Advanced Technical Skills (ATS) North America

IBM Storwize V3700 System

Al Watson
alw@us.ibm.com

12/13/2012

Agenda

- **Introducing IBM Storwize V3700**
  - Positioning in the IBM Storwize family
  - Enclosures
  - Base Features and Options
  - Models
- **The Hardware**
  - Node Enclosures
  - Expansion Enclosures
  - Drive Support
  - Customer Replaceable Parts
- **The Software**
  - Virtual storage design
  - Inherited SVC basic functionality
  - Inherited Fea
- **Management**
  - Initial configuration
  - Using the GUI
  - Help

The Smarter Storage approach

Integrated Solutions

PureFlex

IBM SmartCloud
Virtual Storage Center

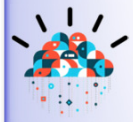
IBM Smart Analytics Solutions (ISAS)

Built-in Innovation

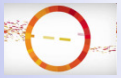
Storage Virtualization SW and SVC

Easy Tier

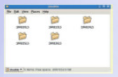
Real-time Compression



IBM Active Cloud Engine™



Deduplication



Linear Tape File System (LTFS)

Optimized Storage Systems

For Enterprise Workloads

DS8000

XIV

SONAS

For Midrange and Entry Workloads

Storwize V7000 Unified

Storwize V7000

N series

Storwize V3700

DS3500

For Data Protection and Retention

ProtecTIER TS7610/20/50

Tape drives LTO 3, 4 and 5

Tape Library TS3310

Tape Automation TS3500

Tape Virtualization TS7740

Storage Management Software

Tivoli Storage Productivity Center

Tivoli Key Lifecycle Manager

Tivoli Storage FlashCopy Manager

Tivoli Storage Manager

What is Storwize V3700?

- **Storwize V3700 is an entry level storage controller**
- **1Gb/s iSCSI host attachment standard**
- **10Gb/s iSCSI/FCoE, 8Gb FC options available on V3700**
- **Built using the proven SVC technology as a base**
- **Internal virtualization gives access to advanced functions: rapid volume provisioning, thin provisioned volumes, flash copy, volume mirroring, data migration**
- **Internal drives**
  - SSD, 15K SAS, 10K SAS and Nearline SAS
  - Supports up to 120 x 2.5” (SFF), 60 x 3.5” (LFF), or combination.
- **SAS backend network for up to four expansions**
- **Customer installable and maintainable**
  - With a Call home feature capabilities
- **Easy setup and management using the intuitive GUI provided**

Enclosures / Models

- **Enclosures**
  - 2U 19 inch rack mount enclosure
  - Four enclosure models
  - Control/Expansion and/or 12/24 drives
  - No controls on the enclosure
- **Models**
  - 2072-12C V3700 control enclosure 12 x 3.5” drives
  - 2072-24C V3700 control enclosure 24 x 2.5” drives
  - 2072-12E V3700 expansion enclosure 12 x 3.5” drives
  - 2072-24E V3700 expansion enclosure 24 x 2.5” drives

Hardware Components

Enclosure - Front

- **There are either:**
  - 12 3.5 inch drive slots, mounted horizontally 4 wide and 3 high with drive assemblies. The drive slots are numbered 1 to 12, starting top left and going left to right, top to bottom
  - 24 2.5 inch drive slots, 1 row of 24 vertically mounted drive assemblies. The drive slots are numbered 1 to 24, starting from the left. (There are 2 vertical center drive bay moldings between slots 8 and 9, and between slots 17 and 18
- **The left enclosure ear on both enclosure chassis are identical and contain 3 LED indicators**

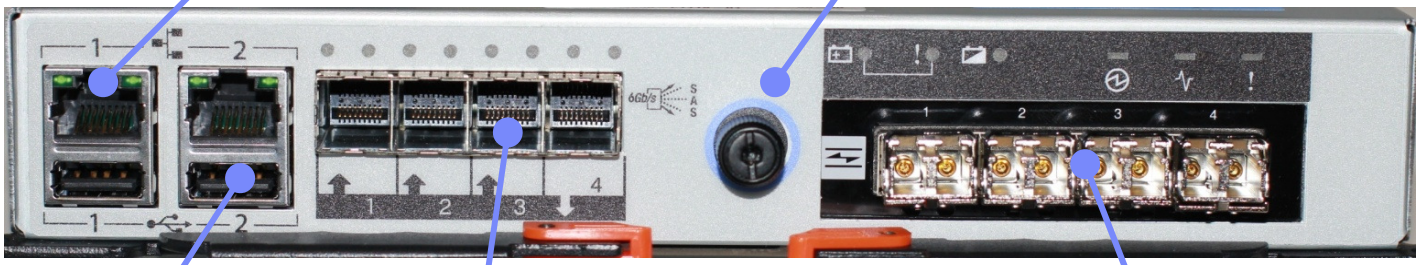
Enclosure - Rear

- **Rear of the Enclosure:**
  - There are two power supply slots along the bottom of the unit, each taking up half of 1U. The left hand slot is power supply 1, the right hand slot is power supply 2. The power supplies are inserted the same way up.
  - There are two canister slots along the top of the unit, again taking up half of 1U The left slot is canister 1, the right slot is canister 2. The canisters are inserted the same way up.
  - Fans are contained within the PSU, replacement requires a new PSU
  - Fan speed is variable and under system control
  - Fans continue to operate in a PSU which has failed or lost AC power

Node Canister Physical

1GbE ports(2) *
- **management**
- **iSCSI**

HIC retention thumbscrew



USB ports(2)

Quad 6Gb SAS ports
- **3 Unused (for future use)**
- **1 expansion(4)**

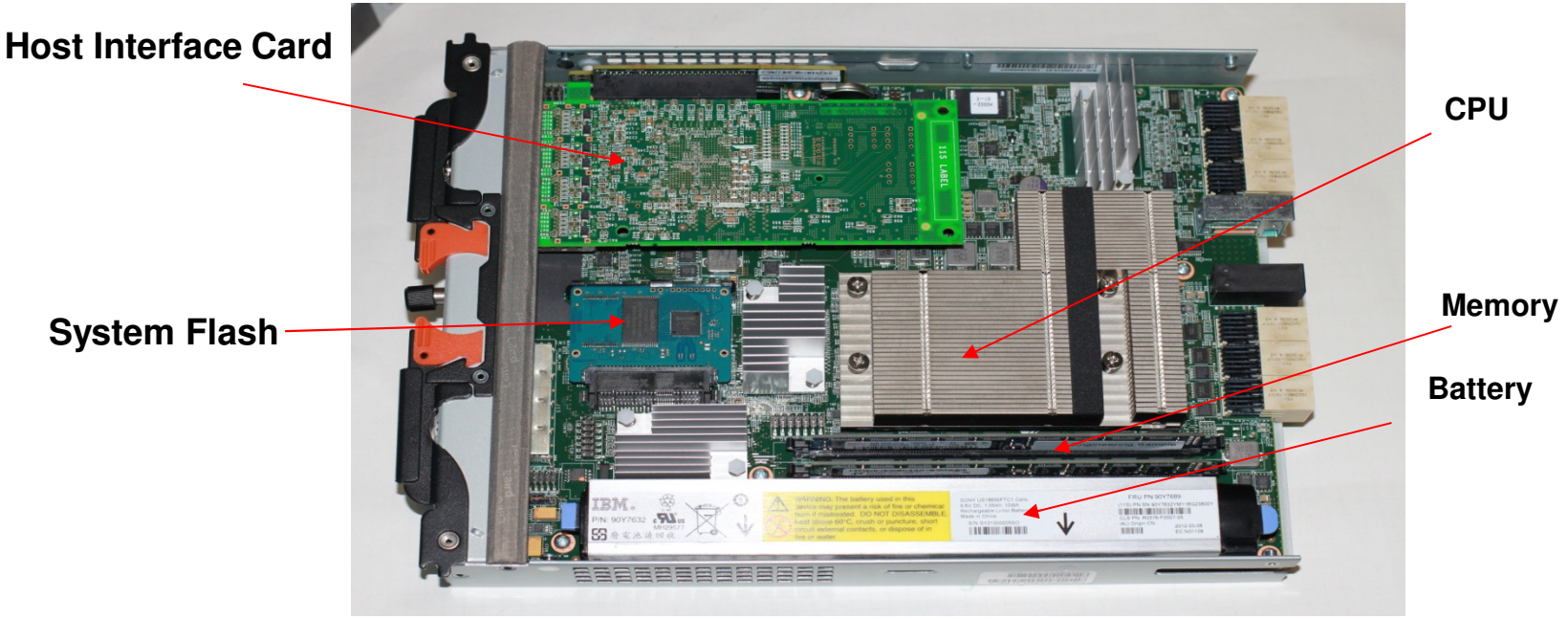
Expansion slot
- **4x 8Gb FC**
- **4x 1GbE (iSCSI)**
- **2x 10GbE iSCSI/FCoE**

*** Note:of port 1 is required for management**

Expansion Canister

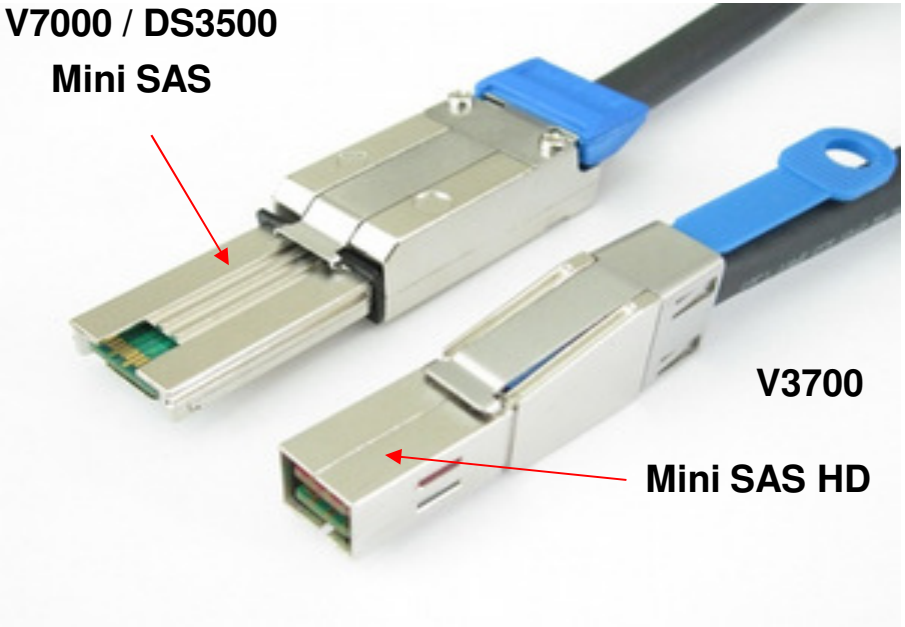
- **2 x 6Gb/s SAS ports, usage of port 1 is mandatory**

Node Canister Internals



- Intel Sandy Bridge architecture
- Dual core Celeron G530T
- CPU runs in energy saving Green Mode
- 4GB memory per node canister (8GB total)
- Can be upgraded to 8GB per node canister (16GB total)
- Battery Backup Unit inside node

New Mini SAS HD Connectors



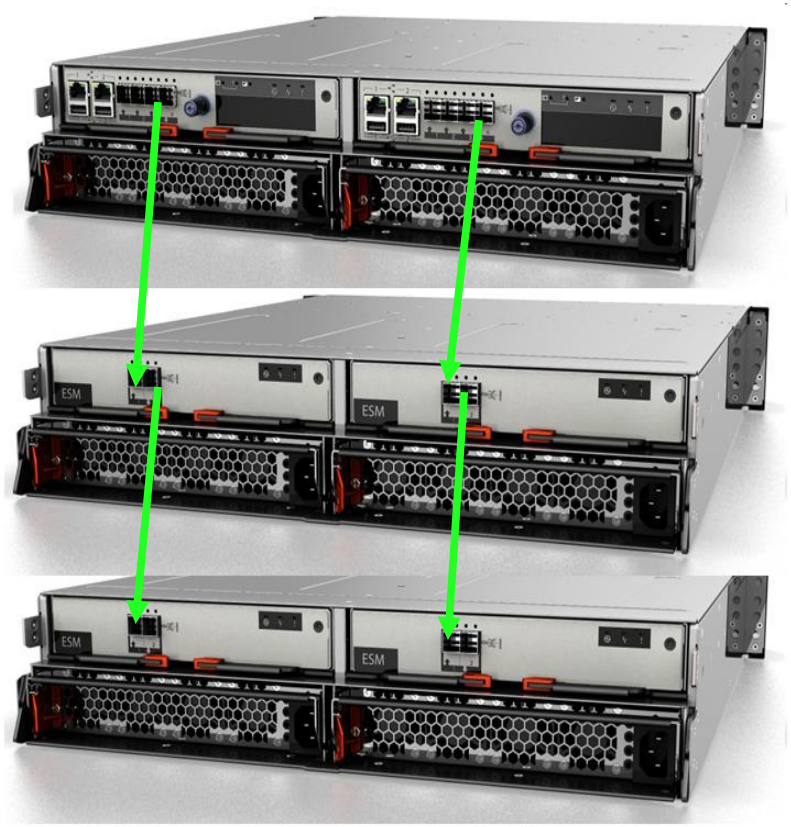
New Expansion Enclosure Attachment Cables		
0.6m SAS Cable (mSAS HD)	Feature ACTA	SEO/PN 00Y2465
1.5m SAS Cable (mSAS HD)	Feature ACTA	SEO/PN 00Y2467
3m SAS Cable (mSAS HD)	Feature ACTA	SEO/PN 00Y2469

DS3500 and Storewize V7000 use the SFF-8088 (mini SAS)

V3700 uses the SFF-8644 (mini SAS HD)

SAS Network

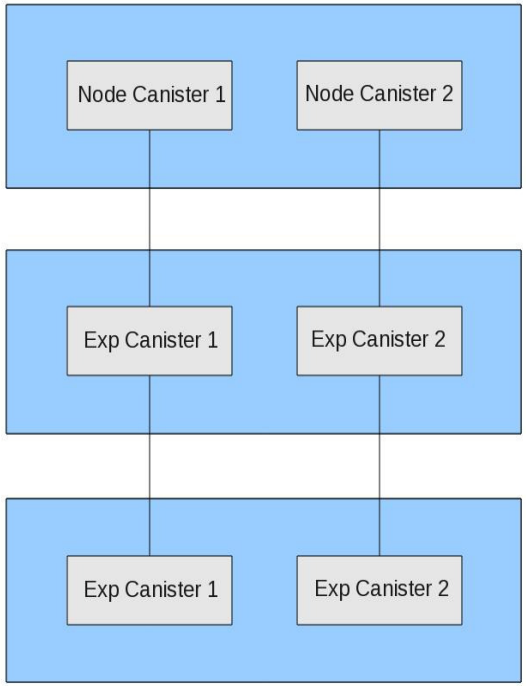
- V3700 node canister has a single expansion SAS chain
- V3700 supports up to 4 expansion enclosures
- Node canisters use SAS port 4 for the expansion connection
- In release 1, SAS ports 1-3 are unused (should have a dust cover on them)



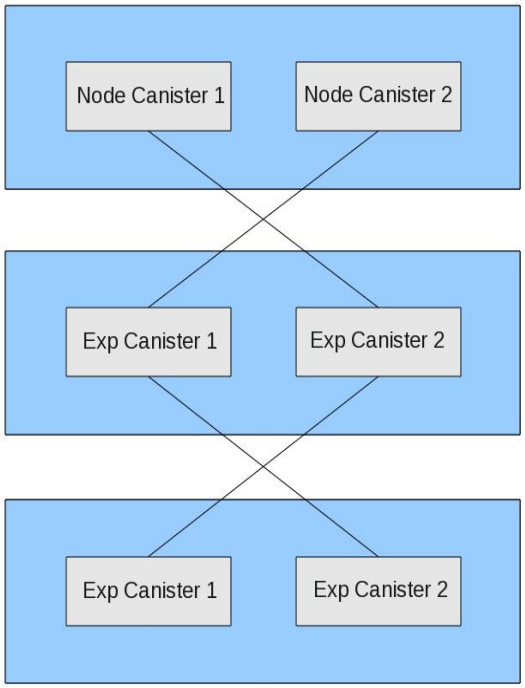
SAS Network – Wiring Rules

CORRECT

Top/Down – Top/Down



INCORRECT



- **V3700 only supports V3700 expansion enclosures**
- **V7000 expansion enclosures not supported**
- **DS3500 expansions are not supported**
- **V7000 and DS3500 can not support the V3700 expansions**

