Storage Reinvented:
IBM XIV® Storage System

Shiva Anand Neiker, XIV Sales Leader
IBM XIV Storage Technology Profile

- **Disruptive (Grid) Technology providing one virtual (Plug in the Wall) platform**
- More than 1000 systems in production to date, more than 500 customers
  - 100% of evaluation systems have gone into production at end of testing
- Product in development for more than 7 years
  - More than 5 years in production
  - More than 50 patents filed
- For our customers, this means:
  - Next-generation storage product
  - IBM integration, support and services
IBM XIV Storage System is allowing us to meet our recovery time objectives while reducing our storage total cost of ownership

Greg Johnson, Director & CTO, IT Technology & Engineering Services, VCU Health Systems

“We are exceeding our SLA’s and driving cost down”. Maher Atwah, Ph.D. Vice President and CTO, Health Data Management Solutions (HDMS) a Aetna Subsidiary
**Gartner**

“The XIV’s innovative architecture and IBM ownership mean that it will be included on many user shortlists where its scale and functionality, and server connectivity, match user needs”

“For many workloads, this type of storage system appears to be the future of storage, offering lower acquisition cost, increased flexibility of data management, massive scalability and much easier management”

**Forrester**

“XIV remains unstoppable like the best of enterprise storage, but may be fundamentally more extensible, scalable, and adaptable as technologies evolve. Without a doubt, it brings a new set of economics to the table for enterprise-level storage”.

“In a perfect world 64% - 80% of 80% - of all corporate data could be migrated from high cost storage arrays to much lower cost storage clusters” – **The Storage Mojo**
IBM Information Infrastructure is Complete

Intelligent Management. Protected Information. Smarter Insights.

**Disk Systems**
- IBM XIV® Storage System
- SAN Volume Controller
- DS family of disk drives
- Solid State Subsystems

**Tape Systems**
- TS family of tape drives, libraries and virtualization
- Diligent VTS

**Services**
- Consulting
- Assessments
- Design
- Migration
- Deployment
- Hosting
- Business Partners

**Availability Management**
- IBM XIV Storage management
- TotalStorage Productivity Center
- Global Mirror, Metro Mirror
- Tivoli Provisioning Manager
- Tivoli Storage Process Manager
- IBM Systems Director family

**Business Continuity**
- IBM XIV unlimited snapshots
- Productivity Center for Replication
- Tivoli Storage Manager (TSM) family
- Tivoli Continuous Data Protection (CDP)
- Tape cluster grids and Peer-to-Peer
- GDOC, GDPS

**Compliance and Retention**
- DR550, DR550 Express, FS gateway
- Grid Archive Manager, GMAS
- TSM Space Management for Unix/Windows
- GPFS, DFSMS
- N series SnapLock™
- WORM tape support

**Storage Networking**
- Switches
- Directors
- Routers

**Security**
- Encrypted Media
- Tivoli Security Management family
IBM Information Infrastructure: Enterprise Disk Storage

For clients requiring:
- One solution for mainframe and distributed platforms
- Disaster Recovery
  - Across 3 sites
  - Across 2 sites > 60 miles apart
- Secure encryption

**DS8000**
- Supports mainframe and distributed platforms
- Global Mirroring
- RAID 6*
- Encryption*
- Optimized for Capacity > 50TB

For clients requiring:
- Distributed environment support
- Save power, cooling and space
- Future-proof capacity expansion
- Optimized capacity utilization
- OLTP and Databases (Oracle, etc.)
- Proven in Financial markets
- Exchange and Web 2.0 workloads
- Rapid storage provisioning

**XIV**
- Supports distributed platforms
- Simple management
- Virtually unlimited no overhead snapshots
- Thin provisioning
- Rapid capacity roll-out
- Optimized for capacity > 50TB

For clients requiring:
- IBM i support
- Distributed environment support with a focus on tier 2 cost-efficiency
- Optimized for Oracle and DB2 environments

**DS5000***
- Supports IBM i and distributed platforms
- Oracle, DB2 environments
- Cost efficient storage for capacity < 50TBs

For clients requiring:
- Virtualization of multi-vendor storage infrastructure silos

**SVC**
- Virtualizes multiple vendor environments, including IBM, EMC, HP and others

For clients requiring:
- Support for mid-range mainframe platforms

**DS6000**
- Support for intensive computational applications
- High performance computing

For clients requiring:
- NAS or File Storage support

**DCS9900***
- Support for intensive computational applications
- High performance computing

**N series**
- Scale Out File Storage (SOFS)

*Note: Products and capabilities described include current and future roadmap enhancements thru 1Q09
IBM XIV Storage Provides Exceptional Value

