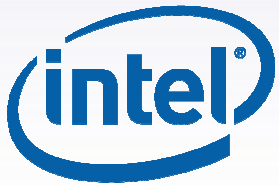
Non-Volatile Memory Cache Enhancements:

Turbo-Charging Client Platform Performance

By Robert E Larsen
NVM Cache Product Line Manager
Intel Corporation



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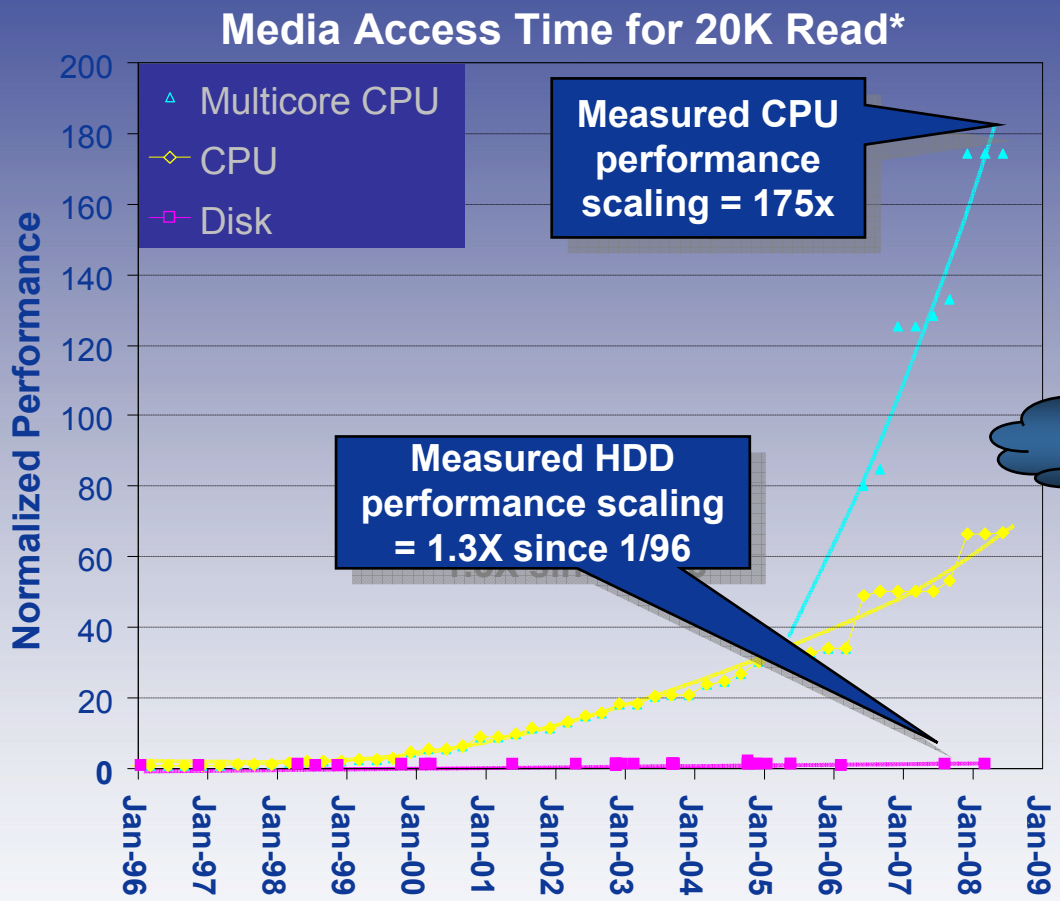
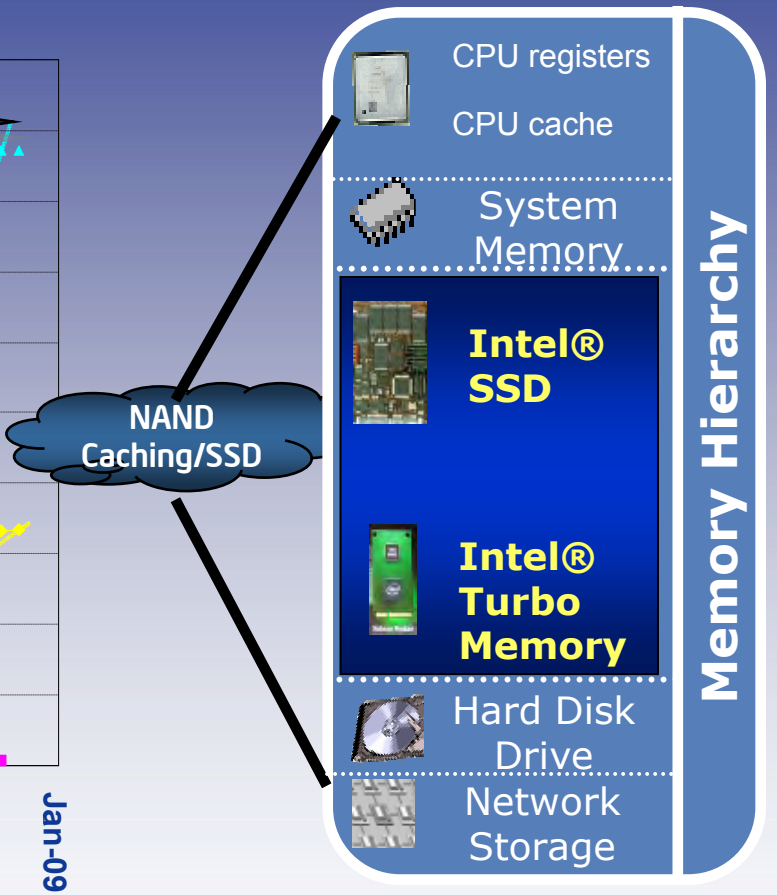
Agenda

