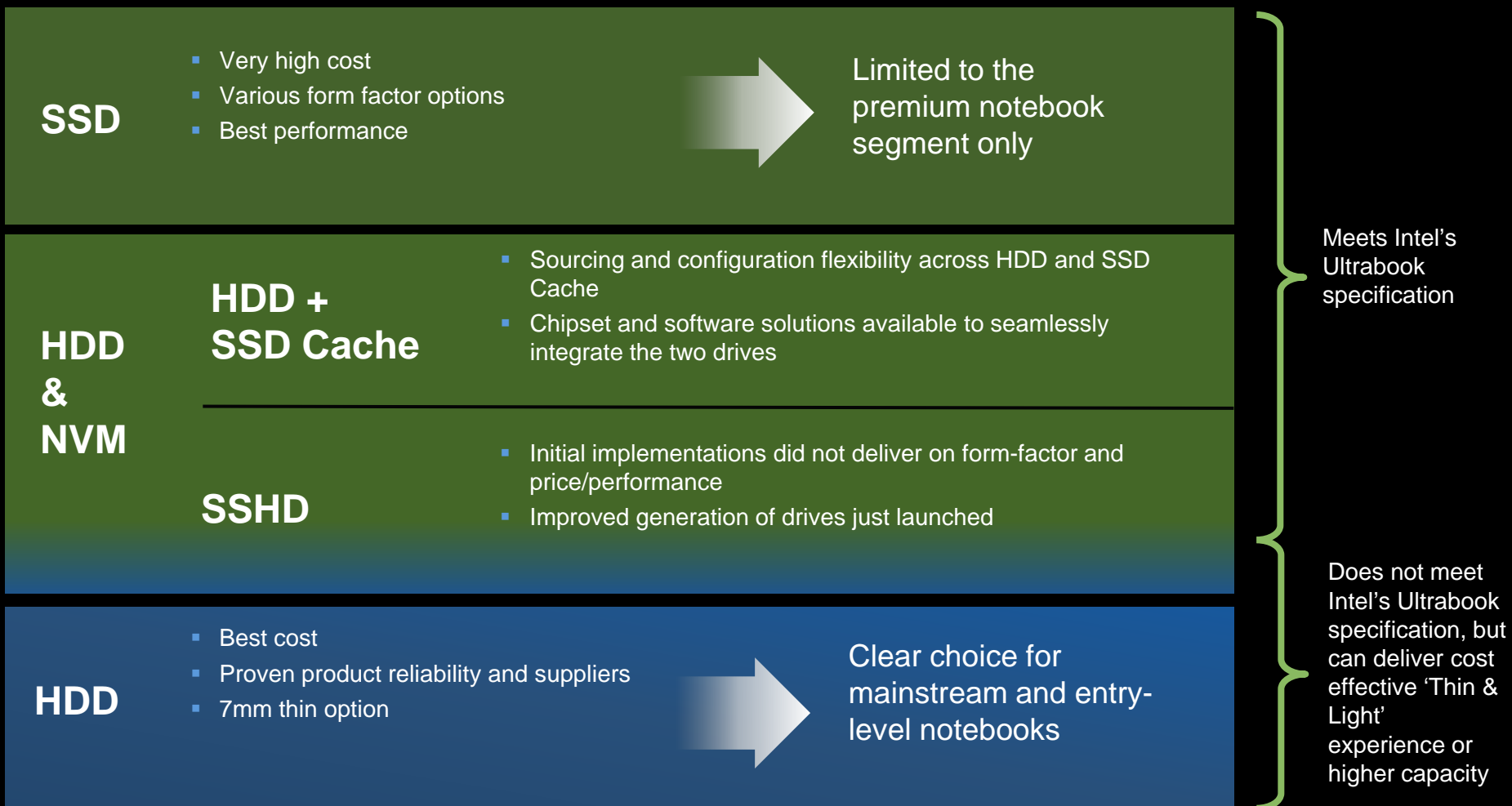
Capacity Forecasted to Remain Relevant



IDC March 2013

Notebook Storage – Performance Options

Several drive options are available to improve the system experience, including boot, application start-up, resume from sleep and battery life

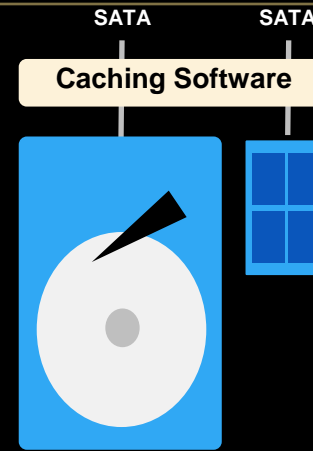


Cost of Mobile Storage Options



Source: newegg.com August 12, 2013

Mobile SSHD



Mobile Dual Drive: HDD + SSD

Common Advantages:

Much higher performance than HDD alone, approaching SSD for certain applications, can meet Ultrabook spec;
Equivalent cost structure, BOM dominated by NAND, plus controller & interface

