This preview version does not show numerical data as presented in the Flash Memory Summit session. The cost to purchase a copy of the full presentation (which includes all numerical data) is $495. Contact cheryl.parker@itbrandpulse.com to order.
IT Brand Pulse

Year in Review

2015 Flash Brand Leaders

2015 Flash Adoption Trends
About Us

A trusted source to 20,000 IT pro subscribers for product testing, research, and analysis about data center infrastructure
IT Brand Pulse

Year in Review

2015 Flash Brand Leaders

2015 Flash Adoption Trends
6’7” 250 lb. Penguins
“[We] offer [TLC 3D NAND] SSDs at approximately the same price per gigabyte as high-end 15K HDDs and with up to 24 times performance improvement, up to six times the density, lower latency and lower power consumption”. – Dell, 7/21/15
Software Defined [Flash] Storage

Cost of 250TB Growing 25% Per Year

<table>
<thead>
<tr>
<th>Year</th>
<th>EMC VNXe 3200</th>
<th>NetApp E2700</th>
<th>NEC M110</th>
<th>Dot Hill Ultra56</th>
<th>SUSE Enterprise Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 1</td>
<td>$192,922</td>
<td>$60,206</td>
<td>$83,017</td>
<td>$55,979</td>
<td>$70,100</td>
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<tr>
<td>Year 2</td>
<td>$213,468</td>
<td>$87,838</td>
<td>$103,285</td>
<td>$64,493</td>
<td>$76,579</td>
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<td>Year 3</td>
<td>$242,108</td>
<td>$144,718</td>
<td>$130,975</td>
<td>$87,555</td>
<td>$84,825</td>
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<tr>
<td>Year 4</td>
<td>$308,338</td>
<td>$196,890</td>
<td>$178,055</td>
<td>$104,713</td>
<td>$96,238</td>
</tr>
<tr>
<td>Year 5</td>
<td>$380,010</td>
<td>$261,622</td>
<td>$225,203</td>
<td>$123,774</td>
<td>$108,607</td>
</tr>
</tbody>
</table>
Flash reliability breaks out

- **WARRANTY**
  - 5 YEARS PERIOD

- **WARRANTY**
  - 10 YEARS

Logos of HP, Samsung, Teqile, SanDisk, Kingston, and Corsair.
Enterprise IT OEM public clouds rolled back out as fast as they rolled in
I believe the hottest storage company over the last year was:

- EMC
- Nimble Storage
- NetApp
- Pure Storage
- Amazon
- VMware
- SanDisk
- IBM
- Google
- HP
- Nutanix
- SolidFire
- Samsung
- Seagate
- Other (please specify)
- Tegile
- Microsoft
- Western Digital
- Micron
- Kaminario
- Red Hat
- Violin Memory
- HDS
The Symbols for IT Brand Leadership

