

# Tom's Hardware

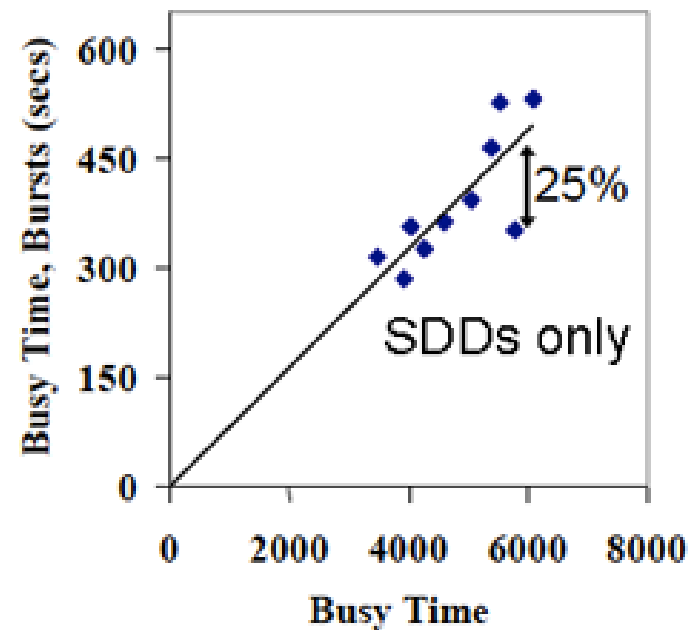
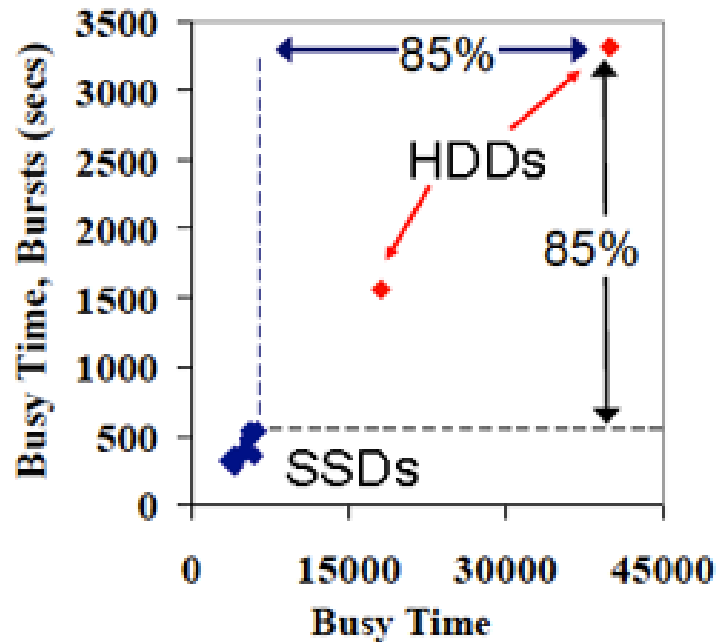
## End User Perspectives

