Agenda

• Hitachi Mainframe Strategy
  – Today’s IT challenges
  – People – Process – Technology
  – Mainframe Themes and Use Cases
  – IBM Compatibility and Hitachi Value Add

• Hitachi Virtual Storage Platform
  – Introduction to VSP

• Mainframe Roadmap
  – Hitachi Dynamic Provisioning
  – Hitachi Dynamic Tiering
  – Mainframe Performance

• Summary
Today's IT Challenges

• **Increasing Business Demands** – higher availability, better performance, rapid deployment, time to market, generation of new data is exploding

• **Growing Complexity** – New business models, new technologies, new applications, new users, challenging SLA

• **Burden of Legacy Systems** - more of the budget is spent on maintaining old rather than investing in new innovations

• **Staffing** - understaffed, over worked, constant need for new and broader technical skills, round the clock operations, training, retirement

• **Increased Risk** – Fraud, Business Continuity, Overruns, Disasters, Privacy, increasing regulations, audits, fines

• **Doing More With Less** – deliver more high quality services in an increasingly complex environment with a flat budget
Delivering unsurpassed customer value

• Leverage technology to create customer value

• help our customers’ people become more productive

• Drive value by improving the operational and managerial processes within our customers’ organizations

• Summarize benefits and differentiators of the strategic Mainframe technology themes we are pursuing on behalf of our customers.
Applying Hitachi Technology to IT challenges

*Business Demands, Complexity, Increased Risks, Staffing*

- **Consolidation, High Availability and Security**
  - USP V and VSP designed and built for Zero Downtime operation
  - Highest Performance and Scalability
  - Hardware-based Encryption for Data at Rest

- **Lower TCO – Increase ROA**
  - Leverage Hitachi Storage Virtualization to attach lower Cost External Storage
  - Hitachi Content Platform for long term Archival on Disk instead of Tape

- **Backup**
  - In-System Replication Technology such as ShadowImage and Flashcopy provide Disk-to-Disk backup to minimize backup Window

- **Disaster Recovery**
  - Hitachi Universal Replicator for 3-Data Center DR
  - Cascading and/or Multi-Target Topologies
  - Basic Hyperswap
  - No Impact on Host Resources

**Differentiators & Benefits**

- Management Simplification
- Reduced Cost
- Improved Productivity
- Improved RTO/RPO
HDS Academy

• IBM Mainframe Expertise is rare and much in demand
  – Skill Shortage and lack of young skilled Mainframe System Engineers pose a serious threat to the future viability of S/390 platform

• HDS Academy actively helps our customers with IBM Mainframe Training
  – Own Curriculum on all Storage Related Aspects (BCM, HUR, TC, SI)
  – Cooperation with the European Mainframe Academy GmbH and Merritt Systems in the USA

• HDS Mainframe Competency Centers
  – 10 Regional Centers WW staffed with experienced Mainframe Experts ensure deep technical know-how is available to HDS field and customers
  – Investing in maintaining and expanding our Mainframe Skills
Lower TCO – Increase ROA

• Leverage Hitachi Storage Virtualization
  – Attach External low-cost Storage via Universal Volume Manager (needs FC I/F)
  – Use Case 1: HSM ML2 on Disk
  – Use Case 2: Mainframe Archive on Disk
  – Use Case 3: Lower cost for PiT and DR

Benefits of Storage Virtualization;
Lower Tape Use and Improve “nearline” Storage
From Disaster Recovery to Business Continuity

- Quality of DR and BC Solution is determined by RPO and RTO:
  - Recovery Point Objective: Amount of acceptable data loss and point to which data must be restored
  - Recovery Time Objective: Amount of time it takes to be back Online

- Key Design Objective is to lower RTO and RPO:
  - Make effective Use of Array Based Remote Replication Technologies
  - Avoid using Host Resources (e.g. Data Mover)
  - Provide RPO that is measured in seconds
  - Is Cost Effective

- Address Requirements for Both Local and Wide Area Solutions
  - Business Requirements and Replication Distance dictate choice of technology

- Seamless Integration in Host Based High Availability (Clustering) Solutions
  - Parallel Sysplex provides non-disruptive and continuous operations
Remote Replication for Disaster Recovery – 2DC

- Synchronous – limited by distance
  - Achieving RPO of Zero and Fast Recovery Time
  - With Automation Solutions (IBM’s GDPS or HDS’ Basic Hyperswap) able to achieve RTO of almost Zero

