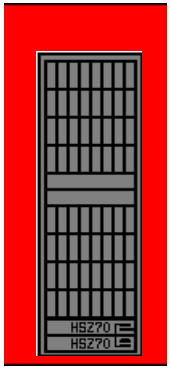
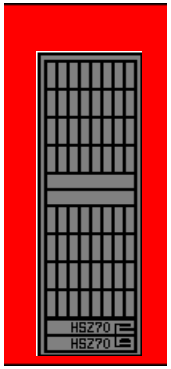


Technical Overview of the Enterprise Virtual Array



Objectives

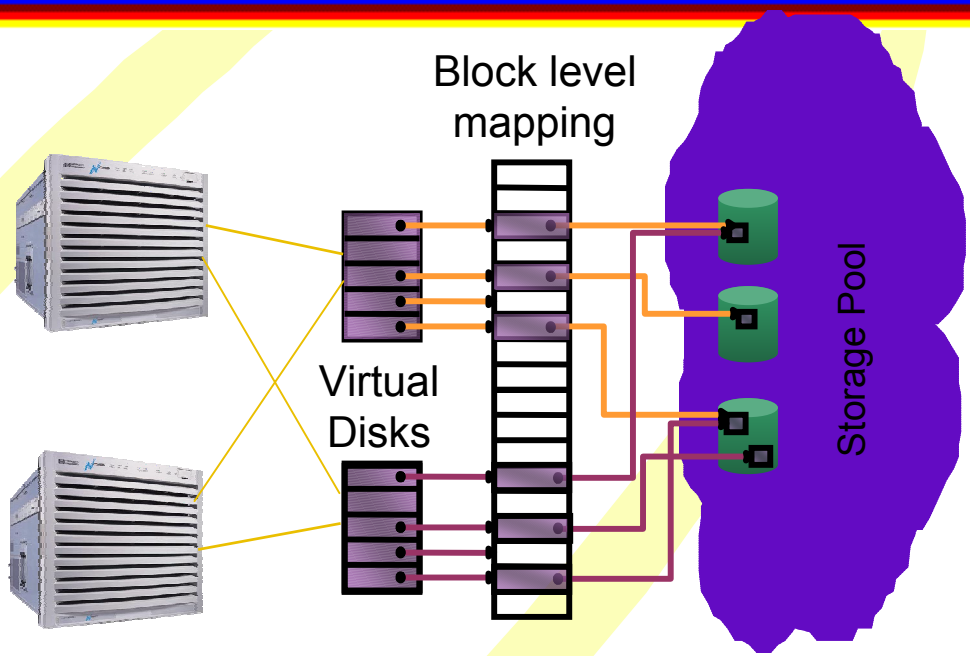
- Discuss storage virtualization
- Describe the hardware features and functions of the Enterprise Virtual Array
- Distinguish between the Modular Arrays and the Enterprise Virtual Array
- Describe the Software features of the Virtual Controller Software (VCS).
- Identify examples of SAN-based solutions that incorporate the Enterprise Virtual Array

the value of virtualization

hp StorageWorks

eva3000

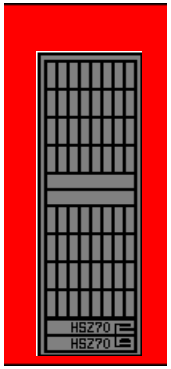
eva5000



EVA family values

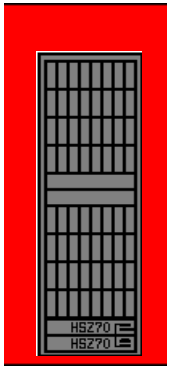
the technology . . .

- **capacity is treated as a pool of storage blocks, not discrete disks**
- **powerful mapping techniques present a logical view of storage to host servers**



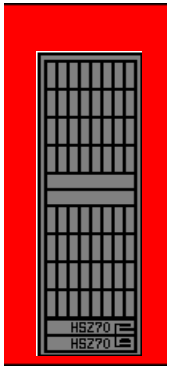
What is Storage Virtualization?

- Combination of hardware, software, and networking gear that turns a SAN into a "coherent, intelligent storage subsystem capable of automating information management processes." (Illuminata, April 2001)
- Allows heterogeneous storage devices to be combined into a SAN-attached storage pool that is managed as a single storage resource. (IDC, November 2000)