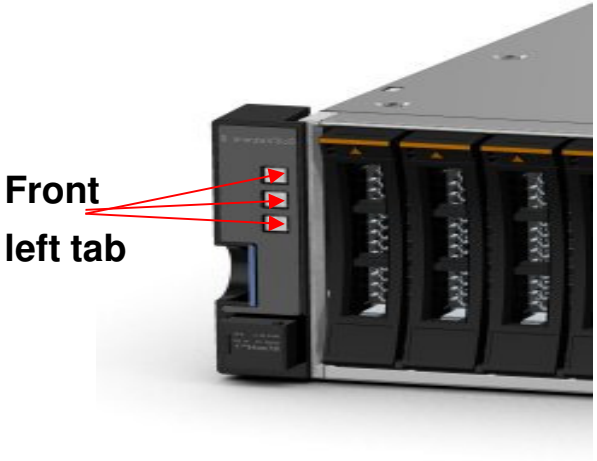
Drives

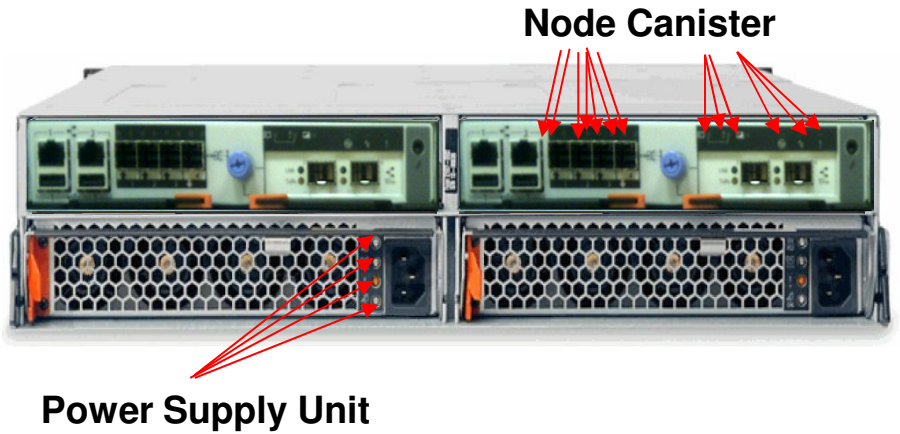
Size	Type
146GB/300GB	2.5” 15K HDD
300GB/600GB/900GB	2.5” 10K HDD
500GB/1TB	2.5” 7.2K Nearline HDD
2TB/3TB	3.5” 7.2K Nearline HDD
2TB/3TB	3.5” 7.2K Nearline HDD
200GB/400GB	2.5” SDD

Notes: Only V3700 drives can be used in V3700 enclosure

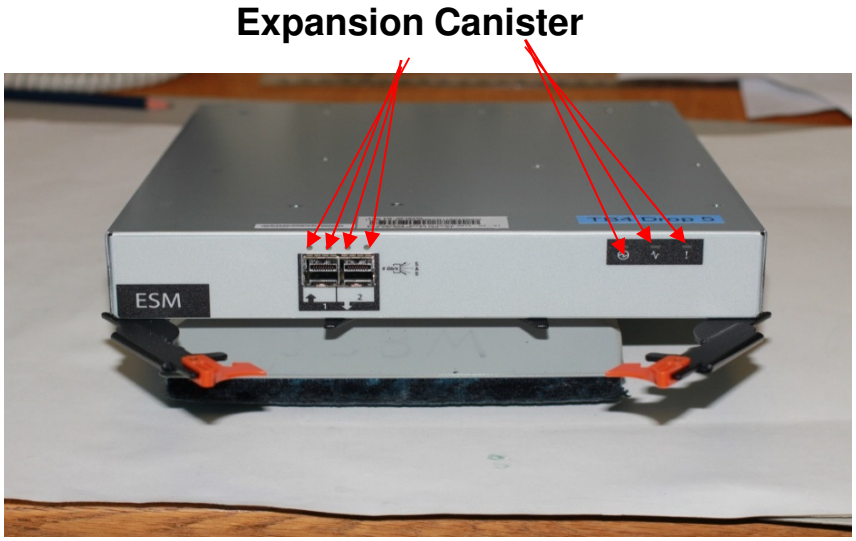
Drive types can be mixed within an enclosure

LED Indicators - Enclosure



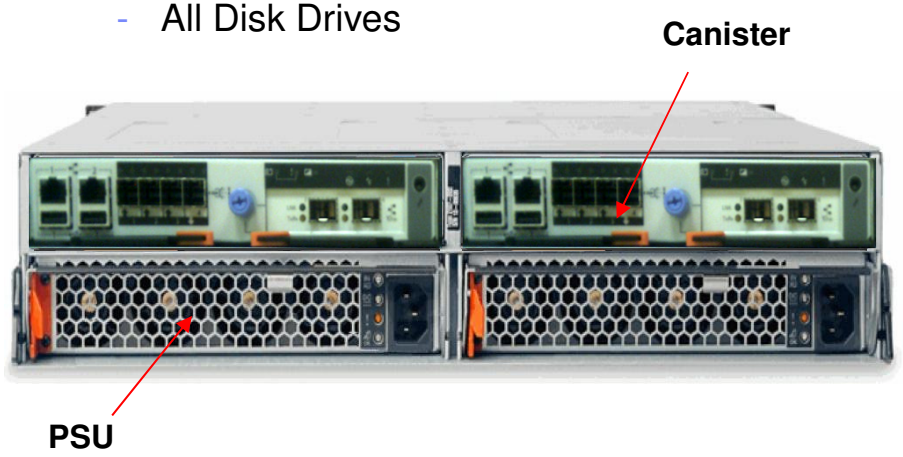


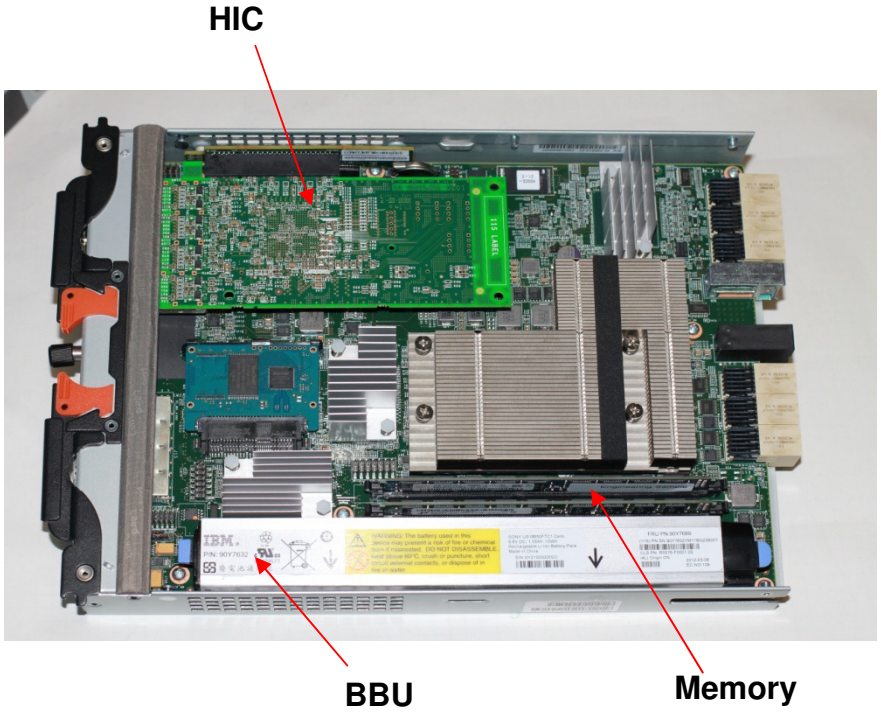
LED indicators for Activity, Normal and Error Conditions are provided



Replaceable Parts

- **Customer Replaceable Units (CRU)**
  - PSU (containing Fans)
  - Node / Expansion canisters
  - Battery Backup Unit (BBU)
  - Cache memory
  - Host Interface Card (HIC)
  - All Disk Drives





- **Field Replaceable Units (FRU)**
  - Enclosure midplane
- **Enclosure metalwork not replaceable**

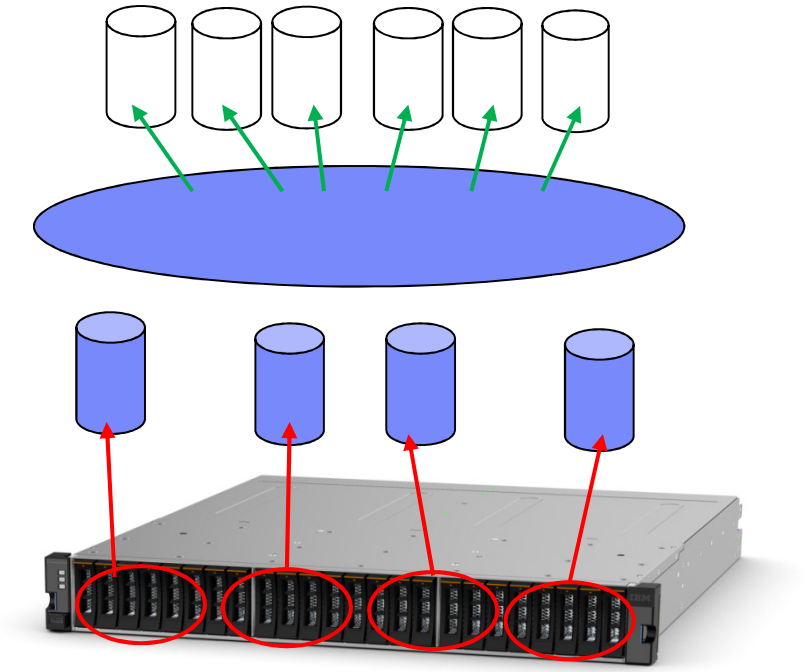
Other Features & Limitations

- **#3690, SEO/PN 90Y8780 - RACK SHIPMENT BRACKET**
  - This is a customer-installable bracket used when a Storwize V3700 enclosure will be shipped installed in a rack.
    - This feature does not result in Manufacturing integration of the unit.
- **#5810, SEO/PN 68Y7501 - 10M OM3 FIBER CABLE (LC-LC) (for LA, EMEA, and AP)**
  - This feature provides a 10 meter 50.0/125 micrometer OM3 fiber optic cable terminated with LC Duplex connectors and is used to connect a Storwize V3700 FC port or 10Gb iSCSI/FCoE port to a server or fabric port.
- **V3700 canisters and enclosures are not interchangeable with other Storwize Virtual products**
  - They are separate products.
  - V3700 expansions will not be accepted by other products.
  - Drives are the also not the same as they have different VPD.
- **No clustering is allowed outside of the control enclosure**
  - A single IO group is all that can be supported.

Virtualization Function

Logical Building Blocks

- **The Storwize V3700 uses basic storage units called managed disks and collects them into one or more storage pools**
- **These storage pools then provide the physical capacity to create volumes for use by hosts**



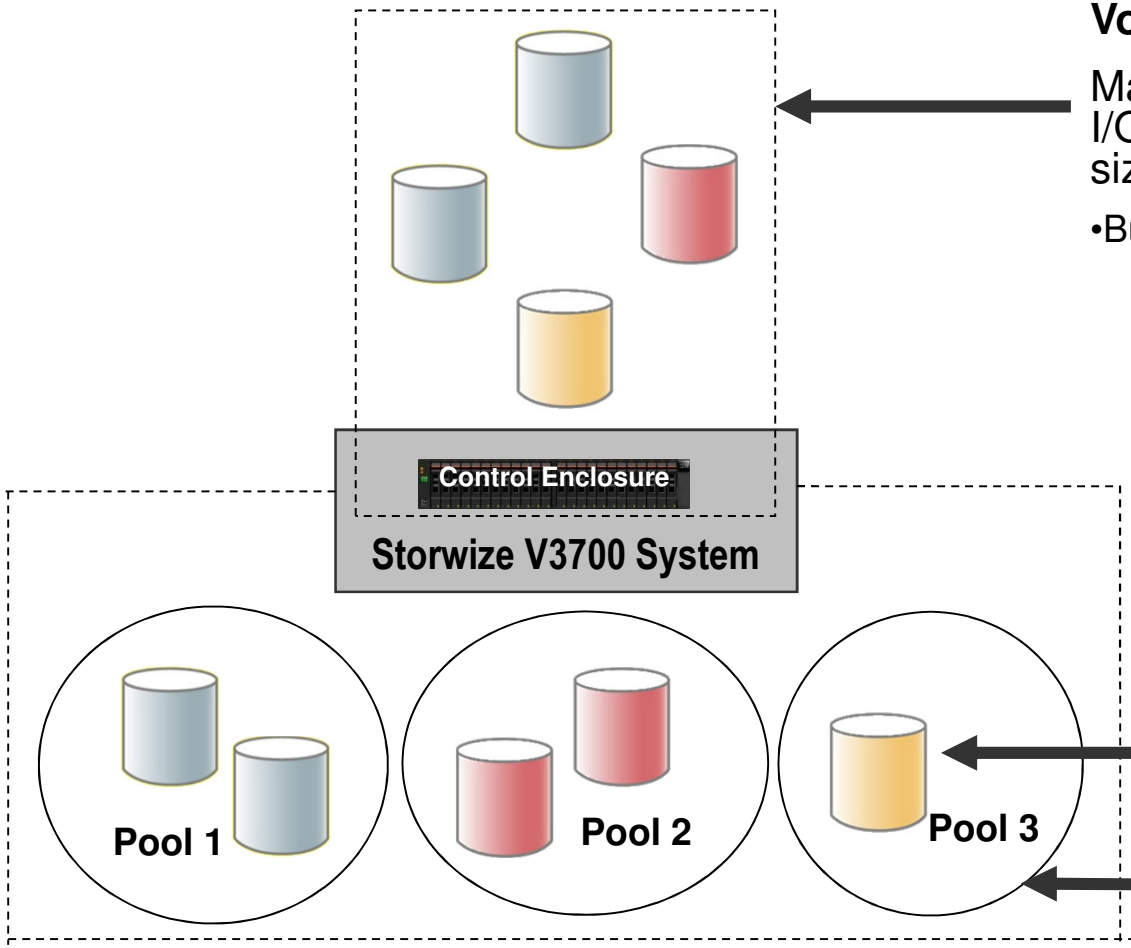
Volumes

Storage Pool

Managed Disks (MDisks)

Internal Disks Drives

Virtualization – The Big Picture



Volumes:

Max 2048 Volumes assigned to the I/O Group, with each up to 256TB in size and each assigned to:

•Built from a specific Storage Pool

Managed Disks (MDisks):

• Internally or externally provided

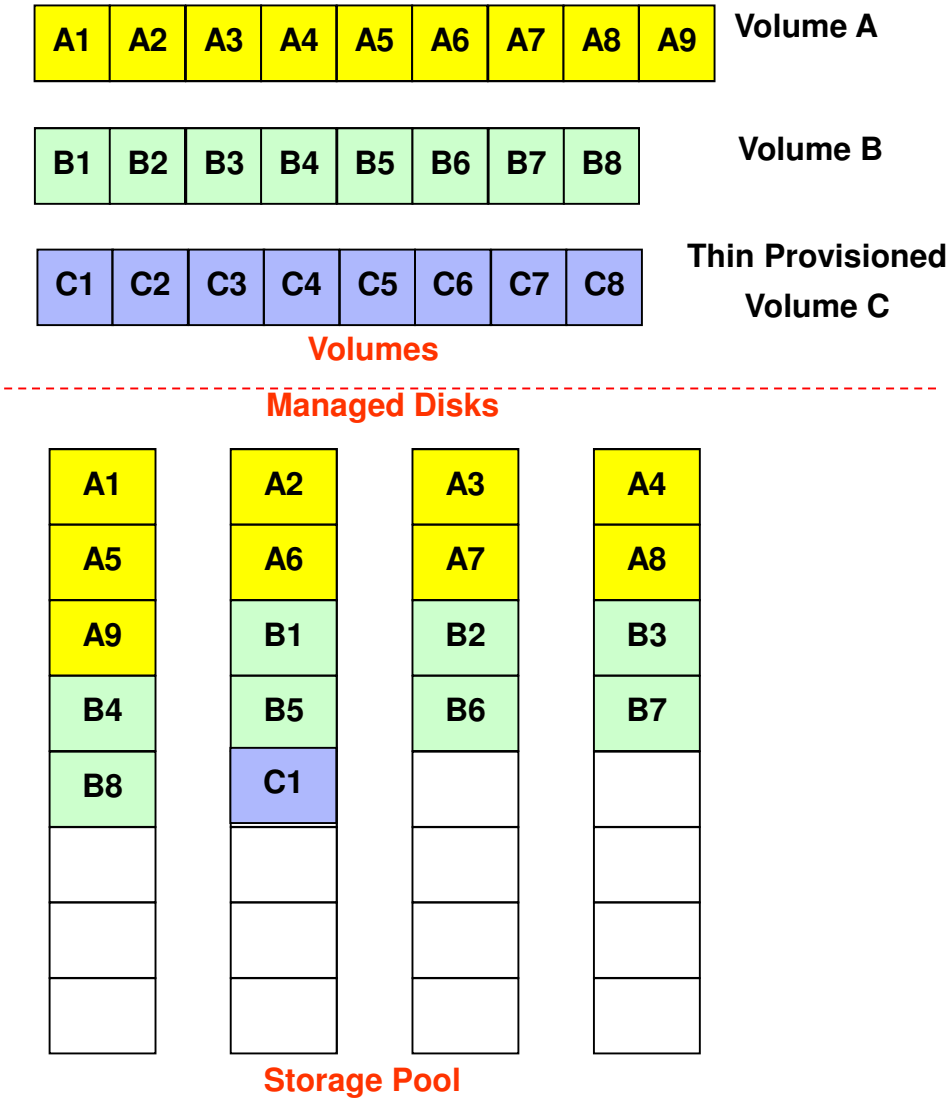
• Max 4096 MDisks per System

Storage Pools:

• Max 128 Storage Pools

• Max 128 MDisks per Pool

Volumes



- When the managed disks are added into storage pools, the managed disks are split into chunks of storage known as extents
- The size of these extents is a property of the storage pool
  - Default is 256MB
- Whenever you create a new volume you must pick a single storage pool to provide the physical capacity
- By default the created volume will stripe all of it's data across all the managed disks in the storage pool as shown on the left diagram
- Thin provisioned volumes consume extents only as actual data is written to disk

Volume Presets Speed Deployment

- **Generic**
  - Running command:
    - svctask mkvdisk -cache readwrite -copies 1 -iogrp io_grp0 -mdiskgrp mdiskgrp0 -name G_1 -size 20 -syncrate 50 -unit gb -vtype striped
- **Thin**
  - Running command:
    - svctask mkvdisk -autoexpand -cache readwrite -copies 1 -grainsize 32 -iogrp io_grp0 -mdiskgrp mdiskgrp0 -name TP_1 -rsize 2% -size 20 -syncrate 50 -unit gb -vtype striped
- **Mirror**
  - Running command:
    - svctask mkvdisk -cache readwrite -copies 2 -iogrp io_grp0 -mdiskgrp mdiskgrp0:mdiskgrp0 -name M_1 -size 20 -syncrate 50 -unit gb -vtype striped
- **Thin Mirror**
  - Running command:
    - svctask mkvdisk -autoexpand -cache readwrite -copies 2 -grainsize 32 -iogrp io_grp0 -mdiskgrp mdiskgrp0:mdiskgrp0 -name TP_M_1 -rsize 2% -size 20 -syncrate 50 -unit gb -vtype striped

Default Configuration

- **This is the default configuration that is automatically built during the initial configuration of the V3700**
  - Not an optional choice
- **A one click GUI setup exists to configure all drives into RAID arrays**
  - Solid state drives will be configured as RAID 1 with 2 members and 1 spare
  - SAS drives will be configured as RAID 5 with 8 members and 1 spare
  - Near line SAS drives will be configured as RAID 6 with 12 members and 1 spare
- **All members of an array will have the same drive class**
  - All SAS, all SSD or all NL SAS
  - Same RPM and capacity
- **One storage pool will be created for each drive class**
- **Different configuration requires the default to be deleted before creating.**

Supported RAID levels

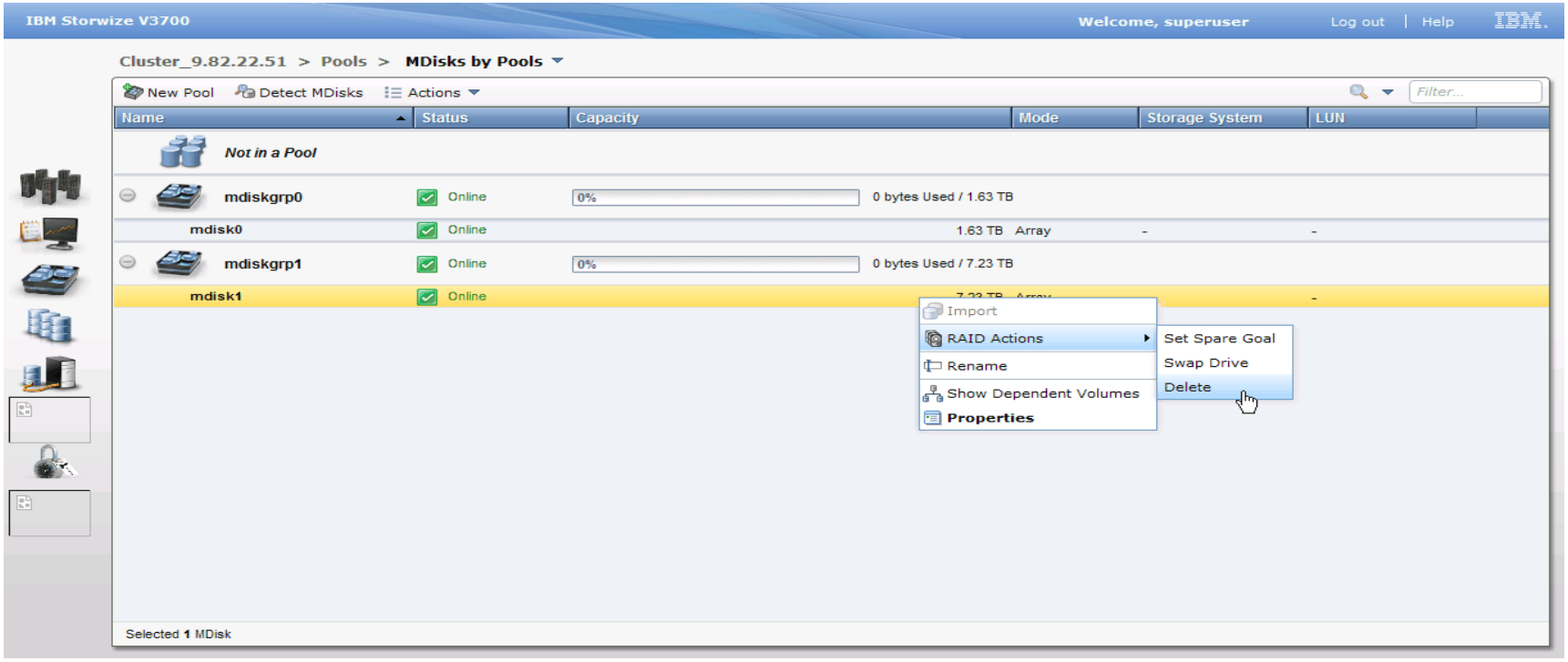
- **Storwize V3700 will support the following RAID levels:**
  - RAID 0 (striping, no redundancy)
  - RAID 1 (mirroring between 2 drives)
  - RAID 5 (striping, can survive one drive fault)
  - RAID 6 (striping, can survive two drive faults)
  - RAID 10 (RAID 0 on top of RAID 1)
- **More details about the what the RAID levels actually mean is available at URL below:**
  - http://en.wikipedia.org/wiki/RAID

Creating a RAID Array

- **In Storwize V3700 a RAID array is created at the point that you add the array into the pool**
- **When the array is created a single managed (a.k.a Mdisk) is created for the full capacity of the array**
- **Wizards and Pre-sets are available to suggest configurations to users based on the hardware attached to the system**
- **Currently there is no way to grow an existing array or change the RAID level of an array**
  - E.g. Can't grow a 4+P RAID-5 array to a 6+P array
  - E.g. Can't convert a 7+P RAID-5 array to a 4+4 RAID-10 array or vice versa
  - Requires removing array from pool and recreating it larger or with different RAID level
- **If the Mdisk built on internal storage is removed from the pool, then the array and the associated managed disk is unconfigured**
  - Drives go back to candidate status to be used to create another array

Deleting an Mdisk from a V3700 Storage Pool

- **Deleting a Mdisk from a storage pool**
  - Internal Mdisk require you delete them using the RAID array functions not the Mdisk ‘right click’ and ‘Remove from pool’ which will be grayed out
    - Internal Mdisks are RAID arrays and when you delete the Mdisk from a pool the array is deleted as well and the member drives return to candidate state



Spare Drive Design

- **Spare drives are global spares**
  - This means that any spare which is at least as big as the drive which is being replaced can be used in an array
    - Thus a SSD array with no SSD spare available would use a HDD spare
- **The spare system will prefer best possible match based on the following parameters:**
  - Technology type
    - SAS vs SSD vs. NL-SAS
  - Speed/RPM
  - Capacity
  - Location
- **Each array has a spare goal property**
  - Indicates how many spares must be available to protect the array
  - If the number of spares drops below the goal then alert sent to notify admin

Replacing a physical drive

- **In existing entry level controllers, it is often the case that physically replacing the drive in the slot is all that is required for a drive replacement.**
- **In Storwize V3700, additional software steps are required to make the system use the newly inserted drive.**
- **If the drive is replaced under guidance from the Directed Maintenance Procedure (DMP), these actions will be automatically performed by the DMP.**
  - Using DMP for all hardware replacement is basically required to make process as easy as possible for the customer
  - Do not just pull the bad part(s) and replace them without guidance from the procedures.
- **If the drive is a perfect replacement (matches all of the member goals) then RAID will automatically queue the drive to be included into the array**
  - If the array is still rebuilding onto a spare then the rebuild will be completed first
  - If the array is fully redundant (all members present in the array) Then the spare will be exchanged with the replaced drive
    - A member exchange swaps the data between two drives so that a member can be replaced concurrently without removing redundancy
      - Array width will grow by one drive during this process
  - If there had not been a suitable spare in the system, then the array will be rebuilt to include the replaced drive

Features

Features

- **SSDs can be used in the V3700 for Storage.**
- **FlashCopy – Full-copy, no-copy and incremental**
- **Volume Mirroring – the ability to mirror a volume from one storage pool to another in the IO group (internal to the V3700)**
  - Volume management, migration and availability
- **A Storwize V3700 can be virtualized as external storage behind an SVC**

Statement of Direction

IBM plans to enhance Storwize V3700 with:

- 6Gb SAS host attachment support
  - When available, SAS host attachment support can be enabled through a no-charge machine code upgrade

Optional Features:

- Easy Tier
- Remote mirroring
- FlashCopy support for up to 2,040 targets
  - Optional features can be enabled with the purchase of the applicable feature code / option part number and a no-charge machine code upgrade

** Note: IBM's statements regarding its plans, directions, and intent are subject to change or withdrawal without notice at IBM's sole discretion. Information regarding potential future products is intended to outline our general product direction and it should not be relied on in making a purchasing decision. The information mentioned regarding potential future products is not a commitment, promise, or legal obligation to deliver any material, code, or functionality. Information about potential future products may not be incorporated into any contract. The development, release, and timing of any future features or functionality described for our products remains at our sole discretion.

Limitations

- **No Real Time Compression**
- **No external storage virtualization**
  - However, a V3700 can virtualise external mdisks in image mode for migrations only

FlashCopy Overview

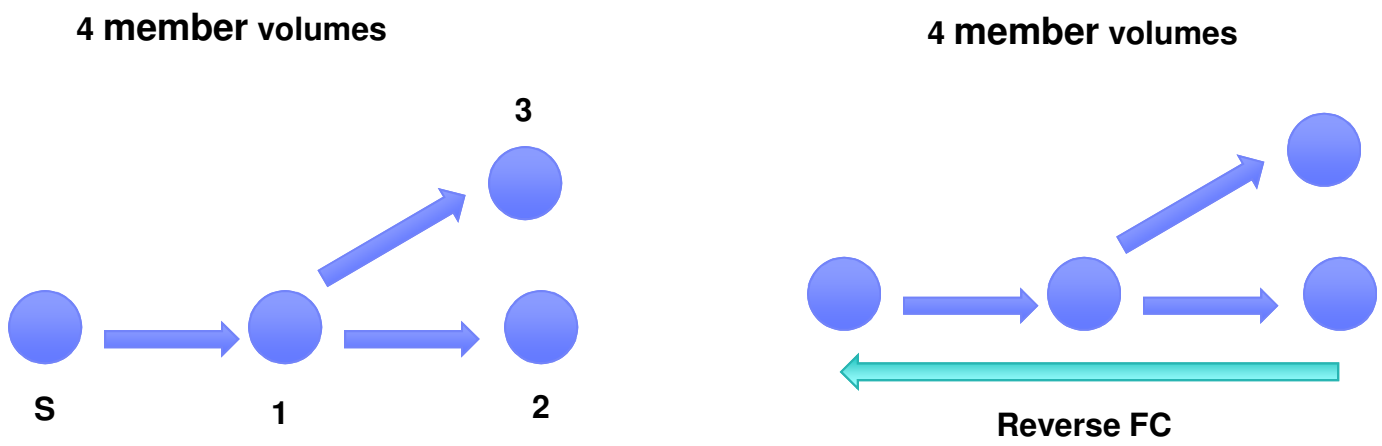
Three types of FlashCopy are provided

- **Standard "Full image" copy – creates a complete image copy of the source**
- **Incremental Flash Copy only copies changes since previous start**
  - Significant reduction in time to achieve independent copy after initial full copy
- **"Nocopy" copy – Only copies the change data of either the source or the target to the repository**
- **Reverse FlashCopy – Offers ability to restore to a given point**
- **Uses a bitmap with a grain size of 256K (default) or 64K**

V3700 Base FlashCopy Limit

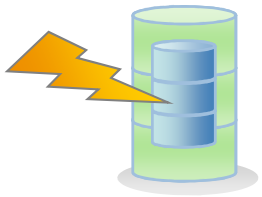
- **By default, the FlashCopy limit is 64.**
  - This restriction can be lifted on the V3700 with a license in the future.
- **The limit needs to be explained carefully:**
  - It's not 64 mappings or 64 volumes in FC mappings.
  - It is the sum total of all the “volume counts” for all the FC groups for the system
    - “Volume count” is the number of member volumes involved in the FC group minus one.
    - Do not permit the sum of the total per-graph scores to exceed 64.”

FlashCopy Limit - Example

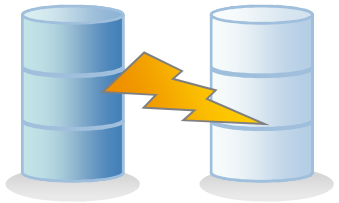


Both of these FlashCopy graphs contribute as “3” towards the total system limit of “64”

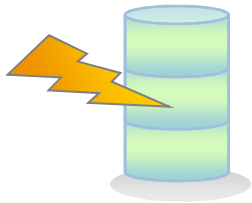
FlashCopy Presets Simplify Operations



Snapshot



Clone



Backup

Snapshot

- Instant thin-provisioned copy
- Create on-going backups of data such as e-mail

Clone

- Creates a complete one-time replica of the source
- Attach to test, reporting or other servers, etc

Backup

- Complete point in time replica that can be incrementally refreshed
- Create up to date backups of volumes

Direct Attach Fibre Channel

- **The V3700 supports direct attach fibre channel for many hosts**
  - Lower the cost of using high speed fibre channel
- **A maximum of 4 redundant fibre channel hosts can be directly attached.**
- **Closely matches the direct connect capabilities of the DS3500**
  - With the exception of AIX direct connect support
- **The full interoperability list will be posted to the web upon GA.**
  - Expect a fairly extensive interoperability matrix.
    - AIX direct connect support is one of the exception
  - Some host types will be phased into the mix
- **For current list of *all* supported host and configurations see the *IBM System Storage Interoperation Center (SSIC)* at:**

  http://www-03.ibm.com/systems/support/storage/ssic/interoperability.wss
- **Cannot directly attach a V3x00 to a V7000 for a direct attach V3x00 "behind" V7000 configuration.**

Licensed Machine Code

- **V3700 software is delivered as "Licensed Machine Code" rather than as "Software".**
- **Under IBM rules, this means that users do not have to purchase and install a separate license to use the system.**
- **The term "Software" is replaced with "machine code" throughout all CLI help/documentation/output and errors.**
  - CLI names that have "software" remain, e.g. applysoftware, but the help will say "applysoftware – Upgrades the system to a new level of machine code"
- **There is no EULA to be accepted as part of the initial setup.**
- **The following commands have changed some field headings:**
  - sainfo lsservicestatus
  - svcinfo lsnodevpd

Energy Star

- **“A joint program of the U.S. Environmental Protection Agency and the U.S. Department of Energy helping us all save money and protect the environment through energy efficient products and practices”**
- **The V3700 meets this goal**
- **We are a Green Machine!!**

Out of Box Experience

IP Addressing

The number of IP addresses required will depend on which HIC is fitted.