- The Need for NVM Cache
- Initial NVM Cache Products
- New Intel® Turbo Memory with User Pinning
- The Path Beyond

Vision:
NAND Solutions can unleash Computing



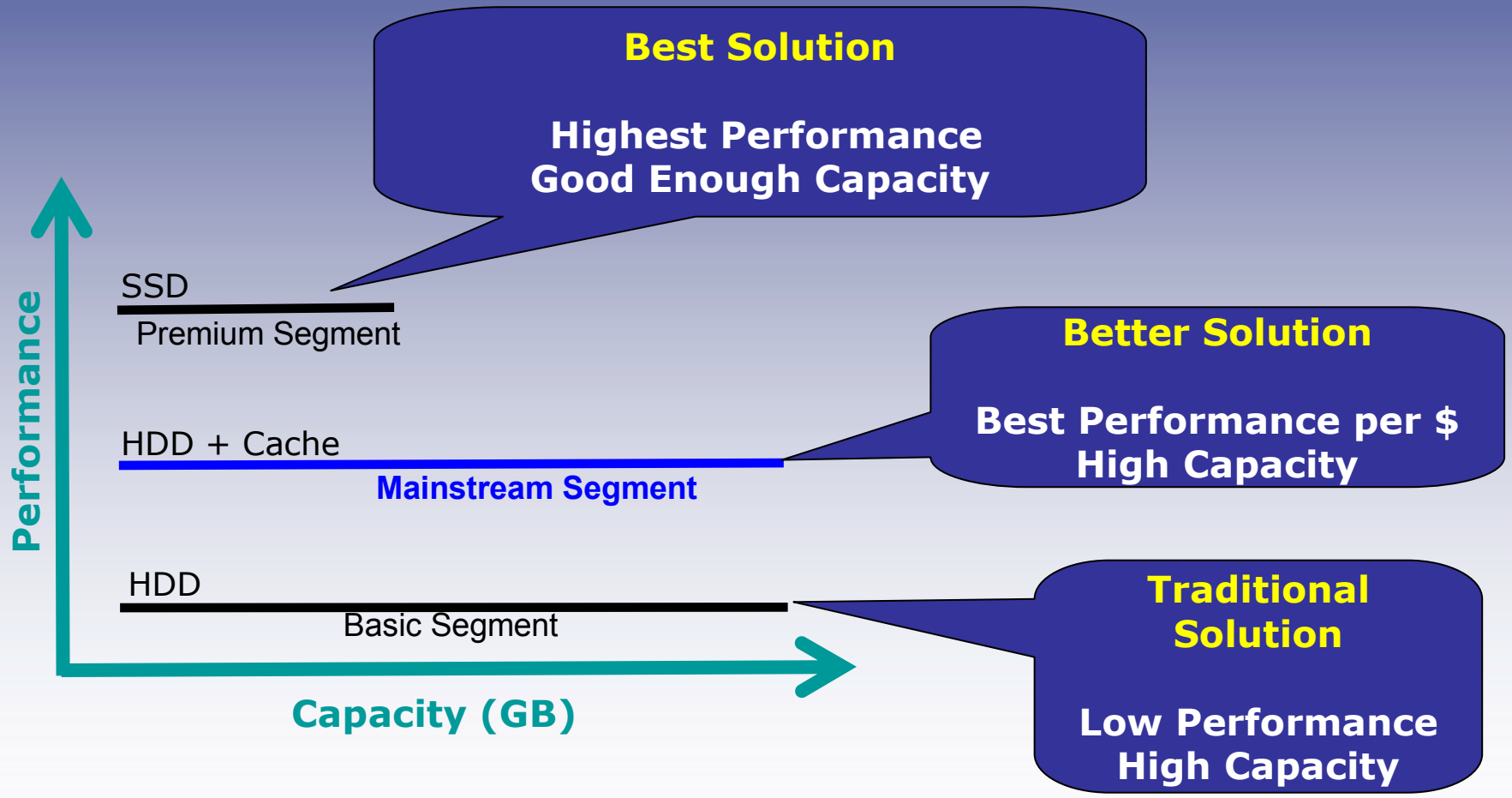
Source: Intel measurements



Our Mission is to remove that bottleneck

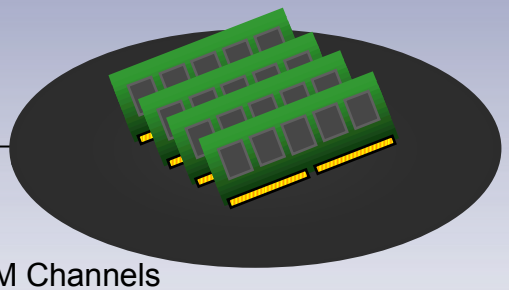
* Normalized CPU Performance
Normalized Media Access Time for 20K Read

NVM Computing Solutions Enables the Optimum Platform Solution for Performance, Capacity & Cost



NVM Caching Overview

Front Side Bus



DRAM Channels

DMI

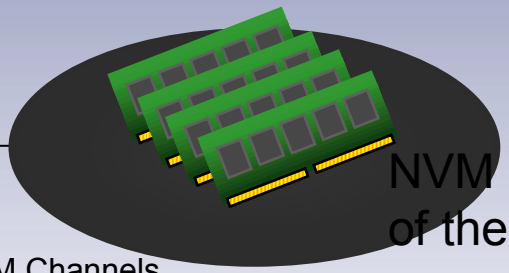
SATA

Optimized platform performance when DRAM contains code/data.

If information not in DRAM, system slows to wait for HDD access.

NVM Caching Overview

Front Side Bus



DRAM Channels

DMI

PCIe

SATA

Optimized platform performance when DRAM contains code/data.

If information not in DRAM, system slows to wait for HDD access.

NVM Caching alleviates the latency of the HDD and improves system responsiveness

Up till now …

- NVM Caching Algorithms
  - Write through architecture
  - Utilize Microsoft “ReadyBoost”*
- Technology Limited Practical Densities
  - 1 -2 GB
  - Increases sensitivity to caching algorithms and hit rates
- Additional Usability Features
  - Improved boot times
  - Microsoft “Ready Drive”*
- Representative of Intel® Turbo Memory Products
  - 1GB Launched in ’07 with Mobile Centrino Platforms
  - 1GB Launched in late ’07 for Desktop Platforms
  - 2GB Recently launched – Mobile Centrino® 2 & Desktop 4 Series Platforms

