External Storage for IBM i

Sue Baker
IBM Power Systems Advanced Technical Skills
smbaker@us.ibm.com

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Terminology and abbreviations

- **CEC** – Central Electronics Complex.
  - Refers to the processor enclosures for POWER5/5+, POWER6/6+, and POWER7 systems.
  - 520, 550, 710, 720, 730, 740, and 750 systems have a single enclosure
  - 560, 570, 770, and 780 systems have 1 or more enclosures.
- **DAS** – Direct Attach Storage
- **HSL** – High Speed Link – POWER4 thru POWER6 I/O bus interconnect, same as RIO but called HSL when used on System i
- **IOA** – Input/Output Adapter
- **IOP** – Input/Output Processor
- **LIC** – Licensed Internal Code, part of IBM i operating environment
- **NPIV** – N_Port ID Virtualization, aka virtual fibre channel
- **PCIe** – PCI Express – latest and fastest enhanced PCI card and slot
- **PCI-x** – PCI eXtended – enhanced PCI card and slot
- **RIO** – Remote I/O – POWER4 thru POWER6 I/O bus interconnect, same as HSL but called RIO when used on System p
- **SAN** – Storage Area Network
- **SAS** – Serial Attached SCSI
- **SCSI** – Small Computer System Interface
- **SFF** – Small Form Factor – 2.5” HDDs or SSDs
- **SmartIOA** – an IOA which doesn’t require an IOP, reducing card slot usage and cost
- **SSD** – Solid State Drive
- **vFC** – virtual Fibre Channel, aka NPIV
- **VIOC** – virtual I/O Client
- **VIOS** – Virtual I/O Server
- **vSCSI** – virtual SCSI
- **12X** – IBM’s implementation of InfiniBand bus interconnect for Power servers
IBM Power® Systems storage for IBM i

Historically

High End
Mid Range
Entry

SAN attached

Direct Attached Storage (DAS) (Integrated)

Today

High End
Mid Range
Entry

SAN attached

Virtualized

Combining HDDs and SSDs

DAS (Integrated)
Storage Management Styles – IBM i Compared To ...

Object A  Object B  Object C  Object D

IBM i
Storage Management
I/O
System ASP
DAS, SAN attached, or virtual

Boot & OS
'C'

'G'  'H'  'I'  'J'  'K'  'L'
PGMs
DB
Page

Unix  Linux  Windows

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SAN attached disk storage servers for IBM i

[Diagram showing various IBM storage devices and their connections]

A summary of supported storage is available at
http://www-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/PRS4563
## DS family of storage devices from IBM

<table>
<thead>
<tr>
<th>Systems</th>
<th>DS3000</th>
<th>DS4000</th>
<th>DS5000</th>
<th>DS6000</th>
<th>DS8000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>POWER7 BladeCenter</td>
<td>POWER6 BladeCenter</td>
<td>POWER6 BladeCenter</td>
<td>POWER6 BladeCenter</td>
<td>POWER6 BladeCenter</td>
</tr>
<tr>
<td>Server connectivity</td>
<td>SAS*, 4Gb or 8Gb fibre channel</td>
<td>4Gb fibre channel</td>
<td>4/8Gb fibre channel</td>
<td>1Gb or 2Gb fibre channel</td>
<td>2Gb, 4Gb, or 8Gb fibre channel</td>
</tr>
<tr>
<td>Cache</td>
<td>512 MB to 48 GB</td>
<td>2 to 4 GB</td>
<td>2 to 64 GB</td>
<td>4 GB</td>
<td>16 to 1024 GB</td>
</tr>
<tr>
<td>RAID support</td>
<td>0, 1, 3, 5, 6, 10</td>
<td>0, 1, 3, 5, 6, 10</td>
<td>0, 1, 3, 5, 6, 10</td>
<td>5, 10</td>
<td>5, 6, 10</td>
</tr>
<tr>
<td>SSDs</td>
<td>No</td>
<td>no</td>
<td>Yes</td>
<td>No</td>
<td>yes</td>
</tr>
<tr>
<td>HDDs</td>
<td>SAS 15K, SATA 7200</td>
<td>FC 15K, SATA 7200</td>
<td>SAS 10K, FC 15K, SATA 7200</td>
<td>FC 15K, FATA 7200</td>
<td>FC 15K, FATA 7200</td>
</tr>
<tr>
<td>Maximum drive count (varies by specific model)</td>
<td>360</td>
<td>varies</td>
<td>448</td>
<td>128</td>
<td>1536</td>
</tr>
</tbody>
</table>