A minimum of 3 IP addresses are required for management and cluster

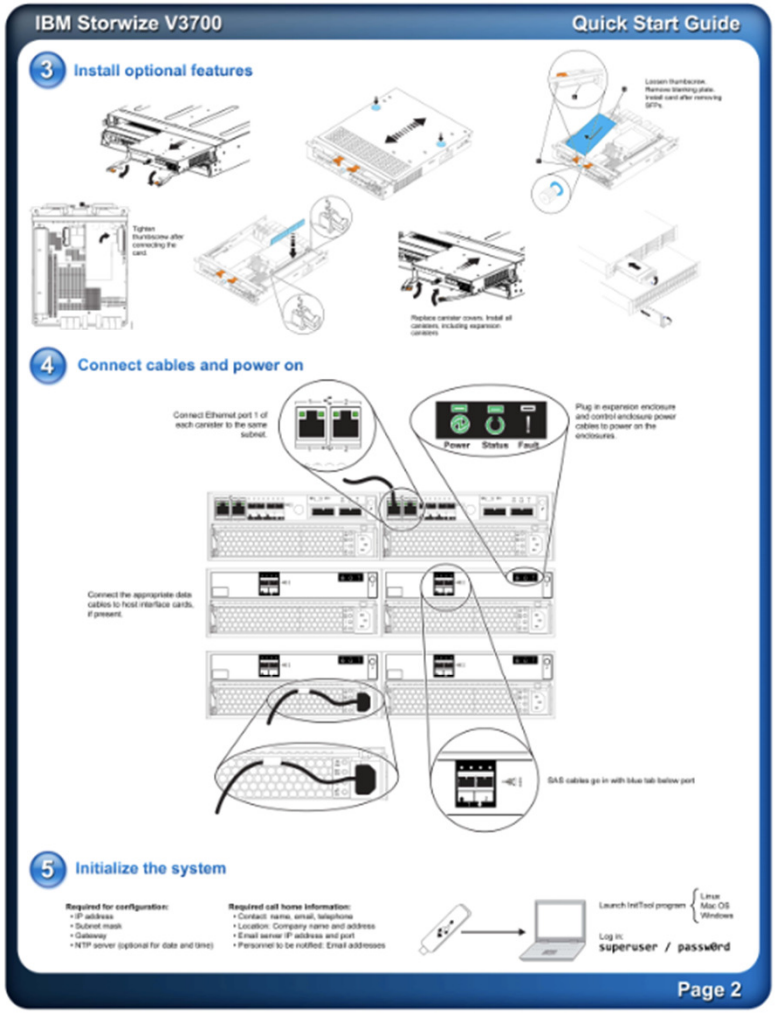
Maximum of 8 IP addresses without additional HIC cards

IP	Node Canister	Physical Port	Function
1	1	1	Service IP
2	2	1	Service IP
3	Both	1	Cluster IP
4	Both	2	Cluster IP (optional)
5	1	1	iSCSI
6	1	2	iSCSI
7	2	1	iSCSI
8	2	2	iSCSI

OOBE Installation Steps - Improvements

- **The Out of Box experience (OOBE) of a V3x00 is similar to that of a V7000 with some improvements:**
  - Usability improvements to the init tool.
  - New two page quick installation poster.
- **Poster quickly describes how to physically assemble the system and place it into a rack.**
- **Installation wizards lower the barrier to entry by walking the user through the first installation tasks:**
  - System setup
  - Expansion enclosure detection
  - Call home and notification setup
  - Host creation

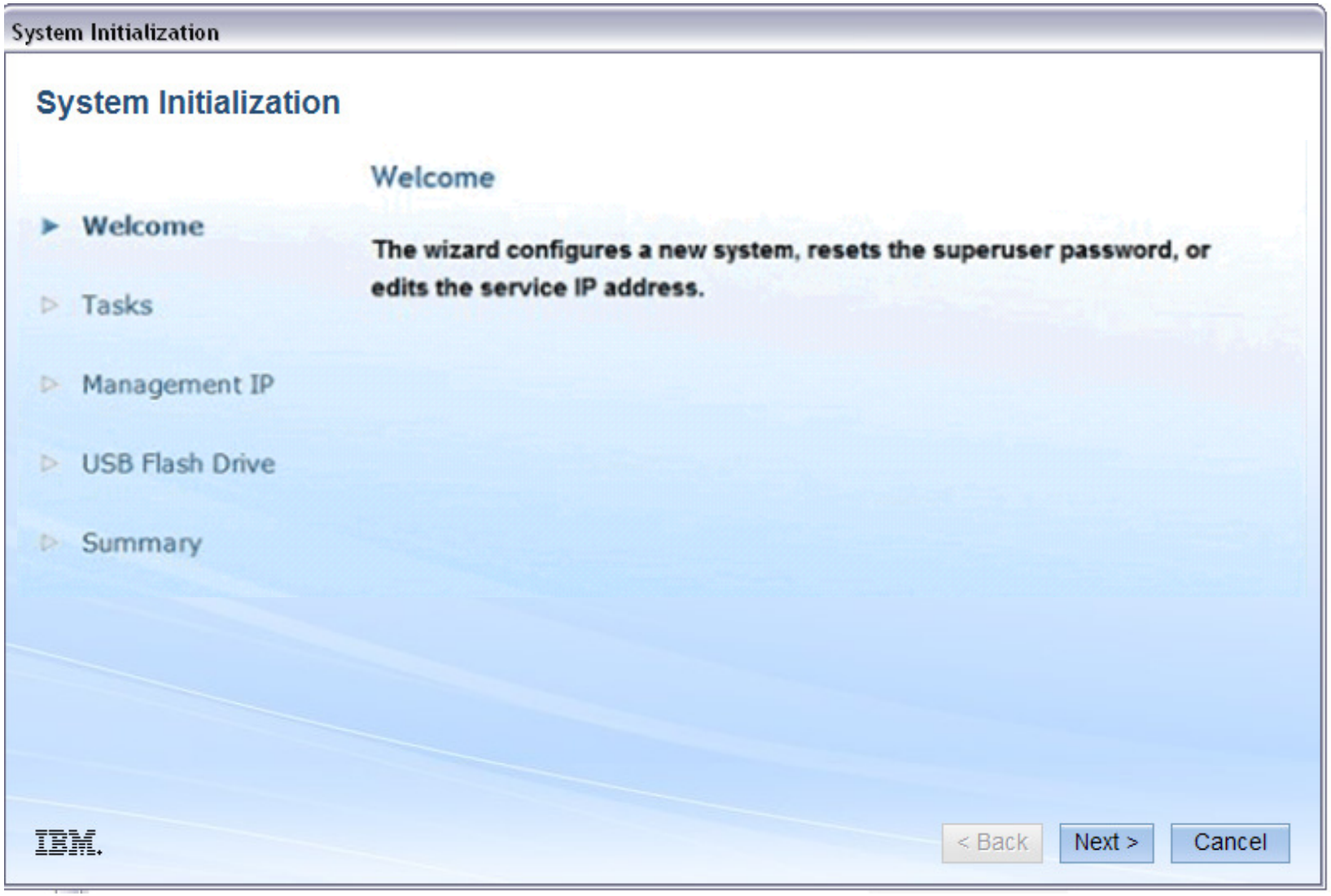
OOBE Installation Steps – Poster



OOBE Installation Steps - Init Tool

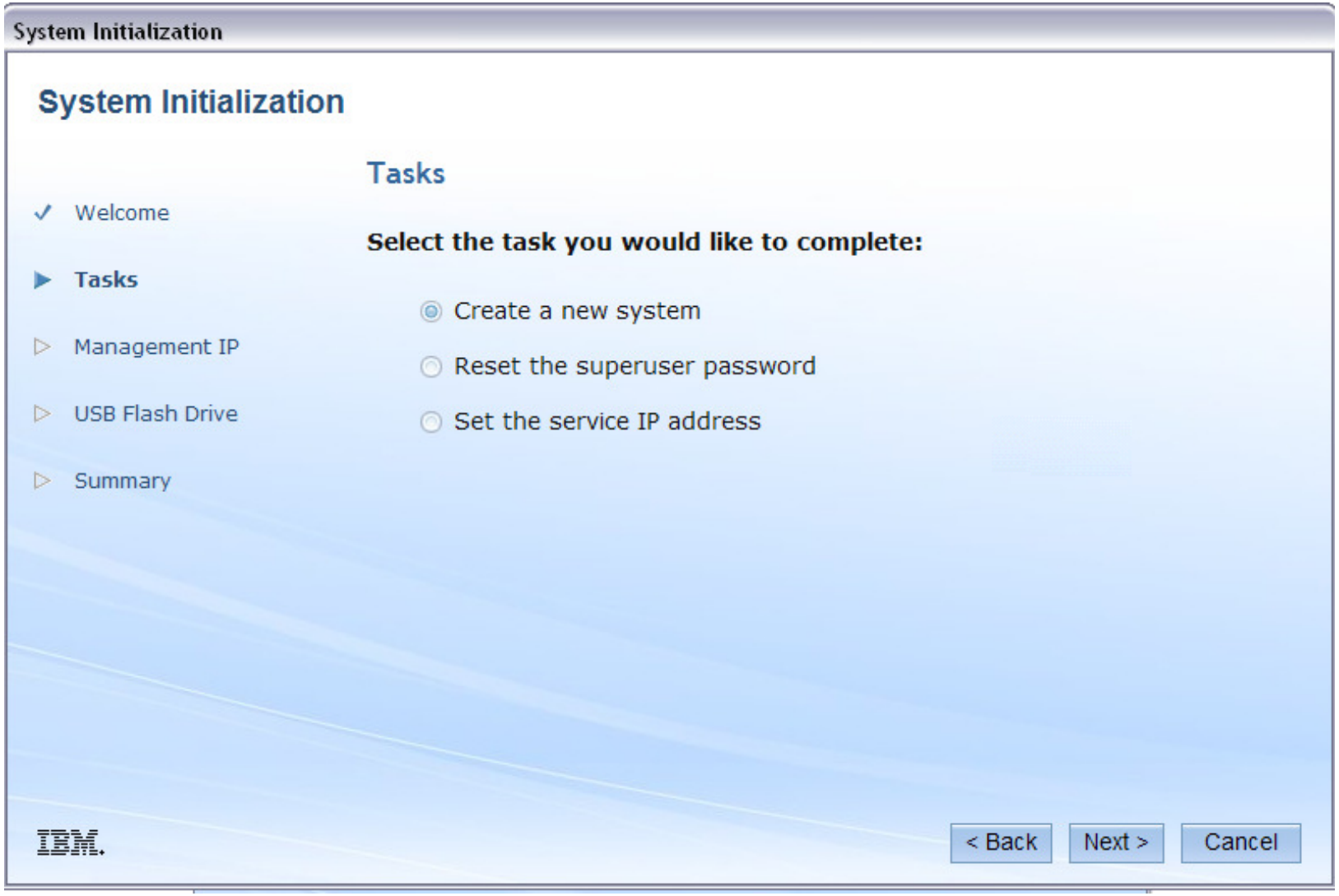
- **The init tool is a small utility for initial system setup.**
  - Now available on Microsoft Windows, Apple Mac OS and Linux.
    - InitTool.bat (on Microsoft Windows)
- **Supplied in a USB disk that comes with the system.**
  - Similar experience to Storwize V7000
- **Information required for initial setup:**
  - Cluster IP address.
  - Gateway
  - Netmask

