WAN Optimization with Riverbed™ Steelhead™ for Hitachi Data Ingestor and Hitachi Content Platform

Lab Validation Report

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Feedback

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WAN Optimization with Riverbed™ Steelhead™ for Hitachi Data Ingestor and Hitachi Content Platform

Lab Validation Report

This document presents performance validation of Riverbed™ Steelhead™ with Hitachi Data Ingestor (HDI) and Hitachi Content Platform (HCP) conducted at Hitachi Data Systems labs. It establishes that Riverbed Steelhead provides a WAN optimization solution and addresses the core problem of data migration performance and throughput which otherwise provides challenges in situations with restricted network bandwidth, impaired networks with high latency, and errors and data loss due to packet drops that are common to remote offices and longer distance geographical deployments.

The results demonstrated Riverbed Steelhead WAN optimization techniques like MX-TCP and Data Reduction techniques (data dedupe and compression) achieved the following benefits:

- Accelerated migration performance by reducing the time required to complete the migration operations by as much as 1.5× - 2× times.
- LAN like performance
- Improved throughputs by a significant margin.
- Reduced the WAN bandwidth and improved productivity in a network-impaired environment.

The converged solution stack of HDI, HCP and along with Riverbed WAN optimization techniques and data reduction techniques ensure optimal performance across the widest range of applications and WAN environments.
Product Features

Hitachi Data Ingestor

The Hitachi Data Ingestor (HDI) provides a standard CIFS/NFS on-ramp into the Hitachi Content Platform (HCP) for remote or distributed environments and cloud deployments. Because HDI is essentially a caching device, it provides users and applications with seemingly endless storage and a host of newly available capabilities. Moreover, HDI presents a standards-based file system interface to applications to provide seamless access for users.

Hitachi Content Platform

Hitachi Content Platform is a distributed object store that provides advanced storage and data management capabilities to help you address challenges posed by ever-growing volumes of unstructured data. You can divide a single Content Platform into multiple virtual object stores, secure access to each and uniquely configure them for particular workloads.

Riverbed Steelhead

The Riverbed® Steelhead® product is a WAN optimization solution that accelerates application performance and data transfer over the wide area network (WAN), overcoming bandwidth and geographical limitations to improve productivity and enable global collaboration. The Riverbed Steelhead appliance optimization and duplication technique can speed up applications, raise productivity, and eliminate the impact of distance between branch offices, mobile workers, the data center, and business headquarters.
Test Environment Configuration

Table 1 lists the test environment components.

Table 1. Test Components

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hitachi Data Ingestor VMA</td>
<td>Version 4.0.0.1</td>
<td>2</td>
</tr>
<tr>
<td>Hitachi Content Platform</td>
<td>Version 6.0.0.95</td>
<td>1</td>
</tr>
<tr>
<td>WAN simulator Linktropy mini2™</td>
<td>Version 3.0.11</td>
<td>1</td>
</tr>
<tr>
<td>Riverbed™ Steelhead™ 7050</td>
<td>Version 8.0.2 (x86_64)</td>
<td>2</td>
</tr>
<tr>
<td>Microsoft ® Windows Server ® for CIFS client</td>
<td>Version 2008 R2</td>
<td>1</td>
</tr>
</tbody>
</table>
Figure 1 shows the high-level system architecture.

**RIVERBED / HDI / HCP TEST ENVIRONMENT DIAGRAM**

**ESX SERVER 5.x**

**HDI SERVER 1 / VSPHERE CLIENT**
- Windows Server 2008 R2-64Bit
  - Data
  - LUN=150GB
  - RAID6(5D+1P)
  - SAS DISK-15K/10K