Notes:
- DS5000, DS6000, and DS8000 can be natively connected to IBM i.
  - DS5000 native connect to IBM i excludes IBM DS5020, requires IOP-less adapters, and requires LIC 6.1.1 or later.
- SSD backed LUNs can be created on DS8000, DS5100, and DS5300. Requires LIC 6.1.1 or later.
- DS3000 SAS connection limited to Power blades.
## More SAN attached storage from IBM

<table>
<thead>
<tr>
<th></th>
<th>XIV</th>
<th>SVC</th>
<th>Storwize V7000</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Systems</strong></td>
<td>POWER6</td>
<td>POWER6</td>
<td>POWER6</td>
</tr>
<tr>
<td></td>
<td>POWER7</td>
<td>POWER7</td>
<td>POWER7</td>
</tr>
<tr>
<td></td>
<td>BladeCenter</td>
<td>BladeCenter</td>
<td>BladeCenter</td>
</tr>
<tr>
<td><strong>Server connectivity</strong></td>
<td>iSCSI, 4Gb or 8Gb fibre channel</td>
<td>1Gb iSCSI, 4/8Gb fibre channel</td>
<td>8 Gb fibre channel and 1 Gb iSCSI</td>
</tr>
<tr>
<td><strong>Cache</strong></td>
<td>48 to 120 GB</td>
<td>24 to 96 GB</td>
<td>4 to 16 GB</td>
</tr>
<tr>
<td><strong>RAID support</strong></td>
<td>data mirroring</td>
<td>provided by attached disk subsystem</td>
<td>RAID 0, 1, 5, 6, and 10</td>
</tr>
<tr>
<td><strong>SSDs</strong></td>
<td>as cache device</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>HDDs</strong></td>
<td>SATA 7200</td>
<td>provided by attached disk subsystem</td>
<td>SAS 10K, SAS 15K, SAS 7200</td>
</tr>
<tr>
<td><strong>Maximum quantity of drives (varies by specific model)</strong></td>
<td>180</td>
<td>Attached subsystem limits</td>
<td>240&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

### Notes:
- None of these storage solutions can be natively connected to IBM i. In other words, all require VIOS.
- EasyTier must be 7 utilized for SSDs in SVC or Storwize v7000.
- Maximum of 960 drives in a clustered environment.
What do you consider when facing a storage decision?
## Overview of fibre adapters (HBAs) for SAN attached storage

