



Realizing SSD Value through Caching Software

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VP Business Development

NVELO BACKGROUND

- Denali Software, since 1995:
 - EDA Products for ASIC Verification (DRAM, NAND, PCIe, SATA, USB)
 - IP Products for ASIC Design (DDR-DRAM, NAND, PCIe)
 - SoC Platform: ASIC Reference design for PCIe SSD
 - NVMHCI Host Software for cache management
- In June, 2010, NVELO spins-off from Denali
 - Host Software for NVM cache management
 - Seasoned, successful team:
 - R&D, business development, finance, operations

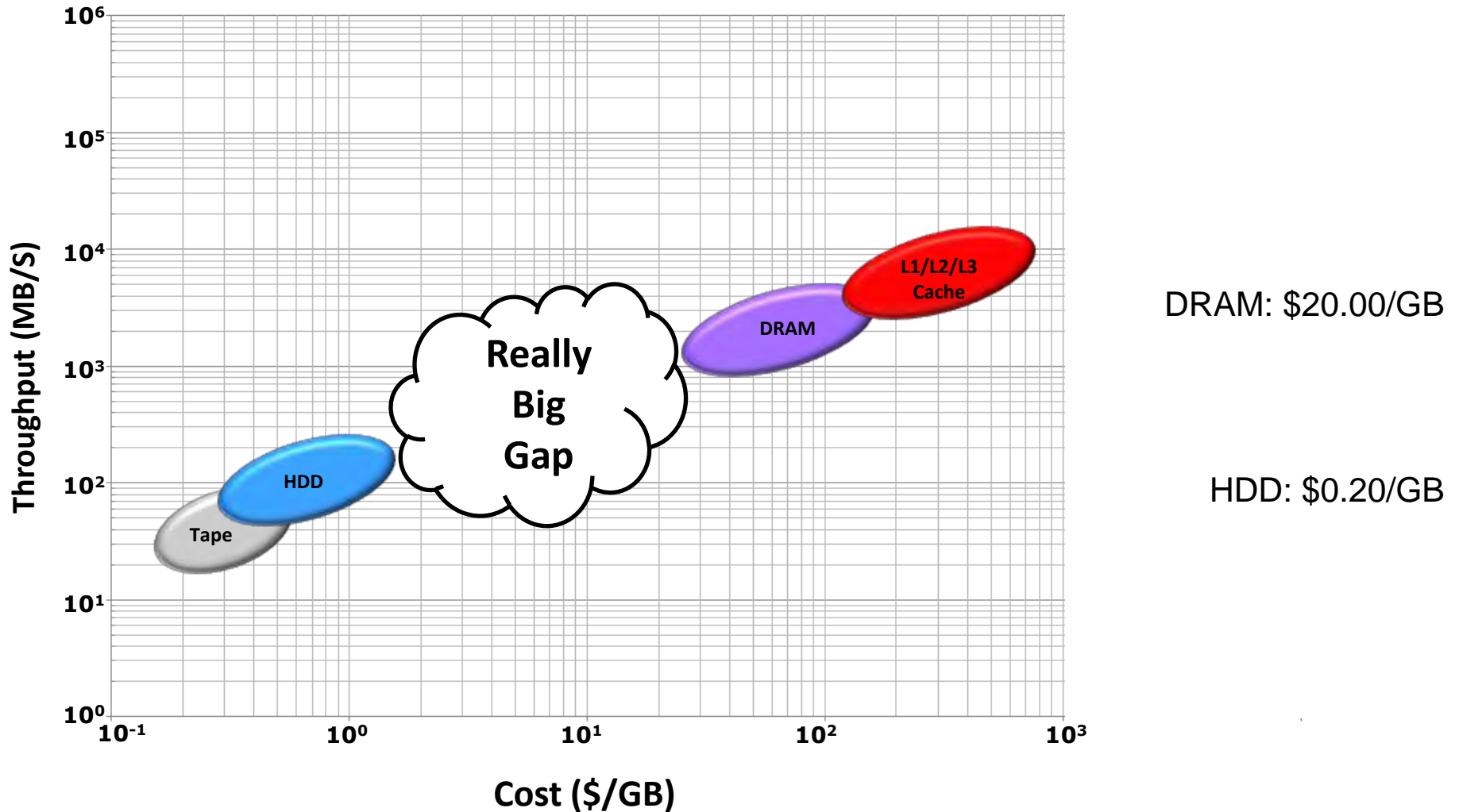
NVELO MISSION

NVELO was formed to develop innovative software products that use SSD technology to break the I/O bottleneck

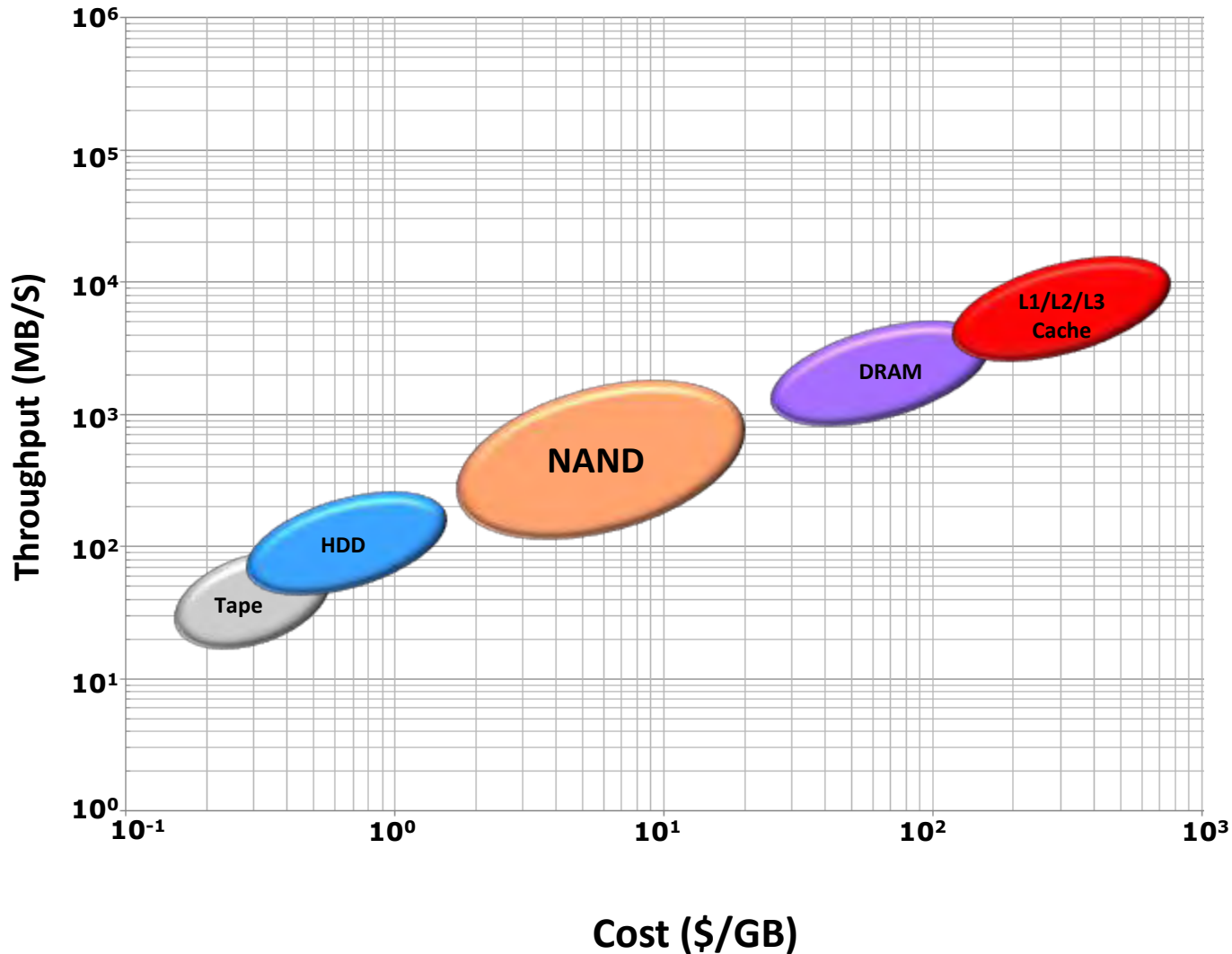
- Despite steady/significant gains in core computing technology:
 - DRAM performance
 - CPU performance
 - HDD capacity
- Growth in “System-Level” computing performance has stalled...



