Implementing iSCSI in Storage Area Networks

The Advantages of a Software Initiator Solution

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Introduction

- ADNET Systems, Inc.
- NASA Goddard Space Flight Center
- Task HECN – High End Computing Network
- Project Manager – J. Pat Gary
Outline

- Network Storage
- Implementation of Storage Area Network
- Implementation of iSCSI
- The iSCSI Test
Network Storage

- Direct Attached Storage (DAS)

- Network Attached Storage (NAS)
  - Advantages = multiple users; platform independence; expandability; fault tolerance

- Storage Area Network (SAN)
  - Advantage = prevents normal data backup over SAN from polluting regular network traffic
### Implementation of SAN

<table>
<thead>
<tr>
<th></th>
<th>Fibre Channel</th>
<th>iSCSI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td>✓ Speed</td>
<td>✓ Cost</td>
</tr>
<tr>
<td></td>
<td>✓ Market Dominance</td>
<td>✓ Ethernet Ubiquities</td>
</tr>
<tr>
<td></td>
<td>✓ Data Only Traffic</td>
<td></td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>✓ Cost</td>
<td>✓ Speed</td>
</tr>
<tr>
<td></td>
<td>✓ Additional Training</td>
<td>✓ Mixed Network Traffic</td>
</tr>
</tbody>
</table>
Implementation of iSCSI

- iSCSI Initiator
- iSCSI Target
- iSCSI Gateway
Implementation of iSCSI (Continued)

iSCSI Initiator Selections, e.g.

- Software Initiator
- Hardware Initiator

Adaptec 7211C
Adaptec TOE NAC 7711C
Implementation of iSCSI (Continued)

Off Load Scheme Selections

No Off-Load (Software Initiator)

- CPU
- iSCSI TCP/IP
- CARD
- Cisco’s iSCSI Driver w/ NIC

TCP Off-load Engine (TOE)

- CPU
- iSCSI
- CARD
- TCP/IP
- Adapted TOE NAC 7711C adapter

iSCSI Host Bus Adapter (HBA)

- CPU
- CARD
- iSCSI TCP/IP
- Adapted 7211C iSCSI adapter card
Test Overview

- Goal
- Variables
- Configuration
- Results
- Analysis
- Conclusions
Test Goal

Compare performance of iSCSI data transfer using different offload methods

Do different operating systems affect the data transfer speed and efficiency?

Do different PC configurations affect the data transfer speed and efficiency?
### Test Variables

#### High End PC
2 GHz Xeon with 64-bit/100 MHz PCI

- Cisco iSCSI Driver
- Adaptec 7211 iSCSI adapter card
- Adaptec TOE NAC 7711C

#### Low End PC
1.4 GHz Pentium IV with 32-bit/33 MHz PCI

- Cisco iSCSI Driver
- Adaptec 7211 iSCSI adapter card
- Adaptec TOE NAC 7711C

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Test Variables

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- Adaptec TOE NAC 7711C
- Adaptec 7211 iSCSI adapter card
Test Variables

1. **High End PC**
   - 2 GHz Xeon with 64-bit/100 MHz PCI

2. **Low End PC**
   - 1.4 GHz Pentium IV with 32-bit/33 MHz PCI

- **Cisco iSCSI Driver**
- **Adaptec TOE NAC 7711C**
- **Adaptec 7211 iSCSI adapter card**
- **Adaptec 7211 iSCSI adapter card**
- **Target LUN0**
  - 1 TB Apple Xserve Raid
- **Fibre Channel Switch**
  - Brocade 3800
- **NASA GSFC SAN Fibre Channel Fabric**
- **iSCSI Gateway**
  - Nishan 3000
Test Configuration (Continued)

- **SPEED TEST — IOZONE**
  - File System Benchmark Tool
  - Versatile in Simulating Actual Apps
  - Write / Rewrite / Read / Re-read

1 thread with a file size of 8 GB
2 thread with a file size of 4 GB
4 thread with a file size of 2 GB
8 thread with a file size of 1 GB
Test Configuration (Continued)

- EFFICIENCY TEST — CPU Usage

Windows—Task Manager

Linux—TOP
Test Results

**High End PC**
2 GHz Xeon with 64-bit/100 MHz PCI

**Low End PC**
1.4 GHz Pentium IV with 32-bit/33 MHz PCI

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<thead>
<tr>
<th>Cisco iSCSI Driver</th>
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Test Results (Continued)