<table>
<thead>
<tr>
<th>Power Systems generation:</th>
<th>5 &amp; 5+</th>
<th>6 &amp; 6+</th>
<th>7 &amp; 7+</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOP based fibre adapters</td>
<td></td>
<td></td>
<td><img src="image" alt="Note" /></td>
</tr>
<tr>
<td>– Requires HSL loop technology</td>
<td></td>
<td></td>
<td><img src="image" alt="Note" /></td>
</tr>
<tr>
<td>– Only available in PCI-x technology</td>
<td></td>
<td></td>
<td><img src="image" alt="Note" /></td>
</tr>
<tr>
<td>PCI-x single port or dual port 4Gb (IOP-less)(^1,2,3)</td>
<td></td>
<td><img src="image" alt="Note" /></td>
<td><img src="image" alt="Note" /></td>
</tr>
<tr>
<td>– Cannot be used for IBM i load source on POWER5/5+ systems</td>
<td></td>
<td><img src="image" alt="Note" /></td>
<td><img src="image" alt="Note" /></td>
</tr>
<tr>
<td>– Cannot be used for tape on POWER5/5+ systems running IBM i</td>
<td></td>
<td><img src="image" alt="Note" /></td>
<td><img src="image" alt="Note" /></td>
</tr>
<tr>
<td>PCIe single port or dual port 4Gb (IOP-less) (^1)</td>
<td></td>
<td><img src="image" alt="Note" /></td>
<td><img src="image" alt="Note" /></td>
</tr>
<tr>
<td>PCIe dual port 8Gb (IOP-less) – NPIV capable (^1)</td>
<td></td>
<td><img src="image" alt="Note" /></td>
<td><img src="image" alt="Note" /></td>
</tr>
<tr>
<td>PCIe quad port 8Gb – NPIV capable (^1,5)</td>
<td></td>
<td><img src="image" alt="Note" /></td>
<td><img src="image" alt="Note" /></td>
</tr>
<tr>
<td>PCIe Fibre Channel over Ethernet (FCoE) – NPIV capable (^1,4)</td>
<td></td>
<td><img src="image" alt="Note" /></td>
<td><img src="image" alt="Note" /></td>
</tr>
<tr>
<td>GX++ 2-port 16Gb Fibre Channel Adapter (^1,6)</td>
<td></td>
<td><img src="image" alt="Note" /></td>
<td><img src="image" alt="Note" /></td>
</tr>
<tr>
<td>GX++ 2-port 10Gb FCoE CNA SR Optical Adapter (^1,6)</td>
<td></td>
<td><img src="image" alt="Note" /></td>
<td><img src="image" alt="Note" /></td>
</tr>
</tbody>
</table>

### Notes:
1. IOP-less adapters require IBM i 6.1 or 7.1
2. IOP-less PCI-x single port adapter is not supported by IBM i.
3. IOP-less PCI-x dual port adapter have unique feature codes for AIX, Linux, PowerVM, and IBM i.
4. IBM i requires VIOS to utilize FCoE adapter.
5. Requires PCIe generation 2 I/O slot.
6. GX++ adapters only available on POWER7 795 systems.
What do you consider when facing a storage decision?

- Server Platform
- Operating system
- Availability needs (HA/DR)
- Cost
- Performance
- RAID-5
- Hot spare?
- Mirrored / RAID-10
- RAID-6
- Virtual or Native
- Physical planning

What do you consider when facing a storage decision?
Virtualizing storage hardware for partitions on traditional servers

- **IBM i hosting**
  - Disk storage resources owned by an IBM i partition, used by secondary partitions (AIX®, IBM i, Linux, and/or Windows)
  - DAS or SAN attached storage
  - HMC usually required
  - Can mix virtual and direct I/O in client partitions

- **Virtual I/O Server (VIOS) hosting**
  - Disk storage resources owned by VIOS partition, used by secondary partitions (AIX, IBM i, Linux)
  - DAS or SAN attached storage
  - Virtual SCSI or virtual fibre channel (NPIV)
  - HMC usually required
  - Can mix virtual and direct I/O in client partitions
Virtualizing storage with IBM i or VIOS

- Single IBM i or VIOS host provides access to SAN or DAS storage
  - AIX, IBM i, or Linux client partitions
  - Protect data via RAID-5, RAID-6, or RAID-10

- Redundant IBM i or VIOS hosts provide access to SAN or DAS storage
  - AIX, IBM i, and Linux client partitions
  - Client LPAR protects data via mirroring
  - Two sets of disk and adapters

- Redundant VIOS hosts multiple paths to attached SAN storage with MPIO
  - AIX, IBM i, and Linux client partitions
  - One set of disk
N_Port ID Virtualization (NPIV) – aka virtual Fibre Channel (vFC)

- N_Port ID Virtualization (NPIV) provides direct Fibre Channel connections from client partitions to SAN resources, simplifying SAN management
  - Physical fibre channel adapter (IOA) is owned by VIOS partition
  - Supported with PowerVM Express, Standard, and Enterprise Edition
  - Supports AIX 5.3, AIX 6.1, AIX 7.1, IBM i 6.1, IBM i 7.1, and Linux
  - POWER6 or POWER7 systems with 8Gb PCIe fibre channel adapter, 10Gb Fibre Channel over Ethernet (FCoE) adapter, or 16Gb fibre channel adapter