**CIFS CLIENT**
- Windows Server 2008 R2
  - Data
  - LUN=50GB
  - RAID6(5D+1P)
  - SAS DISK-15K/10K

**NFS CLIENT**
- Redhat Linux 6.x
  - Data
  - LUN=50GB
  - RAID6(5D+1P)
  - SAS DISK-15K/10K

**HCP 6.X 4-NODE CLUSTER**

**STEELHEAD 7050 TOP**
- In-Path LAN0_1
  - 172.17.38.47

**STEELHEAD 7050 BOTTOM**
- In-Path LAN0_1
  - 172.17.38.43

**PRIVATE NETWORK SWITCH**

**PORT 42**

**PORT 41**

**PORTS 17,19,21,23**

**PORT 50**

**PORT 51**

**PORT 52**

**HCP 1 Nodes 172.17.38.95-98**

**HCP 2 Nodes 172.17.38.27-29**

**HCP 3 Management IP 172.17.38.46**

**HCP 4 Management IP 172.17.38.46**

**PRIVATE NETWORK**

**WAN**

**ESX SERVER 5.x**

**HDI SERVER 2 / VSPHERE CLIENT**
- Windows Server 2008 R2-64Bit
  - Data
  - LUN=100GB
  - RAID6(5D+1P)
  - SAS DISK-15K/10K

**ESX SERVER 5.x**

**HDI SERVER 1 / VSPHERE CLIENT**
- Windows Server 2008 R2-64Bit
  - Data
  - LUN=200GB
  - RAID6(5D+1P)
  - SAS DISK-15K/10K

**ESX SERVER 5.x**

**HDI SERVER 2 / VSPHERE CLIENT**
- Windows Server 2008 R2-64Bit
  - Data
  - LUN=250GB
  - RAID6(5D+1P)
  - SAS DISK-15K/10K
Test Methodology

The goal of this testing effort was to ensure that Riverbed Steelhead v8.0.2 works seamlessly with HDI/HCP and helps attain the overall performance in the areas of throughputs, migration performance, and data loss under varying WAN conditions like insufficient bandwidth, latency, and packet loss. The scope of this testing was migration only. Migration uses HTTP as the transport protocol at the HDI and namespace levels on HCP.

In order to accomplish this goal, the test was divided into four categories.

1. The first test was baseline LAN HDI to HCP migration testing. The objective of this test was to study the LAN behavior and performance. This test was run with default compression enabled at HDI since the data can be better handled there.

2. The second test was to execute migration tests under varying WAN conditions like insufficient bandwidth, latency, and packet loss. The objective of this test was to understand how migration performance and throughput was impacted.
   - Test Topology:
   - WAN Capacity: 35Mb/sec, 100Mb/sec
   - WAN Latency: 20 ms, 80 ms, 100 ms round-trip time
   - Packet Loss: 0%, 1%, 0.1%

3. The third test was to run with Riverbed optimization techniques like QoS and MX-TCP to achieve high throughput rates thereby improving the migration performance.
   - Test Topology:
   - WAN Capacity: 35Mb/sec, 100Mb/sec
   - WAN Latency: 20 ms, 80 ms, 100 ms round-trip time
   - Packet Loss: 0%, 1%, 0.1%

4. This set of tests was performed by enabling and disabling native HDI compression to determine and understand the time taken for migration over WAN. The results are compared with the data reduction policy enabled on Riverbed Steelhead to determine the benefits of Riverbed Steelhead compression and de-duplication capabilities.
5. Since the objective of these tests was focused on data reduction, bandwidth reduction and not entirely throughput, the Linktropy WAN simulator was set to unlimited bandwidth and no latency.

- Test Topology:
- WAN Capacity: Unlimited
- WAN Latency: 0 Latency
- Packet Loss: 0%

**Workload Generation**
The workload sizes were around 32GB (206,081 files) of test data comprised of unstructured data of varying sizes in KB, MB and GB.

- MS office files
- images
- videos
- application executable
- tar files

For every test, this data was copied on each CIFS share.

**WAN Simulation**
For simulating the WAN environment, Riverbed provided a Linktropy WAN simulator installed to mimic WAN-like induced latency, packet loss, and restricted bandwidth.