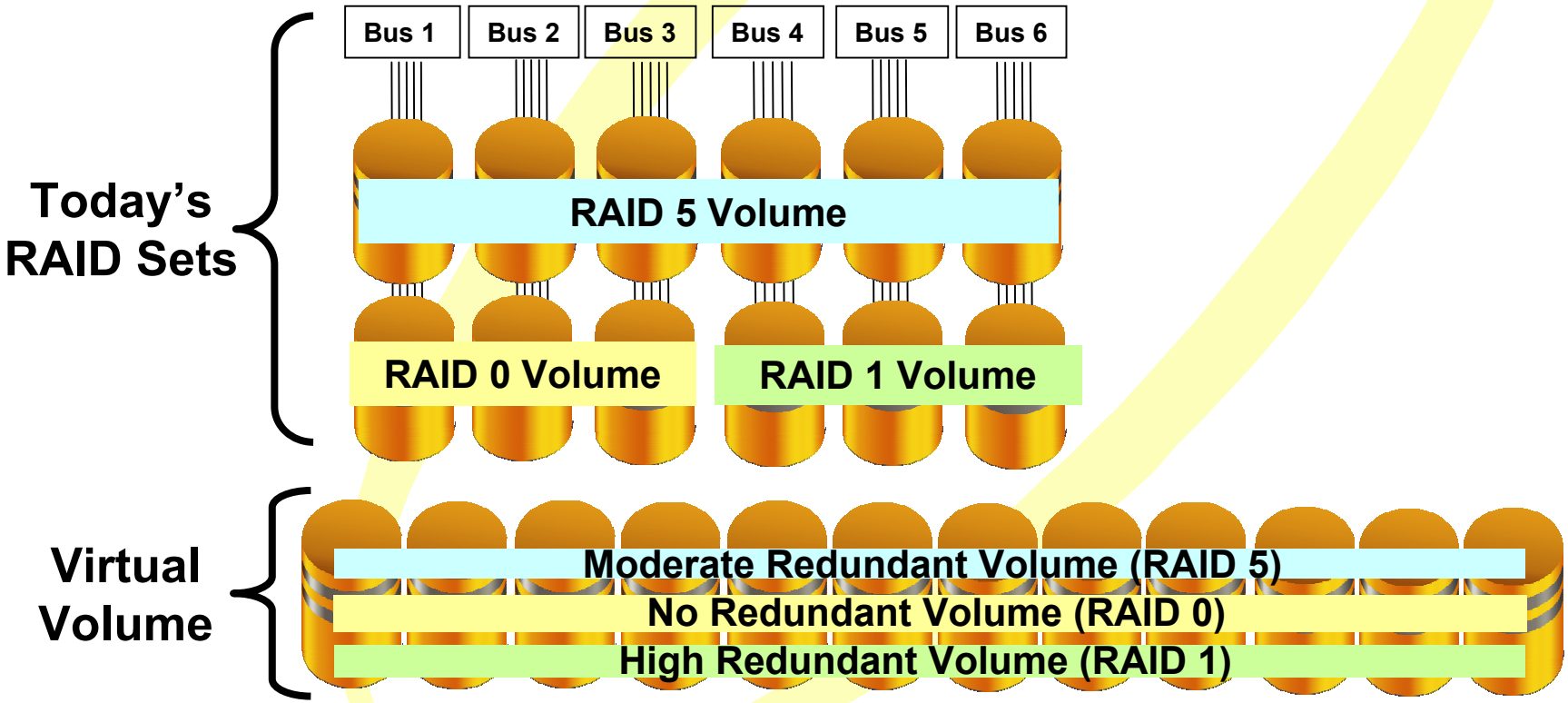
virtualization on EVA

- All raw disk storage is pooled
- Virtual Disks (VDs) (or LUNs) are drawn from a pool
- Less overhead for:
  - Controller state
  - Mapping metadata
  - Audit / error logs
- Virtual Disks managed by customer to these constraints:
  - Size range 1GB – 2TB, in 1GB increments
  - Up to 512 Virtually Disks — selectively presented to hosts
  - Each Virtual Disk can be zero (none), medium or high redundancy
    - Vraid0, Vraid5, or Vraid1
  - Virtual Disk size can be dynamically expanded, but not shrunk

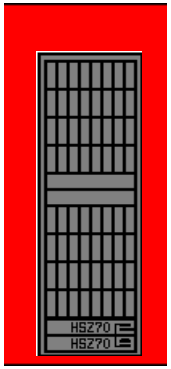


Virtualization

- Eliminate throughput bottlenecks
- Eliminate load balancing procedures for application and Data Base



Workload is evenly distributed across all spindles in group

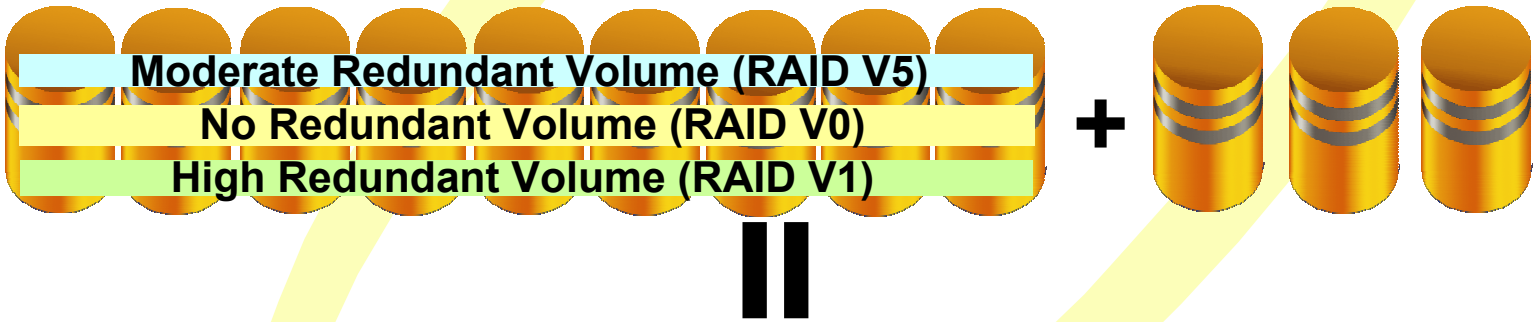


Virtual Storage Pools

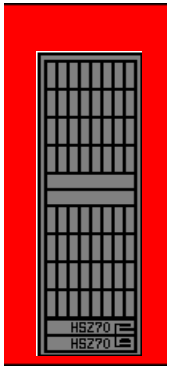
- Dynamic pool capacity changes
- Pool capacity can be expanded by spindle(s)
- Virtual Disk blocks are automatically relocated to level spindle use

- **Disk Spindles Becoming a Throughput Bottleneck**
- **No Additional Storage Space Available**