IBM i requires:
- LIC 6.1.1 or LIC 7.1
- DS8000/DS5100/DS5300 storage subsystem and/or
- Supported tape/tape library devices
Virtualization – today and in the future
Contemporary PCI Virtualization on POWER

IO Bus Virtualization with Dedicated Adapters

- LPAR A
  - Physical Adapter
  - PCI adapter
  - Port
  - Func
- LPAR B
  - Physical Adapter
  - PCI adapter
  - Port
  - Func
- Hypervisor
- Fabric

IO Adapter Virtualization with VIO Server

- LPAR A
  - Virtual Adapter
  - Server
  - Virtual Adapter
  - Server
  - Physical Adapter
  - PCI adapter
  - Port
  - Func
- LPAR B
  - Virtual Adapter
  - Server
  - Virtual Adapter
  - Server
  - Physical Adapter
  - PCI adapter
  - Port
  - Func
- VIOS LPAR
- Virtual Fabric
- Hypervisor

Increasing Adapter BW & Increasing LPAR Density per Slot
In the not too distant future ….

**IO Adapter Virtualization with SR-IOV**
When VIOS virtualizes hardware for IBM i, you can

- Utilize Live Partition Mobility
- Utilize active memory sharing
- Utilize VMControl via Systems Director to rapidly provision new LPARs
- Utilize Shared Storage Pools
- Utilize Remote Restart RPQ
- Upgrade to POWER7+ without upgrading to IBM i 7.1
- Save $$ by:
  - Reducing the quantity of adapters, which
  - Reduces card slot requirements, which
  - Reduces I/O expansion unit requirements, which
  - Reduces U’s of rack space, which
  - Reduces number of racks on the floor
  - Potentially eliminates need for loops, which can change the model purchased (SWMA savings!)
What do you consider when facing a storage decision?
IBM i resiliency and replication solutions

Software replication
- Vendor provided logical replication software
- Domino clusters
- Storage and virtualization agnostic

Operating system delivered resiliency and replication
- PowerHA Switchable IASPs and devices (requires DAS)
- PowerHA Geographic Mirroring replication
- Admin Domain (security and config data)
- Mostly storage agnostic

External storage resiliency
Basic external storage resiliency
- Full system copy (cloning)
- Crash consistent copy
IASP with external storage resiliency
- PowerHA plus Advanced Copy Services (ACS)
- DS8000 LUN Level Switching

DS = Storage such as DS6000 or DS8000
PowerHA + IBM System Storage Copy Services

Flash Copy
- Point in time copy

Metro Mirror
- Short distance sync copy

Global Mirror
- Long distance Async copy

Combinations

Note:
- V7000 uses SVC copy services which is supported by IBM i 7.1 TR3 with PowerHA 7.1
- SYSBAS storage not shown, however it can be located on integrated disk or in the external storage subsystem
IBM i Native Attach Storage and Resiliency

### Storage is a key part of your HA/DR solution decision

<table>
<thead>
<tr>
<th>Feature</th>
<th>DAS SAS/SSD (1)</th>
<th>DS5000</th>
<th>DS6000</th>
<th>DS8000</th>
<th>EMC (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>POWER5/6/7</td>
<td>POWER6/7</td>
<td>POWER5/6/7</td>
<td>POWER5/6/7</td>
<td>POWER5/6/7</td>
</tr>
</tbody>
</table>

#### PowerHA 6.1 or PowerHA SystemMirror 7.1

- **FlashCopy**: No Yes Yes Yes Yes No (Timefinder)
- **Metro Mirror**: No Yes Yes Yes Yes No (SRDF)
- **Global Mirror**: No Yes Yes Yes Yes No (SRDF)
- **Switched IASP**: Yes Yes Yes Yes No
- **LUN Level Switching**: No No Yes (6.1) Yes (6.1) No
- **Geographic Mirroring**: Yes Yes Yes Yes Yes

#### PowerHA 6.1 or PowerHA SystemMirror 7.1 plus Advanced Copy Services (ACS)

- **FlashCopy**: No Yes Yes Yes Yes No (Timefinder)
- **Metro Mirror**: No Yes Yes Yes Yes No (SRDF)
- **Global Mirror**: No Yes Yes Yes Yes No (SRDF)
- **LUN Level Switching**: No No Yes (6.1) Yes (6.1) No
- **Metro/Global Mirror**: No No Yes Yes No