THE OLD MEMORY/STORAGE HIERARCHY



THE NEW MEMORY/STORAGE HIERARCHY



DRAM: \$20.00/GB

NAND: \$2.00/GB

HDD: \$0.20/GB



BREAKING THE I/O BOTTLENECK

- CPU & DRAM performance has increased dramatically, and now Storage is the bottleneck for system performance
- No “game-changing” developments in the near term
 - HDD’s provide optimal \$/GB => use for capacity
 - SSD’s provide optimal MB/s => use for performance



WE CAN DELIVER THE BEST OF BOTH WORLDS

- Caching enables the use of SSD's and HDD's - ***together***
 - The most frequently/recently used “hot” data stays on the “small/fast” SSD
 - “cold” data remains on the slower but larger capacity HDD
 - Users get affordable SSD performance, without sacrificing HDD capacity!



HOW DOES CACHE STACK UP?

- Throw away your HDD, Replace with an SSD
 - Not exactly economically feasible if you need any capacity
- Throw away your HDD, Replace with a Hybrid-HDD
 - Better than an HDD, but still far from SSD performance
- Load your OS onto a small/cheap SSD (boot drive)
 - Great for boot times, but what about the “system-level” performance
- Use a low capacity SSD as a “cache” for you high-capacity HDD
 - Provides maximum flexibility to utilize best-in-class SSD/HDD technology,
 - Requires intelligent, adaptive software