Add More Disks

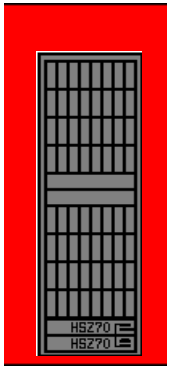


- **Disks Running at Optimum Throughput (dynamic load balancing)**
- **Additional Storage Space Available**



Enterprise Virtual Array

- Modular, scalable and highly available design
  - Redundant Power
  - Redundant Cooling
  - Distributed hot spare disk drives
  - Mirrored Cache with battery backup
- virtual RAID architecture
  - vRAID 0
  - vRAID 1
  - vRAID 5
- Full 2Gb fibre channel front to back
  - 1Gb fibre channel SAN compatible
- Centralized, unobtrusive "LiteTouch" manageability

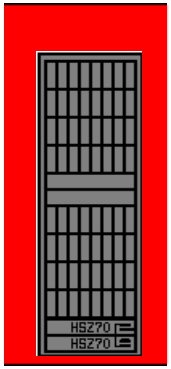


vRAID levels

- Virtual Disk redundancy:
  - None (VRAID0): Data is striped across all physical disks in the Disk Group.
  - Moderate (VRAID5): Data is striped with parity across all physical disks in the Disk Group.
  - High (VRAID1): Data is striped mirrored across all physical disks in the Disk Group. Established pairs of physical disks mirror each other.

EVA Family Characteristics

- 2Gb FC Array Controller
- Automatic load balancing
- Virtualized data distribution
- Snapshot/SnapClone
- Dynamically expandable disk pools
- Load leveling & Auto Sparing
- Mirrored write-back cache
- NSPOF design
- New Performance Architecture
- Supports up to 240 drives
- Dual ported 2 Gb FC drives



EVA Family

- EVA 5000
- EVA 3000

HP StorageWorks eva3000
Enterprise functionality to the mid-range

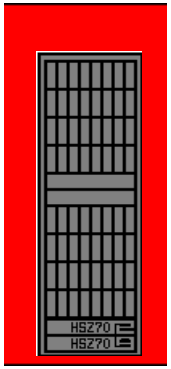
Highlights

- End-to-end 2Gb/s FC architecture
- Redundant HSV100 controllers
- Up to 4 drive enclosures per controller-pair
- Up to 56 drives per controller-pair
- Up to 335MB/s per controller-pair
- Great for moderate storage growth environments
- Scalable up to 8TB per controller pair
- Optional: business-data protection, business continuance and storage management software

HP StorageWorks eva5000
The new enterprise storage benchmark

Highlights

- End-to-end 2Gb/s FC architecture
- Redundant HSV110 controllers
- Up to 18 drive enclosures per controller-pair
- Up to 240 drives per controller-pair
- Up to 560MB/s w/one controller-pair
- Scalable up to 24TB/cabinet
- Scalable up to 35TB per controller-pair
- Optional: business-data protection, business continuance and storage management software

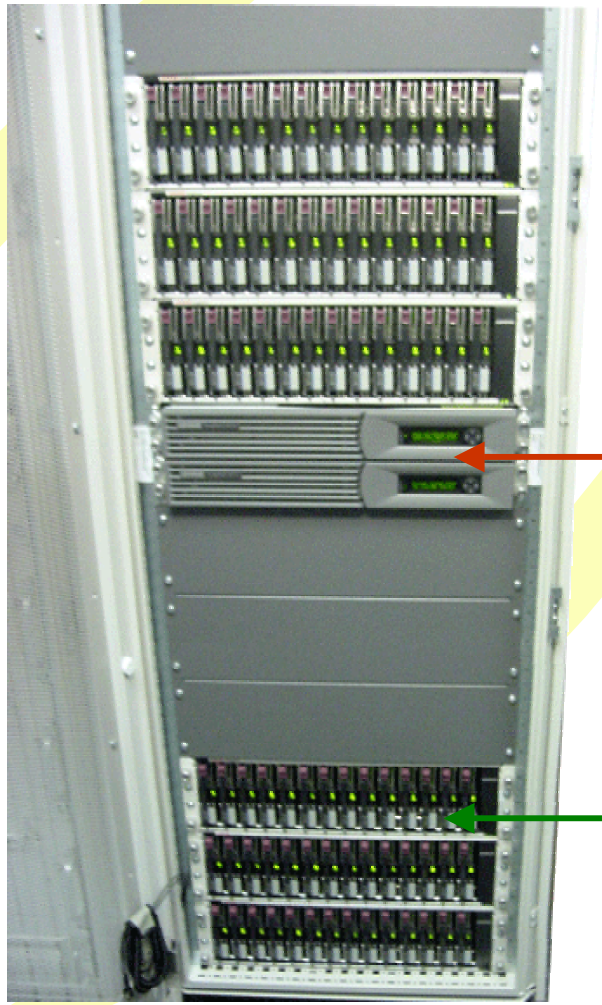


array comparisons

Array	eva3000	eva5000
# controllers	2	2
host interface	FC	FC
host ports	4	4
drive interface	FC	FC
drive enclosure density	14	14
maximum capacity (raw)	8TB	35TB
disk sizes / speeds (rpm)	146GB/10k 73GB/15k,10k 36GB/15k,10k	146GB/10k 73GB/15k,10k 36GB/15k,10k
maximum number of drives supported	56	240

Product Description

- Inside the cabinet, things are different
  - HSV Controllers
  - Fibre Channel Drive Enclosures
  - Fibre Channel Drives
  - FC-AL Cabling
  - FC Loop Switch