Disruptive (Grid) technology providing one (Plug in the wall) platform for all enterprise storage requirements with self-healing and self-tuning

XIV Support Value

• Up to 80% decrease in power, space and cooling costs/TB (SATA)
• Up to 70% savings on Tier 1 storage costs (commodity components, Thin Provisioning, snaps, DR - all included)
• 70-80% reduction in operating cost (Virtual volume management, Elimination of storage tiering, data classification and performance tuning)
• Rapid roll out of new applications (Snap Shots and Seamless migration)
• Capacity Savings – Thick to Thin Migration

Problems XIV Solves

• Data centre power, space and cooling constraints
• High cost, complexity, management and risk associated with tiered storage
• New application time to market
• Virtual Server roll outs (VMWare)
• Database and OLTP consistent performance issues
• Compliance and regulatory issues by backup and archiving to Disk via high performance VTL (Diligent)
Key Attributes for Enterprise Information Infrastructure

- **Reliability** – Business data more critical than ever, with no tolerance for downtime; requirement is now greater than 5 nines

- **Functionality** – Tier 1 functions (e.g. snap, replication, thin provisioning) that scale with no performance penalty and are inherently built-in to the architecture

- **Power and Space** – “Green”, Minimize power usage, cooling and floor-space

- **Manageability** – Total system virtualization, with emphasis on ease of use

- **Performance** – Consistent performance under all conditions, eliminating hot spots and staying consistent under hardware failures

- **Cost** – Reasonable capital cost and minimal ongoing cost - so business can concentrate its efforts on its core and not on IT

- **Future Proofed** – Ease of volume growth and scalability of architecture supports requirements for today and tomorrow.
With this legacy architecture, scalability is achieved by using more powerful (and more expensive) components.
Tiered Storage Solutions Can Add Cost and Complexity

- Traditional approach is to try to cope with storage pains by using multi-tiered storage
  - Tiered storage management and data classification can be costly and complex
  - Excessive data movements may create reliability and performance issues
  - Utilization rates remain low, with limited ability to execute thin provisioning

Imagine prioritizing electricity at home…

```
Laundry Power?  Lamp Power?  TV Power?
```

Price and Value

Tier 1

Tier 2

Tier 3
IBM XIV Storage Architecture

Design principles:
• Massive parallelism
• Granular distribution
• Off-the-shelf components
• Coupled disk, RAM and CPU
• User simplicity
IBM XIV Storage is a Grid Architecture
IBM XIV Storage System Hardware Details

- New IBM XIV hardware
  - 15 modules with 12 drives per module
  - 6 of them with FC ports (four 4Gb ports per module)
  - 24 x 4Gb FC ports
  - 6 x 1Gb iSCSI ports
  - 120GB of memory (15 * 8)
  - 3 x uninterruptible power supplies
  - 180TB Raw; 79TB Useable (1TB disks)
    - Global spare space – full module plus 3 disks
    - 79TB = (180 – 12 – 3)/2 – 3.5 (internal use)
- Ordered through eConfig/AAS
- IBM Branded CLI, GUI and HW
- IBM Service and Support
  - 3 to 5 years, 4 hour response, 24x7 Same Day On-Site Repair
  - IBM HW and SW Installation
Summar:

- +27% more usable TB
- -40% power needed
- -38% cooling
- XIV about 53% more efficient!

Fine print:

One bay DMX vs. one rack XIV
DMX: (240) 300GB drives, Raid 5 7+1
XIV: (180) 1TB drives

<table>
<thead>
<tr>
<th>DMX-3 and DMX-4</th>
<th>1 Storage bay</th>
<th>2 Storage bay</th>
<th>3 Storage bay</th>
<th>4 Storage bay</th>
<th>5 Storage bay</th>
<th>6 Storage bay</th>
<th>7 Storage bay</th>
<th>8 Storage bay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive count, max</td>
<td>240</td>
<td>480</td>
<td>720</td>
<td>960</td>
<td>1200</td>
<td>1440</td>
<td>1680</td>
<td>1920</td>
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<tr>
<td>Power consumption (kVA)</td>
<td>12.5</td>
<td>18.6</td>
<td>27.7</td>
<td>36.8</td>
<td>36.9</td>
<td>43.0</td>
<td>49.1</td>
<td>55.2</td>
</tr>
<tr>
<td>Heat dissipation (BTU/hr)</td>
<td>41,380</td>
<td>61,180</td>
<td>80,980</td>
<td>100,780</td>
<td>120,580</td>
<td>140,380</td>
<td>160,180</td>
<td>179,980</td>
</tr>
</tbody>
</table>
IBM XIV Storage Power Consumption: KW per TB

- Gen 1: 6KW per 120TB raw, 51TB net
- Gen 2: 7.7KW per 180TB raw, 79 TB net
- Future - 2TB drives double power efficiency!
- High-end architecture with SATA drives
  - Provide revolutionary power (cooling) consumption
  - Minimize floor space

Without compromising performance!
IBM XIV Storage Distribution Algorithm

• Each volume is spread across all drives
• Data is “cut” into 1MB “partitions” and stored on the disks
• XIV algorithm automatically distributes partitions across all disks in a pseudo-random manner.