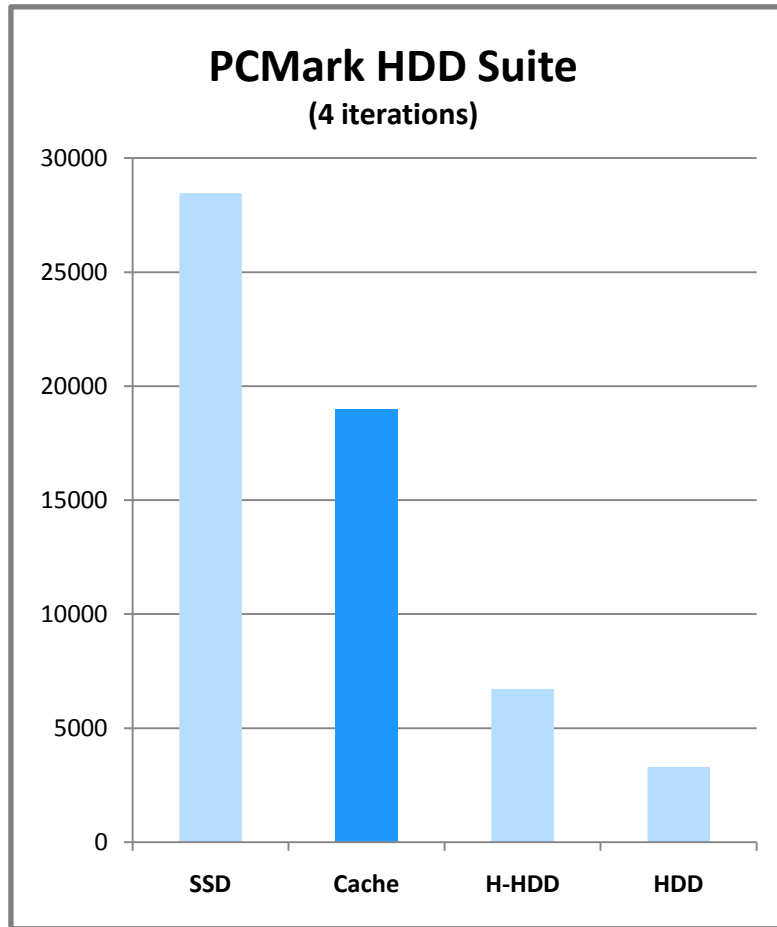
NVELO's FIRST PRODUCT: DATAPLEX

- Dataplex™: *Intelligent, Adaptive NVM Cache Storage Manager*
 - Software product that resides on the host computer/PC
 - Utilizes an SSD device as a high-performance “cache” for the HDD
 - Intelligent algorithms adapt to user behavior, and store the most important (most frequently and recently used) data on the faster SSD
 - No user “pinning” or storage management is required
- The Results?
 - Users get affordable SSD performance, with HDD capacity.

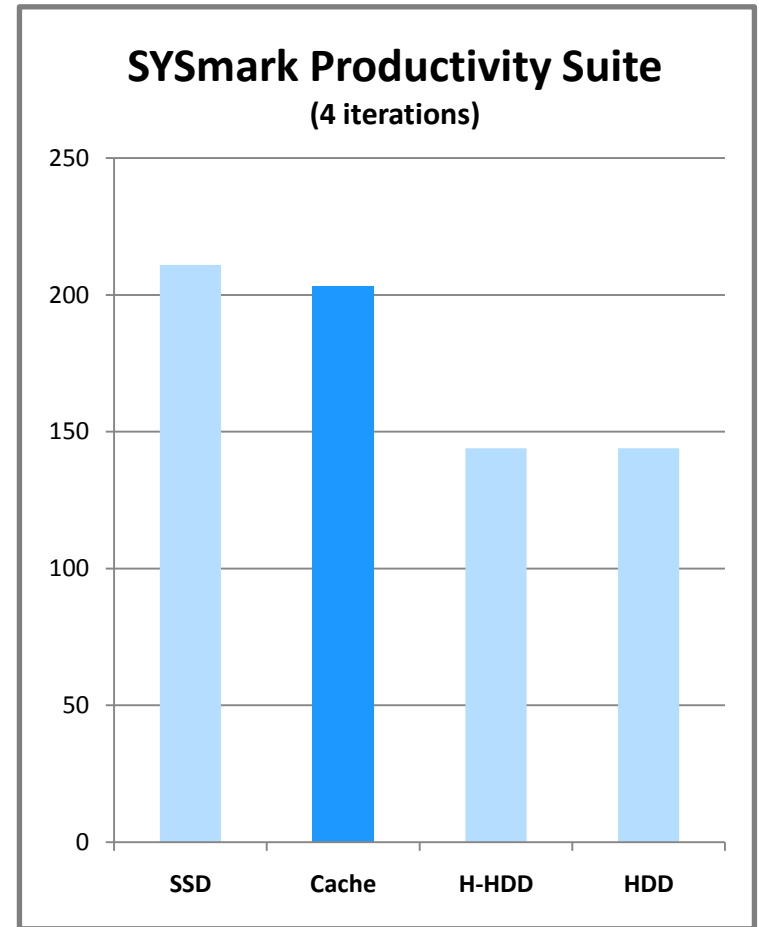
MEASURING PERFORMANCE

- Different benchmarks measure different things, differently...
 - SYSmark
 - PCmark
 - IOMeter
- Multiple iterations are required for “Adaptive” storage systems
 - HDD + Cache module
 - Hybrid-HDD
- Comparing scores:
 - % of SSD performance
 - % improvement over HDD
 - % improvement over delta between HDD & SSD performance