OOBE Installation Steps - Init Tool

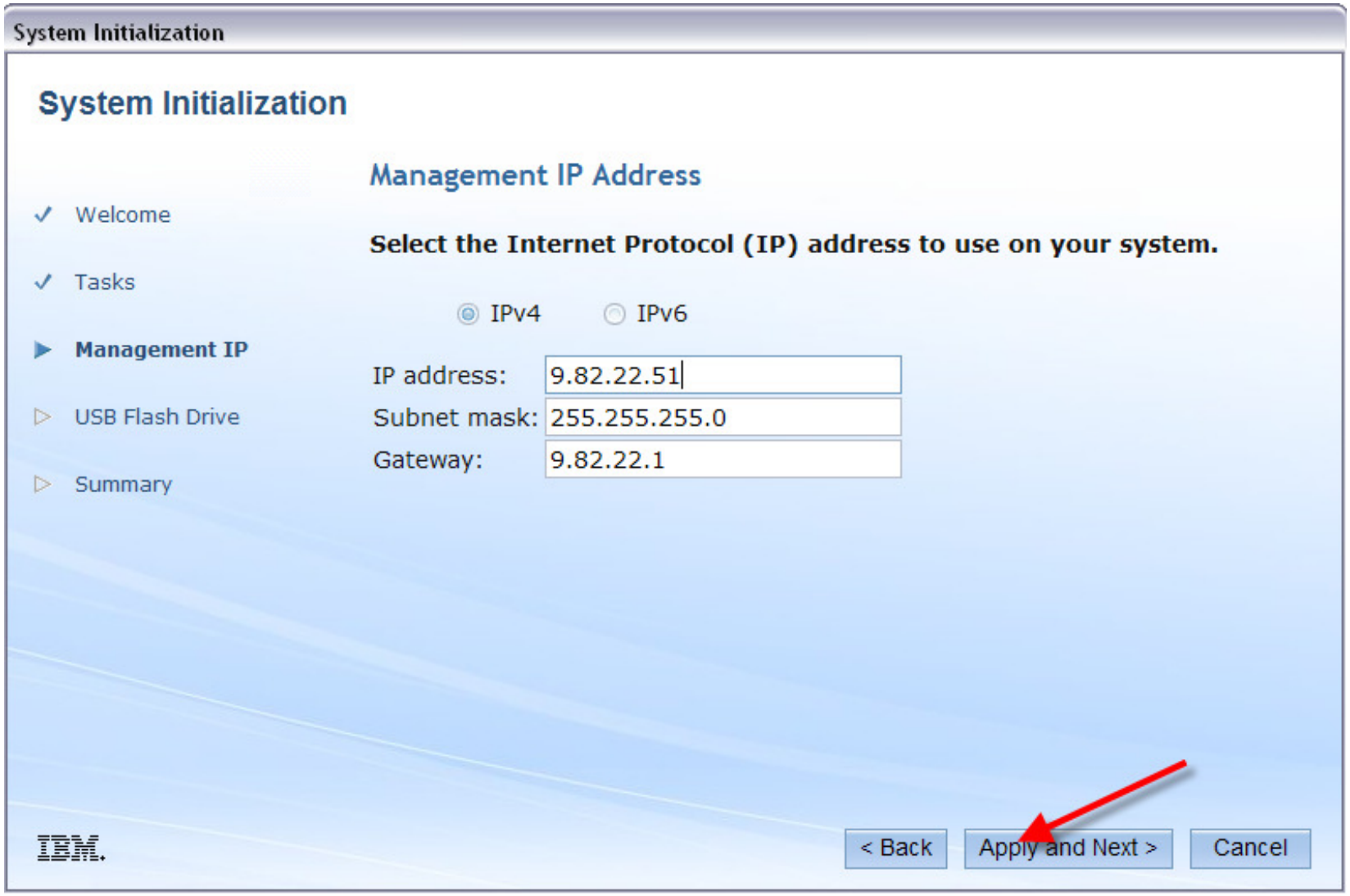


OOBE Installation Steps - Init Tool - cont'd

Take the default to create your new system



OOBE Installation Steps - Init Tool - cont'd



OOBE Installation Steps - Init Tool - cont'd

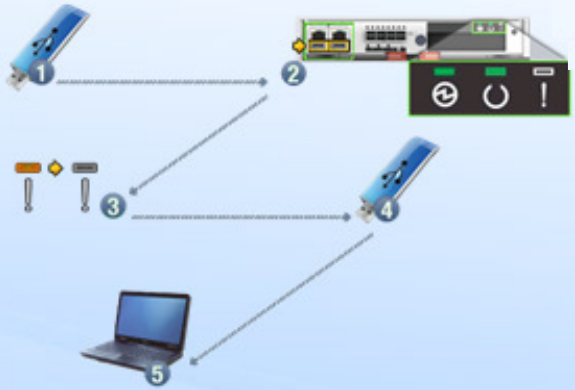
System Initialization

System Initialization

- ✓ Welcome
- ✓ Tasks
- ✓ Management IP
- ▶ **USB Flash Drive**
- ▷ Summary

USB Flash Drive

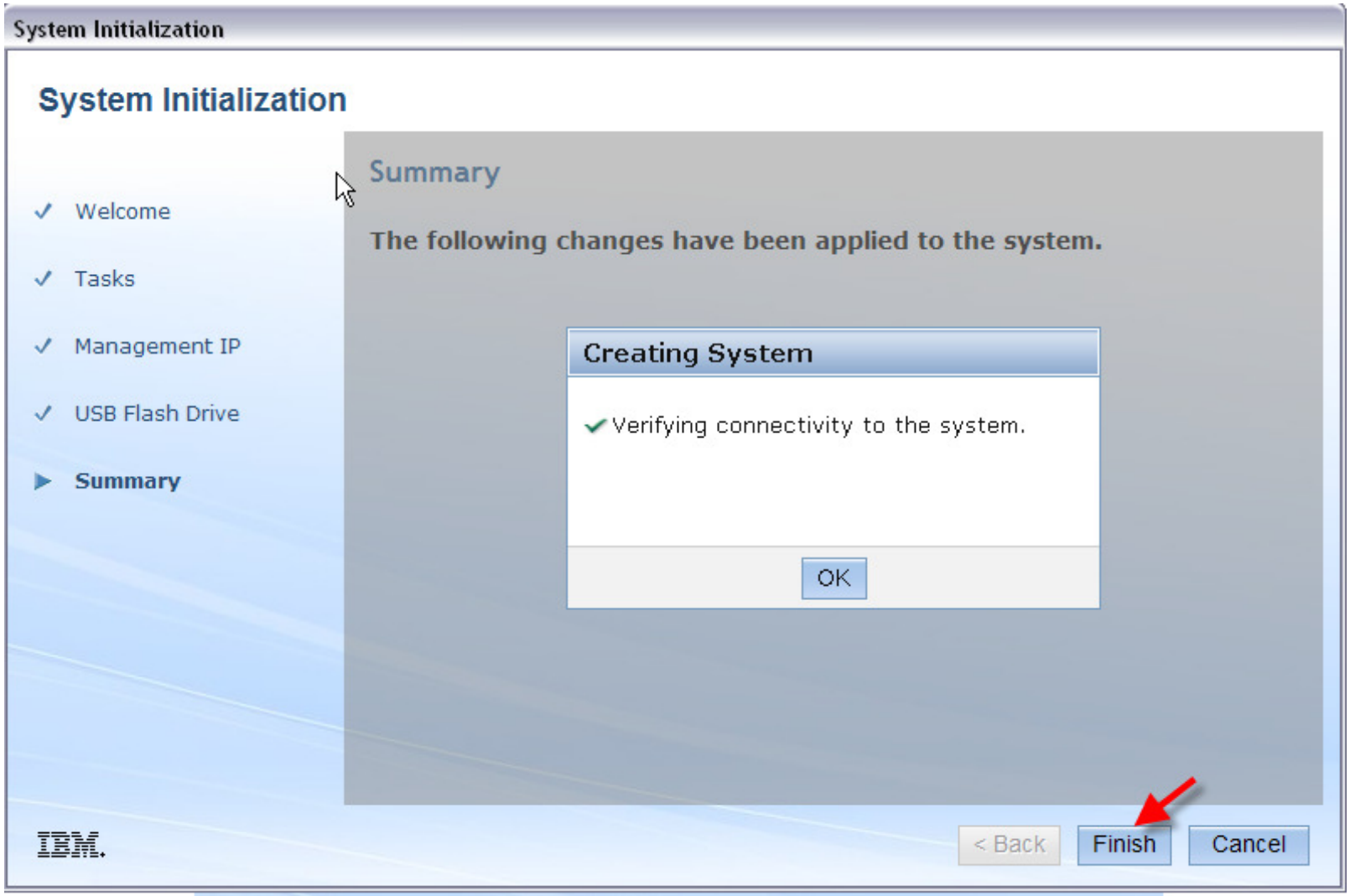
Use the following instructions to initialize the system.



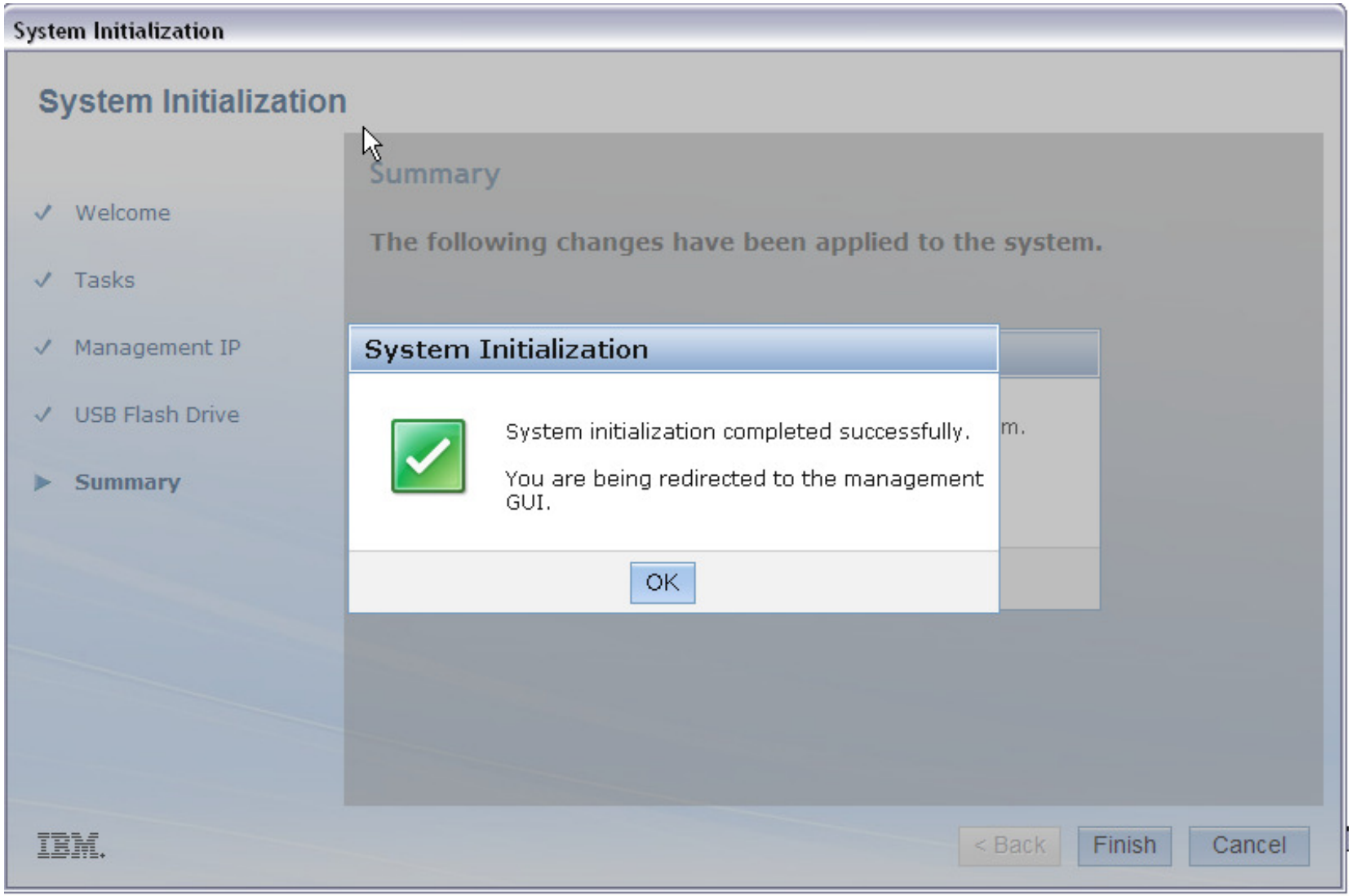
1. Safely eject the USB flash drive from your PC.
2. Select one canister in the control enclosure. On the right side of that canister look for the LEDs. Ensure the LEDs are (from left to right) on, blinking, and off. And then, insert the USB flash drive in to any port on that canister.
3. Wait for the amber fault LED to stop blinking. It is the third LED on the right side of the canister. This process can take up to 5 minutes.
4. Remove the USB flash drive.
5. Reinsert the USB flash drive into your PC and click **Next**.

< Back | Next > | Cancel

OOBE Installation Steps - Init Tool - Successfull

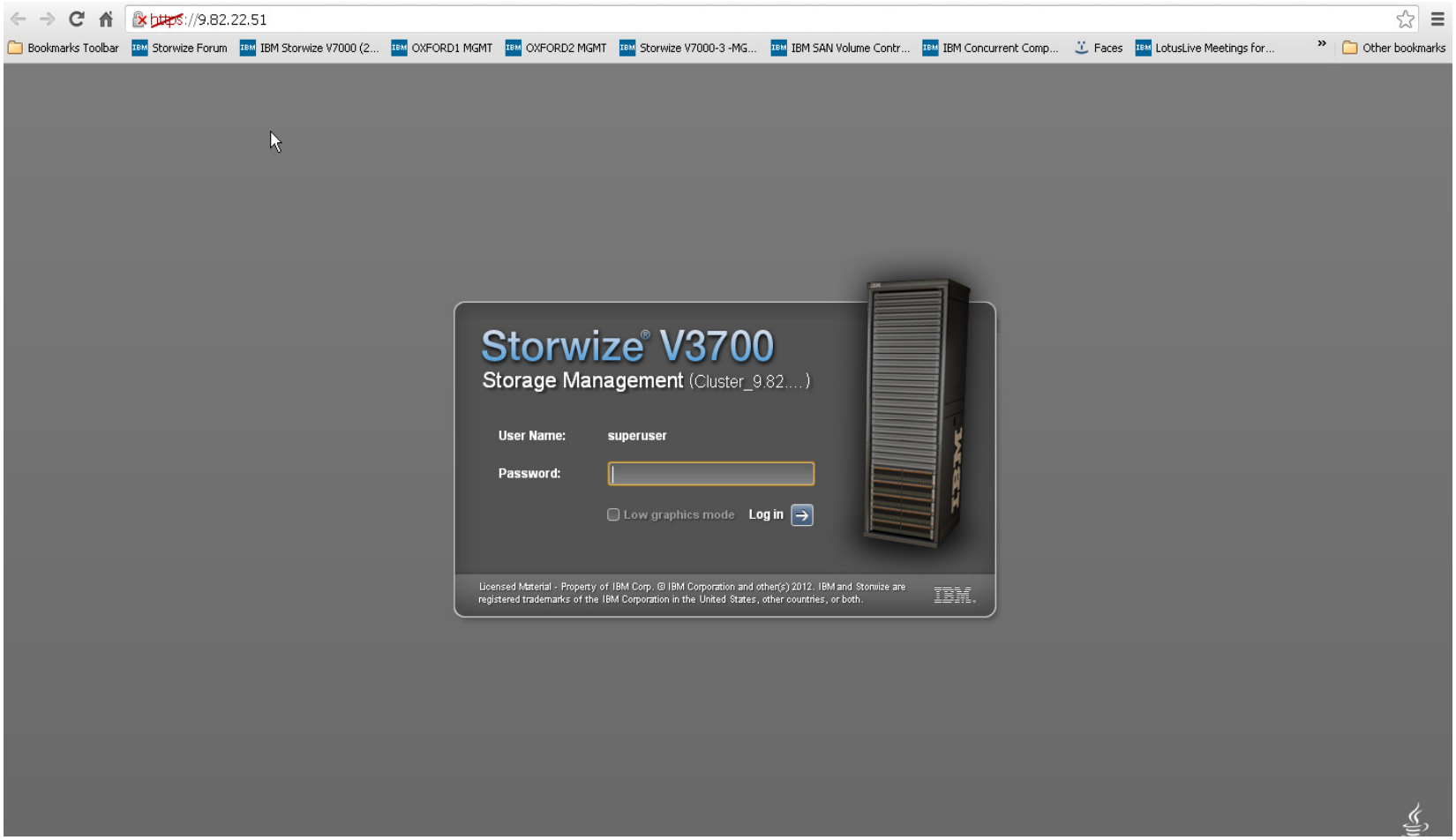


OOBE Installation Steps - Init Tool - Successfull



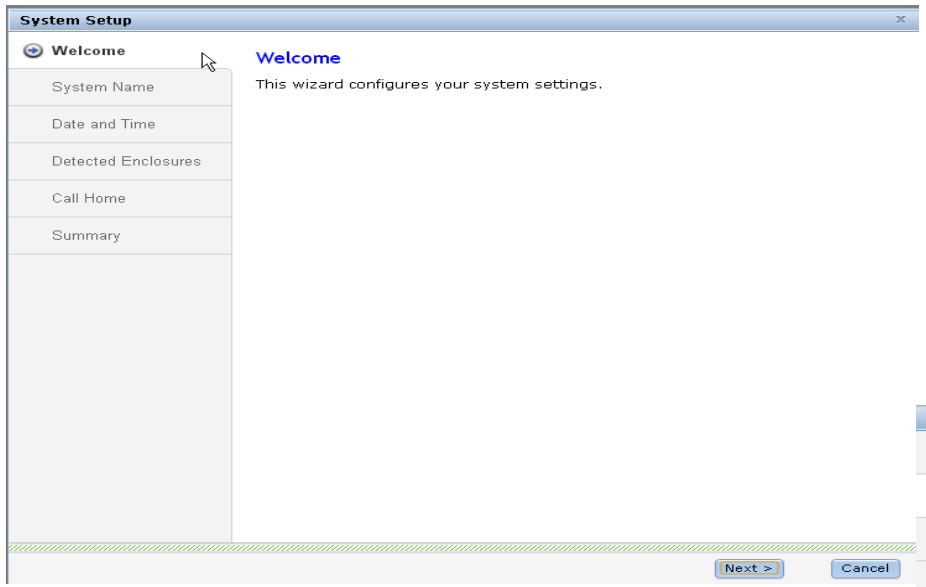
OOBE Steps - Initial Screen

The Web Browser automatically points to the configured IP address 9.82.22.51, userid is : superuser and default password is: passw0rd, change to new password and login