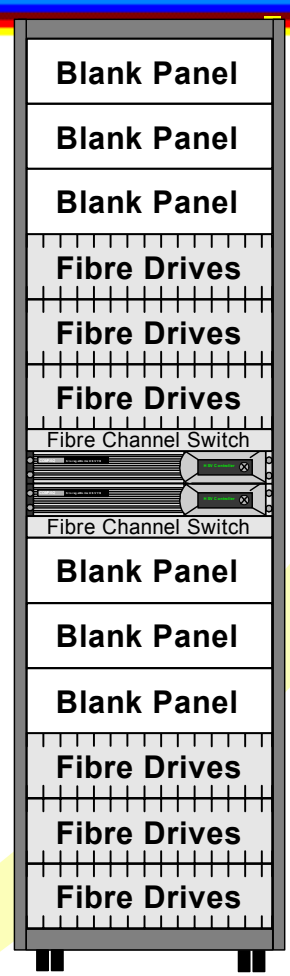


Controllers and Enclosures

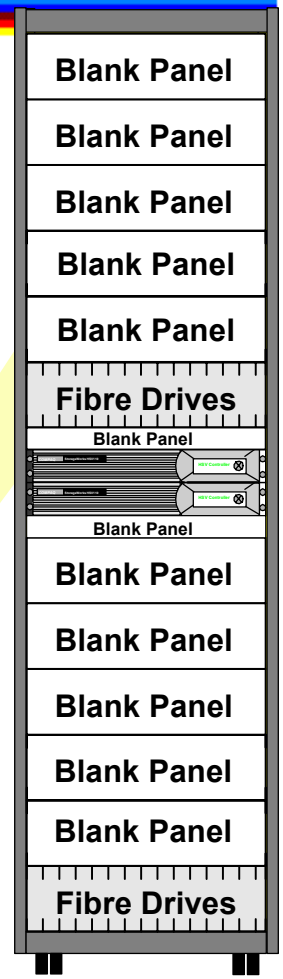
FC Drives and Enclosures

eva5000 2C2D Configuration

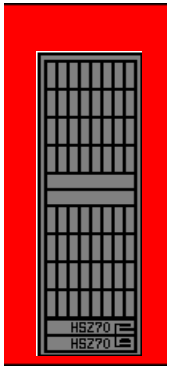
- 2C2D configured to be easily expanded
  - CTO in factory up to 2C5D with or without FC loop switches
  - Field upgradeable all the way to 2C12D (with FC loop switches)



2C6D-B
with FC Loop Switches



2C2D-B
without FC loop switches



eva5000 2C6D Configuration

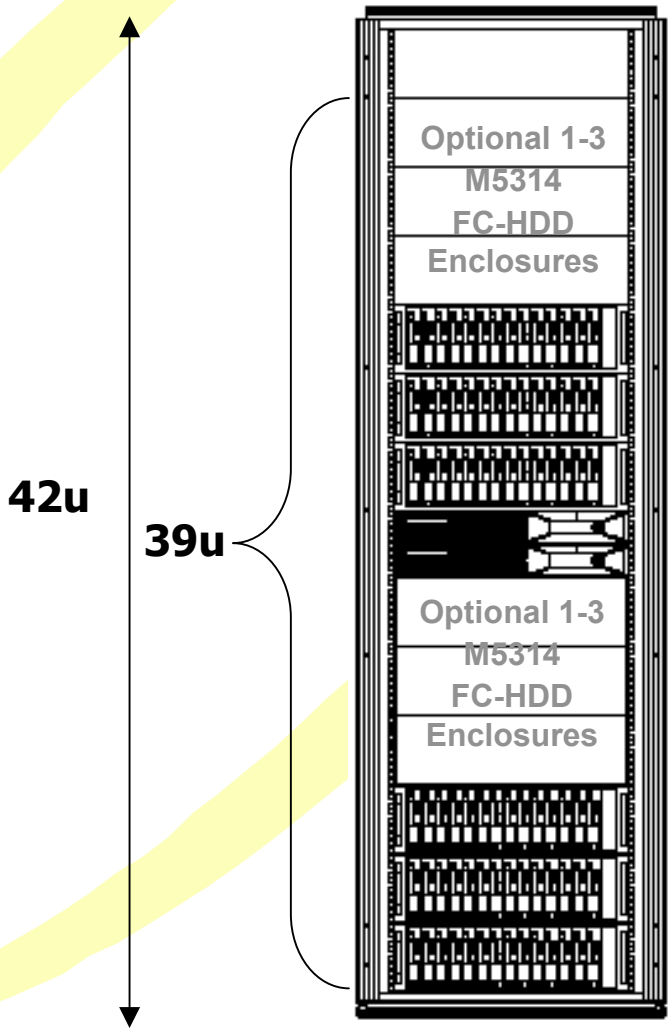
Model 2C6D

(1) 42U Modular storage cabinet
(1) M3220 Enclosure pair w
(2) HSV110 Controllers
(2) Cache batteries per enclosure
(6) 14-bay FC enclosures
(17) Int FC Cables
(7) 2-port EMU boxes
(8) AC strips
(2) 0u PDUs