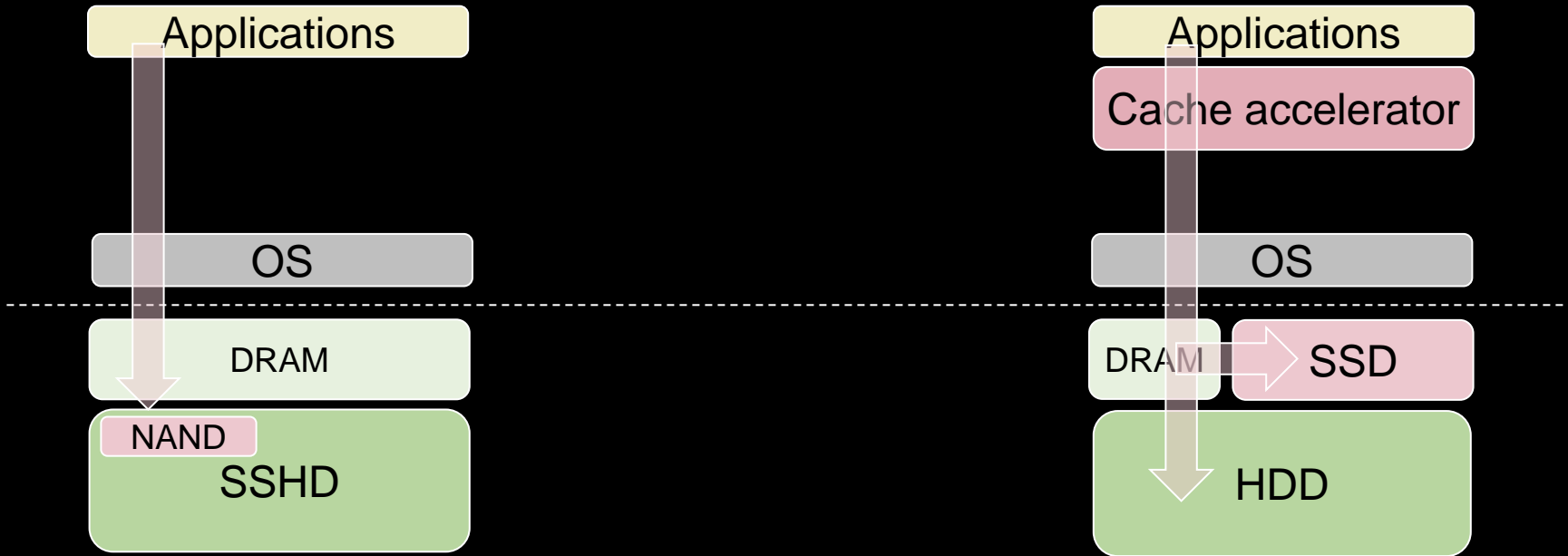
Advantages

- Less complexity leveraged qualification
- Potential for cost savings of a more integrated solution
- HDD form factor
- No space required for mSATA in system
- Can be used instead of HDD in any system

Advantages

- Flexibility to mix and match “best of breed” HDD and SSD for performance and capacity points
- Easy multi-sourcing of HDD and SSD
- SKU leverage (3x3=9)
- Caching software can leverage CPU resources and file awareness to deliver better performance
- Potential performance benefit of Independent and scalable interfaces

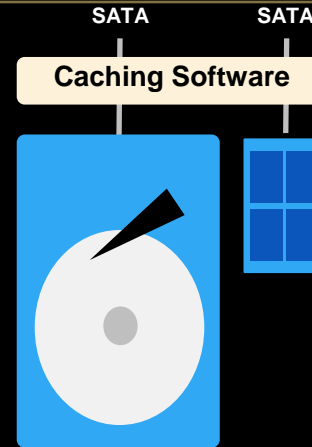
SSHD vs. Dual-drive Architecture



SSHD vs. Dual-drive Architecture

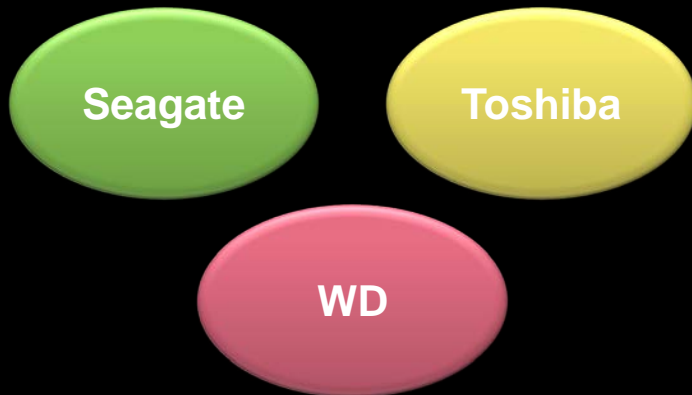
- Pros:
 - Only one I/F port needed
 - No SW installation needed
 - Transparent upgrade to the system
 - Cons:
 - Cache management shares embedded CPU
 - Requires dedicated DRAM: For running filtering and classification algorithms and maintaining frequency tables
 - Page faults may still incur ~10 ms latencies
 - Increased firmware complexity:
 - More complex reliability validation and data integrity verification
 - Makes it hard for systems designers to optimize since it decreases control and adds a level of indirection
- Pros:
 - Cache accelerator software has DRAM access, sharing it with the rest of the systems
 - SSD may be used as: (1) a separate storage tier, (2) as a 2-nd tier cache to DRAM, or (3) even both
 - Cache accelerator runs on x86 CPU and can implement compression & de-duplication
 - Accelerator has more application and OS semantics to maneuver: choice of write back/write-through and can also keep all data on primary storage (HDD)
 - More flexibility in choice of algorithms and settings
 - Cons:
 - Requires software installation
 - Requires one additional I/F port