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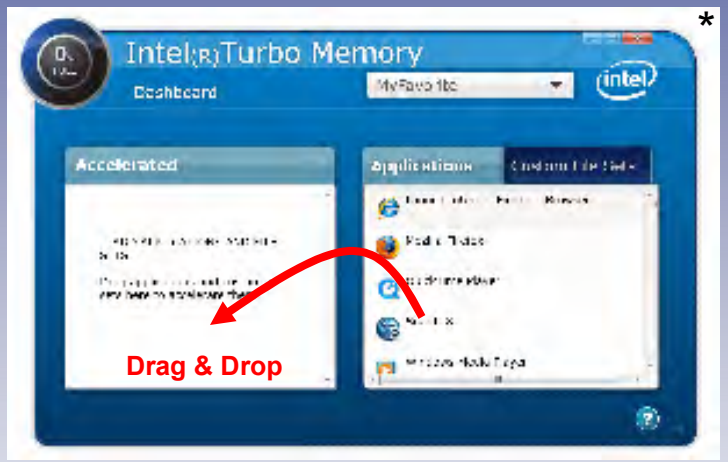
New
Intel® Turbo Memory with User Pinning

- Enables User Direct Control of which Applications to Accelerate
  - User pinning allows the choice of which applications or files are stored in NVM
  - Create “personalized” PCs



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- Technology Enabled Capacities that Align with Application Requirements
  - 2-4 GB

- Increases Usability Features
  - Microsoft “Ready Drive”* support
    - Improved boot times
  - RAID compatible
  - Backward compatible 2GB MS “Ready Boost”* configuration option

- Form factor PCIe solutions for both Mobile & Desktop platforms

Personalize Your System and Improve Performance for the Applications You Choose with Intel® Turbo Memory

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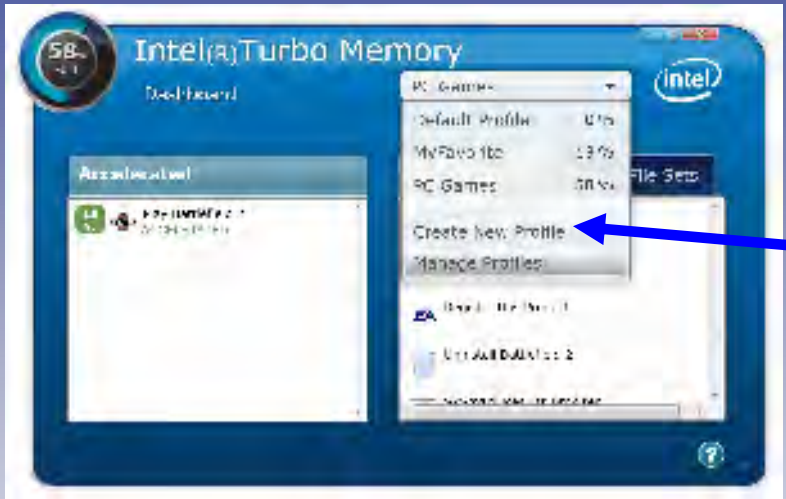
Intel® Turbo Memory User Pinning via the Intel® Dashboard



Quick Pin

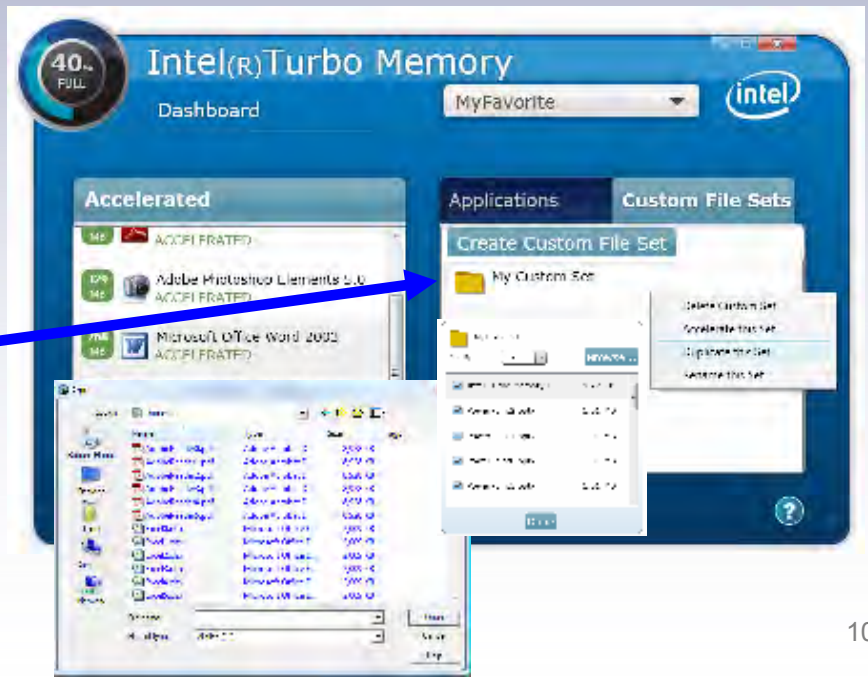
Drag & Drop apps for quick performance boost