### On SSDs

# Challenges to SSD Adoption

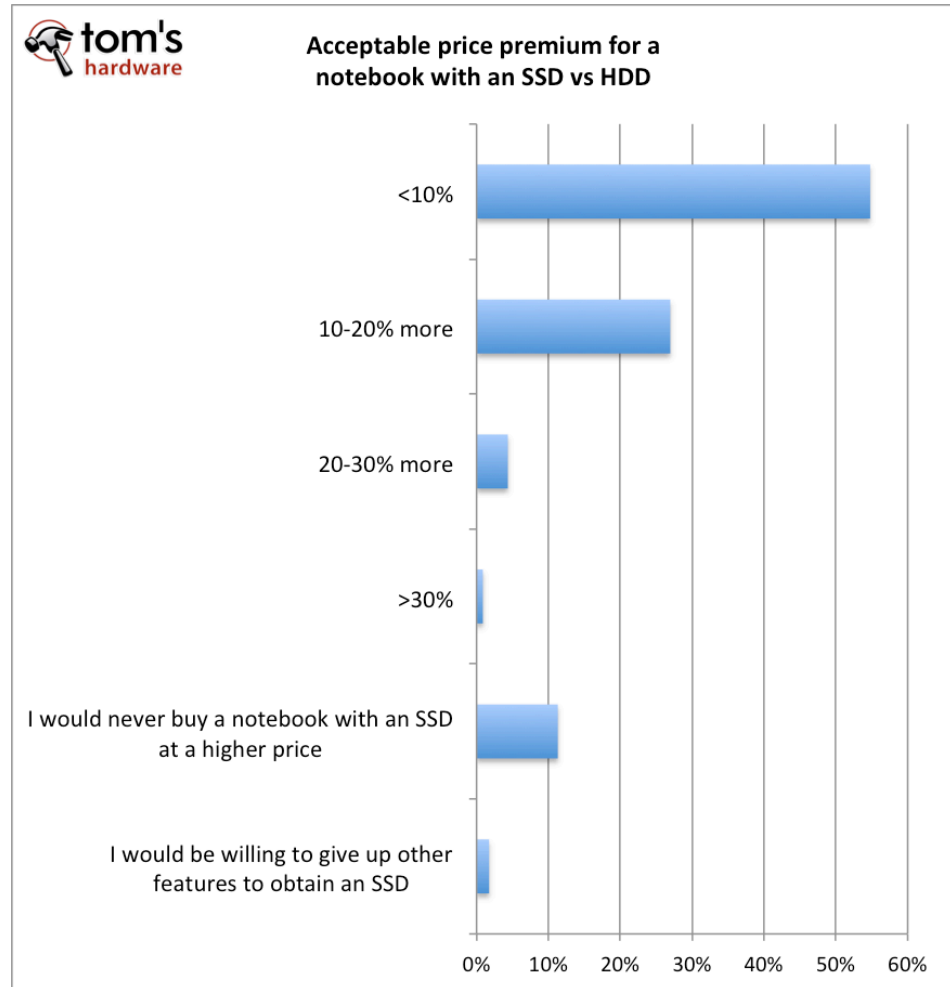
## ■ Performance

- Benefits of SSDs over HDDs - Well Understood
- Consumer Use Model: Smaller Differences Between SSDs



# Challenges to SSD Adoption

- Cost
  - Tight Budget Constraints
    - HDD: 160 GB ~ \$40
    - SSD: 120 GB ~ \$240



Newegg Prices July 2011  
July 2011 Tom's Hardware Facebook poll

# Consumer Strategies

- Global Internet Video Traffic Accounts for 40% of Consumer Internet Traffic
- Consumer IO Shifting Toward Content Creation and Consumption
  - Intel's QuickSync Architecture
- Dual Track Priorities: Performance and Cost/Capacity
  - Caching
  - Hybrid Systems