#### External Storage Full System Copy (crash consistent copy and cloning)

- **FlashCopy**: No Yes Yes Yes Yes Yes (Timefinder)
- **Global Mirror**: No Yes Yes Yes Yes Yes (SRDF)
- **Metro Mirror**: No Yes Yes Yes Yes Yes (SRDF)

#### Logical Replication Add-on Software

- **Vendor provided**: Yes Yes Yes Yes Yes

---

(1) SSD requires POWER6 or POWER7. (2) DMX, VMAX

Note. Native attach means the partition contains a SCSI, SAS or Fiber Channel card used to connect to the storage.
IBM i as a VIOS Storage Client and Resiliency

<table>
<thead>
<tr>
<th></th>
<th>DS3000</th>
<th>DS4000</th>
<th>DS5000</th>
<th>DS6000</th>
<th>DS8000</th>
<th>XIV</th>
<th>SVC / V7000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BladeCenter</td>
<td>POWER6/7 BladeCenter</td>
<td>POWER6/7 BladeCenter</td>
<td>POWER6/7 BladeCenter</td>
<td>POWER6/7 BladeCenter</td>
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### PowerHA 6.1 or PowerHA SystemMirror 7.1

<table>
<thead>
<tr>
<th>Feature</th>
<th>DS3000</th>
<th>DS4000</th>
<th>DS5000</th>
<th>DS6000</th>
<th>DS8000</th>
<th>XIV</th>
<th>SVC / V7000</th>
</tr>
</thead>
<tbody>
<tr>
<td>FlashCopy</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>V7.1 – PTF</td>
</tr>
<tr>
<td>Metro Mirror</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>V7.1 – PTF</td>
</tr>
<tr>
<td>Global Mirror</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>V7.1 – PTF</td>
</tr>
<tr>
<td>Switched IASP</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>LUN Level Switch</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Geo’mirroring</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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</tbody>
</table>

### PowerHA 6.1 or PowerHA SystemMirror 7.1 plus Advanced Copy Services (ACS)

<table>
<thead>
<tr>
<th>Feature</th>
<th>DS3000</th>
<th>DS4000</th>
<th>DS5000</th>
<th>DS6000</th>
<th>DS8000</th>
<th>XIV</th>
<th>SVC / V7000</th>
</tr>
</thead>
<tbody>
<tr>
<td>FlashCopy</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Metro Mirror</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Global Mirror</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>LUN Level Switch</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>External Storage Full System Copy (crash consistent copy and cloning) **</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
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</table>

### Logical Replication Add-on Software

<table>
<thead>
<tr>
<th>Feature</th>
<th>DS3000</th>
<th>DS4000</th>
<th>DS5000</th>
<th>DS6000</th>
<th>DS8000</th>
<th>XIV</th>
<th>SVC / V7000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor provided</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* Requires IBM i 7.1 TR3 or later
** See Redbook “IBM i and Midrange External Storage SG247668”
* Requires NPIV capable fiber channel adapter / DS5000 NPIV support requires IBM i 7.1 TR2
What do you consider when facing a storage decision?
Performance Disclaimer

- “it depends …”
- Performance information and recommendations in this presentation is based on measurements, analysis, and projections in a controlled environment for specific performance workloads.
- Your results will vary significantly and are dependent on the application and configuration.
- This information is provided along with general recommendations for you to better understand system and disk subsystem performance.
- Information is provided AS IS without warranty of any kind.
DS5300 results for OLTP-like application

- **DS5300 1818-53A**
  - 32 GB Cache
  - (8) GB FC Host Adaptors
  - (28) 1818-D1A Drive Enclosures
- (2) 8 Gbps Host Port Card Pairs