Disks ordered separately

3.0 TBytes (36GB)
6.0 Tbytes (72GB)

Max Drive Configurations



(3) M5214 Enclosures

(2) M3220 Enclosures

(3) M5214 Enclosures

eva5000 8C8D
Write Performance Model

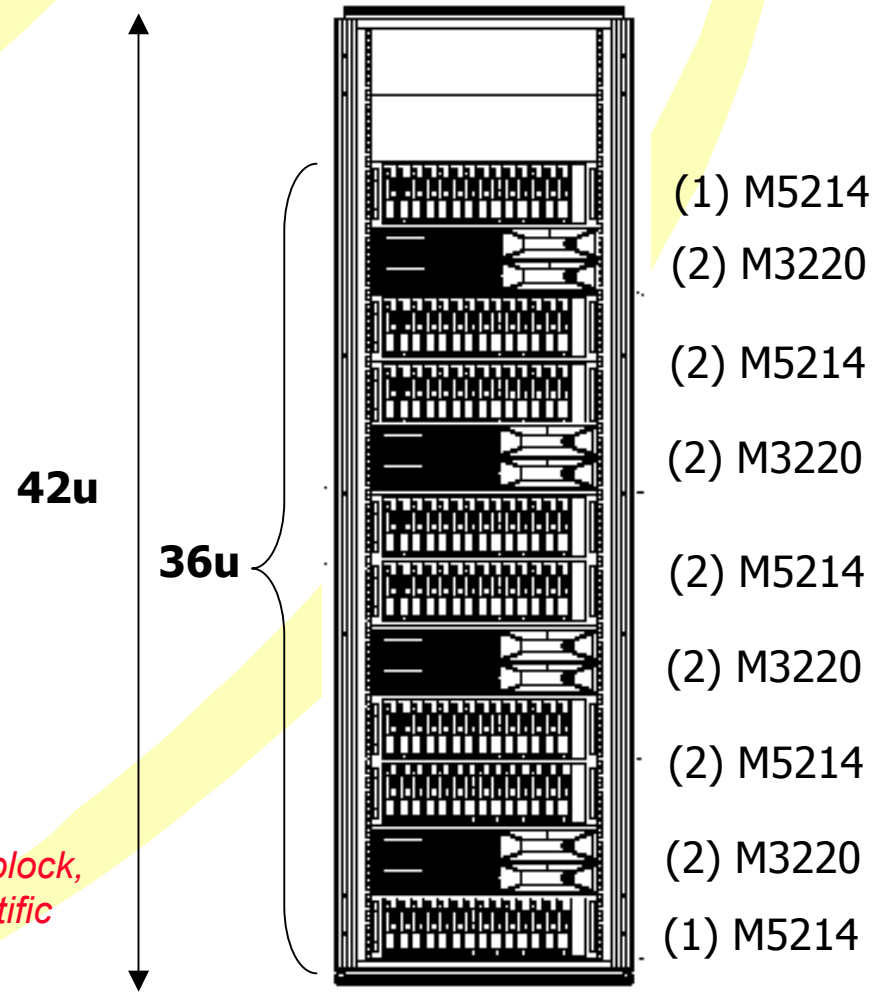
Model 8C8D

(1) 42U Modular Storage Cabinet
(4) M3220 Enclosure pair w
(8) HSV110 Controllers
(8) Cache Batteries
(8) 14-bay FC Enclosures
(36) Int FCCables
(7) 2-port EMU boxes
(8) AC strips
(2) 0u PDUs

Disks ordered separately

16.0 TB (112x 146GB) - Max Drive Configuration

**This model is for "memory dump" (high speed, large block, consecutive 100% write) operations typically for Scientific Applications*



eva5000 - 2C12D Configurations

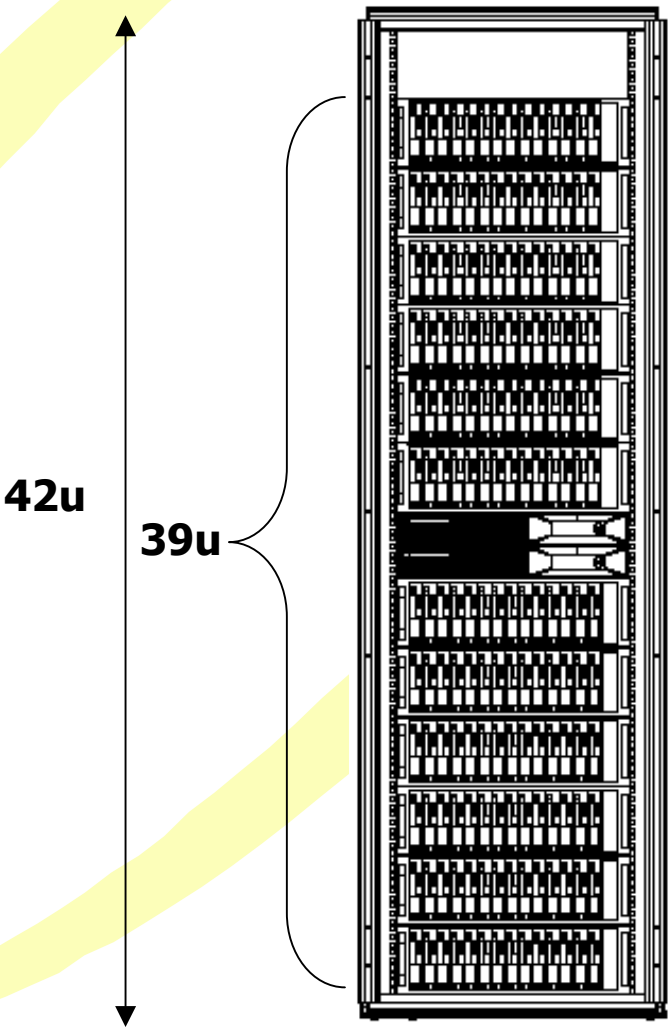
Model 2C12D

(1) 42U Modular storage cabinet
(2) M3220 Enclosure pair w
(2) HSV110 Controllers
(2) Cache batteries per enclosure
(12) 14-bay FC enclosures
(37) Int FC cables
(7) 2-port EMU boxes
(8) AC strips
(2) 0u PDUs

