HITACHI DYNAMIC TIERING OVERVIEW

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AMERICAS SOLUTIONS AND PRODUCTS
Hitachi Dynamic Tiering (HDT) simplifies storage administration by automatically optimizing data placement in 1, 2 or 3 tiers of storage that can be defined and used within a single virtual volume. Tiers of storage can be made up of internal or external (virtualized) storage, and use of HDT can lower capital costs. Simplified and unified management of HDT allows for lower operational costs and reduces the challenges of ensuring applications are placed on the appropriate classes of storage.

By attending this webcast, you will

- Hear about what makes Hitachi Dynamic Tiering a unique storage management tool that enables storage administrators to meet performance requirements at lower costs than traditional tiering methods.

- Understand various strategies to consider when monitoring application performance and relocating pages to appropriate tiers without manual intervention.

- Learn how to use Hitachi Command Suite (HCS) to manage, monitor and report on an HDT environment, and how HCS manages related storage environments.
AGENDA

- Hitachi Dynamic Tiering
  - Relation to Hitachi Dynamic Provisioning
  - Monitoring I/O activity
  - Relocating pages (data)
  - Tiering policies
  - Managing and monitoring HDT environments with Hitachi Command Suite
- Virtualize devices into a pool of capacity and allocate by pages
- Dynamically provision new servers in seconds
- Eliminate allocated but unused waste by allocating only the pages that are used
- Extend Dynamic Provisioning to external virtualized storage
- Convert fat volumes into thin volumes by moving them into the pool
- Optimize storage performance by spreading the I/O across more arms
- Up to 62,000 LUNs in a single pool
- Up to 5PB support
- Dynamically expand or shrink pool
- Zero page reclaim
Different tiers of storage are now in 1 pool of pages

Data is written to the highest-performance tier first

As data becomes less active, it migrates to lower-level tiers

If activity increases, data will be promoted back to a higher tier

Since 20% of data accounts for 80% of the activity, only the active part of a volume will reside on the higher-performance tiers
VIRTUAL STORAGE PLATFORM: PAGE-LEVEL TIERING

- Automatically detects and assigns tiers based on media type
- Dynamically
  - Add or remove tiers
  - Expand or shrink tiers
  - Expand LUNs
  - Move LUNs between pools
- Automatically adjust sub-LUN 42MB pages between tiers based on captured metadata
- Supports virtualized storage and all replication/DR solutions
THE MONITOR-RELOCATE CYCLE

Monitor I/O

Relocate and Rebalance

HDT

Concurrent and Independent

Monitor Capacity

Alerts

Virtual volumes

Pool

SSD

SAS

SATA
HDT: POLICY-BASED MONITORING AND RELOCATION

- **Manual mode**
  - Monitoring and relocation separately controlled
  - Can set complex schedules to custom fit to priority work periods

- **Automatic mode**
  - Customer defines strategy; it is then executed automatically
  - 24-hour sampling
    - Allows for custom selection of partial day periods
  - Sampling at ½-, 1-, 2-, 4-, or 8-hour intervals
  - All aligned to midnight
  - May select automatic monitoring of I/O intensity and automatic data relocation

<table>
<thead>
<tr>
<th>Media Groupings Supported by VSP*</th>
<th>Order of Grouping</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSD</td>
<td>1</td>
</tr>
<tr>
<td>SAS 15K RPM</td>
<td>2</td>
</tr>
<tr>
<td>SAS 10K RPM</td>
<td>3</td>
</tr>
<tr>
<td>SAS 7.2K RPM</td>
<td>4</td>
</tr>
<tr>
<td>SATA</td>
<td>5</td>
</tr>
<tr>
<td>External #1</td>
<td>6</td>
</tr>
<tr>
<td>External #2</td>
<td>7</td>
</tr>
<tr>
<td>External #3</td>
<td>8</td>
</tr>
</tbody>
</table>

* VSP = Hitachi Virtual Storage Platform
Impacts Relocation Decisions and How Tier Properties Are Displayed

**Period mode**
Relocation uses just the I/O load measurements from the last completed monitor cycle.

**Continuous mode**
Relocation uses a weighted average of previous cycles. Short-term I/O load increases or decreases have less influence on relocation.
## MONITORING AND RELOCATION OPTIONS

<table>
<thead>
<tr>
<th>Execution mode</th>
<th>Cycle duration</th>
<th>Monitoring</th>
<th>Relocation</th>
<th>Monitoring/relocation cycle</th>
</tr>
</thead>
</table>
| **Auto execution** | 24 hours | Time of day not specified | After setting auto execution to ON, next 0:00 is reached | After monitoring started, the next 0:00 is reached | One of the following:  
- Relocation of entire pool is finished  
- Next relocation is started  
- Auto execution is set to OFF |
| | 24 hours with time of day specified | | Specified end time is reached | | |
| | 30 min. 1 hour 2 hours 4 hours 8 hours | | After setting auto execution to ON, cycle time begins when 0:00 is reached | | |
| **Manual execution** | Variable | Request to start monitoring is received SN2, RAIDCOM, or HCS | Request to end monitoring is received | One of the following:  
- Relocation of entire pool finished  
- Request to stop relocation is received  
- Auto execution is set to ON  
- Subsequent manual monitoring is stopped |
| See RAIDCOM command | | | | |
HDT PERFORMANCE MONITORING

- Back-end I/O (read plus write) counted per page during the monitor period
- Monitor ignores “RAID I/O” (parity I/O)
- Count of IOPH for the cycle (period mode) or a weighted average (continuous mode)
- HDT orders pages by counts high to low to create a distribution function – IOPH vs. GB
- Monitor analysis is performed to determine the IOPH values that separate the tiers
What is being used now in the pool in terms of capacity and performance.