Drag & Drop apps from list to the "accelerated" list

Profile

Build profiles for your favorite activities

Includes one or more files "accelerated" and saved for later use



Custom File Set Pin

Create custom file set for common files; all of your game level maps

Create a custom file set with all files from various directories; then drag & drop the file set to "accelerated" list

Demo – Intel® Turbo Memory

Mobile Content Creation Demo

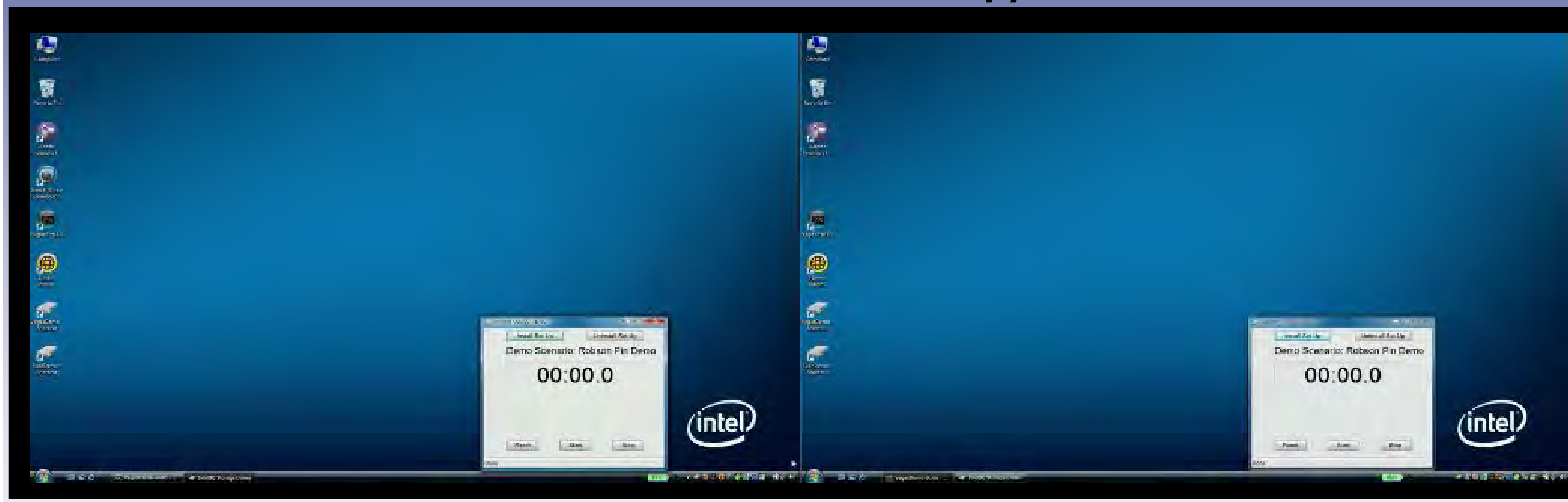
Intel® Turbo Memory delivers multi-tasking improvements