Disks ordered separately

6 TBytes (36GB)
12 Tbytes (72GB)
24 Tbytes (146GB)

Max Drive Configurations



2C12Ds with 0C12D Expansion Cabinet

Expansion Cabinet

- 70 Terabytes
  - 480, 146GB FC disks
- 4 controllers
- Single footprint: 17.7 ft^2 (1.5 m^2)

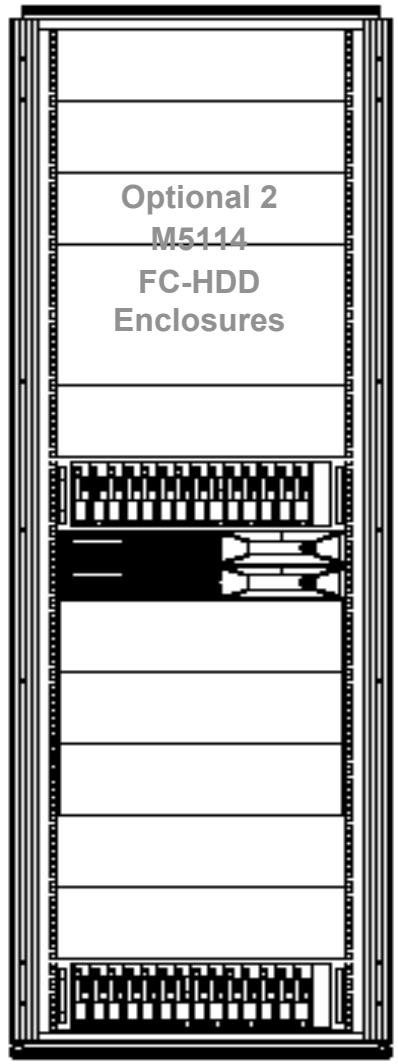
eva3000

eva3000 Configuration

EVA3000 Base model

(1) 42U Modular storage cabinet
(1) M3200 Enclosure pair w
(2) HSV100 Controllers
(2) Cache batteries per enclosure
(2) 14-bay M5114 FC enclosures
(7) 2-port EMU boxes
(8) AC strips
(2) 0u PDUs

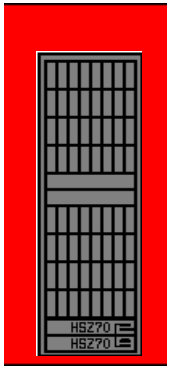
Disks ordered separately



(1) M5114 Enclosure

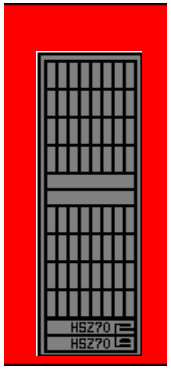
(2) M3200 Enclosures

(1) M5114 Enclosure



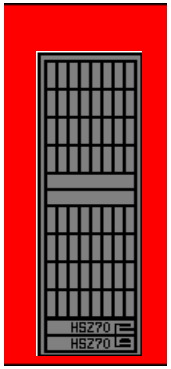
eva3000 architecture

- Base eva3000 module:
  - Dual HSV100 controllers in an M3200 enclosure
    - Four optical 2Gbit front-end loops to host
    - Two copper 2Gbit back-end loops to drive enclosures
    - 2GB cache and dual power supplies
  - Two M5114 FC drive enclosures
  - One 42U 10,000 series graphite metallic rack
  - Redundant zeroU PDUs
  - Scales up to 56 drives (with the addition of two drive enclosures to the initial two enclosure subsystem)



