IOPS: Changing Needs

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Objective Analysis
Outline

- The Survey
- Application Distribution
- Top-Level Survey Results: IOPS, Capacity and Latency
- Developing storage tiers
- Implications/Projections
- Authors & Sources
Our Survey

- Ongoing. Take our survey at: http://TinyURL.com/IOPSsurvey
- Asks for IOPS, capacity and latency needs
  - Also their primary applications
- Some results will appear in a SNIA SSSI white paper
- Full report, analyzing and interpreting the results, can be purchased online
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Applications: 2012

- Databases, 40%
- OLTP, 24%
- Cloud storage or services, 11%
- Scientific or Engineering, 10%
- Video Creation or Distribution, 7%
- Archiving and backup, 4%
- Mail server and mail storage, 4%

Databases are the largest category at 40%, followed by OLTP at 24%. Cloud storage or services account for 11%, and Scientific or Engineering applications take 10%. Video Creation or Distribution is 7%, Archiving and backup is 4%, and Mail server and mail storage is also 4%.
Applications: 2016

- Databases, 45%
- OLTP, 16%
- Archiving and backup, 9%
- Cloud storage or services, 7%
- Scientific or Engineering, 6%
- Video Creation or Distribution, 6%
- Mail server and mail storage, 4%

OLTP, 16%
Databases

- Large data sets
- Random traffic
- High I/O load
- Early SSD adopter
  - Previously used DRAM SSDs
- Some load the entire DB on flash memory
OLTP
(On-Line Transaction Processing)

- Verified writes
  - Write/read back
  - Doubles I/O load
- No room for errors
- Speed is imperative
  - Delays lose customers

Image courtesy of Square, Inc.
Archiving & Backup

- Snapshots and replication gaining momentum
  - Both require high-speed storage
- Business continuity places high demands on storage
- Active archives growing faster than passive archives
Cloud Storage/Services--Virtualization

- The “IO Blender”
  - Many streams
  - Scrambled I/O
  - Highly random
- Suits SSDs better than HDDs for rapid access
- Many VM and VDI systems using flash cache to meet demand speed needs

Image courtesy of Waring Corp.
Cloud Storage or Services

- Cloud storage is efficiently used
  - Cost-benefit is well understood (opex versus capex)
- Performance is a key differentiator
- Purchasers are more sophisticated
Science & Engineering

- Complex problems
  - Genome sequencing
  - CAD/CAM
  - Natural Resources
  - Nuclear modeling
- Large data sets
- Expensive talent
  - Don’t want them sitting around waiting
Video Creation or Distribution

- Large data sets
- Multiple video streams
  - Randomizes access
- High bandwidth required
- Expensive talent
  - Don’t want them sitting around waiting

Image courtesy of the US Library of Congress
Flash M&E revenue share is growing

2015

- Flash: 38%
- HDD: 55%
- Tape: 6%
- Optical: 1%

2021

- Flash: 51%
- HDD: 46%
- Tape: 3%

2016 Digital Storage in Media and Entertainment Report, Coughlin Associates
Growing use of flash memory in Media and Entertainment

2021 Projections

- Acquisition: 91.4%
- Post Production: 4.0%
- VOD: 4.6%
Exchange Server

- Multiple tasks
  - e-mail
  - Scheduling/calendars
  - Data storage
- Thousands of users
- Chaotic e-mail workload
  - Multiple mailboxes
  - Asynchronous sends & receives
  - Spam & virus filters

Image courtesy of Dell Computer
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37% increase in median IOPS Required
Capacity Required

17% increase in mean capacity required

Share of Responses

Capacity

1GB 10GB 50GB 100GB 500GB 1TB 5TB 10TB 50TB >50TB

2012 2016
Other Hardware IOPS Bottleneck

36% increase in mean IOPS Bottle

- Share of Responses
- IOPS

2012
2016
Fastest Latency the System Can Use

73% decrease in mean latency
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Touch rate versus response time indicating various types of uses.
Digital storage technologies overlaid on the Touch Rate chart

![Diagram of Technology Application Regions]

- **Flash**
- **Performance HDD**
- **Capacity HDD**
- **Hi IOPS**
- **Transaction**
- **Near Line**
- **SemiActive**
- **ColdActive**
- **Tape**
- **InActive**

**Response Time (s)**
- 1D
- 1H
- 100,000s
- 10,000s
- 1,000s
- 100s
- 10s
- 1s
- 100ms
- 10ms
- 1ms
- 100μs
- 10μs

**Touch/Y**
- 100,000
- 10,000
- 1,000
- 100
- 10
- 1
- 10%
- 1%
- 0.1%
HDD-Flash tiering/caching touch rate chart
How To View Latencies

- DRAM Access
  - One heartbeat
- SSD Access
  - 1,000 heartbeats
    - Walking a mile
- HDD Access
  - 1,000,000 heartbeats
    - Riding a bike from San Francisco to Miami

(Thanks to Jim Pappas for this analogy)
Memory & Storage Price vs. Bandwidth

From Objective Analysis: *Are Hybrid Drives Finally Coming of Age?*
Price/GB Roughly Follows IOPS
IOPS by Form Factor

HDD

SATA/SAS

NVMe/PCIe

Memory Channel

$10^2$  $10^3$  $10^4$  $10^5$  $10^6$  $10^7$
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Implications/Projections

- Users need more IOPS and capacity and lower latencies
- Increased SSDs adoption for higher IOPS
- HDDs filling a tier behind SSDs
- Other system elements become the bottleneck
  - Network, software, servers...
- Users focusing more attention on IOPS
  - Translates to growth for both SSDs and HDDs
Report Compiles Survey Results

- Full details can be purchased for immediate download at www.Objective-Analysis.com
- Orders can also be processed through Coughlin Associates at: http://www.TomCoughlin.com/techpapers.htm or by contacting Tom at:
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Your Presenters

Tom Coughlin, President, Coughlin Associates is a highly-respected storage analyst and consultant with over 30 years in the data storage industry in engineering and management at high profile companies.

Jim Handy is a widely recognized semiconductor analyst, has over 30 years in the electronics industry. His background includes marketing and design positions at market-leading suppliers.
Source Material

- **2016 How Many IOPS is Enough?**, Objective Analysis and Coughlin Associates
- Objective Analysis report: *Are Hybrid Drives Finally Coming of Age?*