Can display just the performance graph for a tiering policy.

The I/O distribution across all pages in the pool. Combined with the tier range, HDT decides where the pages should go.
- What determines if a page moves up or down?
- When does the relocation happen?
At the end of a monitor cycle the counters are recalculated
- Either IOPH (period) or weighted average (continuous)

Page counters with similar IOPH values are grouped together

IOPH groupings are ordered from highest to lowest

Tier capacity is overlaid on the IOPH groupings to decide on values for tier ranges
- Tier range is the “break point” in IOPH between tiers

Relocation processes DP-VOLs page by page looking for pages on the “wrong” side of a tier range value
- For example, high IOPH in a lower tier
- Relocation will perform a ZPR test on a page it moves

You can see the IOPH groupings and tier range values in SN2 “Pool Tier Properties”
- Tier range stops being reported if any tier policy is specified
RELOCATION

- Standard relocation throughput is about 3TB/day
- Write pending and MP utilization rates influence the pace of page relocation
  - I/O priority is always given to the host(s)
- Relocation statistics are logged
## TIERING POLICIES

<table>
<thead>
<tr>
<th>Policy</th>
<th>2-Tier Pool</th>
<th>3-Tier Pool</th>
<th>Purpose</th>
<th>Default New Page Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>Any Tier</td>
<td>Any Tier</td>
<td>Most flexible</td>
<td>T1 &gt; T2 &gt; T3</td>
</tr>
<tr>
<td>Level 1</td>
<td>Tier 1</td>
<td>Tier 1</td>
<td>High response but sacrifice Tier 1 space efficiency</td>
<td>T1 &gt; T2 &gt; T3</td>
</tr>
<tr>
<td>Level 2</td>
<td>Tier 1 &gt; 2</td>
<td>Tier 1 &gt; 2</td>
<td>Similar to level 1 after level 1 relocates</td>
<td>T1 &gt; T2 &gt; T3</td>
</tr>
<tr>
<td>Level 3</td>
<td>Tier 2</td>
<td>Tier 2</td>
<td>Useful to reset tiering to a middle state</td>
<td>T2 &gt; T1 &gt; T3</td>
</tr>
<tr>
<td>Level 4</td>
<td>Tier 1 &gt; 2</td>
<td>Tier 2 &gt; 3</td>
<td>Similar to level 3 after level 3 relocates</td>
<td>T2 &gt; T3 &gt; T1</td>
</tr>
<tr>
<td>Level 5</td>
<td>Tier 2</td>
<td>Tier 3</td>
<td>Useful if dormant volumes are known</td>
<td>T3 &gt; T2 &gt; T1</td>
</tr>
</tbody>
</table>

### 2-Tier
- Tier 1: Level 1, 2, 4
- Tier 2: Level 3, 5

### 3-Tier
- Tier 1: All
- Tier 2: Level 2
- Tier 3: Level 4
AVOIDING THRASHING

- The bottom of the IOPH range for a tier is the “Tier Range” line.
- The top of the next tier is slightly higher than the bottom of the higher tier.
  - The overlap between tiers is called the “delta” and is used to help avoid thrashing between the low end of 1 tier and the top of the next tier.

To avoid pages “bouncing in and out of a tier” the pages in the “grey zone” are left where they are, unless the difference is 2 tiers.
HDT USAGE CONSIDERATIONS

- Application profiling is important (performance requirements, sizing)
  - Not all applications are appropriate for HDT. Sometimes HDP will be more suitable

- Consider
  - 3TB/day is the average pace of relocation
    - Will relocations complete if the entire DB is active?
  - Is disk sizing of pool appropriate?
    - If capacity is full on 1 tier type, the other tiers may take a performance hit or page relocations may stop
    - Pace of relocation is dependent on array processor utilization
MANAGING HDT WITH HITACHI COMMAND SUITE

DEMO
**Solution capabilities**

- Automated data placement for higher performance and lower costs
- Simplified ability to manage multiple storage tiers as a single entity
- Self-optimized for higher performance and space efficiency
- Page-based granular data movement for highest efficiency and throughput

**Business value**

- Capex and opex savings by moving data to lower-cost tiers
- Increase storage utilization up to 50%
- Easily align business application needs to the right cost infrastructure
QUESTIONS AND DISCUSSION
UPCOMING WEBTECHS

- **WebTechs**
  - Hitachi Dynamic Tiering: An In-Depth Look at Managing HDT and Best Practices, Part 2, November 13, 9 a.m. PT, noon ET
  - Best Practices for Virtualizing Exchange for Microsoft Private Cloud, December 4, 9 a.m. PT, noon ET

Check [www.hds.com/webtech](http://www.hds.com/webtech) for

- Links to the recording, the presentation, and Q&A (available next week)
- Schedule and registration for upcoming WebTech sessions
- Questions will be posted in the HDS Community: [http://community.hds.com/groups/webtech](http://community.hds.com/groups/webtech)
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