<table>
<thead>
<tr>
<th>LUNS</th>
<th>Controllers A and B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Attached</td>
<td>➢ Queue Depth 6 at i&lt;br&gt; ➢ Round Robin Algorithm&lt;br&gt; ➢ Uses only Active Paths&lt;br&gt; ➢ Passive Paths are fail over</td>
</tr>
<tr>
<td></td>
<td>➢ LUNS assigned to A and surfaced from A are active&lt;br&gt; ➢ LUNS assigned to B and surfaced from A are Passive&lt;br&gt; ➢ LUNS assigned to B and surfaced from B are active&lt;br&gt; ➢ LUNS assigned to A and surfaced from B are Passive</td>
</tr>
<tr>
<td>VIOS Attached</td>
<td>➢ Queue Depth 32 at i&lt;br&gt; ➢ Round Robin Algorithm&lt;br&gt; ➢ All paths are Active</td>
</tr>
<tr>
<td></td>
<td>➢ All LUNS are active paths</td>
</tr>
<tr>
<td>VIOS</td>
<td>➢ Queue Depth default to 10&lt;br&gt; ➢ Fail Over Algorithm is default&lt;br&gt; ➢ Passive Path are fail over</td>
</tr>
<tr>
<td></td>
<td>➢ LUNS assigned to A and surfaced from A are active&lt;br&gt; ➢ LUNS assigned to B and surfaced from A are Passive&lt;br&gt; ➢ LUNS assigned to B and surfaced from B are active&lt;br&gt; ➢ LUNS assigned to A and surfaced from B are Passive</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adaptor Scaling</th>
<th>LUN Scaling*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native Attached</td>
<td>➢ 1, 2 and 3 Fiber Channel connections.&lt;br&gt; ➢ Increased Performance&lt;br&gt;</td>
</tr>
<tr>
<td></td>
<td>➢ 16, 32 and 64 LUNS&lt;br&gt; ➢ Increased performance</td>
</tr>
<tr>
<td>VIOS Attached</td>
<td>➢ 1, 2 and 3 Fiber Channel connections.&lt;br&gt; ➢ Equivalent performance&lt;br&gt;</td>
</tr>
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<td></td>
<td>➢ 16, 32 and 64 LUNS&lt;br&gt; ➢ Equivalent performance</td>
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DS5300 native attach scaling

1, 2 and 3 Active Paths

Transactions Per Minute

Response Time in Seconds

- 64L 3 Adaptor
- 64L 2 Adaptor
- 64L 1 Adaptor
DS5300 VIOS vSCSI scaling

![Graph showing VIOS Adaptor Scaling](image)

- **VIOS 64L 3 Adaptors**
- **VIOS 64L 2 Adaptors**
- **VIOS 64L 1 Adaptors**

**Axes:**
- **X-axis:** Transaction Per Minute
- **Y-axis:** Response Time in Seconds
DS8800 results for OLTP-like application

- HDD baseline configuration:
  - 144 15K rpm 146G drives
  - 4 DA pairs

- SSD configuration
  - 96 15K rpm 146G drives
  - 16 SSDs
  - 4 DA pairs

![Graph showing DS8800 Baseline vs Easy Tier performance](image)
IBM System Storage Easy Tier

New generation of smart storage that intelligently adapts to application workloads

- Smart storage
  - Automated and granular:
    - Automated movement of data based on actual workload performance
    - Flexibility to move 1GB segments or full volumes
  - Virtually no administrative effort:
    - Easy Tier optimizes storage tiering without laborious manual tuning
    - Setup takes 15 minutes and requires only moving a volume into the Easy Tier storage pool
- Remember the benefits of Easy Tier without SSD
  http://www03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/FLASH10755
DS8000 Easy Tier measurements on IBM i

![Graph showing IBM i DB2 Application performance with HDD Baseline and Easy Tier comparison.](image-url)
Easy Tier in action at IBM i client – IO rate
Backend Read response times
IBM i SSD Integration Choices

- IBM i SSD tools and automation for internal and DS8000/DS5000
  - Manually
    • Create all SSD User ASP or Independent ASP
    • Manually place data onto User ASP or IASP
  - Media Preference (aka UNIT *SSD)
    • User controls over what is on SSD
    • DB2 objects
    • Byte-stream files using UDFS media preference (requires IBM i 7.1)
    • Dynamic changes to media preference supported enabling dynamic data movement
  - ASP Balancer
    • Utilizes read I/O count statistics for each 1 MB extent
    • Migrates “cold” extents from SSDs to HDDs and “hot” extents from HDDs to SSDs

- 5.4 – 7.1: Internal
- 6.1 – 7.1: DS8000
Customer experience – DB2 Media Preference
Total IO rate
Backend Read IO rate
Backend read response time
DB2 Media Preference in action at IBM i client
Backend read response time by Array
Sizing the storage subsystem

- Start by feeding measured data into Workload Estimator
  - Workload Estimator accepts inputs from
    - PM for Power Systems data
    - With measured data
    - With input from IBM i Performance Data Investigator or iDoctor
    - With generic workloads
    - And more!