1

High End PC
2 GHz Xeon with 64-bit/100 MHz PCI

Low End PC
1.4 GHz Pentium IV with 32-bit/33 MHz PCI

Cisco iSCSI Driver
Adaptec TOE NAC 7711C

Cisco iSCSI Driver
Adaptec 7211 iSCSI adapter card

Cisco iSCSI Driver
Adaptec 7211 iSCSI adapter card

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High End PC Running Red Hat 9
Performance Comparison

<table>
<thead>
<tr>
<th>Threads</th>
<th>Initial write</th>
<th>Rewrite</th>
<th>Read</th>
<th>Re-read</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 thread</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 threads</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 threads</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 threads</td>
<td></td>
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</tr>
</tbody>
</table>

Linux w/ Gig E NIC & Cisco software Initiator on a HE PC

Linux w/ Adaptec TOE on a HE PC

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High End PC Running Red Hat 9
CPU Usage Comparison

<table>
<thead>
<tr>
<th>Threads</th>
<th>1 threads</th>
<th>2 threads</th>
<th>4 threads</th>
<th>8 threads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linux w/ Gig E NIC &amp; Cisco SW initiator on a HE PC</td>
<td>Linux overall write</td>
<td>Linux overall read</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linux w/ Adaptec TOE on a HE PC</td>
<td></td>
<td></td>
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Test Results (Continued)

**High End PC**
2 GHz Xeon with 64-bit/100 MHz PCI

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**Low End PC**
1.4 GHz Pentium IV with 32-bit/33 MHz PCI

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High End PC
2 GHz Xeon with 64-bit/100 MHz PCI

Low End PC
1.4 GHz Pentium IV with 32-bit/33 MHz PCI

- Cisco iSCSI Driver
- Adaptec TOE NAC 7711C
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- Cisco iSCSI Driver
- Adaptec TOE NAC 7711C
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Test Results (Continued)

High End PC Running Windows 2000 Pro
Performance Comparison

Performance Comparison

<table>
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<tr>
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<td>4 threads</td>
<td>Re-read</td>
</tr>
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<td>8 threads</td>
<td>Win2K w/ Gig E NIC &amp; Cisco software initiator on a HE PC</td>
</tr>
<tr>
<td>1 thread</td>
<td>Win2K w/ Adaptec iSCSI Card on a HE PC</td>
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<tr>
<td>2 threads</td>
<td>4 threads</td>
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Test Results (Continued)

High End PC Running Windows 2000 Pro
CPU Usage Comparison

Win2K w/ Gig E NIC & CISCO software initiator on a HE PC
Win2K w/ Adaptec iSCSI Card on a HE PC

Threads

1 threads 2 threads 4 threads 8 threads

Initial write
Rewrite
Read
Re-read

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## Test Results (Continued)

### High End PC
- 2 GHz Xeon with 64-bit/100 MHz PCI

### Low End PC
- 1.4 GHz Pentium IV with 32-bit/33 MHz PCI

<table>
<thead>
<tr>
<th>Component</th>
<th>High End PC</th>
<th>Low End PC</th>
</tr>
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<tbody>
<tr>
<td>Cisco iSCSI Driver</td>
<td></td>
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Test Results (Continued)

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2 GHz Xeon with 64-bit/100 MHz PCI

**Low End PC**
1.4 GHz Pentium IV with 32-bit/33 MHz PCI

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Low End PC Running Windows 2000 Pro
Performance Comparison

Threads

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<td>Read</td>
</tr>
<tr>
<td>8 threads</td>
<td>Re-read</td>
</tr>
</tbody>
</table>

Win2K w/ Gig E NIC & Cisco software
initiator on a LE PC

Win2K w/ Adaptec iSCSI Card on a LE PC
Low End PC Running Windows 2000 Pro

CPU Usage Comparison

- Win2K w/ Gig E NIC & CISCO software initiator on a LE PC
- Win2K w/ Adaptec iSCSI Card on a LE PC
Analysis

- Performance & CPU Usage Comparison
- Windows vs. Linux Environment
- High End vs. Low End PC
### High End PC Running Red Hat 9

<table>
<thead>
<tr>
<th></th>
<th>Performance</th>
<th>CPU Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cisco iSCSI Driver</td>
<td>Adaptec TOE NAC 7711C</td>
</tr>
<tr>
<td>Overall Write</td>
<td>100%</td>
<td>110%</td>
</tr>
<tr>
<td>Overall Read</td>
<td>100%</td>
<td>98%</td>
</tr>
</tbody>
</table>
**Analysis (Continued)**