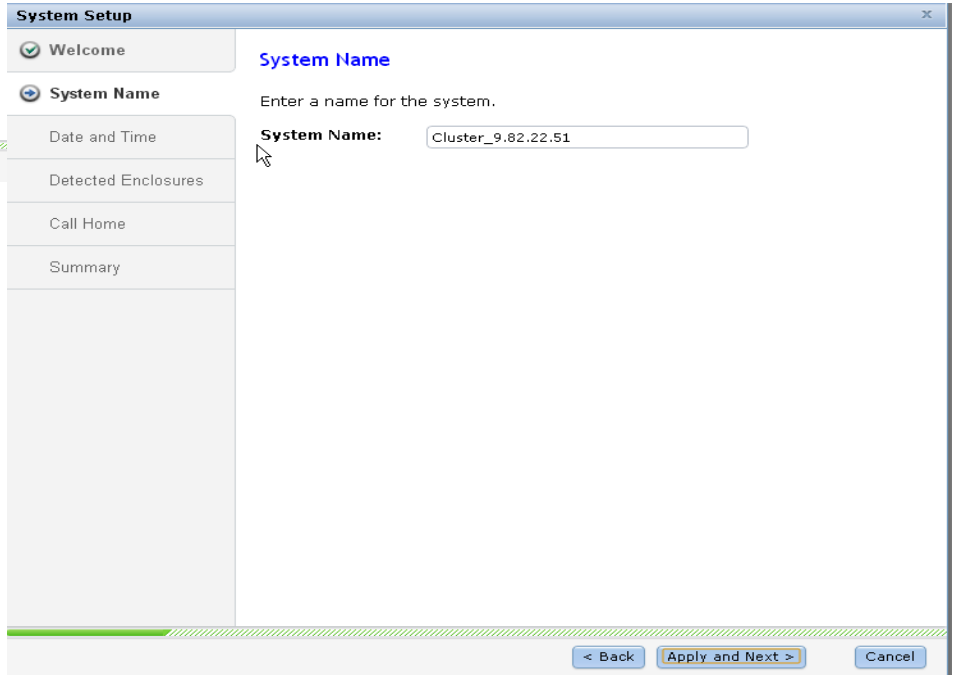


OOBE Steps - Initial Setup Wizard

1) The system will now configure itself to its defaults

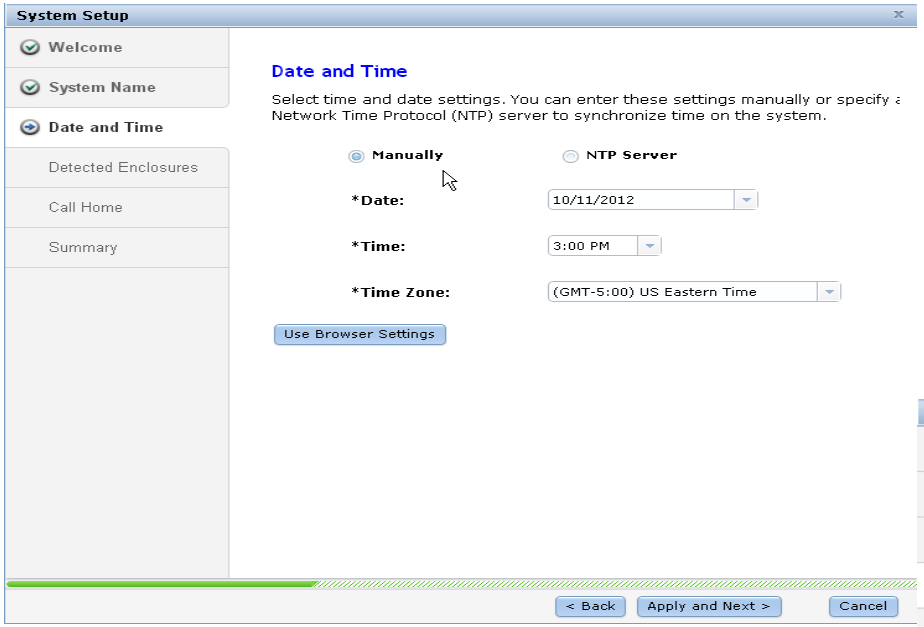


2) System Name

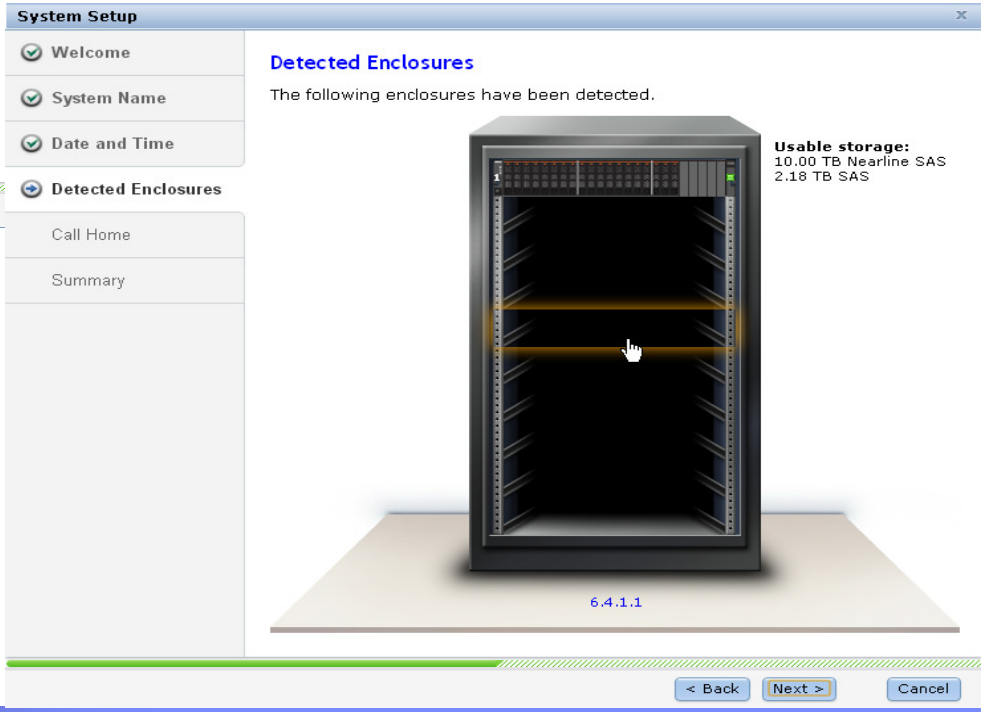


OOBE Steps - Initial Setup Wizard

3) Date and Time

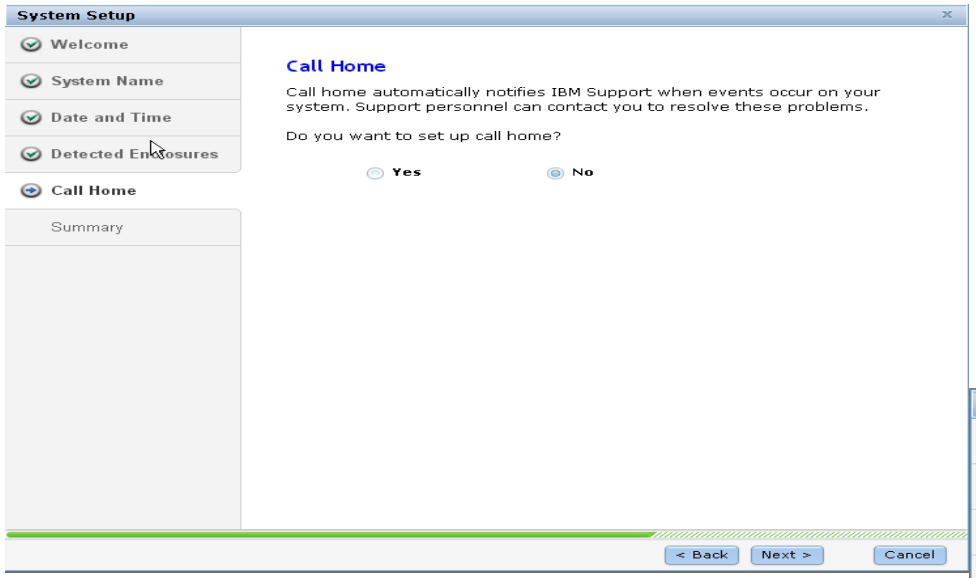


4) Auto-detects all storage

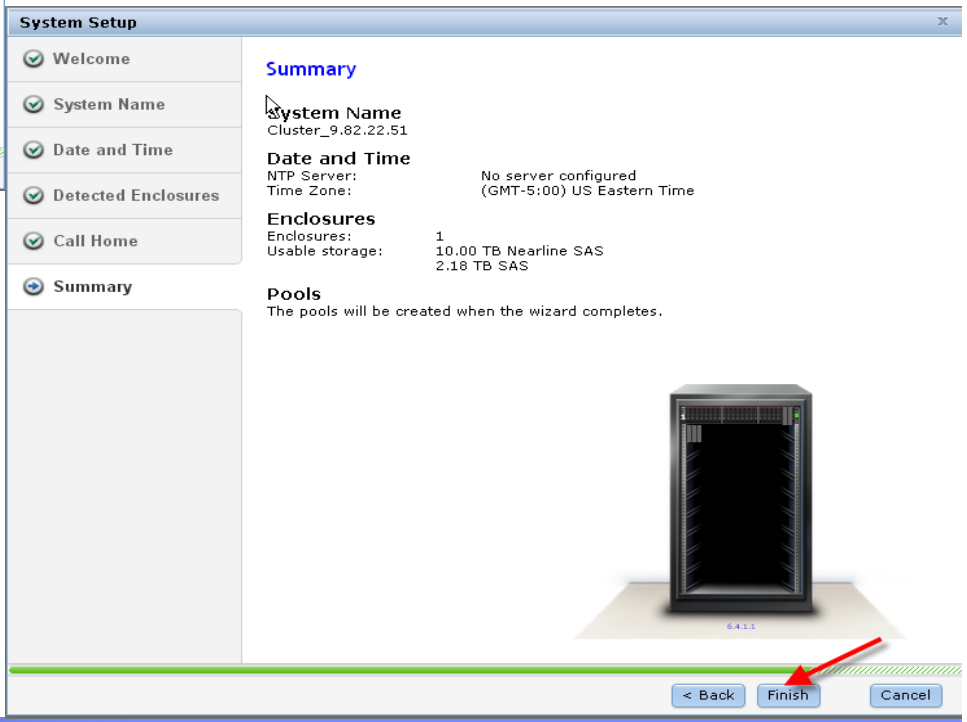


OOBE Steps - Initial Setup Wizard

5) Call Home

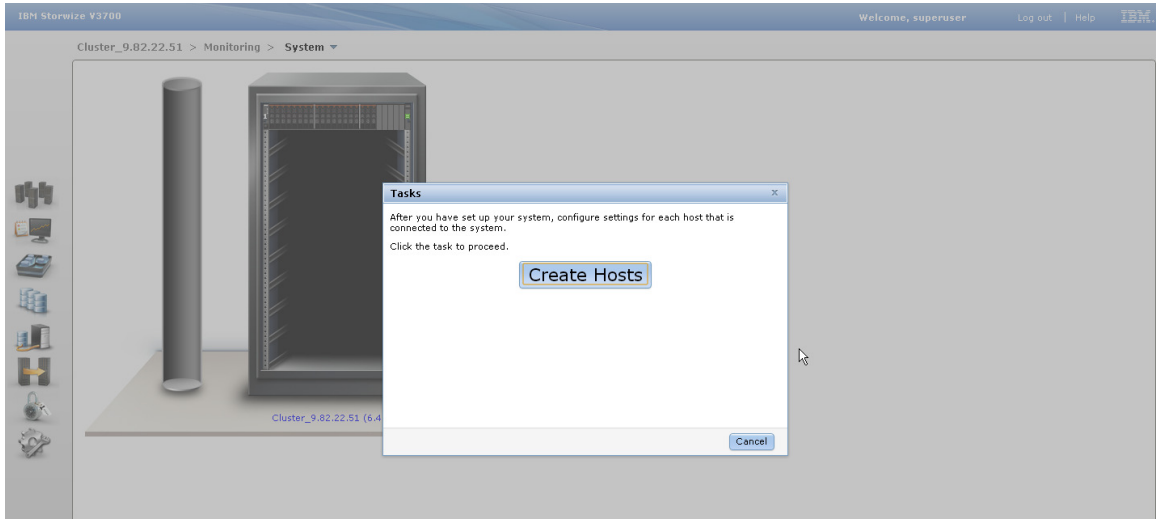


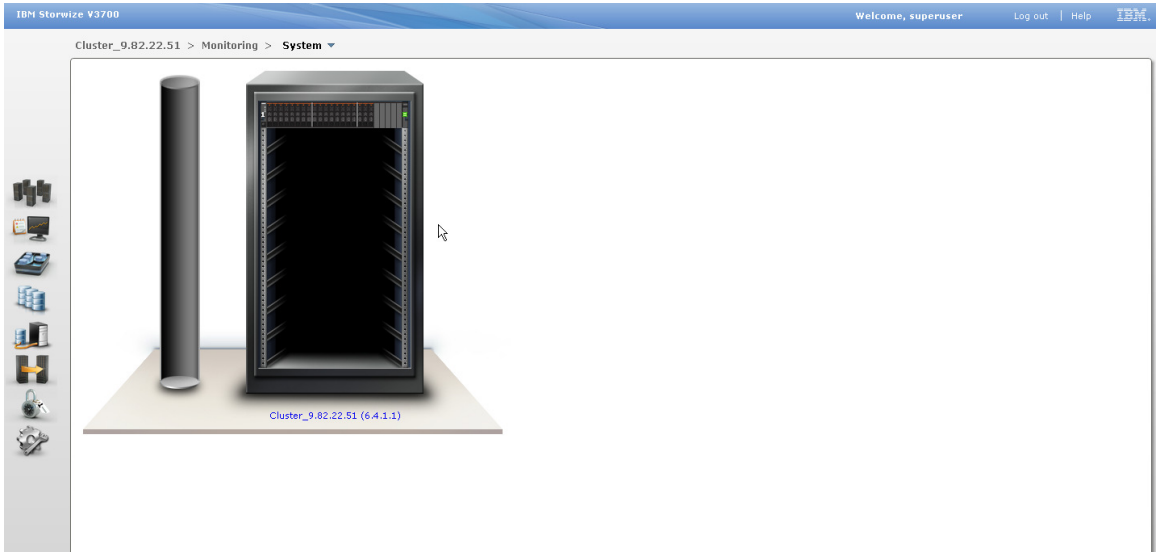
6) Auto-detects all storage



OOBE Steps - Initial Setup Wizard

7) Additional Tasks - Hosts

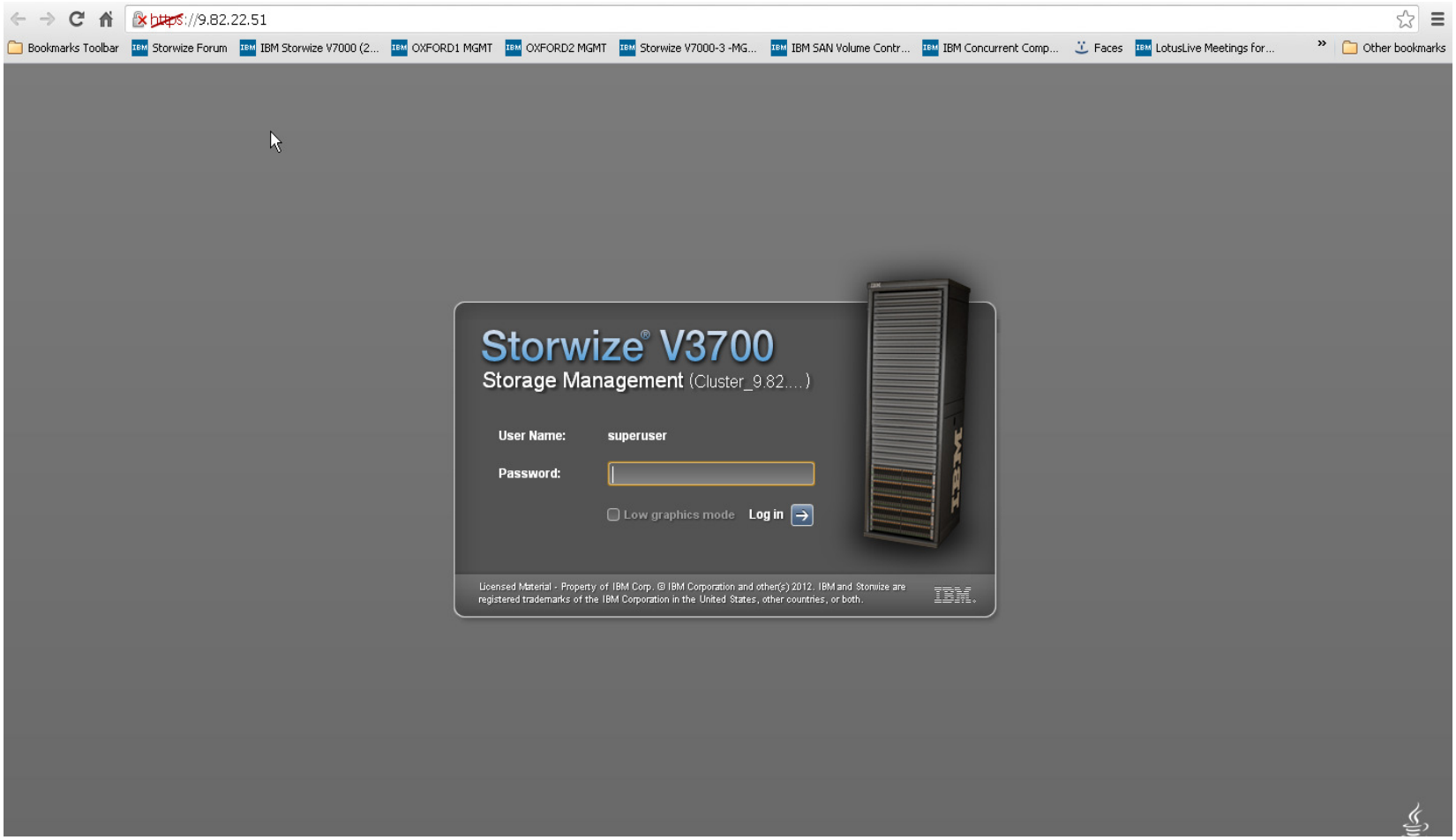




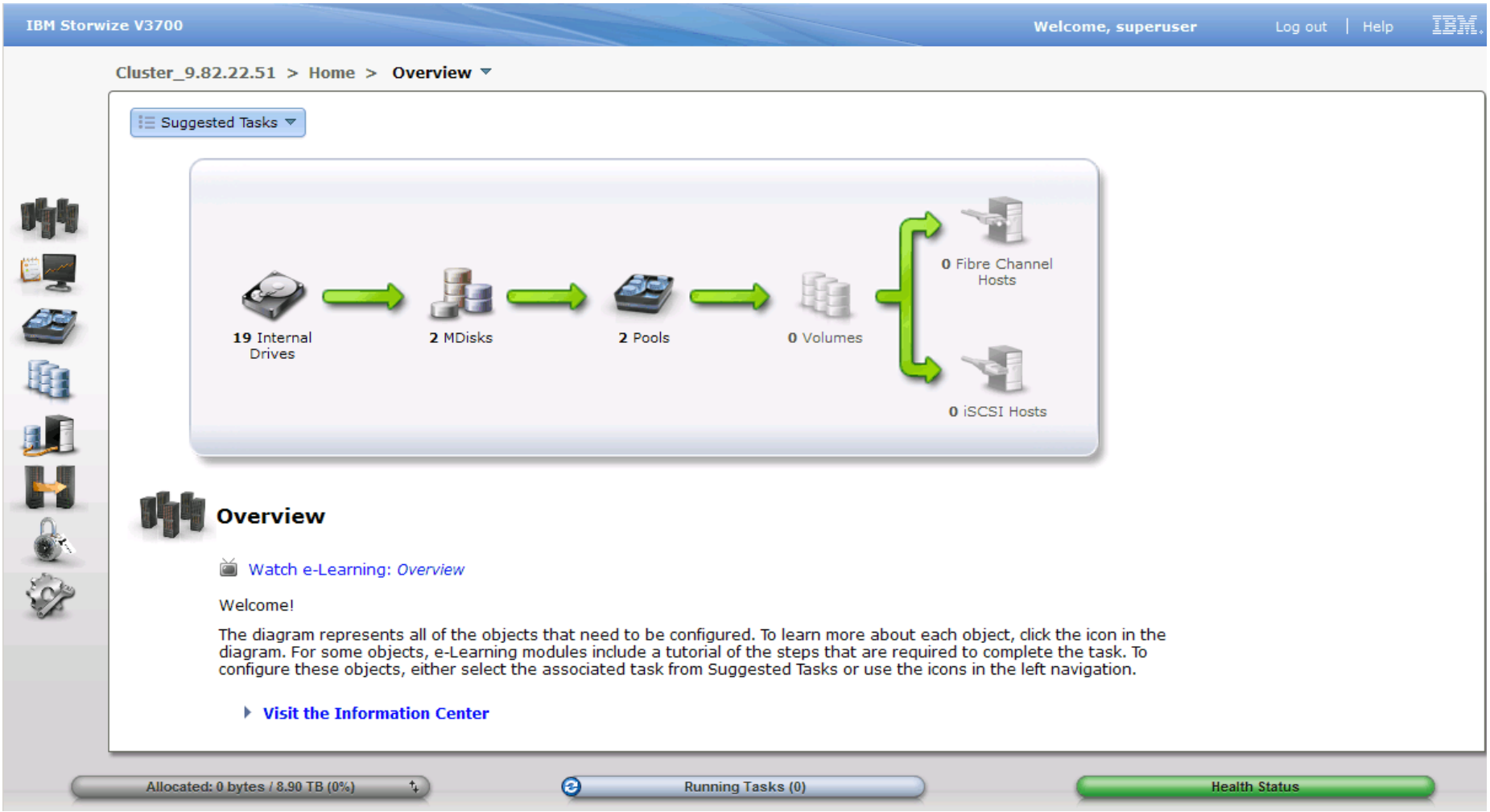
V3700 is ready for use!