Mobile SSHD



**Mobile
Dual Drive:
HDD + SSD**

3 options, 3 distinct architectures



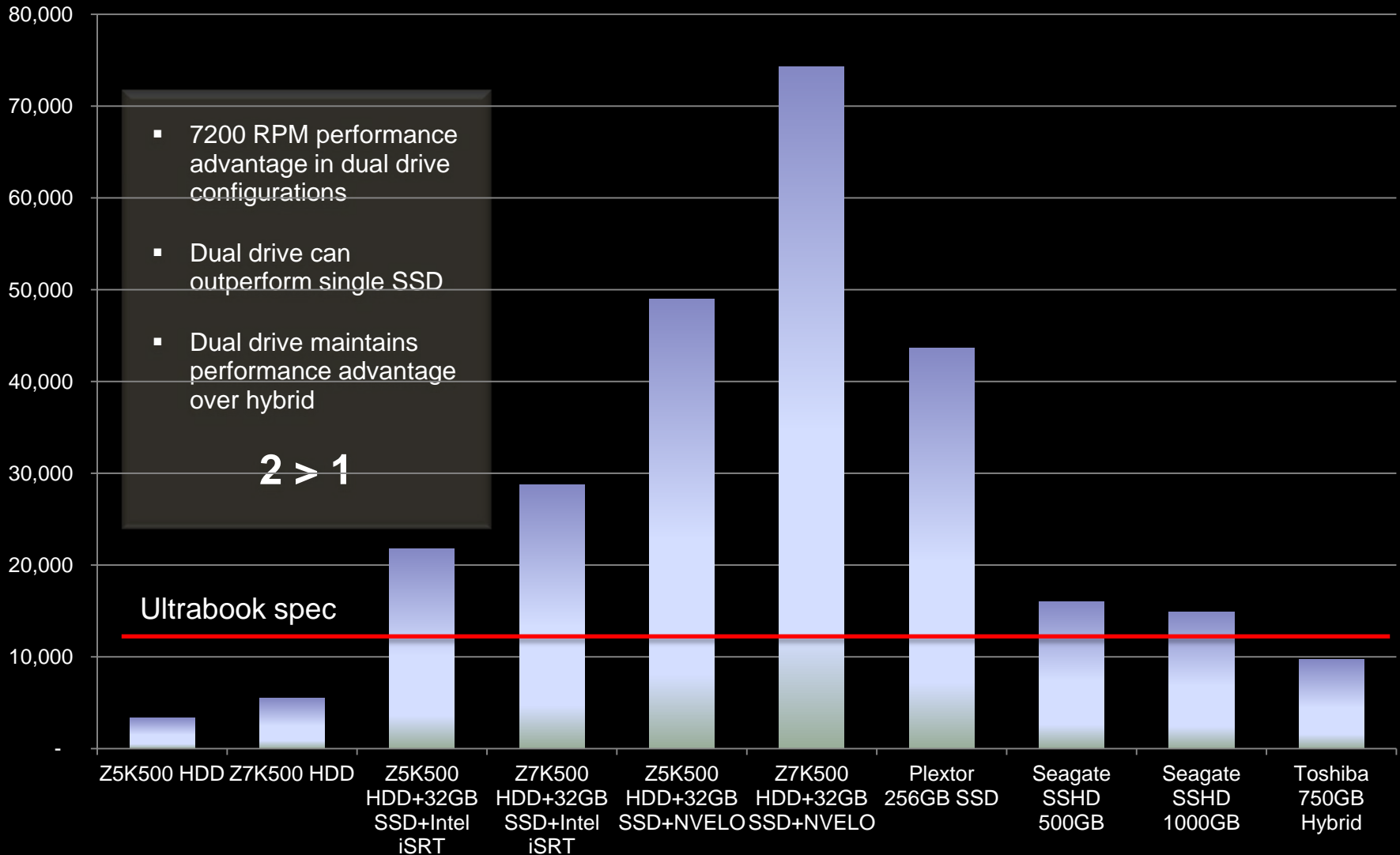
- Limited number of capacity and form factor options
- Limited cache size options
- 5400 RPM only