## Hard Disk Drives (2)



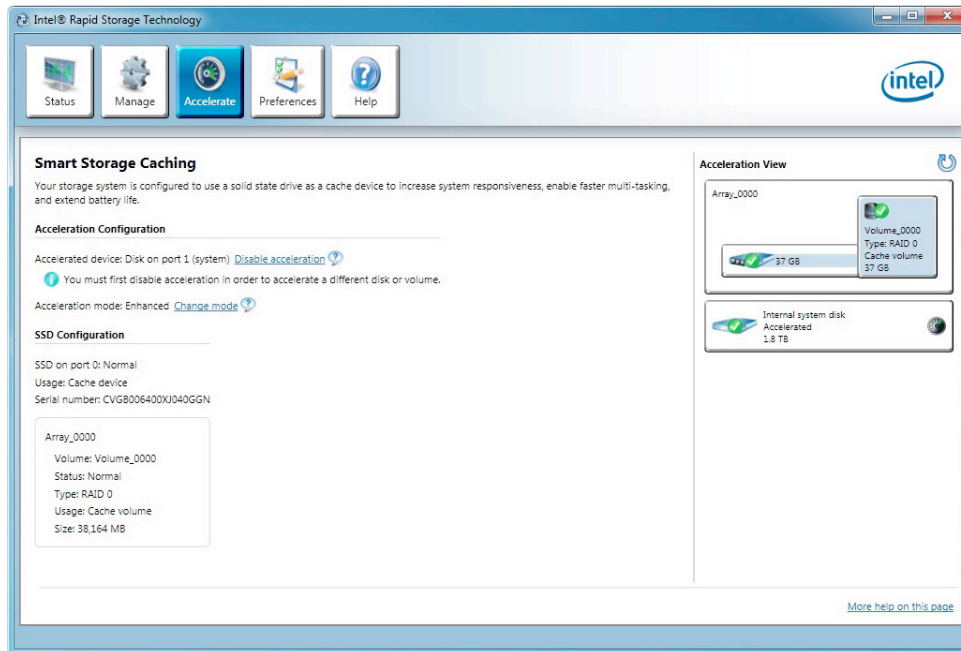
# SSD Caching & Tiered Storage

## ■ SSD Caching

- Low Acquisition Cost
- Fire-and-Forget

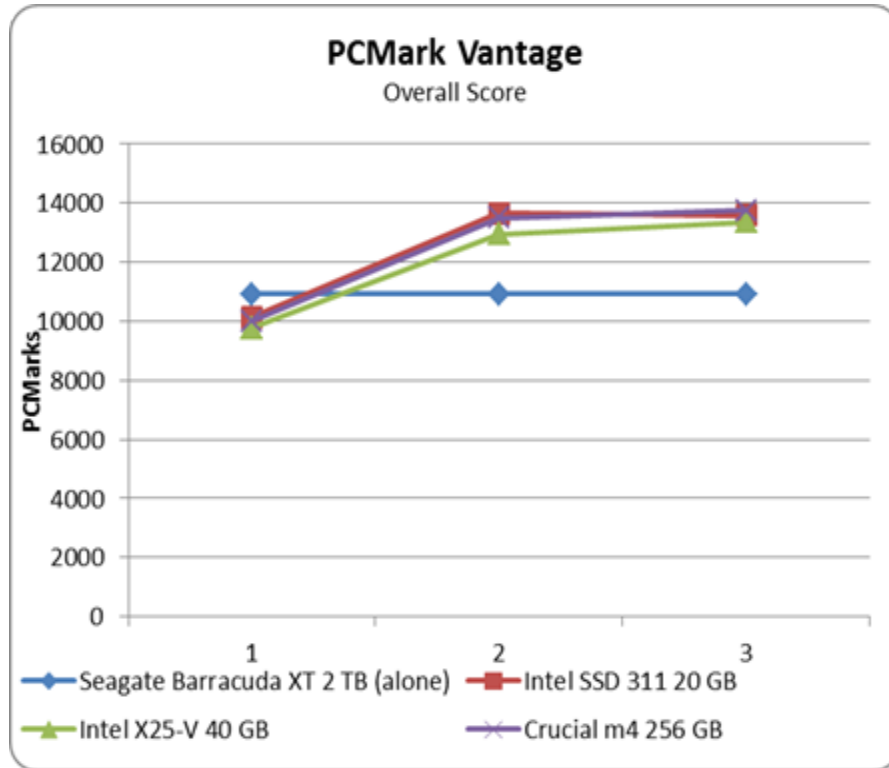
## ■ Tiered Storage

- Variable Acquisition Cost
- Self Managed Storage Topology
- SSD as Boot or System Drive
- Mass Storage: Hard Drives