XIV’s disks behave like connected vessels, as the distribution algorithm aims for constant disk equilibrium.

Thus, IBM XIV’s Storage overall disk usage could approach 100% utilization when loaded.
XIV Distribution Algorithm on System Changes

- Data distribution only changes when the system changes
  - Equilibrium is kept when new hardware is added
  - Equilibrium is kept when old hardware is removed
  - Equilibrium is kept after a hardware failure
XIV Distribution Algorithm on System Changes

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The fact that distribution is full and automatic ensures that all spindles join the effort of data re-distribution after configuration change.

Tremendous performance gains are seen in recovery/optimization times thanks to this fact.
Let’s build a smarter planet.
IBM XIV Storage: Concept of “Spare”

• Traditional approach
  – Dedicated disks used for spares
  – In many systems spares are dedicated for a RAID group

• IBM XIV Storage approach
  – Recovery time: 30 minutes for 1 TB disk (full)
  – No dedicated spare disk, only global capacity
  – All disk are equally used
  – Minimize the risk of technician mistakes
  – Higher availability with no performance impact

• 180TB raw is 79 TB net
  – Spare space for 3 disks and a full module
  – 80 = (180 – 12 – 3 )/2 – 3.5 (internal use)
IBM XIV Storage: Thin Provisioning

- Defining logical volumes bigger than physical capacity
- Installing physical capacity only if and when needed
- No space consumed when data is 0
- Pools are used to manage quota

Results:
- Reduced overall direct storage cost
- Storage expenses spread over time, exploiting price reductions
- Easier management
- Save 20-50% of storage capacity
XIV  Data Migration and Replacing Outdated Hardware

- Automatic data migration
  - XIV is placed between the Servers and the legacy storage array
  - Migrating thick volumes to thin provisioned volumes
  - Online data migration from other Storage arrays
  - Self Tuning
- New hardware can be added to the system
  - Better performance, less power, more density
- Outdated hardware can be phased out and removed
- All system components are replaced, with:
  - No down time
  - No host configuration
  - No administration effort
Migration Redefined

Flexible Migration:
- Thick-to-thin migration
- FC or iSCSI
- Option Source Updating

Host

SAN

XIV Storage System

Existing Storage

Host I/O

Source Updating

Backgroup Copy
IBM XIV Snapshots - Virtually without Limits

- Snapshot creation/deletion is instantaneous
- High performance WITH snapshots
- Unlimited snapshots for data protection
- Differential snapshots save 15-30% of storage capacity

High performance snapshots provide:

- Easier Physical Backup to Tape
- Instant recovery from Logical Backup
- Easy creation of Test Environment
- Boot-from-SAN with easy rollback
- Easy Data-Mining on Production data
VMotion with Traditional Storage

Virtual Machine heavily using CPU and Disk
VMotion moves VMs non-disruptively to resolve CPU bottleneck
Virtual Disk (VMDK) has not moved and hotspot is unresolved
V Motion with XIV

CPU Overload!

Data Module 1

All Hotspots Eliminated
XIV Snapshots vs Traditional Storage

• Eliminate need for full clone copies
• Increase performance of primary data volume when incremental snapshots are being used
• No dedicated reserve space required
• Snap-of-Snap capability
• Massively scalable
Traditional Storage assigns certain spindles to the LUN of the Datastore. Incremental R/W snapshot uses the same limited spindles + snapshot reserve. Production LUN affected negatively when snapshot is in use. To overcome negative affect on production LUNs, full clones are created for each snapshot that needs r/w access.
XIV Snapshots vs Traditional Storage for VMware

- Incremental Snapshots perform well as blocks are already optimally distributed and configured. No dedicated reserve space required.
- Disk required for read/write performance LUN snapshots is reduced exponentially compared to traditional storage.
Traditional Array Copy/Clone process