Choice of standard components

5400 RPM HDD
7200 RPM HDD
250GB-1.5TB
5,7 or 9.5mm

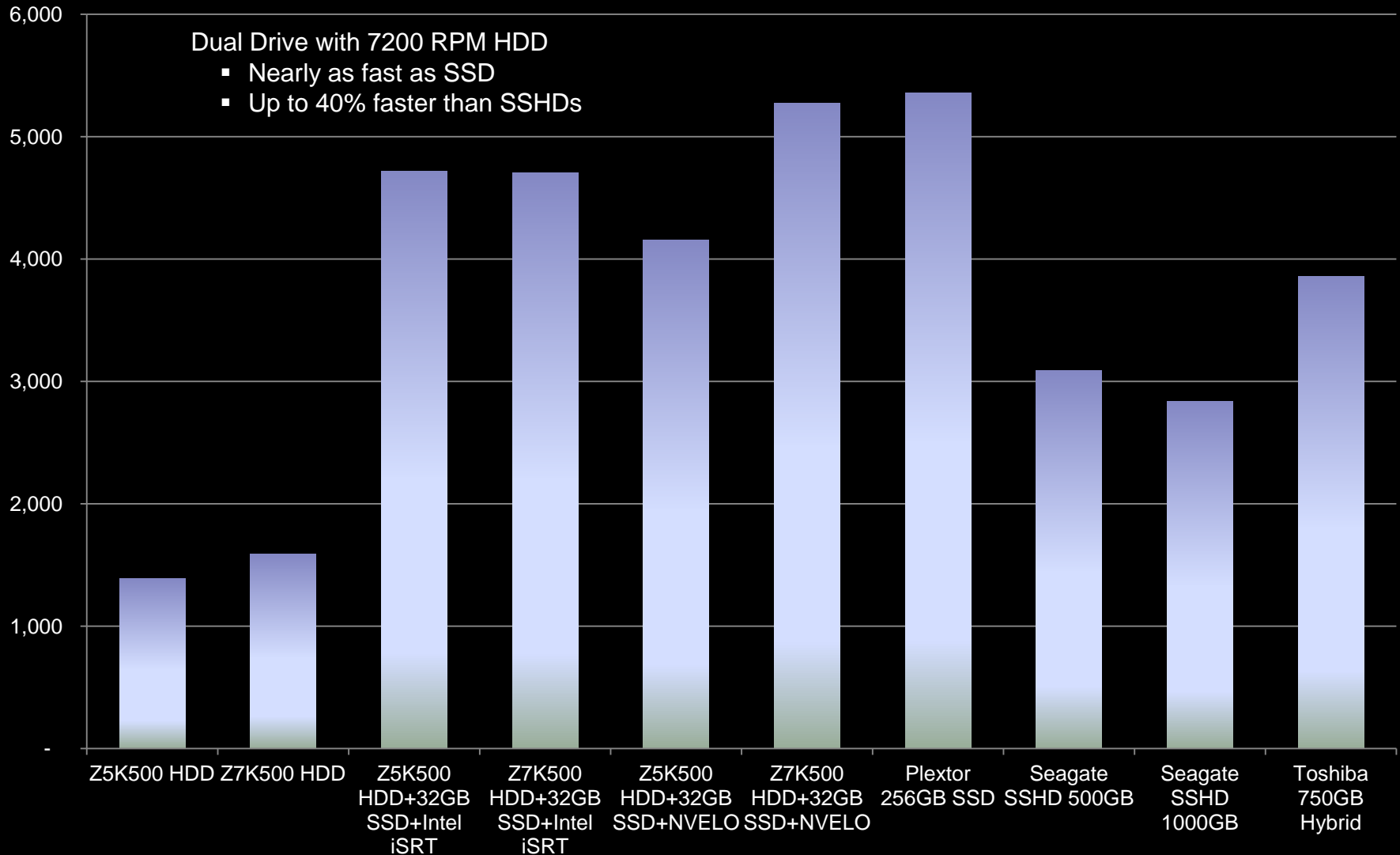
8, 16, 24 or 32 GB cache
mSATA, mSATA mini or M.2
Intel or 3rd party SW driver