Spend less time waiting for your PC

Flash Memory SUMMIT

Intel® Turbo Memory delivers multi-tasking improvements

Adobe* Premiere Elements* 4.0 Application Load



Intel® Turbo Memory | ***Baseline***

Spend less time waiting for your PC

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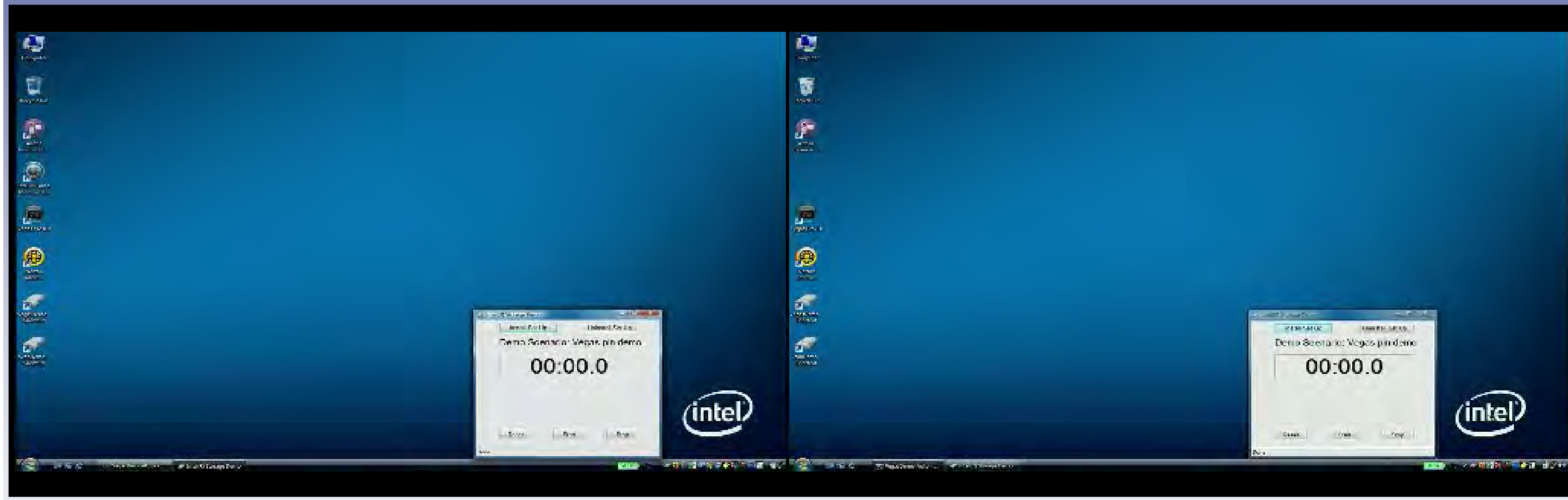
Intel® Turbo Memory delivers multi-tasking improvements