- Asynchronous – no distance limitations
  - No Host Impact on Response Times
  - Offloads MIPS and reduces cost by replacing host based replication methods
  - Data Movement Overhead is on Out-Of Region Array (Pull Technology)
  - Journaling maintains update sequence Integrity
  - RPO measured in seconds, RTO in minutes (and is application dependent)
Extended Consistency Groups

- System timestamp added by mainframe and used as common (synchronized) index of journal
- Arbitration is performed by remote storage controllers
  - No specific software on hosts is needed for arbitration process.
  - Communicate via Remote Link FC Network
- Can support up to 12x12x12
Remote Replication for Disaster Recovery – 3DC

- Combination of Synchronous and Asynchronous Replication Technologies
  - Leveraging HUR Journaling alleviates impact of Link Failures and Cache limitations
  - No Data loss upon loss of Primary Site

- HUR Cascade
  - Data volumes in Intermediate Site shared as TCs Secondary and HUR Primary Volumes

- HUR Multitarget
  - Provides Delta Resynchronization upon Primary Site Failure
  - Can be combined with Automation Solutions e.g. TPC-R Basic Hyperswap, GDPS etc.
Basic HyperSwap and HUR 3DC Integration

- Based on IBM’s TPC-R Basic HyperSwap
  - To manage Production and Hot Standby Site
- Hitachi Universal Replicator – 3 Data Center multi-target solution
  - 1x1x1 configuration with USP V and USP VM
  - Extended consistency group for TrueCopy Sync and Hitachi Universal Replicator along with HUR’s ATTIME Split
- Business Continuity Manager (BCM)
  - Monitor basic HyperSwap
  - Controls True Copy Sync and Hitachi Universal Replicator
  - Monitor the health of the environment
  - Provide automation with scripting

Four Data Center with Multi-target and Cascade
Hitachi Virtual Storage Platform®

Primary Data Center

Hitachi Virtual Storage Platform

Hitachi TrueCopy™
Synchronous Remote Copy

Universal Replicator
Asynchronous Remote Copy

In-region Recovery Data Center

Out-of-region Remote Data Center

Primary Data Volumes
(Synchronous & Asynchronous)

Target Data Volumes
(Synchronous)
Primary Data Volumes
(Asynchronous)

Journal Data Transfers

Journal Read Requests

Out-of-region Remote Data Center

Target Data Volumes
(Asynchronous)
Mainframe Landscape – Hitachi Strategy

Dealing with today's reality and investing in the future

Hitachi Strategy:
Development Focus on Hitachi added Value Solutions

Middleware and Application Level
- IMS, CICS, DB2, MQSeries etc.

IBM Portfolio:
- RCMF
- Hyperswap Manager
- GDPS

Hitachi Portfolio:
- BC Manager,
- Universal Replicator,
- FDM, FC UVM

Solution Level

Storage Functions
- Concurrent Copy, Flashcopy, Metro Mirror (PPRC),
- Global Copy (PPRC-XD), z/OS Global Mirror (XRC)

Operating Systems
- zOS + DFSMSdfp, Linux for System z, zVM, zVSE

Hardware Interface
- FICON, zHPF, FCP, MA, PAV, HyperPAV

Storage Subsystems
- IBM Storage
- Hitachi Storage
- Hitachi Storage

IBM Compatibility (without Host SW)
IBM Compatibility (without Host SW)
IBM Compatibility (without Host SW)
IBM Relationship

- Hitachi/IBM License Agreement to share APIs
  - 2001 – Initial Hitachi / IBM license agreement
    - Hitachi access to IBM API and interface specification for storage platform
      - Enabled PPRC, XRC, FlashCopy, PAV, MA
    - IBM access to Hitachi API for NanoCopy and ShadowImage
  - 2009 – Current agreement signed
    - Ongoing agreement with no expiration – can be cancelled by either party

- Qualification and interoperability testing at IBM
  - New HDS storage platforms & features
  - IBM Mainframes, Operating Systems & Critical Features
    - GDPS PPRC & XRC
    - FlashCopy
    - High Performance FICON (zHPF)

- Problem resolution
  - HDS/Hitachi and IBM have long term agreement
    - Provide assistance in effort to quickly resolve joint customer escalations.
    - Intent of agreement is to jointly determine problem source
    - Root cause and solution is provided by owning vendor
    - Resolve internal issues after customer problem resolution
Integrated Scaleable Storage Portfolio