Source: HGST Test Results

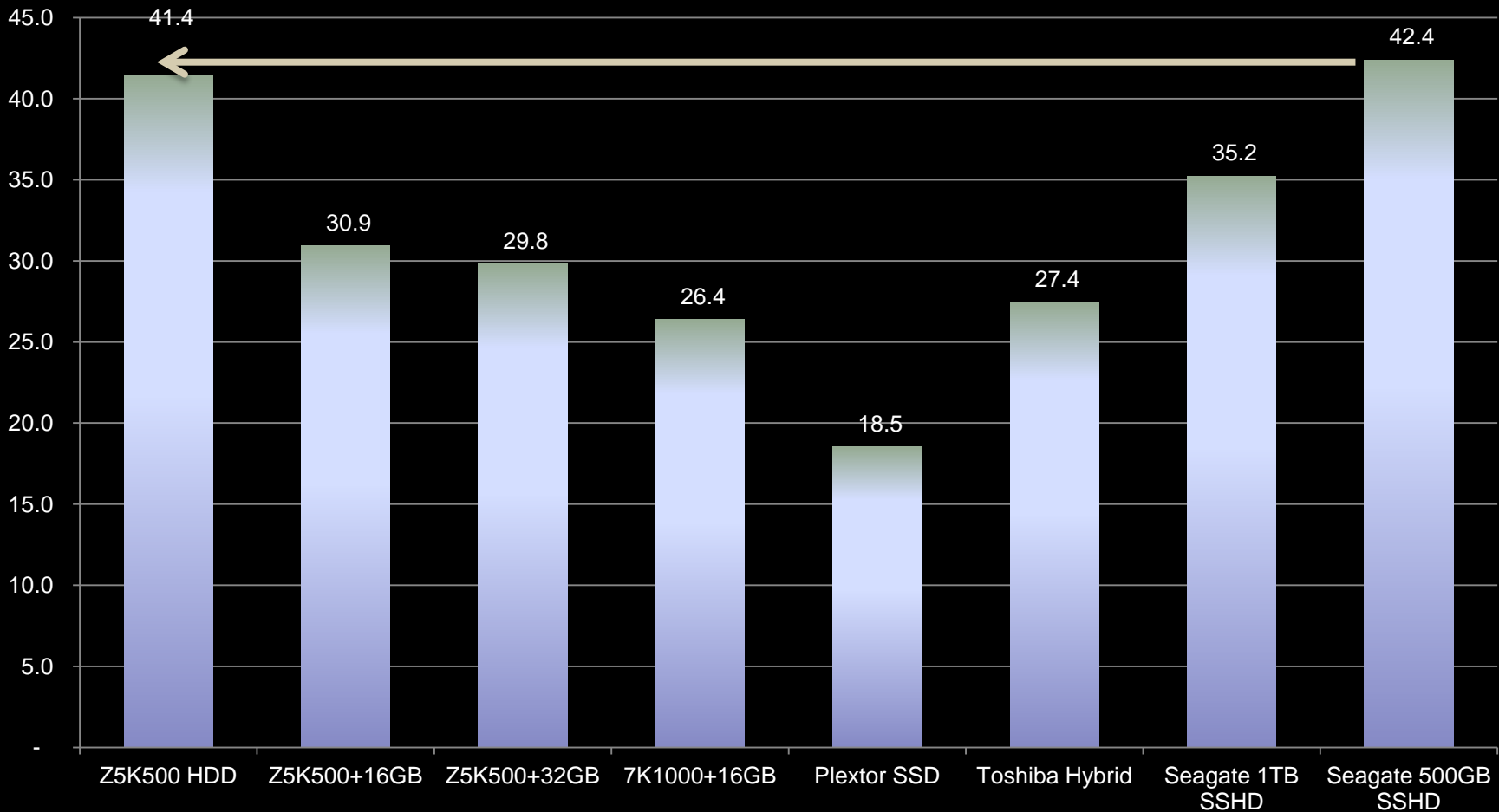
Core i5 Ultrabook, Win7



Source: HGST Test Results

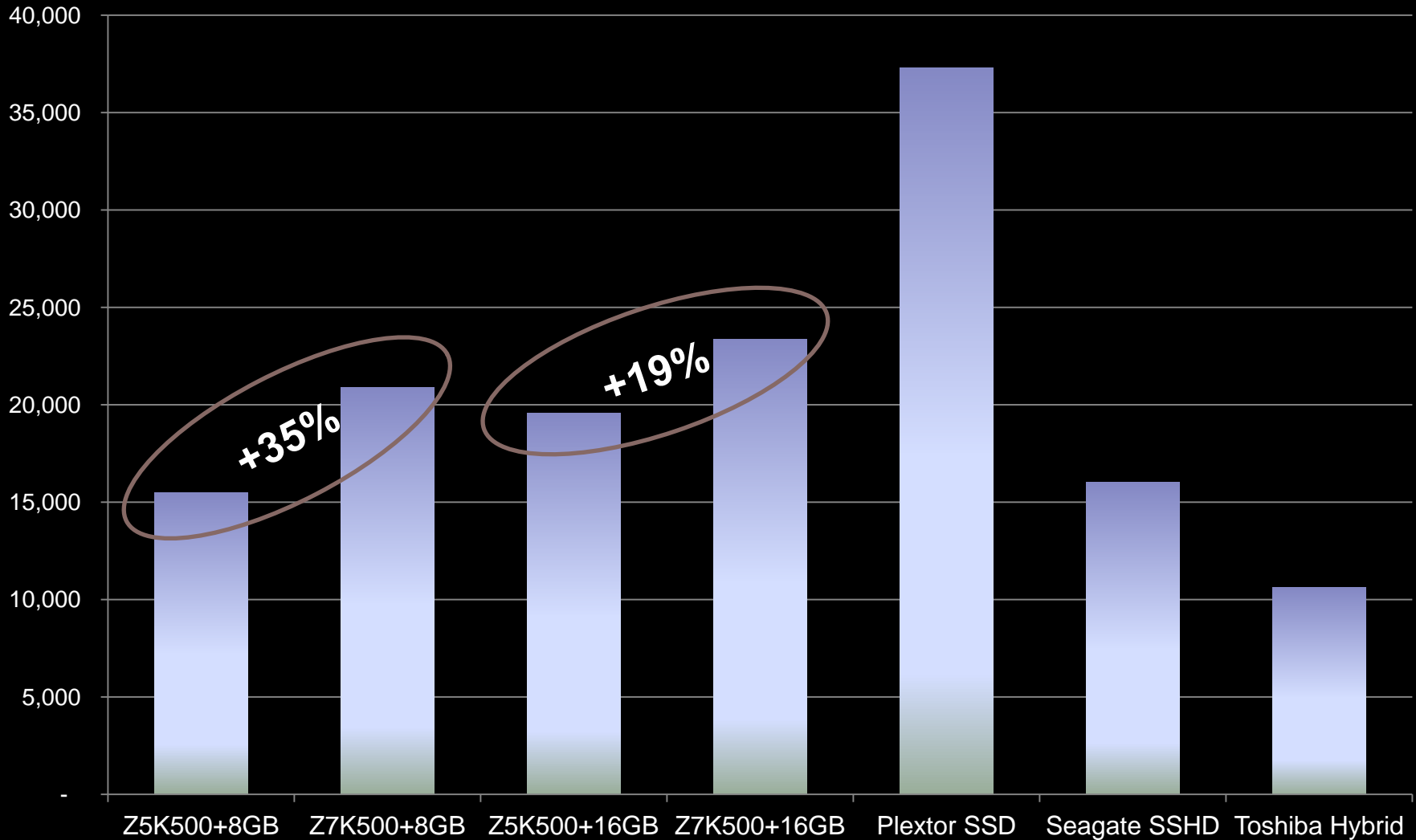