Servers

Storage

Networking

Operating Systems

Converged Systems

Chips
Select List of Survey Respondents

AHCCCS
AHIP
Alba Health
Alliant Techsystems
American Airlines
AOL
Aramco
Argonne National Labs
Assurant
Astoria Bank
ATPCO
AT&T
Attorneys Title Fund Services
Bank of America
Baylor College of Medicine
Bellin
Berkshire Capital Securities
Biotek
Booz Allen Hamilton
Boston Dynamics
CA Traffic Safety Institute
Capital One
Christus Health
Chubb
Criminal Justice Institute
Colliers L&A
DARPA
Delta Airlines
Department of Defense
Disney Interactive
Duke University
Duquesne University
Employment Development Dept.
Entercom
Ernst and Young
Expedia
Exxon Mobil
Fermilab
Ford Motor
Fluor
GE
General Motors
Gulfstream Aerospace
Houghton Mifflin Harcourt
Independence Blue Cross
Intuitive Surgical (ISRG)
ITG
JP Morgan Chase
Kaspersky Lab
Kingston Technology
Lockheed Martin Space Systems
Monsanto
Morgan Stanley
NASA Ames Research Center
National Institute of Health
Nationwide Insurance
Navistar
NAVMISSA
New York Life
Nielsen
NYSE
Omnicon
Owens Corning
Philips
Pitney Bowes
Planar Systems, inc.
Polycom, Inc.
Pratt & Whitney
Providence Health
Prudential
Purdue University
Reallusion
REI
Sandia National Labs
Siemens
Social Security Administration
Sony Online Entertainment
St. Luke’s Hospital
State of PA (Security)
Target
TD Bank
The Children’s Hospital of Philadelphia
The Forum Corporation
The University of Chicago
T-Mobile
TMX
Transamerica
UCSB
UBS
United Airlines
United Health Services
United Nations Federal Credit Union
Universal Parks and Resorts
USC Marshall School of Business
Verizon
Virginia Tech
Walmart
Wells Fargo
Yale University
## 2015 Flash Storage Brand Leader Survey Results

### Brand Leaders

<table>
<thead>
<tr>
<th>Category</th>
<th>Market Leader</th>
<th>Price Leader</th>
<th>Performance Leader</th>
<th>Reliability Leader</th>
<th>Service Leader</th>
<th>Innovation Leader</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Flash Converged System</td>
<td>HP</td>
<td>HP</td>
<td>HP</td>
<td>HP</td>
<td>HP</td>
<td>HP</td>
</tr>
<tr>
<td>All Flash Fibre Channel Array</td>
<td>EMC</td>
<td>Dell</td>
<td>HP</td>
<td>IBM</td>
<td>EMC</td>
<td>IBM</td>
</tr>
<tr>
<td>All Flash Hyperconverged System</td>
<td>Nutanix</td>
<td>HP</td>
<td>Nutanix</td>
<td>HP</td>
<td>HP</td>
<td>Nutanix</td>
</tr>
<tr>
<td>All Flash InfiniBand Array</td>
<td>NetApp</td>
<td>IBM</td>
<td>NetApp</td>
<td>IBM</td>
<td>IBM</td>
<td>NetApp</td>
</tr>
<tr>
<td>All Flash iSCSI Array</td>
<td>Dell</td>
<td>Dell</td>
<td>Dell</td>
<td>Dell</td>
<td>Dell</td>
<td>Dell</td>
</tr>
<tr>
<td>All Flash NAS Array</td>
<td>NetApp</td>
<td>NetApp</td>
<td>NetApp</td>
<td>NetApp</td>
<td>NetApp</td>
<td>NetApp</td>
</tr>
<tr>
<td>All Flash PCIe Adapter</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
</tr>
<tr>
<td>All Flash Unified SAN/NAS Array</td>
<td>NetApp</td>
<td>NetApp</td>
<td>NetApp</td>
<td>NetApp</td>
<td>EMC</td>
<td>NetApp</td>
</tr>
<tr>
<td>Flash Caching Software</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
</tr>
<tr>
<td>Hybrid HDD/SSD Array</td>
<td>EMC</td>
<td>HP</td>
<td>EMC</td>
<td>EMC</td>
<td>EMC</td>
<td>Nimble Storage</td>
</tr>
<tr>
<td>Memory Channel Storage</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
<td>SanDisk</td>
</tr>
<tr>
<td>SAS/SATA SSD Module</td>
<td>Samsung</td>
<td>Seagate</td>
<td>Samsung</td>
<td>Samsung</td>
<td>Seagate</td>
<td>Samsung</td>
</tr>
<tr>
<td>SSD Controller Chip</td>
<td>Intel</td>
<td>Intel</td>
<td>Intel</td>
<td>Intel</td>
<td>Intel</td>
<td>Intel</td>
</tr>
</tbody>
</table>
IT Strategy
My company's storage strategy for frequently-accessed data from our core business applications is:

- All data is stored in our own data center(s), managed by our IT organization.
- Some data is stored in our own data center(s), managed by our IT organization -- some is stored in the cloud.
- Some data is stored in our own data center(s), managed by a managed service provider -- some is stored in the cloud.
- All data is stored in our own data center(s), managed by a managed service provider.
My organization uses the following SSD strategies (select all that apply):

- Add SSD to disk arrays because we trust our disk array products and vendors, and we are familiar with how to deploy and manage them
- Use SAN based SSD arrays because the performance is much better than disk-based SAN arrays and it can be shared by all servers
- Use disk-based storage because SSD is too expensive
- Use server based SSD because it is closest to the processor thus offering the absolute best performance
- Server-based flash because our software defined storage software uses only server-based storage.
- Other (don't know)
My organization plans to completely replace HDDs and deploy SSD as primary storage:

- Never. It will always be more expensive than HDD and be used only for applications which can justify the added cost.
- When SSDs are the same $/GB of HDDs.
- When SSDs are within 10% of the $/GB of HDDs.
- When SSDs are within 20% of the $/GB of HDDs.
- When SSDs are within 30% of the $/GB of HDDs.
- When SSDs are within 40% of the $/GB of HDDs.
- When SSDs are within 50% of the $/GB of HDDs.
Percent of servers in my environment accessing some type of SSD storage:

- **Today**
- **12 months from now**
- **24 months from now**

![Graph showing percent of servers accessing SSD storage over time](image)
SSD will comprise approximately this percentage of my organization’s combined SSD and HDD disk capacity:

- **Today**: 
  - 2015: 
  - 2014: 
  - 2013: 
  - 2012: 

- **12 months from now**: 
  - 2015: 
  - 2014: 
  - 2013: 
  - 2012: 

- **24 months from now**: 
  - 2015: 
  - 2014: 
  - 2013: 
  - 2012: 

2X
IT Purchases
My organization has deployed the following types of SSD products (select all that apply):

- Added to a storage array
- Fibre Channel interface SAN SSD
- SAS/SATA inside server
- iSCSI interface SAN SSD
- Ethernet interface NAS SSD shared by servers
- PCI Express SSD card installed inside servers
- DIMMs with flash memory inside servers
- Have not deployed SSDs
- Other
I purchased the following brands of flash storage in the last year:

1. EMC
2. SanDisk
3. NetApp
4. HP
5. IBM
6. Seagate
7. Dell
8. Pure Storage
9. Intel
10. Samsung

Other:
- Western Digital
- Cisco/Whiptail
- Toshiba
- HDS
- Nimbus
- SolidFire
- Oracle
- Kaminario
- Violin Memory

I did not purchase an SSD product.
I purchased the following brands of enterprise flash storage in the last year (select all that apply):

<table>
<thead>
<tr>
<th></th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Intel</td>
<td>_%</td>
<td>Dell</td>
<td>_%</td>
</tr>
<tr>
<td>2</td>
<td>SanDisk</td>
<td>_%</td>
<td>Western Digital</td>
<td>_%</td>
</tr>
<tr>
<td>3</td>
<td>HP</td>
<td>_%</td>
<td>Samsung</td>
<td>_%</td>
</tr>
<tr>
<td>4</td>
<td>Toshiba</td>
<td>_%</td>
<td>Intel</td>
<td>_%</td>
</tr>
<tr>
<td>5</td>
<td>EMC</td>
<td>_%</td>
<td>HP</td>
<td>_%</td>
</tr>
<tr>
<td>6</td>
<td>IBM</td>
<td>_%</td>
<td>SanDisk</td>
<td>_%</td>
</tr>
<tr>
<td>7</td>
<td>Seagate</td>
<td>_%</td>
<td>Toshiba</td>
<td>_%</td>
</tr>
<tr>
<td>8</td>
<td>Dell</td>
<td>_%</td>
<td>Seagate</td>
<td>_%</td>
</tr>
<tr>
<td>9</td>
<td>Western Digital</td>
<td>_%</td>
<td>NetApp</td>
<td>_%</td>
</tr>
<tr>
<td>10</td>
<td>Samsung</td>
<td>_%</td>
<td>EMC</td>
<td>_%</td>
</tr>
<tr>
<td></td>
<td>Did not purchase SSD product</td>
<td>_%</td>
<td>Did not purchase SSD product</td>
<td>_%</td>
</tr>
</tbody>
</table>
I will purchase the following brands of flash storage in the **next 12 months**:

- EMC
- NetApp
- HP
- IBM
- Pure Storage
- Dell
- Samsung
- SanDisk
- Seagate
- Intel
- Western Digital
- SolidFire
- Nimbus
- Other
- HDS
- Toshiba
- Cisco/Whiptail
- Violin Memory
- Oracle
- Kaminario

Have not decided yet which SSD brand to...

I will not purchase an SSD product
The most strategic (irreplaceable) component of a complete SSD storage solution is the:

- System availability applications such as snap-shot, replication and path management (failover).
- SSD hardware system
- Storage management applications such as auto-tiering, de-duplication and thin provisioning.
- The SSD controller within the hardware system.
- SSD driver and device management software
- Other

![Graph showing the most strategic components over years](image-url)
The following type of server most driving the adoption of SSD in my environment is:

- Database servers
- Virtualized servers with an aggregation of I/O from multiple VMs/applications
- Virtual Desktop Servers
- File servers
- Web Servers
- Analytic app servers
- Email servers
- Video servers
- eCommerce app servers
- VoIP servers
- Other
When I purchase HDD and SSD storage, I factor in compression, de-duplication and thin-provisioning to calculate my price per "usable" gigabyte:

- Sometimes, if I'm comparing systems with and without
- Absolutely, every time
- Never, I just compare basic price per gigabyte
- Other

<table>
<thead>
<tr>
<th>2015</th>
<th>2014</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2015 Flash Memory Summit
The most important feature of an SSD for my environment is:

- Performance (IOPs)
- Cost per gigabyte
- Interoperability with existing storage systems and software
  - The endurance in terms of number of writes
  - The cost per IOP
- The same brand as my existing storage systems
- Other
- The brand of SSD Controller (Intel, LSI/SandForce, etc.)
- The type of NAND Flash (MLC or SLC)
My organization's strategy for SSDs vs. High RPM Drives:

- **Replace high RPM drives with SSD for select workloads**
- **Completely replace high RPM drives with SSD for I/O intensive workloads**
- **Continue to use high RPM drives for I/O intensive workloads**
- **Not sure/don't know**
- **Other**

SSDs with the following type of NAND Flash are best suited for my environment:

- **Multi-Level Cell (MLC)** for lower cost
- **Single-Level Cell (SLC)** for highest performance and write endurance
- **Don’t know**
- **Triple-level Cell (TLC) 3D NAND** for higher capacity and lowest cost
- **Other**
My experience with SSD so far (all that apply):

My SSD performs just like they said it would.

So far my SSD systems have been as reliable or more reliable than my HDD-based storage.

I estimate the total cost of ownership of my SSD is more than my HDD-based storage.

Managing an SSD is less hassle than managing HDD-based storage I’ve had in the past.

I estimate the total cost of ownership of my SSD is actually less than my HDD-based storage.

I have no experience with SSD

My SSD has not performed as well as they said it would.

Managing an SSD is just as much hassle, if not more, than managing HDD-based storage I’ve had in the past.

Other

So far my SSD systems have been less reliable than my HDD-based storage.