- Refine using Disk Magic
  - Available for sales team use from
    - IBMers:
    - Partners:
  - Accepts input from
    - Workload Estimator
    - IOSTATS
    - IBM i Performance Tools reports
    - PM for Power Systems via Workload Estimator
Fibre channel adapter planning or “Will the workload from several LPARs fit?”

<table>
<thead>
<tr>
<th>IOPS planning</th>
<th>FCs 5735, 5273</th>
<th>FC 5729</th>
<th>MB/s planning</th>
<th>FCs 5735, 5273</th>
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FCs = Feature Codes. FC 5735 and 5273 are 8Gb dual (2) port adapters. 5729 is 8Gb quad (4) port adapter.
General guidelines for external storage

- Old guideline: DS8000 is the only option
- **Today’s reality:** A wide choice of storage solutions is available

- Old guideline: Define 2 LUNs/DDM for best throughput
- **Today’s reality:** Disk Magic can model workload to show proper quantity and size of LUNs for most IBM Storage Subsystems

- Old guideline: 2–4 IBM i HBAs (fibre ports) to 1 storage HA
- **Today’s reality:** New Smart IOAs (IOP-less) may map 1:1

- Old guideline: Create 1 DS8K extent pool per rank
- **Today’s reality:** Storage Pool Striping with multi-rank extent pools for each LPAR may deliver a good balance of performance and reliability
LUN Size Hints & Tips

- **DS8000 specific:**
  - LUNs must be defined in specific sizes to provide 520-byte sector support for IBM i.
  - If there are insufficient LUNs, wait time typically increases.
  - The number of LUNs drives the requirement for more FC adapters on the IBM i:
    - 32 LUNs per IOP required adapter
    - 64 LUNs per IOP-less adapter port or NPIV port

- **Other considerations**
  - Minimum LUN size is currently 17.5 GBs (this will change with the next release of the operating system)
  - Maximum LUN size is 2TBs minus 512 bytes
  - A minimum of 6 LUNs is required in any ASP where you care about performance

- Use the IBM tool Capacity Magic to verify capacity and space utilization plans.
- Use the IBM tool Disk Magic to model the size and number of LUNs required
What do you consider when facing a storage decision?
A customer all HDD vs. all SSD comparison

- All HDDs for 5 LPARs
  - To meet capacity and performance requirements: 220 HDDs
  - 10 EXP24S disk enclosures
  - 4 5877 I/O enclosures
  - 1 5802 I/O enclosure
  - 18 feature 5913 disk IOAs
  - Plus cables

- All SSDs for 5 LPARs
  - To meet capacity and performance requirements: 48 SSDs
  - 3 EXP24S disk enclosures
  - 1 5877 I/O enclosures
  - 1 5802 I/O enclosure
  - 5 feature 5913 disk IOAs
  - Plus cables