- Intelligent Virtual Storage Systems
- Advanced Midrange Storage Systems
- File and Content Storage

Functionality

Hitachi Virtual Storage Platform

- VSP
- AMS2300
- AMS2500

Hitachi Adaptable Modular Storage

- AMS2100

Hitachi NAS powered by BlueArc

Hitachi Content Platform

Hitachi Data Discovery Suite

Hitachi Data Systems
Introducing Hitachi Virtual Storage Platform

Only 3D scaling

Industry’s Highest Performance

40% Higher Density

Twice the Connectivity

48% Less Power

New September 2010

Most External Virtualized Capacity

15x Larger Volume Size

Automated Dynamic Tiering

VMware VAAI Integration
Virtual Storage Platform: Internal Switch Architecture

- 2 to 4 Virtual Storage Director blades – 8 to 16 cores
- 2 to 12 FED blades with 16 to 96 ports
- 2 to 8 cache adapters with 32 to 512GB cache
- 2 to 4 BED blades with 16 to 32 SAS links
Virtual Storage Platform: 3D Scaling Architecture

- 5th generation network crossbar switch
- New control memory architecture
- New pool of VSD global processors
- 1024 GB pool of Global cache
- 2.4x OLTP performance
- 79% increase in bandwidth
- Scale up, scale out, scale deep growth path
Next Generation Architectural View
Single control chassis

Virtual Storage Director cluster

SSD protected Cache Memory

Control Memory

Interfaces with offload processors

Control Memory Backup
### Components Descriptions

- **Virtual Storage Director**
  - Runs microcode for I/O command processing, control of user data caching, overall control of Virtual Storage Platform
  - Manages any faults and executing software for all program products.
  - Control data is stored in local memory

- **Cache Adapters**
  - Caches user data on reads and writes. Writes are mirrored, cache is backed up on flash drives

- **FED (Front End Directors) and BED (Back End Directors)**
  - Provides processing for connections between host servers and external storage to data cache
  - Data accelerator processors designed to accelerate I/O and operational performance
Comparison: Universal Storage Platform V Fibre Channel Loops vs. Virtual Storage Platform SAS

- **Universal Storage Platform V with 64 Fibre Channel (FC) loops**
  - 4 FC loops per controller
    - 4 FC loops per back end director
    - Half duplex arbitrated loops
    - 32 FC loops pair at 4 Gb/s

- **Virtual Storage Platform with 64 SAS links**
  - 8 SAS paths per back end director blade
    - 32 full duplex links per control blade
    - 64 SAS links at 6 Gb/s
  - Chassis are connected point-to-point
  - SAS and SATA can be intermixed
Reduce the Storage Footprint with Industry-leading Efficiency

Improvement Details

- **Efficient storage media**
  - 2.5” HDD: greater density, less power, less cooling
  - Use of SDD for highest performance data
  - High performance HDD
    - Consumes 50% less power than standard HDD

- **Improved cache**
  - SDD protected cache minimizes use of batteries
  - Larger cache uses low power memory

- **Improved hardware design**
  - Front-to-back air flow
    - Easy to place within data center’s hot and cold aisles
  - Modular, interconnected blade-based architecture
    - Minimizes extra components
  - Sensors in cabinet control multi-speed fans for power efficient cooling.
The maximum number of racks is 6:
2 control chassis and 16 drive chassis

<table>
<thead>
<tr>
<th></th>
<th>1 control chassis</th>
<th>2 control chassis</th>
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</thead>
<tbody>
<tr>
<td>HDD (2.5”)</td>
<td>0 - 1,024</td>
<td>0 - 2,048</td>
</tr>
<tr>
<td>HDD (3.5”)</td>
<td>0 - 640</td>
<td>0 - 1,280</td>
</tr>
<tr>
<td>Ports</td>
<td>16 - 96</td>
<td>16 - 192</td>
</tr>
<tr>
<td>Cache</td>
<td>Up to 512GB</td>
<td>Up to 1,024GB</td>
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* All channel configuration
Hitachi Dynamic Provisioning

- Virtualize devices into a pool of 42MB pages
- Provision servers in seconds
- Eliminate waste by allocating pages only as used
- Extend to external storage
- Convert fat volumes to thin
- Optimize storage performance
Before (Hierarchical control per volume)

- Need to allocate data to different volumes according to performance requirements (i.e., classify data, but at whole volume).
- Even if data is allocated according to performance requirements, frequently-accessed data and infrequently-accessed data may coexist.
- All of a given virtual volume must reside in a single tier.