2015 2014 2013
What I value most from SSDs is:

- Deployment is simplified when I meet my I/O performance needs with one SSD versus many HDDs
- System availability is higher because SSDs don’t fail as often as HDDs do
- Service is simplified because SSDs don’t fail as often like HDDs do
- Management is simplified because I don’t need to configure HDDs with different speeds.
- Management is simplified because I don’t need to configure LUNs with different quantities of HDDs needed to accumulate the IOs needed.
- Management is simplified because I don’t need to load balance HDDs
- Other
A substantially longer warranty period for SSD storage systems is a strong indicator that SSD technology is more reliable than HDD storage systems. I believe this is:

![Bar chart showing the perception of SSD reliability over years]

- Not true
- Somewhat true
- Absolutely true
- Other

Colors represent the years:
- Blue: 2015
- Yellow: 2014
- Red: 2013
I believe the warranty periods for all-flash arrays are:

- The same as the warranty period for disk arrays
- Longer than the warranty period for disk arrays
- Shorter than the warranty period for disk arrays
- Don't know
- Other
New Technology
This best describes where I'm at with adoption of these new flash storage related technologies:

<table>
<thead>
<tr>
<th>I have not heard of it.</th>
<th>Memory Channel</th>
<th>3D NAND/TLC</th>
<th>DSSD</th>
<th>Hyperconverged systems</th>
<th>Software defined storage</th>
<th>NVM Express (NVMe)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>_%</td>
<td>_%</td>
<td>_%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I am aware of it, but I have no interest.</th>
<th>Memory Channel</th>
<th>3D NAND/TLC</th>
<th>DSSD</th>
<th>Hyperconverged systems</th>
<th>Software defined storage</th>
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<td>_%</td>
<td>_%</td>
<td>_%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I have heard of it, but I have not investigated.</th>
<th>Memory Channel</th>
<th>3D NAND/TLC</th>
<th>DSSD</th>
<th>Hyperconverged systems</th>
<th>Software defined storage</th>
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<td>_%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I plan on evaluating it / products using it.</th>
<th>Memory Channel</th>
<th>3D NAND/TLC</th>
<th>DSSD</th>
<th>Hyperconverged systems</th>
<th>Software defined storage</th>
<th>NVM Express (NVMe)</th>
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</thead>
<tbody>
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<td>_%</td>
<td>_%</td>
<td>_%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>I am evaluating it / products using it.</th>
<th>Memory Channel</th>
<th>3D NAND/TLC</th>
<th>DSSD</th>
<th>Hyperconverged systems</th>
<th>Software defined storage</th>
<th>NVM Express (NVMe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>_%</td>
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</tr>
</tbody>
</table>
I see Software Defined Storage as a technology that:

Will emerge as a class of storage virtualization software separate from the storage hardware—and more important than the commodity storage hardware.

Not sure/don't know

Is an inseparable feature of an enterprise storage "solution"

Other
Some SSD products are "programmable" so they fit into a software defined storage environment. Other SSD products have most functions embedded in the controller hardware. What is best for my organization in the future is:

- Controller hardware based SSD for a more plug-and-play storage.
- Programmable SSD for flexible software defined storage -- but we want vendors to do the programming in their apps.
- Programmable SSD for flexible software defined storage -- and we will do the programming.
- Other
There are different types of Flash Memory (MLC, SLC, TLC, etc.) with new characteristics that define how it works in the data center (wear leveling, write endurance, etc.):

I want to know about flash memory technology and intend to do a deep dive into the technology.

I have already done a deep dive into flash memory technology and am very familiar with it.

I don't want to know that much about flash memory technology -- and I will rely on my storage vendor to have a deep understanding of the technology.

I don't want to know that much about flash memory technology -- but I feel I need to do a deep dive to understand what I'm buying in the future.