*The performance data was collected using the following tools:*

- VMware esxtop
- SAR on all HCP nodes
- Object count from HCP Tenant UI

*The key metrics analyzed to validate the solution are:*

- Network statistics
- Migration Start and end time
Analysis

This analysis includes observations from the tests results and recommendations based on those results.

Observations

1. LAN baseline numbers with unlimited bandwidth and no latency were accomplished. Overall throughputs attained were 47Mb/sec and total migration time took 31 minutes.

2. Migration performance and throughputs decline in restricted bandwidth, high latency and dropped packets WAN environment with no Steelhead appliance in place. The migration task takes significant time to complete especially in a packet loss scenario.

Figure 2 shows the migration performance at 100Mb/sec bandwidth.

![Migration performance 100Mb/sec bandwidth](image)

<table>
<thead>
<tr>
<th></th>
<th>Latency-20 ms</th>
<th>Latency-80 ms</th>
<th>Latency-100 ms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Packet Loss-1%</td>
<td>Packet Loss-0.1%</td>
<td></td>
</tr>
<tr>
<td>Throughputs (Mb/sec)</td>
<td>43</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Total migration time (in min)</td>
<td>44</td>
<td>90</td>
<td>100</td>
</tr>
</tbody>
</table>

Figure 2
Figure 3 shows the migration performance at 35Mb/sec bandwidth.

![Migration performance 35Mb/sec bandwidth](image)

<table>
<thead>
<tr>
<th>Latency-20 ms</th>
<th>Latency-80 ms</th>
<th>Latency-100 ms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throughputs (Mb/sec)</td>
<td>Packet Loss-1%</td>
<td>Packet Loss-0.1%</td>
</tr>
<tr>
<td>31</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>Total migration time (in min)</td>
<td>55</td>
<td>95</td>
</tr>
</tbody>
</table>

**Figure 3**

3. Migration performance and throughputs under network congestion with restricted bandwidth, latency and packet loss increase considerably when QoS and MX-TCP optimization are enabled on the Steelhead appliance. This indicates that Steelhead is able to alleviate delay and data loss under adverse WAN conditions. The performance is close to LAN like performance.

Normal TCP stack, in the presence of loss and high latency will reduce its transmit window and therefore will never be able to fill the WAN pipe; increasing time to complete the migration task and decreasing overall throughput. This is evident in our testing.

Steelhead MX-TCP does two things well:

- Fill a WAN pipe with high latency
- Mitigate the effects of packet loss

When there is a packet loss, MX-TCP does not reduce its transmission window. MX-TCP uses SACK (Selective Acknowledgment) algorithm to recover and retransmit the lost packets and at the same time sender continues to send new packets. With MX-TCP, a surge in migration performance and throughputs as high as 1.5× to 2× were observed.
Figure 4 shows the migration throughput comparison in adverse WAN conditions.

<table>
<thead>
<tr>
<th></th>
<th>Baseline 0ms unlimited bandwidth</th>
<th>Latency-20 ms</th>
<th>Latency-80 ms Packet Loss-1%</th>
<th>Latency-100 ms Packet Loss-0.1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without Steelhead</td>
<td>47</td>
<td>43</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>With Steelhead QoS &amp; MX-TCP</td>
<td>44</td>
<td>33</td>
<td>33</td>
<td>33</td>
</tr>
</tbody>
</table>

**Figure 4**
Figure 5 shows the migration performance comparison in adverse WAN conditions.

![Migration performance comparison 100Mb/sec bandwidth](image)

**Figure 5**

<table>
<thead>
<tr>
<th></th>
<th>Baseline 0ms unlimited bandwidth</th>
<th>Latency-20 ms</th>
<th>Latency-80 ms Packet Loss-1%</th>
<th>Latency-100 ms Packet Loss-0.1%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Without Steelhead</strong></td>
<td>31</td>
<td>44</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td><strong>With Steelhead QoS &amp; MX-TCP</strong></td>
<td>39</td>
<td>51</td>
<td>53</td>
<td></td>
</tr>
</tbody>
</table>
Figure 6 shows the migration throughput comparison in adverse WAN conditions.