OOBE Steps - Initial Screen

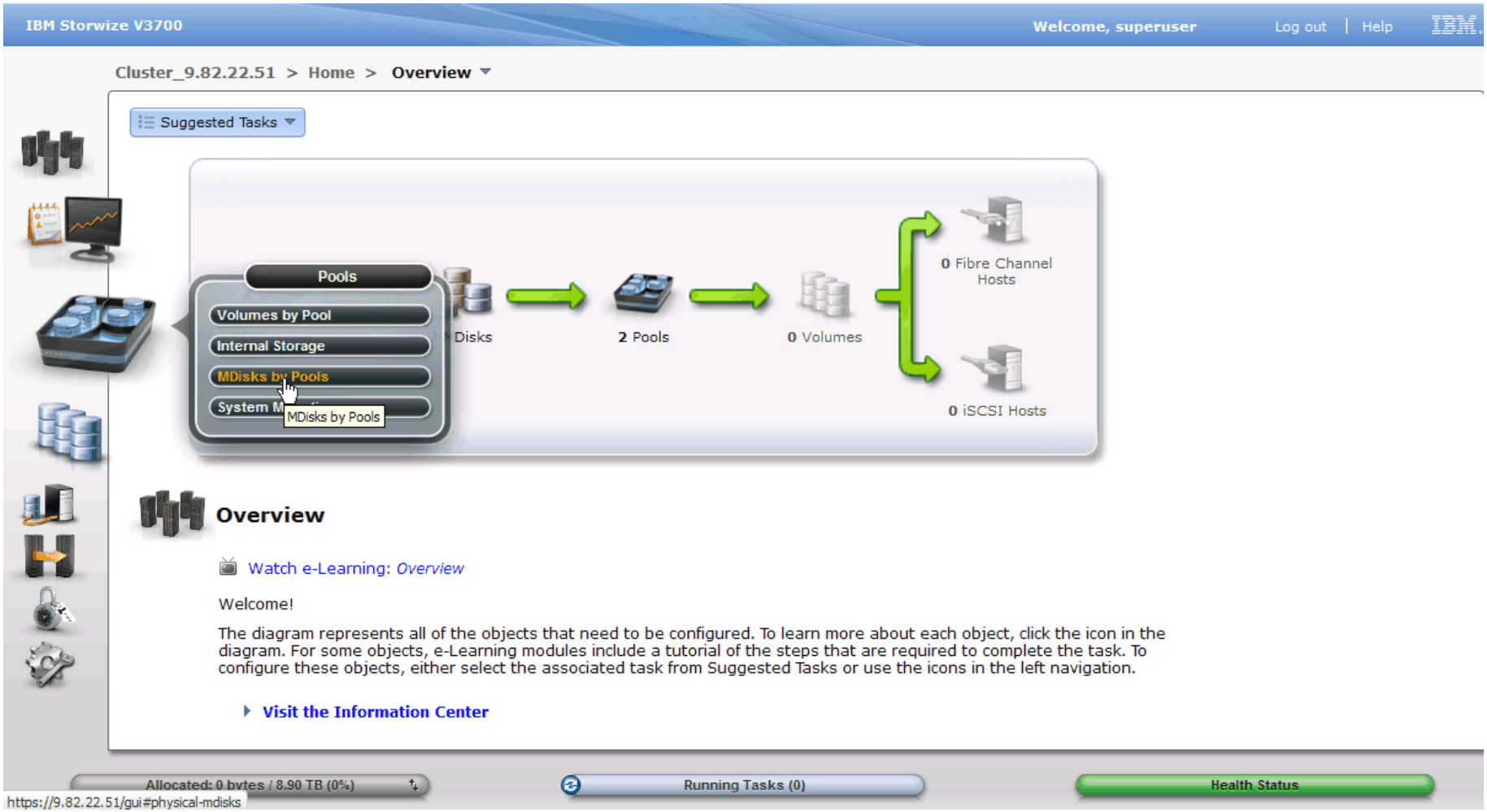
The Web Browser automatically points to the configured IP address 9.82.22.51, userid is : superuser and default password is: passw0rd, change to new password and login