High End PC Running Windows 2000 Pro

<table>
<thead>
<tr>
<th></th>
<th>Performance</th>
<th>CPU Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco iSCSI Driver</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Adaptec 7211 iSCSI</td>
<td>103%</td>
<td>79%</td>
</tr>
<tr>
<td>Overall Write</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall Read</td>
<td>100%</td>
<td>47%</td>
</tr>
<tr>
<td>Overall Read</td>
<td>100%</td>
<td>80%</td>
</tr>
<tr>
<td>Overall Read</td>
<td>100%</td>
<td>47%</td>
</tr>
</tbody>
</table>
### Analysis (Continued)

#### Low End PC Running Windows 2000 Pro

<table>
<thead>
<tr>
<th></th>
<th>Performance</th>
<th>CPU Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cisco iSCSI</td>
<td>Adaptec 7211 iSCSI</td>
</tr>
<tr>
<td>Overall Write</td>
<td>100%</td>
<td>122%</td>
</tr>
<tr>
<td>Overall Read</td>
<td>100%</td>
<td>127%</td>
</tr>
</tbody>
</table>
Analysis (Continued)

- Generally, hardware initiator outperforms software initiator in both data writing and reading
  - Exception – data reading with Windows 2000 on the high end PC
- Generally, more threads yield better write/read performance
  - Exception – data writing with Linux
  - Exception – data writing/reading with Windows 2000 on the low end PC when implementing software initiator
- CPU usage is always greater when using the software initiator
- More threads consume more CPU processing power
  - Exception – data reading with Windows 2000 on the low end PC when implementing software initiator
Analysis (Continued)

High End PC
2 GHz Xeon with 100Mbps PCI

Cisco iSCSI Driver
Adaptec 7211 iSCSI adapter card
Adaptec TOE NAC 7711C

Low End PC
1.4 GHz Pentium IV with 33Mbps PCI

Cisco iSCSI Driver
Adaptec 7211 iSCSI adapter card
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<td>1.4 GHz Pentium IV with 33Mbps PCI</td>
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<tr>
<td><strong>Cisco iSCSI Driver</strong></td>
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<tr>
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<tr>
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<td></td>
</tr>
</tbody>
</table>
## Analysis (Continued)

### Windows and Linux Performance Comparison

<table>
<thead>
<tr>
<th></th>
<th>Software Initiator</th>
<th>Hardware Initiator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Windows 2000 Pro</td>
<td>Linux Red Hat 9</td>
</tr>
<tr>
<td>Overall Write</td>
<td>44%</td>
<td>100%</td>
</tr>
<tr>
<td>Overall Read</td>
<td>81%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Windows 2000 Pro</td>
<td>Linux Red Hat 9</td>
</tr>
<tr>
<td></td>
<td>53%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>66%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Analysis (Continued)

<table>
<thead>
<tr>
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<th>Low End PC</th>
</tr>
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- Cisco iSCSI Driver
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### Analysis (Continued)

#### High End PC & Low End PC Performance Comparison

<table>
<thead>
<tr>
<th></th>
<th>Software Initiator</th>
<th>Hardware Initiator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low End PC</td>
<td>High End PC</td>
</tr>
<tr>
<td>Overall Write</td>
<td>69%</td>
<td>100%</td>
</tr>
<tr>
<td>Overall Read</td>
<td>57%</td>
<td>100%</td>
</tr>
</tbody>
</table>
**Analysis (Continued)**

High End PC & Low End PC CPU Usage Comparison

<table>
<thead>
<tr>
<th></th>
<th>Software Initiator</th>
<th>Hardware Initiator</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low End PC</td>
<td>High End PC</td>
</tr>
<tr>
<td>Overall Write</td>
<td></td>
<td></td>
</tr>
<tr>
<td>216%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>Overall Read</td>
<td></td>
<td></td>
</tr>
<tr>
<td>189%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

**High End PC**

- Hardware Initiator
- Software Initiator

**Low End PC**

- Hardware Initiator
- Software Initiator
Conclusion

- CPU offloading works well
- Linux outperforms Windows
- Hardware initiator is justified better in the case of a Low End PC
Acknowledgements

- Hoot Thompson (Patuxent Technology Partners)
- Mary Shugrue (BPX)
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- Aruna Muppalla (ADNET)
- Paul Lang (ADNET)
- Rich Bono (Adaptec)
- Jeff Martz (CSC)
- Rich Isley (GMRS)
References

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- IOZONE by Don Capps
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