1. Locate physical drives in the array for creating Copy (BCV/Clone) volumes
2. Create volumes for Copy volumes (ensuring no performance impact to existing production volumes)
3. Associate copy volumes with Standard Volumes
4. Create initial establishment (clone/copy creation) - all data is copied from source to copy/clone
   
   repeat steps 1 - 4 for additional copy groups
5. Write script to interface with existing application/filesystem to manage copy/clone process
6. Update entire process when additional capacity is added or source volumes change

XiV Snapshot process

1. Identify Source volumes for Snapshot
2. Using XIV Management GUI initiate snapshot
3. If desired create scripts for scheduling snapshots

If source volume grows, no changes are required to snapshots
Remote Mirroring for Disaster Recovery

• Low granularity – any to any volume replication
• Every I/O is committed to local and remote copies before completion
• Various policies upon link failure
  – Re-sync when link is resumed
  – Full completion or Fail
• Automatic Snap is used to keep copies self-consistent even during re-sync after link failure
• Flexible restore options:
  – Local servers and remote data
  – Remote servers and remote data
  – Remote server and local data
• Over dedicated FC or IP ports
IBM XIV Storage Simple and Intuitive Management

• Intuitive GUI (Java based) with Script Generator
• No dedicated management station
• Command Line Interface (CLI)
• XML over SSL
• Event management (SNMP)
• Complete Event Logging
• Events notification via email, SNMP and SMS
• Role based management:
  • Storage Admin
  • Application Admin
  • Operator
IBM XIV Storage Simple Intuitive Management

example: Creating a Volume

- Used capacity is always known!
IBM XIV Storage Simple Intuitive Management
example: Resizing a Volume
IBM XIV Storage: Volume to LUN Mapping

<table>
<thead>
<tr>
<th>Volume</th>
<th>Size (GB)</th>
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<tbody>
<tr>
<td>Email_Vol_1.snapstore_00002</td>
<td>367</td>
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<tr>
<td>Email Vol 1.mapped</td>
<td>581</td>
</tr>
<tr>
<td>ERP CONSTANTS snap_group_00001.ERP_Vol_1</td>
<td>5033</td>
</tr>
<tr>
<td>ERP CONSTANTS snap_group_00001.ERP_Vol_1</td>
<td>5033</td>
</tr>
<tr>
<td>ERP_Vol_2</td>
<td>979</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>LUN</th>
<th>Name</th>
<th>Size (GB)</th>
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<tbody>
<tr>
<td>0</td>
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<tr>
<td>1</td>
<td>ERP Vol 1</td>
<td>5033</td>
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<td>2</td>
<td>ERP_Vol_2</td>
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Soft: 57586 of 81286 GB (74%)
IBM XIV Storage Consistency Groups
IBM XIV Storage Pools
IBM XIV Storage: Monitoring
IBM XIV Storage: Events Log
Total Cost of Ownership – The impact of IBM XIV Storage

Average Storage TCO for Storage Systems

Source: Gartner Group

- Simplified storage management
- Instant storage provisioning
- Automatic balanced performance
- Rolling upgrade

- Snaps with no impact
- Differential snap
- VSS support
- Simple migration

- Rapid self-healing and scrubbing
- All components are redundant
- Flexible Volume Replication
- Aggressive disk drive elimination

- Downtime 20%
- Backup / Restore 30%
- Administration 13%
- Hardware Management 3%
- Purchase 20%
- Environments 14%
- Reduce power and cooling
- Minimize footprint
- Redundant UPS
- General purpose hardware
- Lower hardware costs
- Efficient thin-provisioned storage
- All Software included

Reduce power and cooling
Minimize footprint
Redundant UPS

Let’s build a smarter planet.
Success story: Navisite

- System installed in June 2007 (as XIV)
- System in production since September 2007
- “The IBM XIV Storage System is going to allow us to provide a highly reliable, highly performing platform to our customers that should help NaviSite gain a competitive advantage over its competitors.”
- “Within three or four minutes, the data on those disks was redistributed with zero impact on our clients. It just performs very consistently in terms of availability and performance.”
More Navisite Quotes

• “The combination of virtualization and IBM XIV storage has reduced deployment time from anywhere as much as 48 hours to under 6 hours, and it takes 5 to 10 minutes to create a volume and assign it to an existing server, that kind of time savings equates to a tremendous gain in efficiency for our IT team.”