![Diagram showing migration throughput comparison with Steelhead QoS & MX-TCP](image)

**Migration throughput comparison 35Mb/sec bandwidth**

<table>
<thead>
<tr>
<th></th>
<th>Baseline 0ms unlimited bandwidth</th>
<th>Latency-20 ms</th>
<th>Latency-80 ms Packet Loss-1%</th>
<th>Latency-100 ms Packet Loss-0.1%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without Steelhead</td>
<td>47</td>
<td>31</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>With Steelhead QoS &amp; MX-TCP</td>
<td>32</td>
<td>25</td>
<td>27</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 6**
Figure 7 shows the migration performance comparison in adverse WAN conditions.

![Migration performance comparison 35Mb/sec bandwidth](image)

**Figure 7**

4. By offloading data reduction capabilities on the Steelhead appliance and setting the value to "Normal" (combination of Data Reduction and Compression), it was observed that the LAN side throughput improved considerably by as much as 4× and significant bandwidth reduction on the WAN side because of less TCP round trips over WAN. Subsequently, the migration performance improved by 30%.

Figure 8 shows Steelhead's data reduction rate over the WAN.

![Steelhead's data reduction rate over the WAN](image)

**Figure 8**
Figure 9 shows a compression performance comparison.

![Compression performance comparison](image)

**Recommendations**

These are recommendations resulting from these tests:

1. For QoS, outbound bandwidth is made to match the minimum guaranteed bandwidth configured. In testing it was set to 35Mb/sec and 100Mb/sec on the Steelhead appliance (both client and server side) matching to Linktropy WAN Simulator bandwidth.

2. Data reduction was set to Normal on the Steelhead appliance client side.
Appendix- Test Results

LAN Baseline Test
The first test was LAN baseline HDI to HCP migration test. The objective of this test was to study the LAN behavior and performance when the data was being migrated from HDI to HCP in an unlimited bandwidth and no latency LAN environment. Table 2 shows the total throughput and total migration completion time.

Table 2. Throughput and Migration Completion Time with Unlimited Bandwidth and No Latency

<table>
<thead>
<tr>
<th>Migration Performance LAN Baseline</th>
<th>Throughputs (Mb/sec)</th>
<th>Data Set Size (GB)</th>
<th>Total Objects Ingested</th>
<th>Total Migration Time (in min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>Latency</td>
<td>Packet Loss</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unlimited BW</td>
<td>0 ms Latency</td>
<td>0% Packet Loss</td>
<td>47</td>
<td>32</td>
</tr>
</tbody>
</table>

Packet Loss with Bandwidth Baseline Tests
This test was to execute migration tests under changing WAN conditions like insufficient bandwidth, latency and packet loss. The objective of this test was to understand how migration performance and throughput was impacted by restricted network bandwidth, latency and packet drops. Table 3 shows migration performance with insufficient bandwidth, latency, and packet loss.

Table 3. Migration Performance with Insufficient Bandwidth, Latency and Packet Loss

<table>
<thead>
<tr>
<th>Migration Performance with Insufficient Bandwidth, Latency and Packet Loss</th>
<th>Throughputs (Mb/sec)</th>
<th>Data Set Size (GB)</th>
<th>Total Objects Ingested</th>
<th>Total Migration Time (in min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>Latency</td>
<td>Packet Loss</td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 Mb/sec</td>
<td>20 ms</td>
<td>0% Packet Loss</td>
<td>43</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>80 ms</td>
<td>1% Packet Loss</td>
<td>15</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>100 ms</td>
<td>0.1% Packet Loss</td>
<td>20</td>
<td>32</td>
</tr>
<tr>
<td>35 Mb/sec</td>
<td>20 ms</td>
<td>0% Packet Loss</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>80 ms</td>
<td>1% Packet Loss</td>
<td>16</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>100 ms</td>
<td>0.1% Packet Loss</td>
<td>18</td>
<td>32</td>
</tr>
</tbody>
</table>
Migration Performance with Riverbed Steelhead Optimization Choosing QoS and MX-TCP Settings

This test was executed with Riverbed optimization techniques like QoS and MX-TCP to achieve high throughput rates thereby improving the migration performance.