Other

2015
2014
2013
There are different types of Flash Storage systems (All Flash Arrays, Hybrid Arrays, PCIe cards, etc.) with new characteristics that define how they work in the data center (software defined vs. plug-and-play SSD, captive PCIe vs. shared PCIe SSD, permanent storage vs. cache, etc.). I:

- Want to know about flash storage systems and intend to do a deep dive into their architectures.
- Have already done a deep dive into flash storage systems and am very familiar with them.
- Don't want to know that much about flash storage systems -- but I feel I need to do a deep dive to understand what I’m buying in the future.
- Don't want to know that much about flash storage systems -- and I will rely on my storage vendor to have a deep understanding of the right system for the application.
- Other
Percent of my overall storage that is in the cloud:

- Today
- 12 months from now
- 24 months from now

Comparison between 2014 and 2015.
My organization's strategy for enterprise-class SSD-backed cloud storage is best described as:

- We are planning to use enterprise-class cloud...
- We have no plans to use enterprise-class cloud...
- Not sure/don't know
- We are using use enterprise-class cloud storage with SSD.
- Other

![Bar Chart](chart.png)
I would expect the AVAILABILITY of SSD storage in my data center to be:

- Higher than SSD cloud storage
- The same as SSD cloud storage
- Lower than SSD cloud storage
- Other
I would expect the PERFORMANCE of SSD storage in my data center to be:

- Lower than SSD cloud storage
- Higher than SSD cloud storage
- The same as SSD cloud storage
- Other

2015
2014
I would expect the COST of SSD storage in my data center to be:

- Lower than SSD cloud storage
- Higher than SSD cloud storage
- The same as SSD cloud storage
- Other

2015

2014
I would expect the CONTROL of SSD storage in my data center to be:

- Higher than SSD cloud storage
- The same as SSD cloud storage
- Lower than SSD cloud storage
- Other

Comparison between 2015 and 2014.
My Thoughts
Enterprise HDD Units Flat-to-Down

Millions

1Q14 2Q14 3Q14 4Q14 1Q15 2Q15 3Q15 4Q15
Time to start thinking about the next big thing

Pivotal time for HDD market. Flash market maturing fast.

Everyone Grows

Overnight success

The hard yards
OEMs fully armed for air, sea & land flash assault
Enterprise Flash Market
Growing profitably was tough
The first stumble
IT as a Service Market

Traditional IT Market
Software Define Storage Ascends over 10 Years

Commercial versions of Enterprise SDS

SDS Apps
Storage-as-a-Service
White Box Servers

Public Cloud

Private Cloud

Enterprise SDS

On Premise

Traditional Enterprise Storage

Source: Wikibon and IT Brand Pulse
Past: Enterprise HW Defined Ecosystem

Cisco & Dwarves

Vendor NOS
Orchestration Monitoring

Appliances
Router
Firewall
Load Balancer
Etc.

EMC & Dwarves

Vendor Storage Software
Failover
DeDup
Compression
Etc.

Vendor Switch
Switch OS

Vendor or Merchant Switch ASIC

Vendor Storage System
Block, File, Object

Vendor Server

Merchant Server OS

Hypervisor

EMC

Hypervisor

Block, File, Object

Vendor Storage System

Merchant Server Processor

EMC

Merchant Server Processor

Hypervisor

KVM

HP, IBM, Dell, Lenovo

CISCO

EMC

KVM

CISCO

EMC

CISCO

EMC
Future: Enterprise SW Defined Ecosystem

Cloud Platform

Software Defined Storage
- Block
- File
- Object
- Failover, Dedup, Compression

Hypervisor

SDN
- Orchestration
- Controller
- Switches
- Monitoring

NFV
- Router
- Firewall
- Load Balancer
- Etc.

Software Defined Storage
- Block
- File
- Object
- Failover, Dedup, Compression

Hypervisor

Merchant Switch OS

White Box Switch

Bare Metal Switch

Merchant Switch ASIC

Merchant Server OS

White Box Server

Bare Metal Server

Merchant Server Processor
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This preview version does not show numerical data as presented in the Flash Memory Summit session. The cost to purchase a copy of the full presentation (which includes all numerical data) is $495. Contact cheryl.parker@itbrandpulse.com to order.