Hitachi Dynamic Tiering

- No need to manually classify data.
- Monitor access frequency of data and automatically allocate to an optimal tier according to frequency.
- A given virtual volume resides in multiple tiers.

Legend:
- Red: Frequently-accessed data
- Blue: Data with moderate access frequency
- Green: Infrequently-accessed data
Introducing Hitachi Dynamic Tiering at the Page Level

- One pool of pages now spans multiple tiers of storage
- Volume Data is written to the highest performance tier first
- Less active volume pages migrate to lower tiers
- Pages can be promoted
- Volumes no longer have to be moved to optimize performance
- Volumes will be able to span across tiers on external storage
- Tiers can grow and shrink independently
Mainframe Roadmap
Hitachi Mainframe Advantage

• IBM Compatibility Advantage
  – Hardware Interface compatibility minimizes Risk – no Host Software required
  – Interoperability Testing with IBM ensures highest quality
  – Intellectual Property Agreements enables continuous support

• Hitachi Added Value Advantage
  – Hitachi IP Leadership in Open Systems Storage becoming available to Mainframe Space
  – More Customer Choices to meet increasing Business Requirements
  – Automation moving into Storage Subsystem to improve productivity and Quality of Service

• Performance Advantage
  – Technology Innovation and Hardware Architecture improvements as strong Foundation
  – Lower Response Time and Higher Throughput enhances Storage Utility Value
  – Larger Subsystems lowers Capital Expenditure
Mainframe Vision and Direction

- Hitachi is bringing storage virtualization technology to the mainframe space
- HDP for Mainframe will provide FCSE/DVE/EAV compatibility
- HDP is technology foundation for the next wave of mainframe virtualization

- Utilize existing assets or low-cost external storage
- Better space efficiency
- I/O load balancing
- Flexible volume allocation

- Automatic Dynamic Tiering
- Effective use of high-speed SSD
Each DPVOL is analyzed and relocated in turn.

- IOPS break point where pages higher than this level are relocated to Tier 0.
- IOPS break point where pages destined for Tier 1 and Tier 2 is determined.

Monitor physical IO to pages.

Page relocations.
HDT Operations (Open Systems)

- Advanced Options
  - Page Reallocation
    - Automatic
    - Manual
  - Reallocation Cycle
    - 1, 2, 4, 8, 24 hours
  - Monitoring Interval
    - Start time
    - End time
This graph gives you visibility into what your application is doing.

Use it to understand IO loads by tier.

Also available for each LDEV.

If graph is flat, it’s not a good candidate for HDT.

Tier Properties window
VSP Highlights

- SAS Backend enables the most cost and resource efficient use of SSD, SAS and SATA and provides solid investment protection

- Frontend enables use of FC, FCoE and FICON and tight Integration into virtual server landscape

- New CPU and Shared memory design enables object management of millions of pages *Measure - Manage - Move*

- Massive Cache > 1TB with SSD protection ASIC Data Accelerator and tightly coupled Architecture for highest performance

- Dynamic Tiering: from HDP to HDT for both Open Systems and Mainframe

- Maintain and Expand Leadership Position in RAS and Performance

- **2’048 Disk Slots**
- **3.5” & 2.5” Disk Drives**
- **SSD - SAS - SATA – NL-SAS**
- **64 x 6Gbps SAS Channels**
- **192 x 8Gbps FICON/FC Ports**
- **FCoE Ready**
- **>70% Power Saving / TB**
• Hitachi Storage Solutions focus on applying economic and financial principles to storage – reducing TCO and improving ROA:
  – Virtualization
  – Consolidation
  – Dynamic Tiering
  – Dynamic Provisioning

• Significant Investment in developing Mainframe capabilities enables Sustainable Customer Value:
  – Maintaining IBM Compatibility
  – Ensuring Interoperability
  – Providing Added value Functions Unique to Hitachi
  – Leveraging Technology to positively impact People and Process

• Maintaining our Core Values of Reliability, Availability, Scalability and Performance
A New Dimension in IT
Is Here