SOME PERFORMANCE RESULTS



SSD: Intel X25-M G2 80GB
Cache: HDD + 16GB PCIe NAND module + Dataplex
H-HDD: Seagate Momentus XT 250GB
HDD: Hitachi 2.5" 7200RPM 320GB

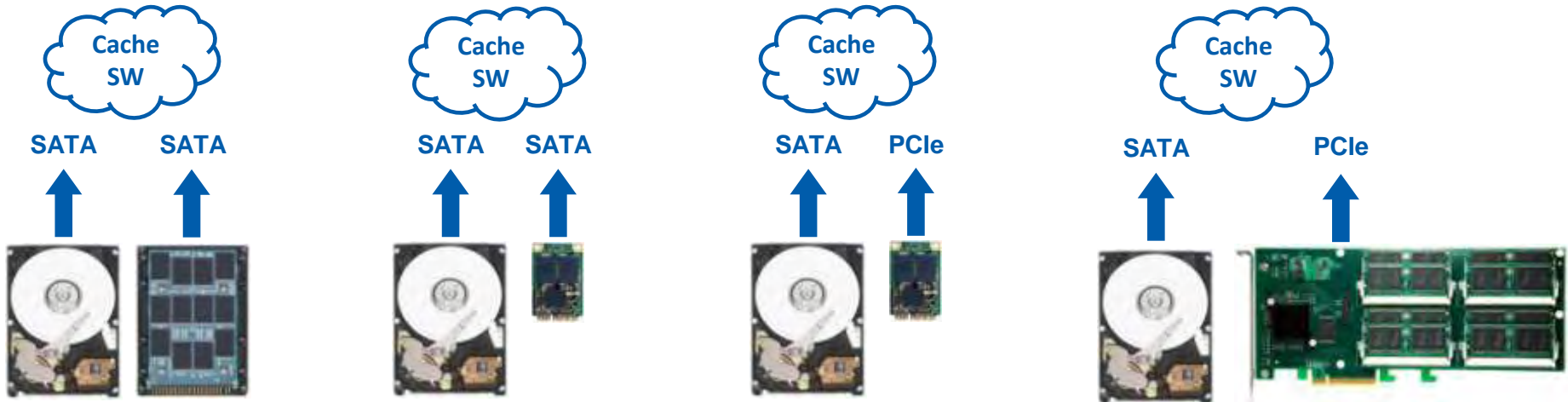


ASUSTeK P6X58D-E
Intel Core i7 CPU 920 @ 2.67GHz
4GB 1066 MHz DDR-DRAM
Win7 Ultimate 64-bit



CACHE FORM-FACTORS

- Many form-factors and interconnect options:
 - HDD + Standard SSD
 - HDD + mSATA module
 - HDD + mini-PCIe module
 - HDD + full-sized PCIe card



REQUIREMENTS FOR EFFECTIVE NVM CACHING

1. The cache device must have sufficient capacity
 - 4x system memory is a good sweet-spot for client computing
2. The cache device must have sufficient performance
 - Performance must be >> HDD (No thumbdrives or SD cards)
3. Need intelligent, adaptive caching algorithms, preferably on the host system
 - Block and file level visibility into system traffic
 - Processing needs: insignificant for host CPU, overwhelming for embedded controller + DRAM

REALIZING SSD VALUE THROUGH CACHING

WINNER!

HDD Only



Price \$50

Capacity 320GB

Performance HDD

SSD Only



Price \$350

Capacity 160GB

Performance SSD

HDD + SSD Cache + Dataplex



Price \$150

Capacity 320GB

Performance SSD

Half the Price

Twice the Capacity

Same Performance

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Summary

- Storage is the bottleneck for system performance
- HDDs and SSD's are not interchangeable
- The most optimal/economical solution comes from a balance of
 - DRAM Memory
 - NAND Cache
 - HDD Storage
- Intelligent software is key to enabling efficient caching for performance, and enables 100% use of the investment in NAND



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Thank you!

For questions, please contact:

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