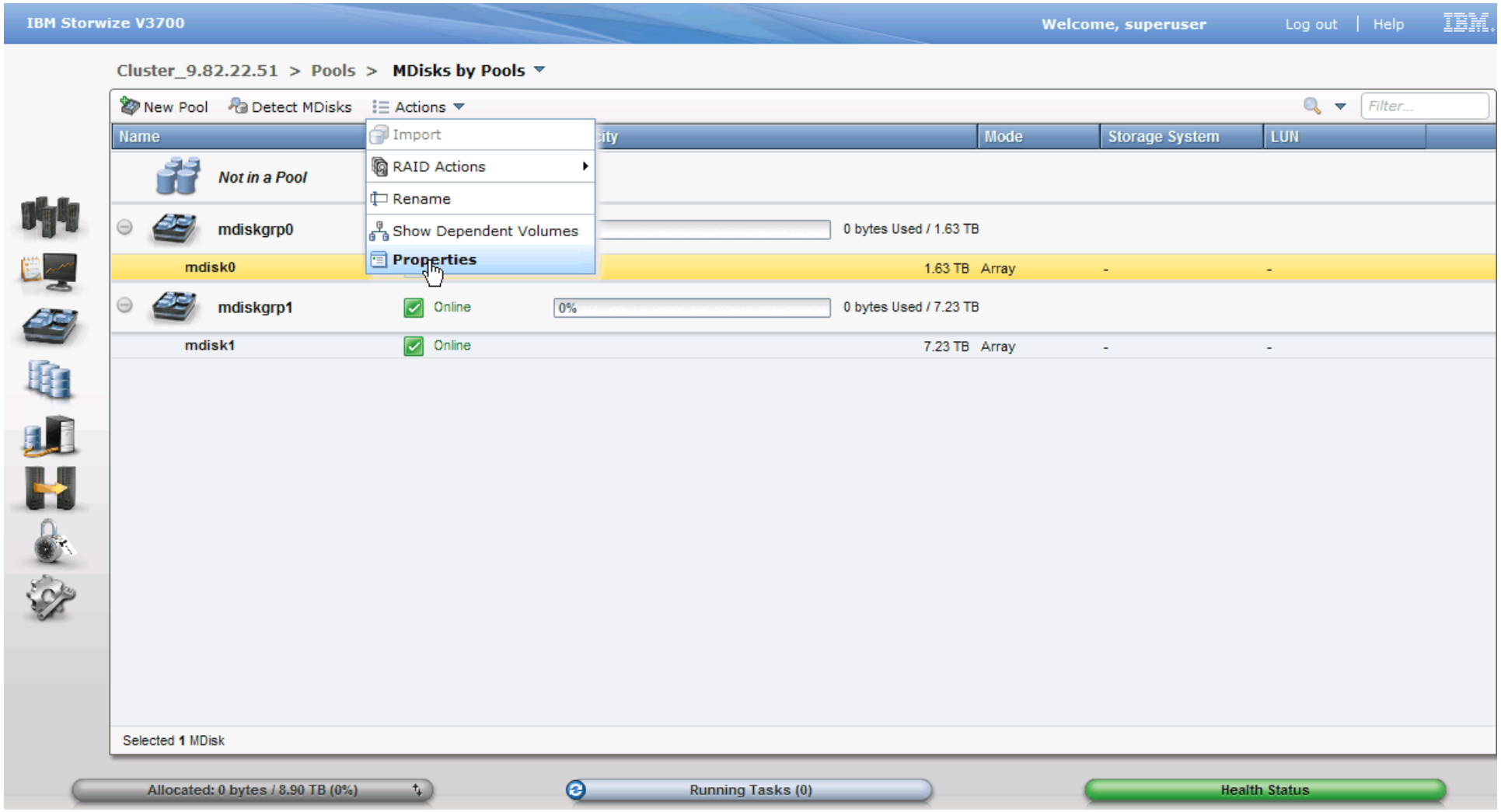
Management GUI



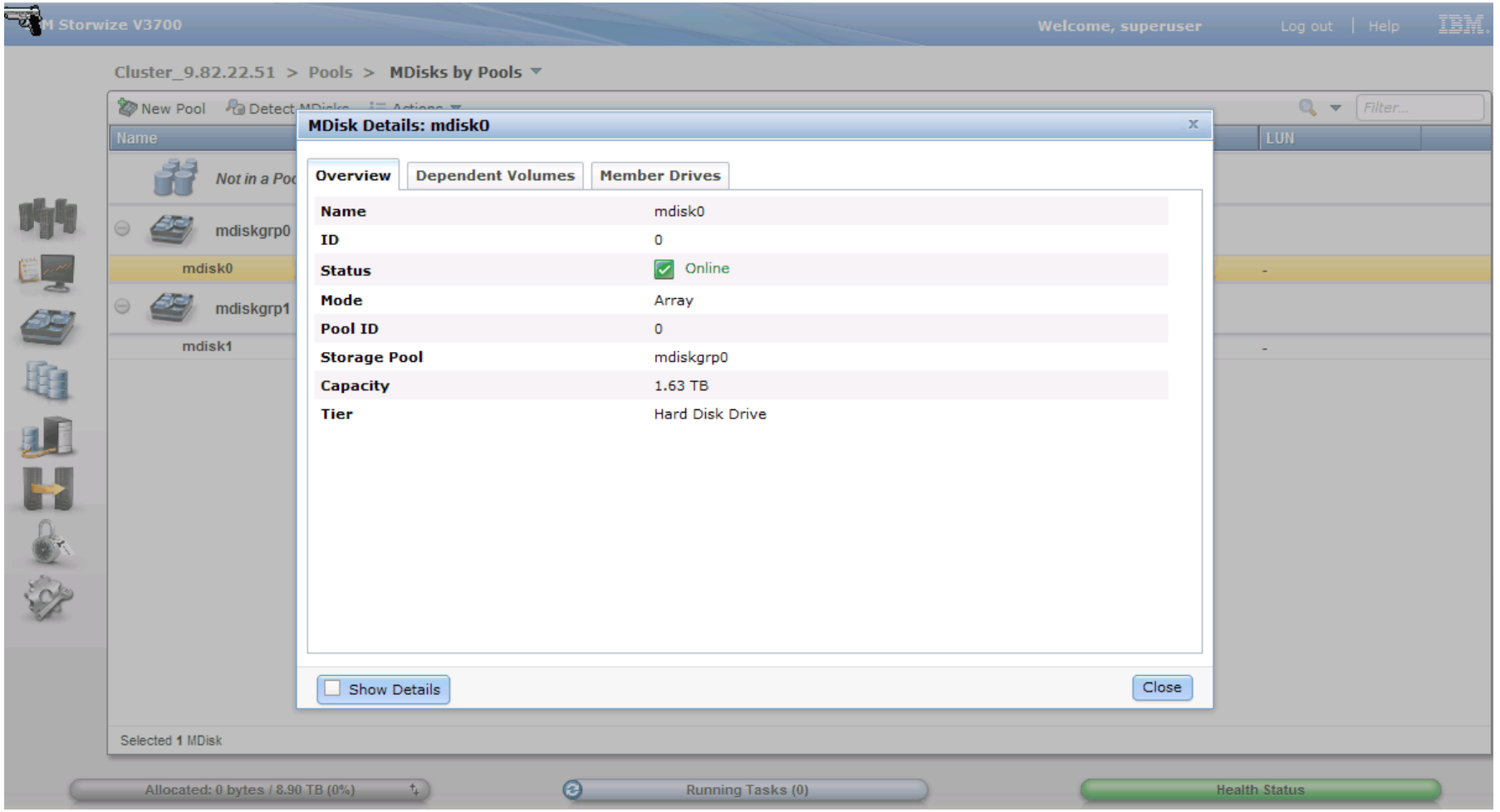
Management GUI – Reviewing Mdisks



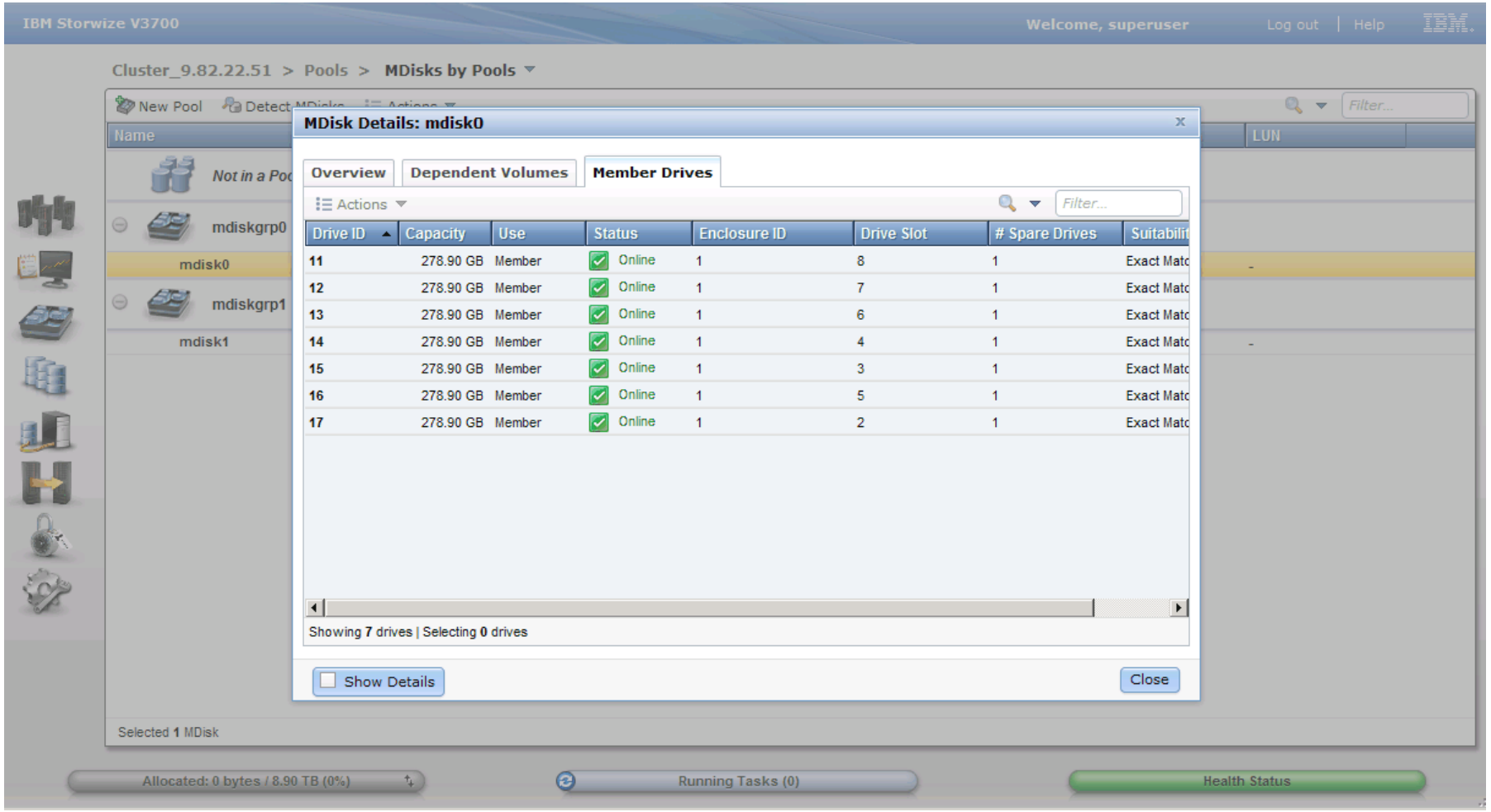
Management GUI



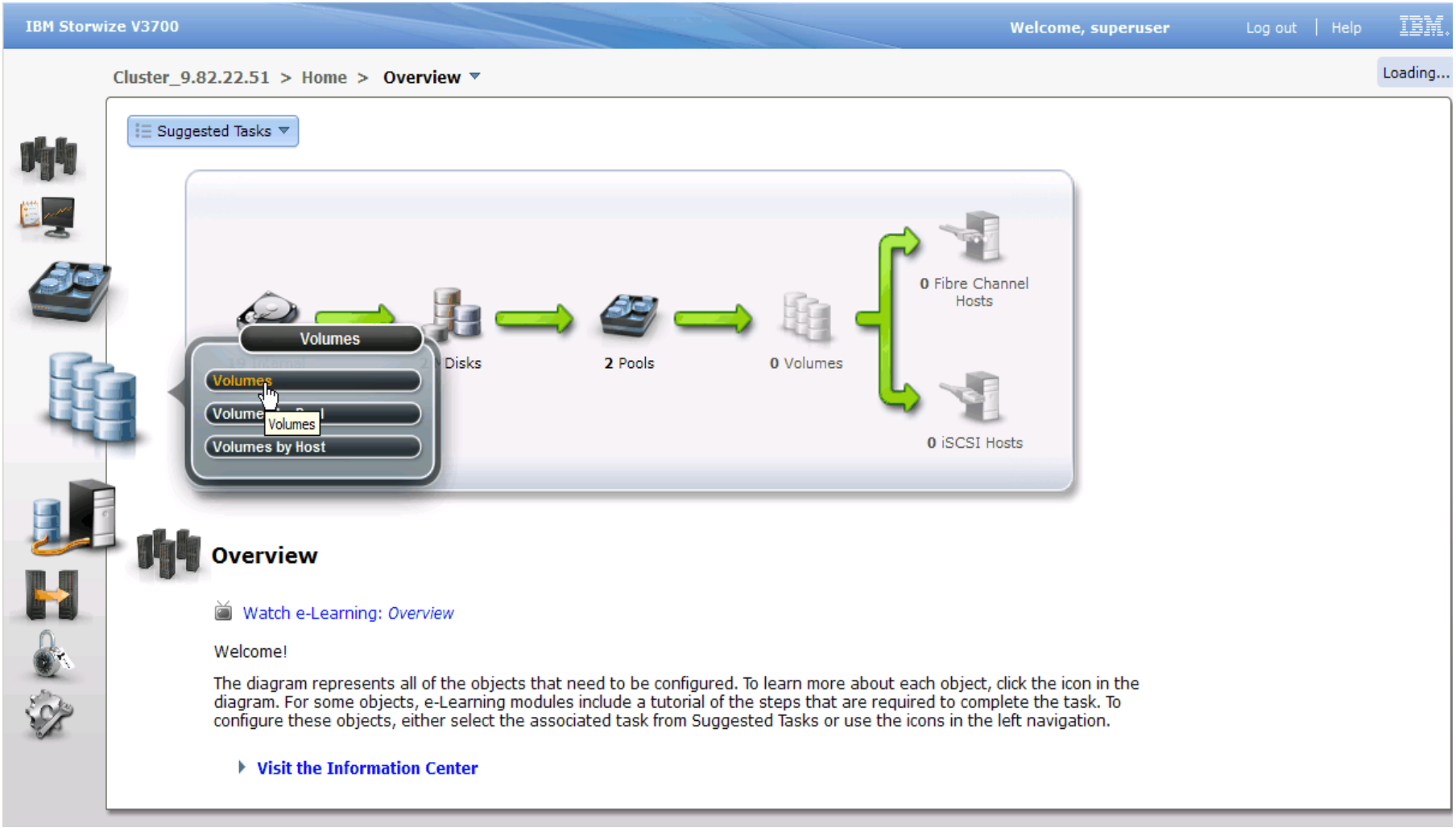
Management GUI – Reviewing Mdisks



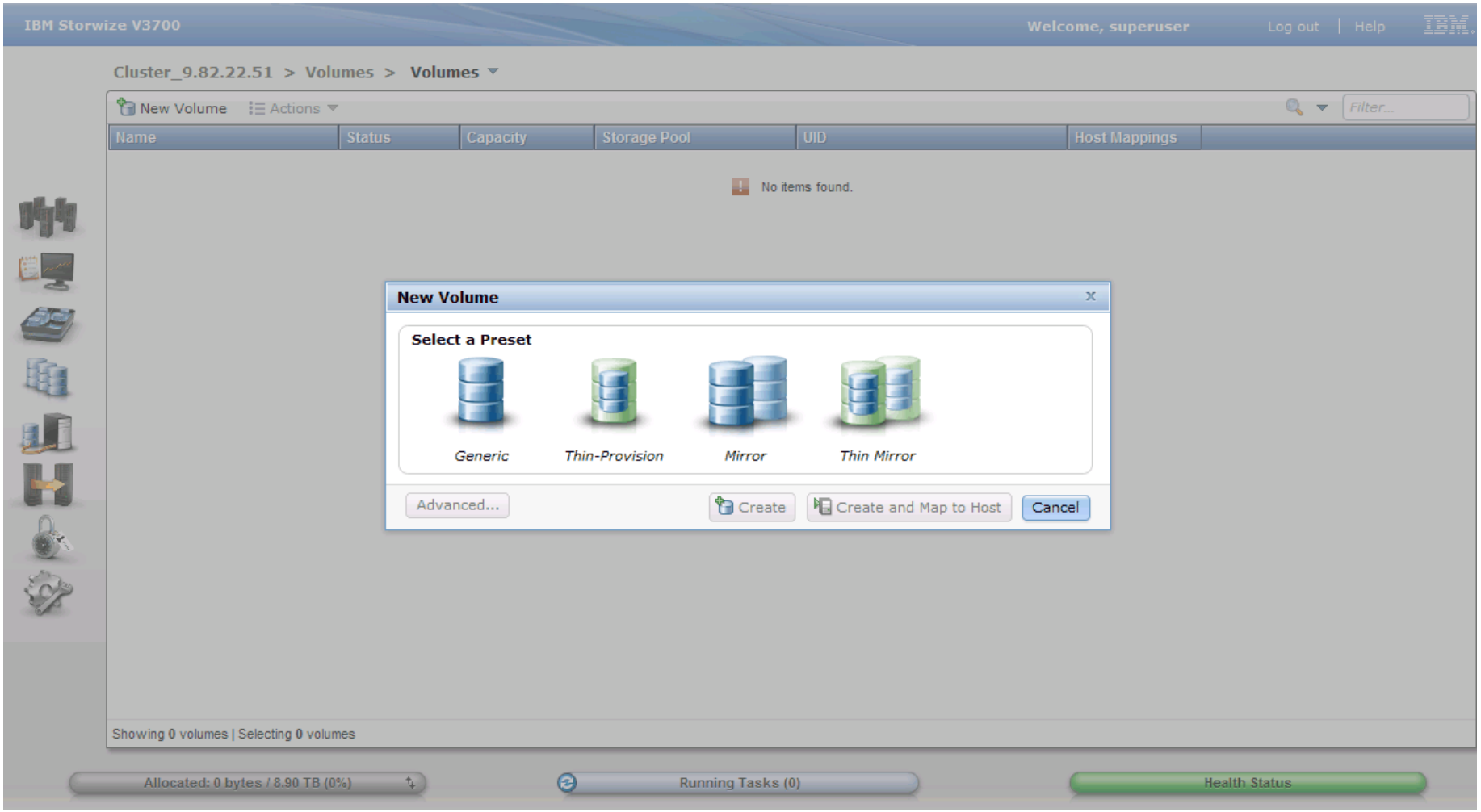
Management GUI – Reviewing Mdisks



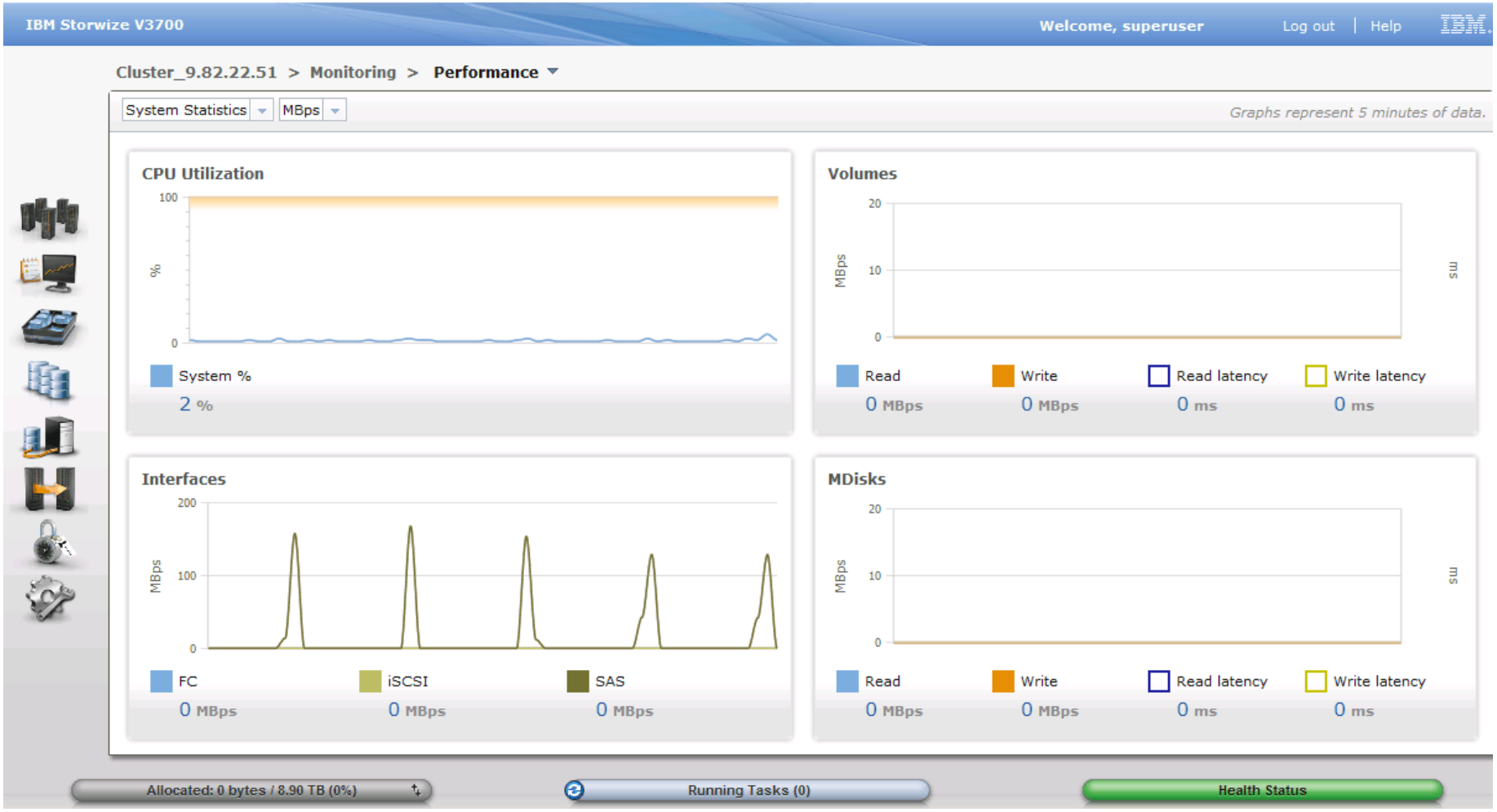
Management GUI – Creating Volumes



Management GUI



Management GUI – Performance Monitor



Performance – current measurements

	V7000	V3700 (Measured) 120611	DS3500 – Base (Released 100514)
Drives	240 x 15K	120 x 15K	96 x 10K
Cache Reads (IOPs)	900,000	280,000	140,000
Disk Reads (IOPs)	110,000	40,000	30,000
Disk Writes (IOPs)	24,000	9,000	7,500
Disk 70/30 (IOPs)	55,000	21,000	19,000
Cache Reads(MB/s)	5,500	3,300	2,500
Disk Reads (MB/s)	4,000	1,990	1,950
Disk Writes (MB/s) (cache mirrored)	2,200	650	500

Support Line for Storage

Support Line is designed to provide a basic level of remote technical support for your storage products

Why Support Line?

1. Answers “how to”, installation, usage, and configuration questions along with problem determination support.
2. Provide consistent, high-quality, technical support
3. Help you get fast and accurate problem resolution
4. Support staff 24 hours a day 365 days a year to answer any question with electronic call submission and voice call submission
5. One or the other are available for a full array of storage products

Client Benefits

Remote support from experienced specialist

- Support Line: Base Level Remote Support
- Increased Storage Availability - Available 24 hours a day 365 days a year to answer product questions
- Unlimited telephone or electronic problem submissions
- Reduces impact and cost of downtime through expert IBM problem isolation and resolution
- Lower Operational Costs
- Increased productivity of IT staff through prompt and accurate remote technical support.
- Enhances Storage ROI
- Supplements in-house IT staff with skilled IBM specialists as needed

Ensures Client has some access to IBM experts when they need help with a problem or a question.

Complements HW Warranty and HWMA services

Support Line for Storage – V3700 ServicePacs

1 Year – PN 29R5810

3 Year – PN 41W9377

Thank You! Questions?

Trademarks

The following are trademarks of the International Business Machines Corporation in the United States, other countries, or both.

Not all common law marks used by IBM are listed on this page. Failure of a mark to appear does not mean that IBM does not use the mark nor does it mean that the product is not actively marketed or is not significant within its relevant market.

Those trademarks followed by ® are registered trademarks of IBM in the United States; all others are trademarks or common law marks of IBM in the United States.

For a complete list of IBM Trademarks, see www.ibm.com/legal/copytrade.shtml:

*, AS/400®, e business(logo)®, DBE, ESCO, eServer, FICON, IBM®, IBM (logo)®, iSeries®, MVS, OS/390®, pSeries®, RS/6000®, S/30, VM/ESA®, VSE/ESA, WebSphere®, xSeries®, z/OS®, zSeries®, z/VM®, System i, System i5, System p, System p5, System x, System z, System z9®, BladeCenter®

The following are trademarks or registered trademarks of other companies.

Adobe, the Adobe logo, PostScript, and the PostScript logo are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States, and/or other countries.
Cell Broadband Engine is a trademark of Sony Computer Entertainment, Inc. in the United States, other countries, or both and is used under license therefrom.
Java and all Java-based trademarks are trademarks of Sun Microsystems, Inc. in the United States, other countries, or both.
Microsoft, Windows, Windows NT, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.
Intel, Intel logo, Intel Inside, Intel Inside logo, Intel Centrino, Intel Centrino logo, Celeron, Intel Xeon, Intel SpeedStep, Itanium, and Pentium are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.
UNIX is a registered trademark of The Open Group in the United States and other countries.
Linux is a registered trademark of Linus Torvalds in the United States, other countries, or both.
ITIL is a registered trademark, and a registered community trademark of the Office of Government Commerce, and is registered in the U.S. Patent and Trademark Office.
IT Infrastructure Library is a registered trademark of the Central Computer and Telecommunications Agency, which is now part of the Office of Government Commerce.

* All other products may be trademarks or registered trademarks of their respective companies.

Notes:

Performance is in Internal Throughput Rate (ITR) ratio based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput that any user will experience will vary depending upon considerations such as the amount of multiprogramming in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance ratios stated here.

IBM hardware products are manufactured from new parts, or new and serviceable used parts. Regardless, our warranty terms apply.

All customer examples cited or described in this presentation are presented as illustrations of the manner in which some customers have used IBM products and the results they may have achieved. Actual environmental costs and performance characteristics will vary depending on individual customer configurations and conditions.

This publication was produced in the United States. IBM may not offer the products, services or features discussed in this document in other countries, and the information may be subject to change without notice. Consult your local IBM business contact for information on the product or services available in your area.

All statements regarding IBM's future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.

Information about non-IBM products is obtained from the manufacturers of those products or their published announcements. IBM has not tested those products and cannot confirm the performance, compatibility, or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.

Prices subject to change without notice. Contact your IBM representative or Business Partner for the most current pricing in your geography.