Sony Vegas Pro 8 Video Application Load and Rendering Session*



Intel® Turbo Memory ***Baseline***

Spend less time waiting for your PC

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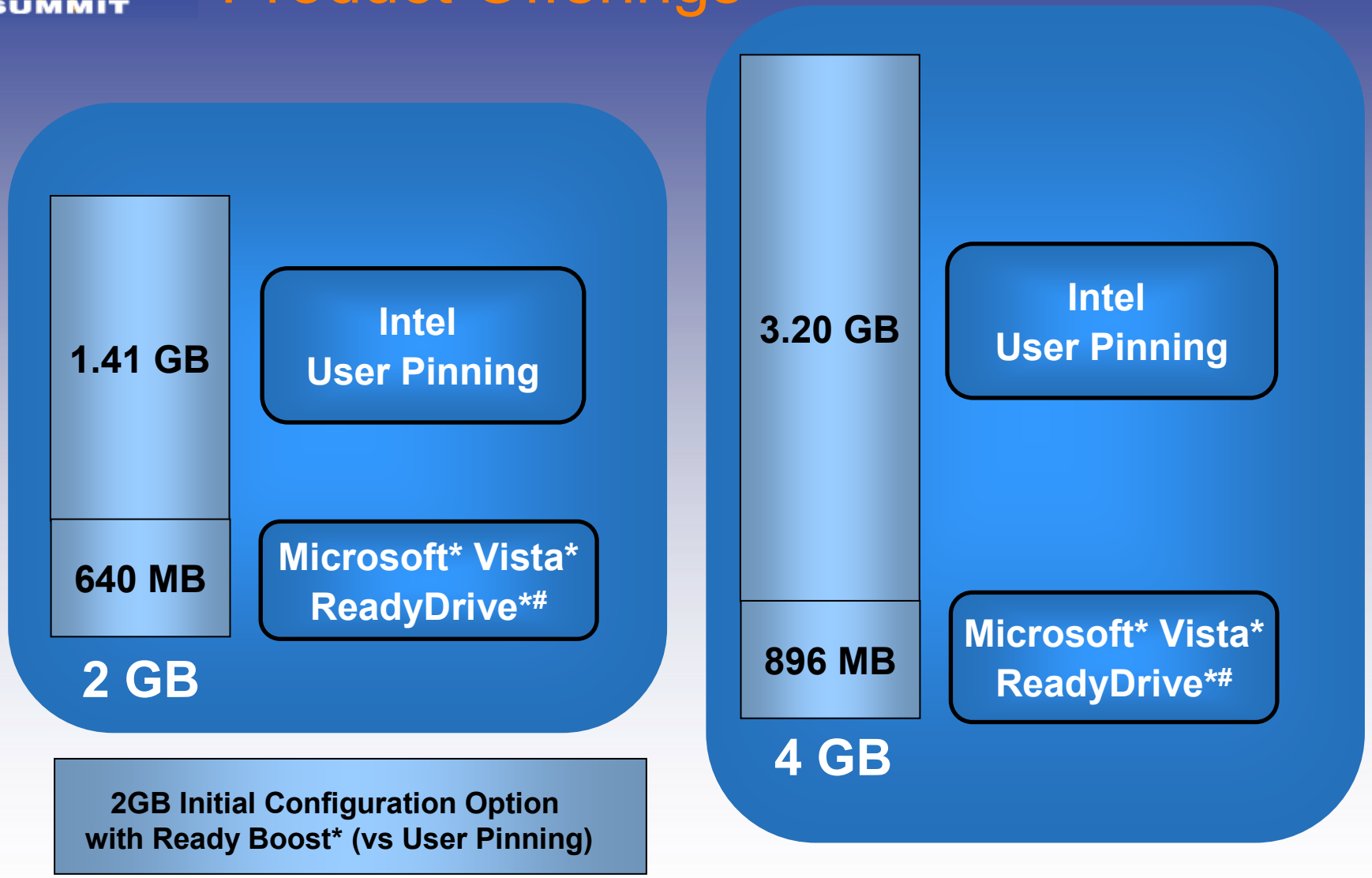
Intel® Turbo Memory Product Offerings



2GB Initial Configuration Option with Ready Boost* (vs User Pinning)

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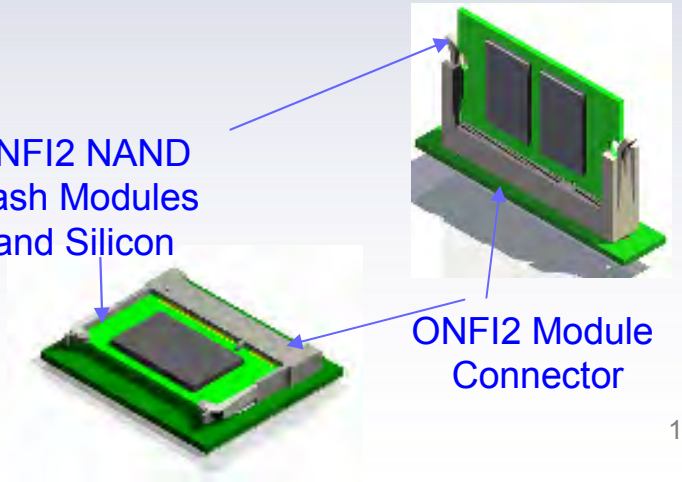
Listed ReadyDrive* capacity is used for ReadyDrive* write caching, formatting and other functions.

A Bright Future for NVM Cache

- Platform Performance Requirements and Storage Challenges Continue
- All Key Vectors Improving for NVM Cache
  - Improved Caching Algorithms
    - Write back cache capable
  - Higher Performance Silicon
    - High Speed NAND architecture is 5x standard flash bandwidths
    - Optimized memory controllers
  - Technology Enabled High Density Silicon
    - Wider caching workloads supported
  - Standards-based Solutions Enable Future Platform Innovation (power, NVM consolidation, etc.)
    - ONFI 2.0 HW and command Interface
    - NVMHCI SW Interface



Summary

- Storage Subsystems Limiting System Performance Benefits Today
- New Intel® Turbo Memory with User Pinning
  - Enables User Direct Control of which Applications/Files to Accelerate
- Platform Performance Requirements and Storage Challenges Continue …
  - The opportunity for NVM Cache innovation expanding

Thank You

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Questions ?