QoS implementation allows organizations to accurately control their applications by the amount of bandwidth they have access to and latency.

MX-TCP - MX-TCP is a QoS class queue parameter. The TCP congestion control mechanism is altered on the Steelhead appliance. The normal TCP behavior of reducing the outbound sending rate when detecting congestion or packet loss is disabled, and the outbound rate is made to match the minimum guaranteed bandwidth configured.

Table 3 lists migration performance details with Riverbed Steelhead optimization choosing QoS and MX-TCP settings. For testing, the bandwidth was set to 35Mb/sec and 100 Mb/sec.

<table>
<thead>
<tr>
<th>Bandwidth</th>
<th>Latency</th>
<th>Packet Loss</th>
<th>Throughputs (Mb/sec)</th>
<th>Data Set Size (GB)</th>
<th>Total Objects Ingested</th>
<th>Total Migration Time (in min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 Mb/sec</td>
<td>20 ms</td>
<td>0% Packet Loss</td>
<td>44</td>
<td>32</td>
<td>206,081</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>80 ms</td>
<td>1% Packet Loss</td>
<td>33</td>
<td>32</td>
<td>206,081</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>100 ms</td>
<td>0.1% Packet Loss</td>
<td>33</td>
<td>32</td>
<td>206,081</td>
<td>53</td>
</tr>
<tr>
<td>35 Mb/sec</td>
<td>20 ms</td>
<td>0% Packet Loss</td>
<td>32</td>
<td>32</td>
<td>206,081</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>80 ms</td>
<td>1% Packet Loss</td>
<td>25</td>
<td>32</td>
<td>206,081</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>100 ms</td>
<td>0.1% Packet Loss</td>
<td>27</td>
<td>32</td>
<td>206,081</td>
<td>67</td>
</tr>
</tbody>
</table>
Migration Performance Comparison when Data Reduction Capabilities are Offloaded to Steelhead Appliance

This test was to compare native HDI compression results with Steelhead data reduction capabilities. The objective of these tests was focused on data reduction over WAN, migration performance, reduced bandwidth traffic and not entirely throughput, and the results are provided in Table 5.

Table 5. Migration Performance Comparison when Data Reduction Capabilities Offloaded to Steelhead Appliance

<table>
<thead>
<tr>
<th>Unlimited Bandwidth</th>
<th>HDI Compression Enabled</th>
<th>HDI Compression Disabled &amp; Steelhead Data Reduction Policy Enabled</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Latency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0% Packet Loss</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Throughputs (Mb/sec) with Steelhead</td>
<td>47 Mb/sec</td>
<td>172 Mb/sec</td>
</tr>
<tr>
<td>Data Set Size (GB)</td>
<td>32 GB</td>
<td>32 GB</td>
</tr>
<tr>
<td>Total Objects Ingested</td>
<td>206,081</td>
<td>206,081</td>
</tr>
<tr>
<td>Total Migration Time (in min)</td>
<td>31</td>
<td>24</td>
</tr>
</tbody>
</table>
Appendix- Additional Analysis

During the testing phase, no issues were reported against the Riverbed Steelhead appliance. However, an observation was made that the Riverbed HTTP optimization technique cannot be leveraged as it relies on HTML encoded data streams where it learns the objects within web pages and either caches or pre-fetches these objects on behalf of the web browser. Traffic from HDI to HCP uses REST API and some traffic uses a Management query engine that utilizes XML based API. The Riverbed Steelhead appliance cannot learn this type of traffic hence, the HTTP optimization technique cannot be leveraged.
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