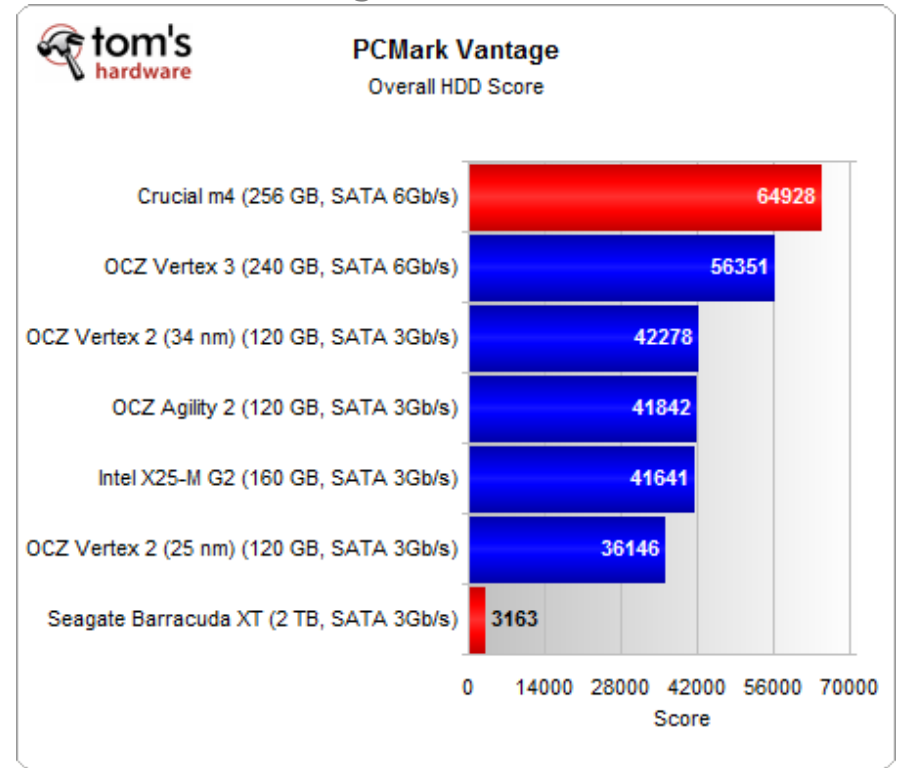


# SSD Caching & Tiered: Performance

- SSD Caching
  - Small Improvement In Reads



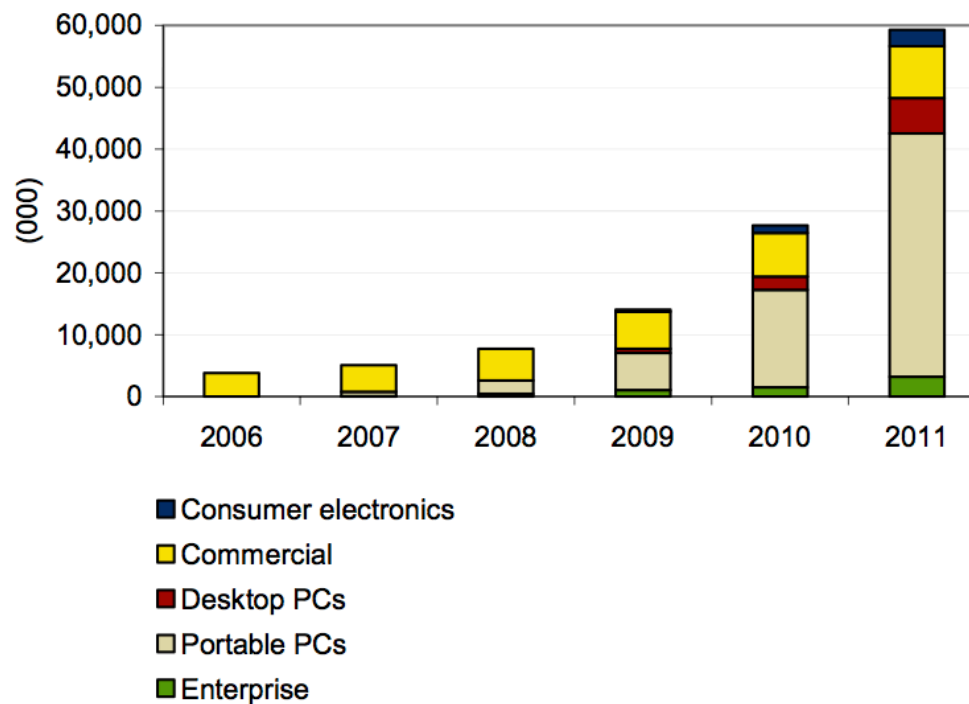
- Tiered Storage
  - Improved Read & Write Speeds
  - Mass Storage: Hard Drives