Core i5 Ultrabook, Win7

Seconds



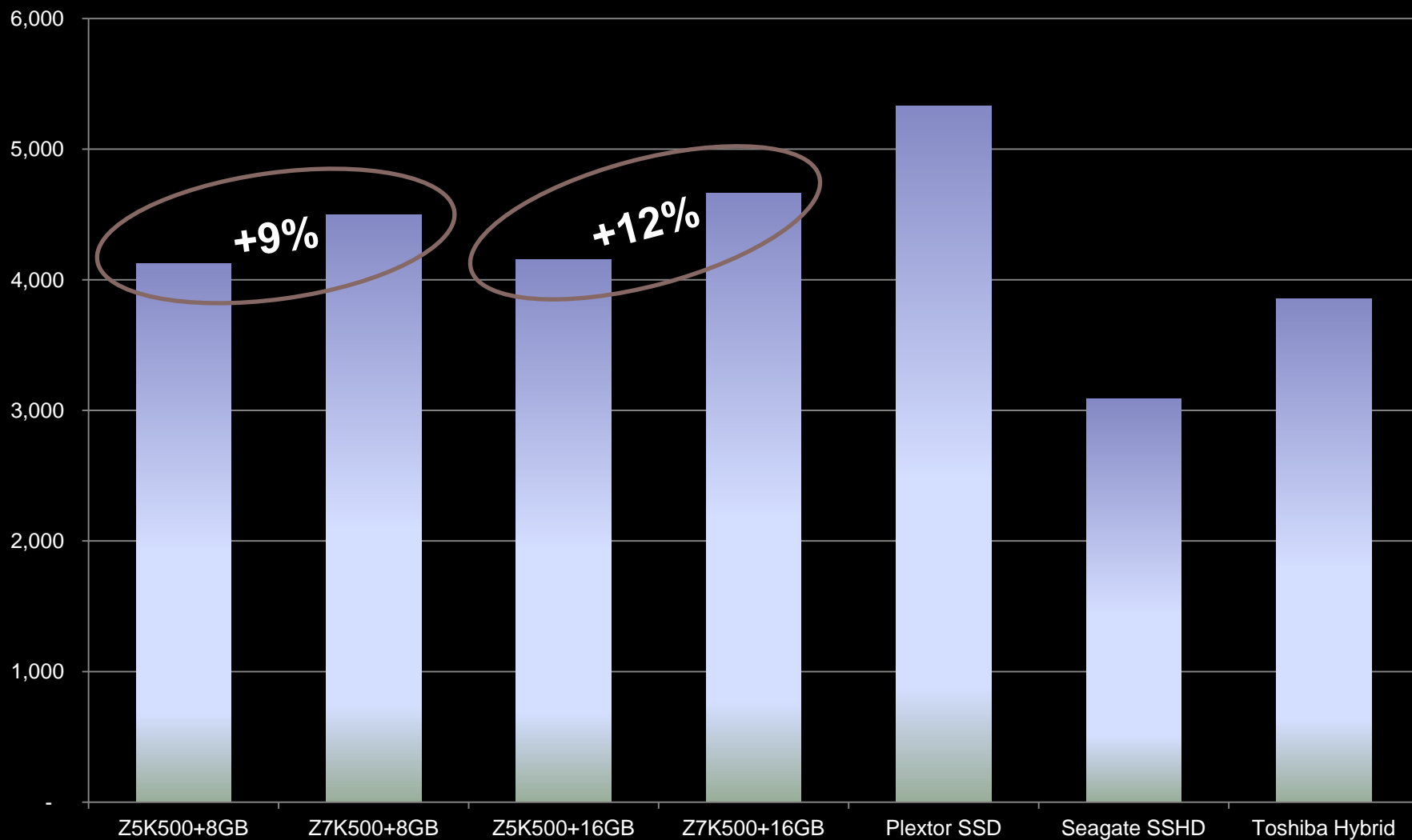
Source: HGST Test Results

Core i5 Ultrabook, Win8 Pro



Source: HGST Test Results