eva5000 architecture

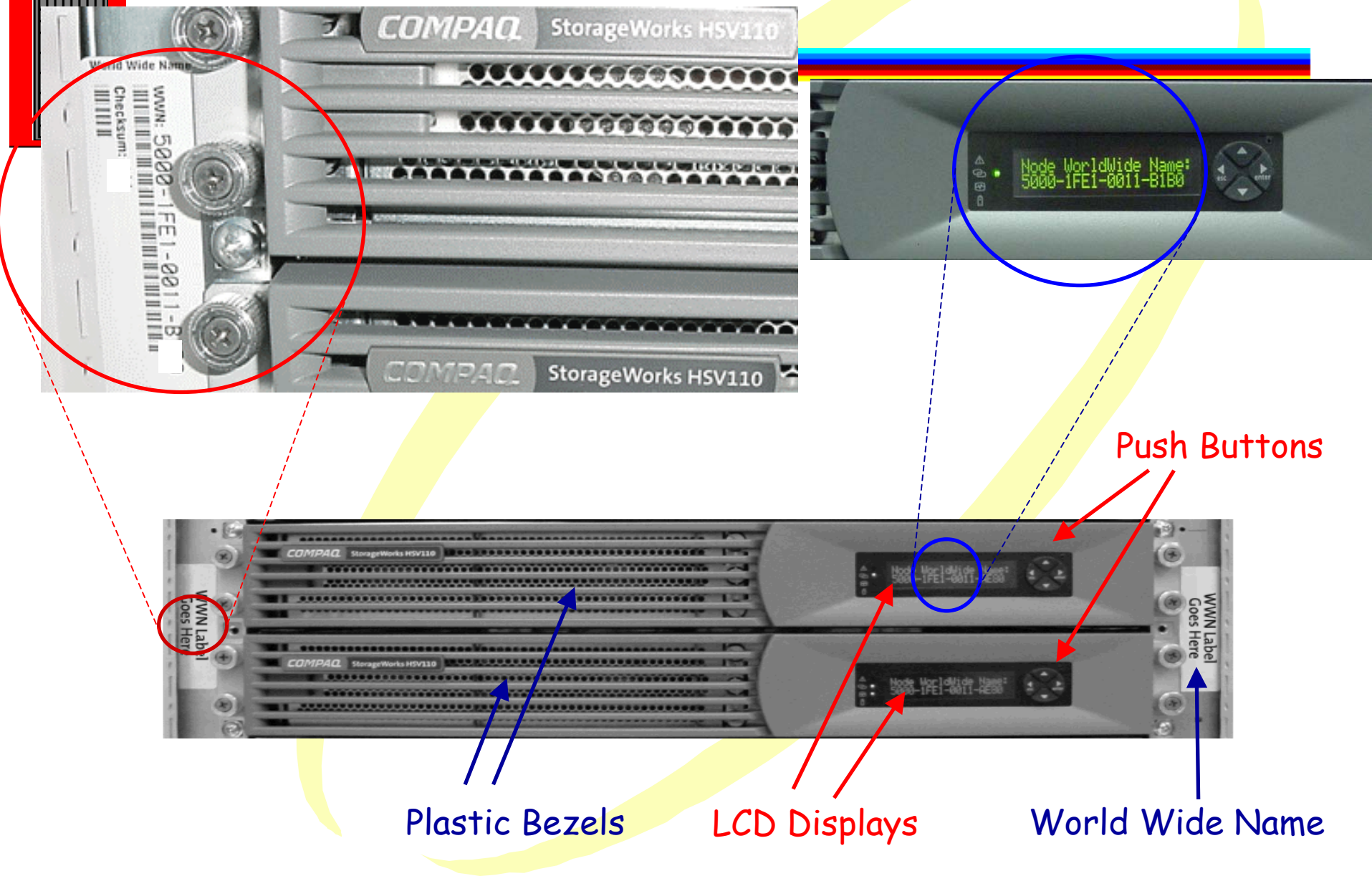
- Base eva5000 module:
  - Dual HSV110 controllers in an M3220 enclosure
    - Four optical 2Gbit front-end loops to host
    - Four optical 2Gbit back-end loops to drive enclosures
    - 2GB cache and dual power supplies
  - M5214 FC drive enclosures
  - One 42U 10,000 series graphite metallic rack
  - Redundant zeroU PDUs
  - Scales up to 240 drives (with the addition of expansion enclosure)



M32x0—Array Controller Enclosures

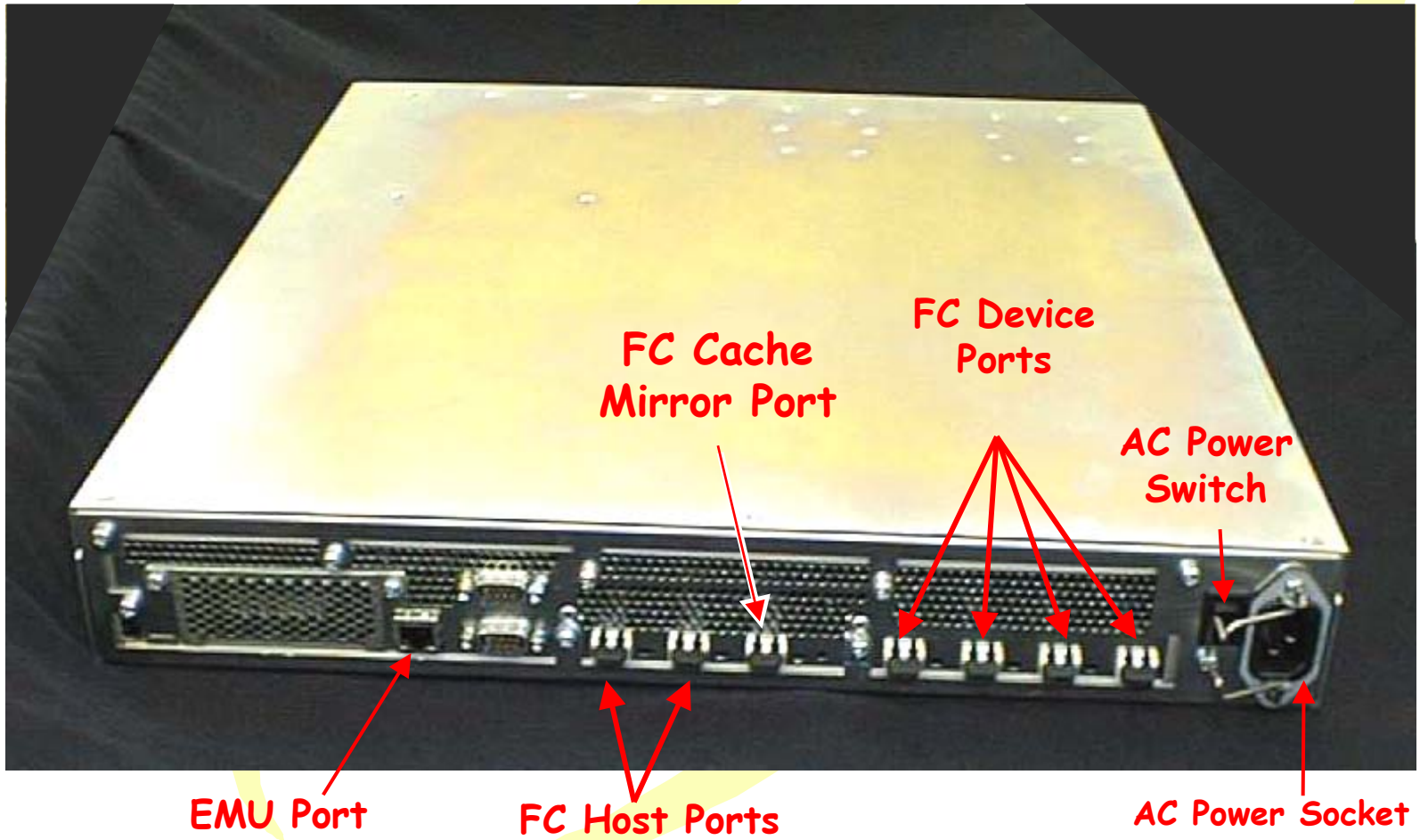
- High performance HSV1x0 controllers
  - High performance Power PC microprocessor
  - Two 2Gb/s "ready" FC-Switch Fabric host ports
    (2Gb/s switches and HBAs not available at first release)
  - Two or Four 2Gb/s FC-AL device ports
    - Arranged in redundant pairs
    - Data load / performance is balanced across a pair of device ports
    - Supports up to 240 disks (120 disks per pair of device ports)
  - 1GB cache per controller, mirrored, with battery backup
  - 2Gb/s FC cache mirroring port (device ports as backups)