# Mobile Users

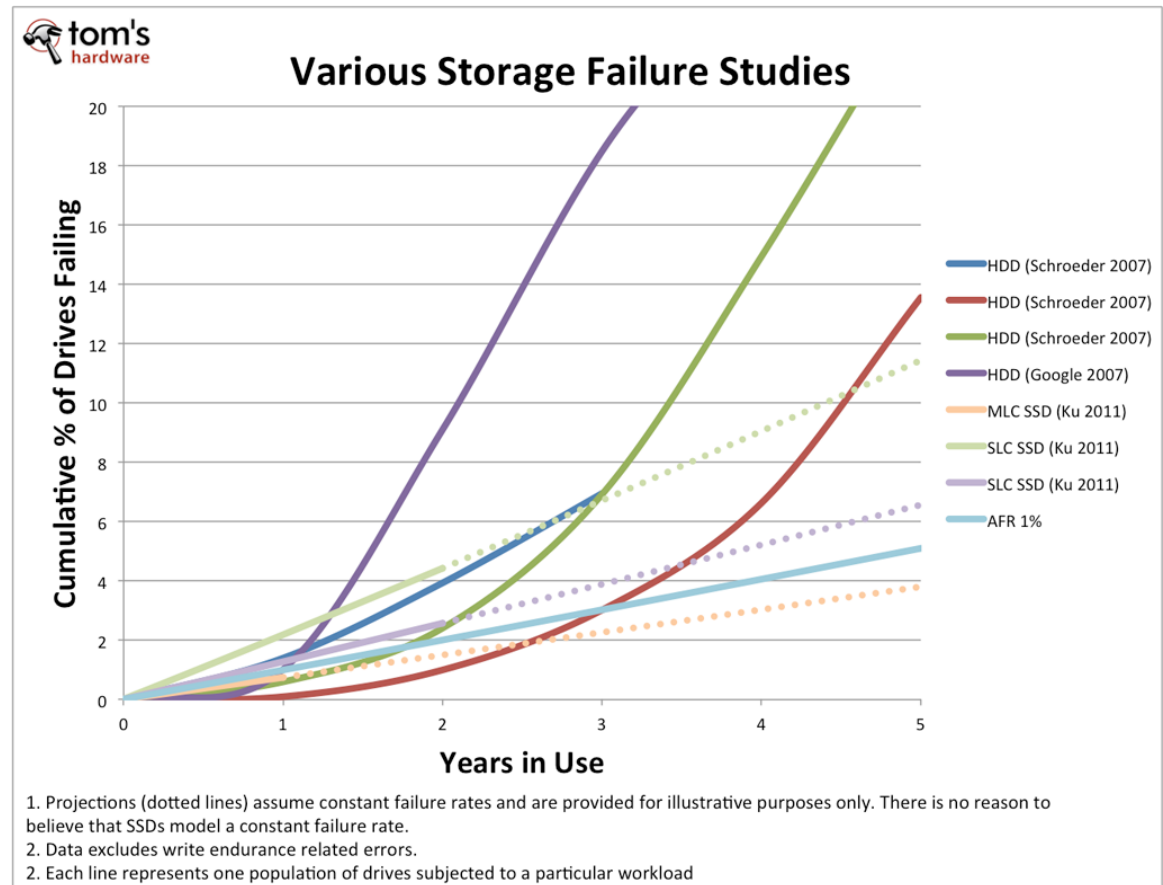
- Priorities for Mobile Users
  - Performance (87%)
  - Rugged
  - Power Savings
- Retaining Capacity
  - External Disk
  - NAS
  - mSATA

SSD Unit Shipments by Application, 2006–2011



# Enterprise Concerns

- SSD Reliability
  - High Tolerance For Harsh Environments
  - Long Term Media Reliability Not Well Understood
  - Error Codes





# Enterprise Concerns

- Declining Production of SLC
  - eMLC alternative?
- Endurance (JESD218)
  - TBW Is Loosely Defined
    - WA Depends on Usage Model
  - HDDs Have Unlimited Write Cycles

$$\text{Terabytes Written (TBW)} = \frac{\text{User Capacity in Bytes} * \text{Endurance in PE Cycles}}{2 * \text{Write Amplification} * 1,000}$$

# Enterprise Strategies

- Early Data, SSD Failure Models Are Not Different From HDD
  - Long-Term Data Unknown
- SSDs Have Lower Effective Failure Rate
  - Replace 1 SSD for 4 HDDs For Same Performance
- Drive Failure In RAID Increases Likelihood of Another Failure
  - Replace 1 SSD for 4 HDDs For Same Performance
- Forget RAID, Replicate Data Three Times, Google's File System
  - High I/O
  - High Reliability
  - Data Redundancy
  - Lower Cost of Simple Cluster File Replication

# Takeaway Points

- Consumers
  - Are willing to pay a premium for SSDs
  - Primarily buy SSDs for performance.
  - Prefer more control over performance
- Enterprise customers
  - Understand perfect SSDs don't exist
  - Are adopting new storage models
  - Waiting for long-term reliability data
  - Still cautious in adopting new technology
- Issues are directly tied to economic constraints
  - Until SSDs become as cheap as HDDs, these issues will persist.

# Questions?



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