• “IBM XIV offers the right blend of cost, features and functionality, so it has become a key component to our environment and the services we deliver.”
Success story: Bank Leumi

- Started an evaluation process in May 2006
- As of September 2006, the system is in use by production, tier-1, batch and user applications
- XIV compared to a Tier-1 SAN system:
  - 2 racks, FC 15K RPM 146GB disks
  - Measured three times the performance on XIV
- Second XIV system installed in September 2006
- Third Nextra system installed on March 2007 (DRP)
- Today: 8 systems, more than 720TB
  - Tier-1, De-dup, development environments, VMWARE, etc.
Other customers who switched to XIV

• Bxxxxx - XIV delivered consistent, predictable, linear performance that met or exceeded EMC DMX Tier One Storage, with high reliability and point and click management.
  – Purchased: First order of 10 XIV frames totaling 1.6 Petabytes (raw) was for VMware environment, Bxxxxx wanted the benefits of virtualized storage behind their virtualized servers.
  – Licensing Simplicity: XIV packaging of "All in software" pricing was desirable from a acquisition value, but even greater from a standpoint that Bxxxxx did not have to worry about version control and retroactive inter-operability of storage applications. With EMC not only is there significant financial impacts but managing EMC multiple products and versions is far to challenging. With XIV it is all handled in one packaged release.
Other customers who switched to XIV

- Warner Brothers - SAP and Backups windows solved by XIV - Advanced Function Wins Business
  - Purchased - 9 frames for SAP, 3 for Diligent
  - Requirements: Warner Brothers wanted a Tier 1 storage technology that could support their demanding SAP environment, and at same time allow them to back it up. Their time to back up had exceeded their window and RPO objectives were challenged.
  - Benefits: Application owners and storage administrators are often at odds with each other due to requirements. XIV brought those two organizations together delivering better performance than EMC as well as snap shots performed in less than 150ms allowing for testing. Storage administration drastically cut complexity as well as with snap shots could now back systems up that previously where not. XIV demonstrated to both application and storage administration how snap shots could create a instant GOLD copy of production data, as well as a instant read/writeable copy for testing. Its was remarked by W.B. that this function took one week with EMC compared to 150ms with XIV.
  - Disappointing Result: When EMC learned they were losing the business, they requested a "Best and Final" price offer, followed by Dinner. Business was awarded to XIV after offer and Dinner was than cancelled as well by EMC
Other customers who switched to XIV

- AXL - In a reverse auction awarded IBM all Tier 2 storage in 2009.
  - Purchased: Tier 2 in 2009 committed to XIV
  - Requirements: After an exhaustive four month proof of concept, IBM was awarded all of AXL tier 2 storage for 2009. What is important to understand Tier 2 for AXL is their most demanding tier of storage.
  - Testing: Performance and Availability was stressed heavily and again the XIV technology met and exceeded EMC's. In a true story that could only believed if seen, the XIV Storage Architect arrived one day and described AXL availability testing as "It looked the scene of the scarecrow and the monkeys of wizard of oz, the XIV frame was literally ripped to shreds, with four data modules removed and drives all over the floor" but the machine was still running
  - Benefits: Consistent performance that met or exceeded EMC, but with a significant value over EMC. AXL now can launch new services to customers that before because of the complexity and cost associated with EMC they couldn't. XIV is allowing AXL to launch new services even in challenging economic environments.
IBM XIV Storage Supports Lower Total Costs

• Lower capital costs, no added charge for XIV software features – mirroring, snapshot, data migration, management

• Less storage needed, thanks to:
  – Thin provisioning
  – Management efficiency
  – Differential snapshots

• Savings in power, cooling, and space with large capacity SATA drives

• Simple, intuitive management – helps to manage more capacity with less staff

• Future ready – architected for easy module replacement to enable capacity, performance, and power efficiency upgrades
Space Consumption per Real Requirements

- Thin provisioning
  - Estimated save 20-50% of storage capacity
- No orphaned space due to virtualization, DR or snaps
  - Estimated save 10-20% of storage capacity
- Differential snaps instead of full copies
  - Estimated 15-30% of storage capacity
- Overall, the same requirements are met with storage capacity
The Bottom Line: Real-World Benefits

- **Reliability**
  - Revolutionary self healing takes minutes, not hours
- **Functionality**
  - Thin provisioning and replication built into the architecture
- **Power and Space**
  - Minimize power, cooling and floor-space with SATA drives
- **Performance**
  - Massive parallelism, spindle utilization, self-healing and cache effectiveness boost performance dramatically
- **Manageability**
  - Simple, easy management; a logical volume has only two parameters: name and size
- **Cost**
  - Off-the-shelf components
  - No charge for software features (Snap, DR, Management)
IBM XIV Storage System is allowing us to meet our recovery time objectives while reducing our storage total cost of ownership.

Greg Johnson, Director & CTO, IT Technology & Engineering Services, VCU Health Systems

“We are exceeding our SLA’s and driving cost down”.
Maher Atwah, Ph.D. Vice President and CTO, Health Data Management Solutions (HDMS) a Aetna Subsidiary
Thank you!

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