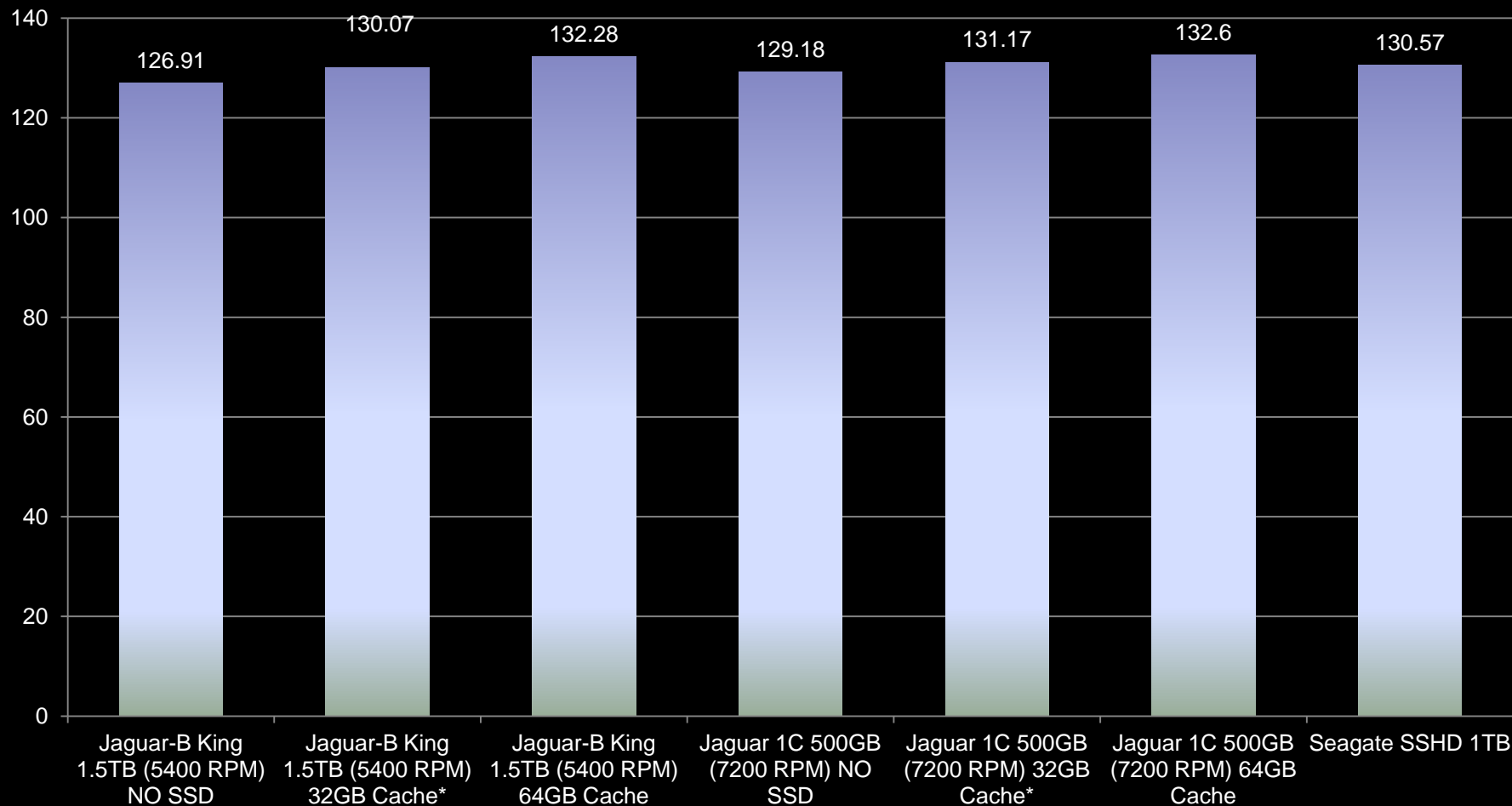
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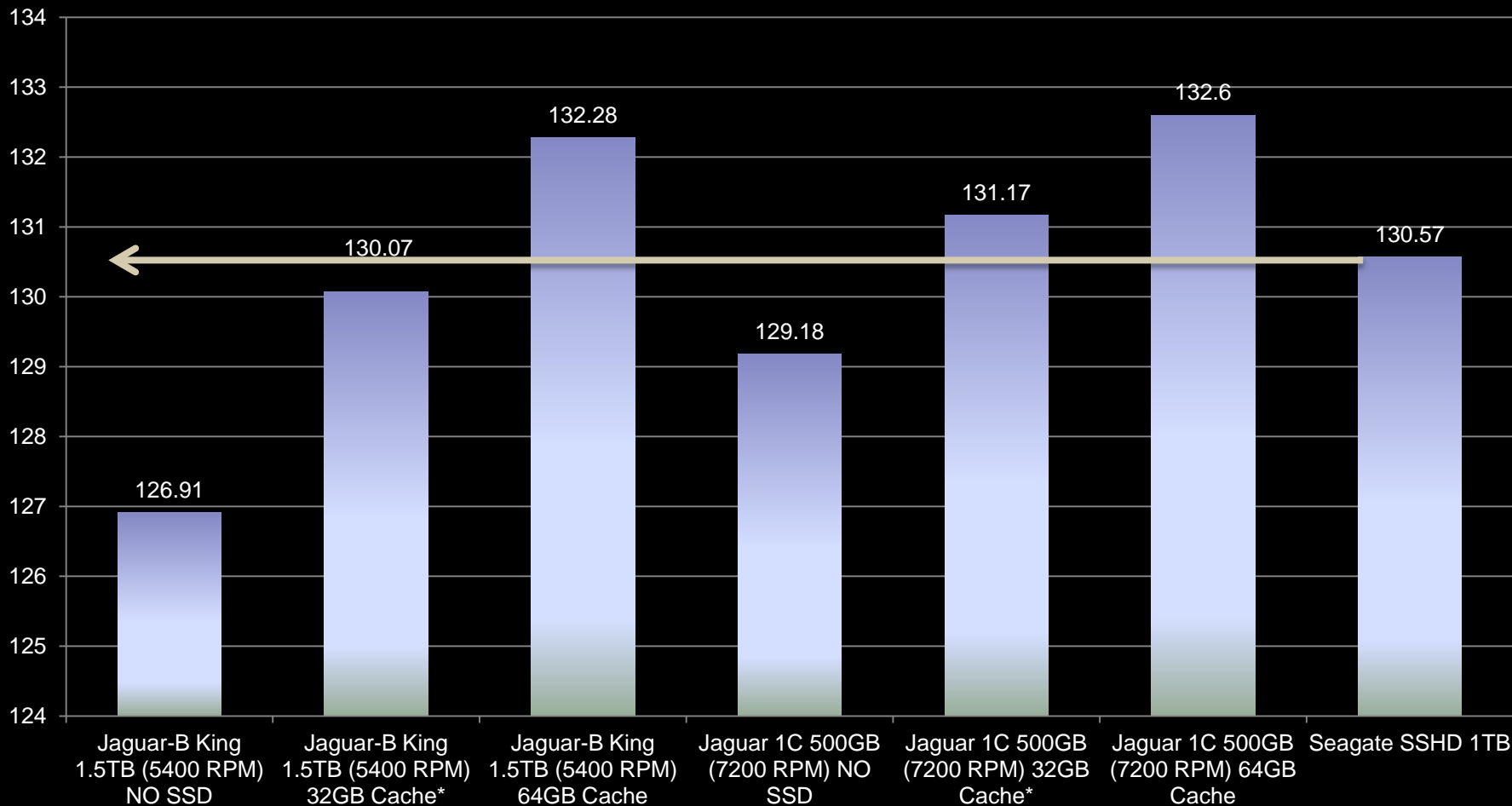
Overall Performance *