Cost
- SSDs: 31% less
- HDDs: 41% less

Maintenance
- SSDs: 65% less
- HDDs: 41% less

Rack Space
- SSDs: 64% less
- HDDs: 65% less

WATTs
- SSDs: 64% less
- HDDs: 65% less

BTUs
- SSDs: 64% less
- HDDs: 65% less
What do you consider when facing a storage decision?
The End, Thank You!
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Revised September 26, 2006
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All performance measurements were made with AIX or AIX 5L operating systems unless otherwise indicated to have used Linux. For new and upgraded systems, AIX Version 4.3, AIX 5L or AIX 6 were used. All other systems used previous versions of AIX. The SPEC CPU2006, SPEC2000, LINPACK, and Technical Computing benchmarks were compiled using IBM's high performance C, C++, and FORTRAN compilers for AIX 5L and Linux. For new and upgraded systems, the latest versions of these compilers were used: XL C Enterprise Edition V7.0 for AIX, XL C/C++ Enterprise Edition V7.0 for AIX, XL FORTRAN Enterprise Edition V9.1 for AIX, XL C/C++ Advanced Edition V7.0 for Linux, and XL FORTRAN Advanced Edition V9.1 for Linux. The SPEC CPU95 (retired in 2000) tests used preprocessors, KAP 3.2 for FORTRAN and KAP/C 1.4.2 from Kuck & Associates and VAST-2 v4.01X8 from Pacific-Sierra Research. The preprocessors were purchased separately from these vendors. Other software packages like IBM ESSL for AIX, MASS for AIX and Kazushige Goto's BLAS Library for Linux were also used in some benchmarks.

For a definition/explanation of each benchmark and the full list of detailed results, visit the Web site of the benchmark consortium or benchmark vendor.

TPC  http://www.tpc.org
SPEC  http://www.spec.org
Pro/E  http://www.proe.com
GPC  http://www.spec.org/gpc
VolanoMark http://www.volano.com
STREAM http://www.cs.virginia.edu/stream/
SAP  http://www.sap.com/benchmark/
Oracle Applications http://www.oracle.com/apps_benchmark/
PeopleSoft - To get information on PeopleSoft benchmarks, contact PeopleSoft directly
Baan http://www.ssaglobal.com
Fluent   http://www.fluent.com/software/fluent/index.htm
TOP500 Supercomputers http://www.top500.org/
Ideas International http://www.ideasinternational.com/benchmark/bench.html
Storage Performance Council http://www.storageperformance.org/results

Revised March 12, 2009
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SPEC http://www.spec.org
Pro/E http://www.proe.com
GPC http://www.spec.org/gpc
STREAM http://www.cs.virginia.edu/stream/
Fluent http://www.fluent.com/software/fluent/index.htm
TOP500 Supercomputers http://www.top500.org/
AMBER http://amber.scripps.edu/
FLUENT http://www.fluent.com/software/fluent/fl5bench/index.htm
GAMESS http://www.msg.chem.iastate.edu/gamess
GAUSSIAN http://www.gaussian.com
ANSYS http://www.ansys.com/services/hardware-support-db.htm
ECLIPSE http://www.sis.slb.com/content/software/simulation/index.asp?seg=geoquest&
MM5 http://www.mmm.ucar.edu/mm5/
MSC.NASTRAN http://www.mscsoftware.com/support/ prod%5Fsupport/nastran/performance/v04_sngl.cfm
NAMD http://www.ks.uiuc.edu/Research/namd
HMMER http://hmmer.janelia.org/
http://powerdev.osuosl.org/project/hmmerAltivecGen2mod

Click on the "Benchmarks" icon on the left hand side frame to expand. Click on "Benchmark Results in a Table" icon for benchmark results.

Revised March 12, 2009
Notes on performance estimates

rPerf for AIX

rPerf (Relative Performance) is an estimate of commercial processing performance relative to other IBM UNIX systems. It is derived from an IBM analytical model which uses characteristics from IBM internal workloads, TPC and SPEC benchmarks. The rPerf model is not intended to represent any specific public benchmark results and should not be reasonably used in that way. The model simulates some of the system operations such as CPU, cache and memory. However, the model does not simulate disk or network I/O operations.

- rPerf estimates are calculated based on systems with the latest levels of AIX and other pertinent software at the time of system announcement. Actual performance will vary based on application and configuration specifics. The IBM eServer pSeries 640 is the baseline reference system and has a value of 1.0. Although rPerf may be used to approximate relative IBM UNIX commercial processing performance, actual system performance may vary and is dependent upon many factors including system hardware configuration and software design and configuration. Note that the rPerf methodology used for the POWER6 systems is identical to that used for the POWER5 systems. Variations in incremental system performance may be observed in commercial workloads due to changes in the underlying system architecture.

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========================================================================

CPW for IBM i

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Revised April 2, 2007