* Synthesis of Office productivity, Media creation, Web development Data/Financial analysis, 3D modeling & System management

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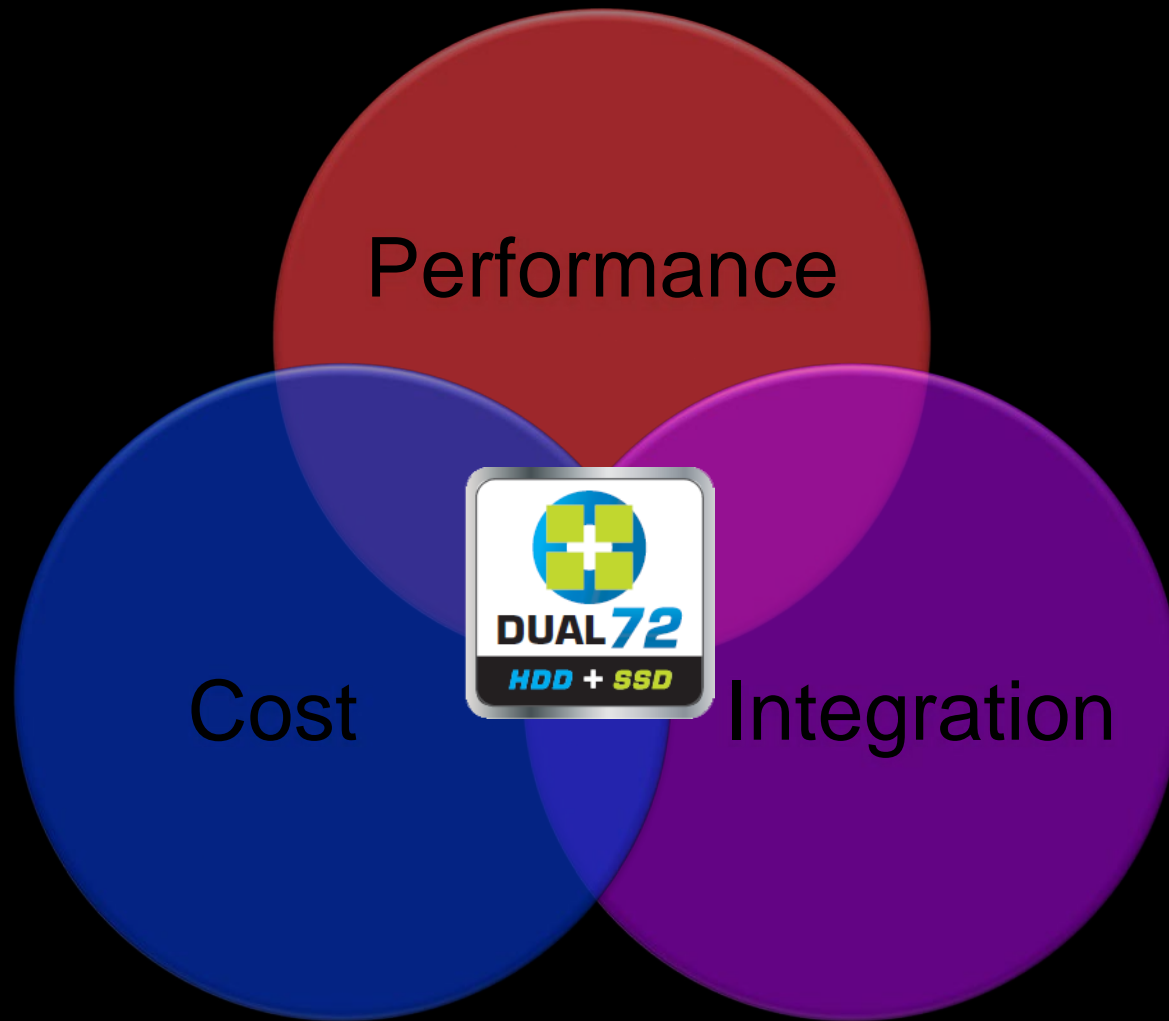
Source: HGST Test Results

Are two drives better than one?

...it depends

Range of Mobile Storage Options





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