Controller Enclosure Pair—Front View

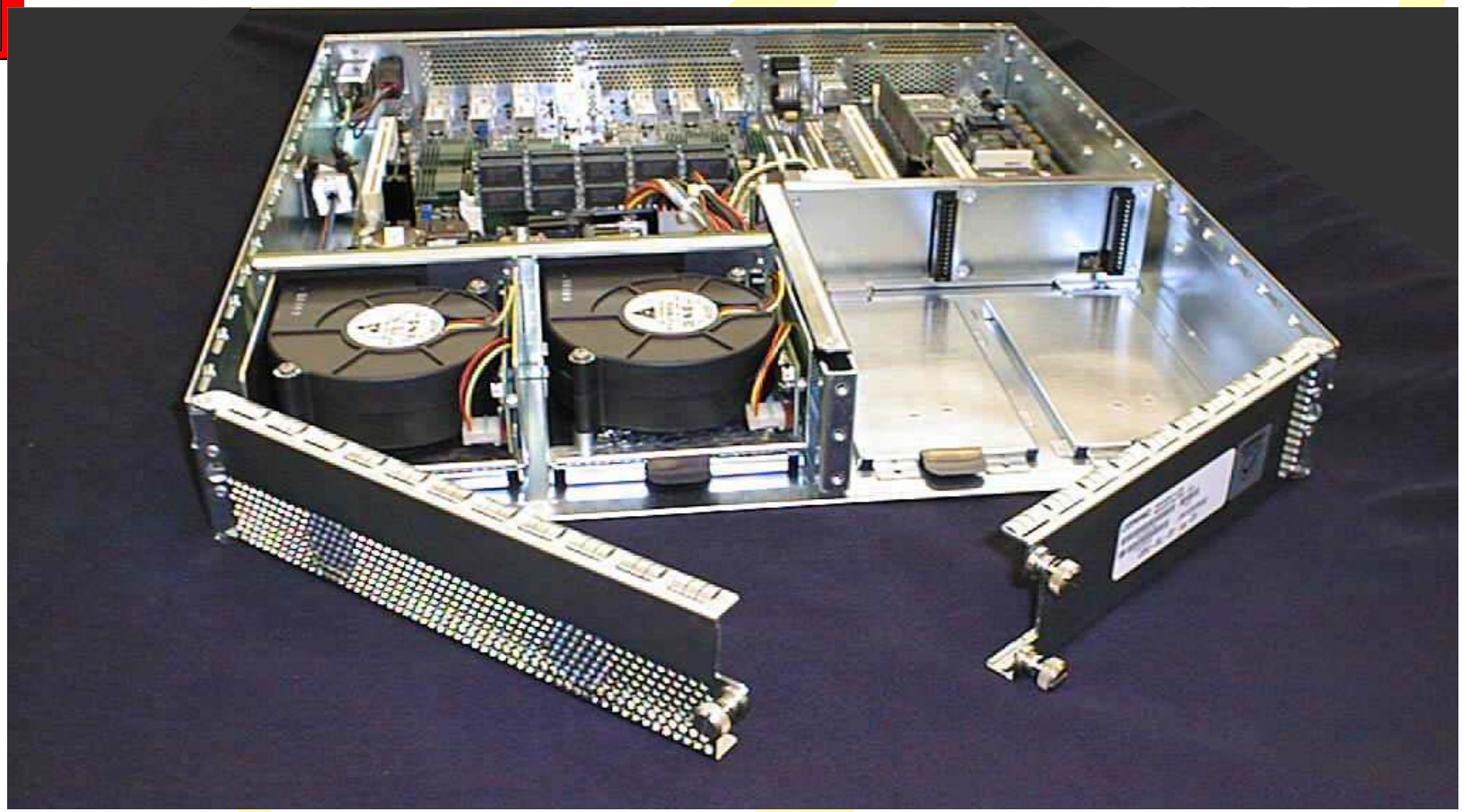


Controller Enclosure - Back View

- 1.5U single controller enclosure (offered only as 3U pair)

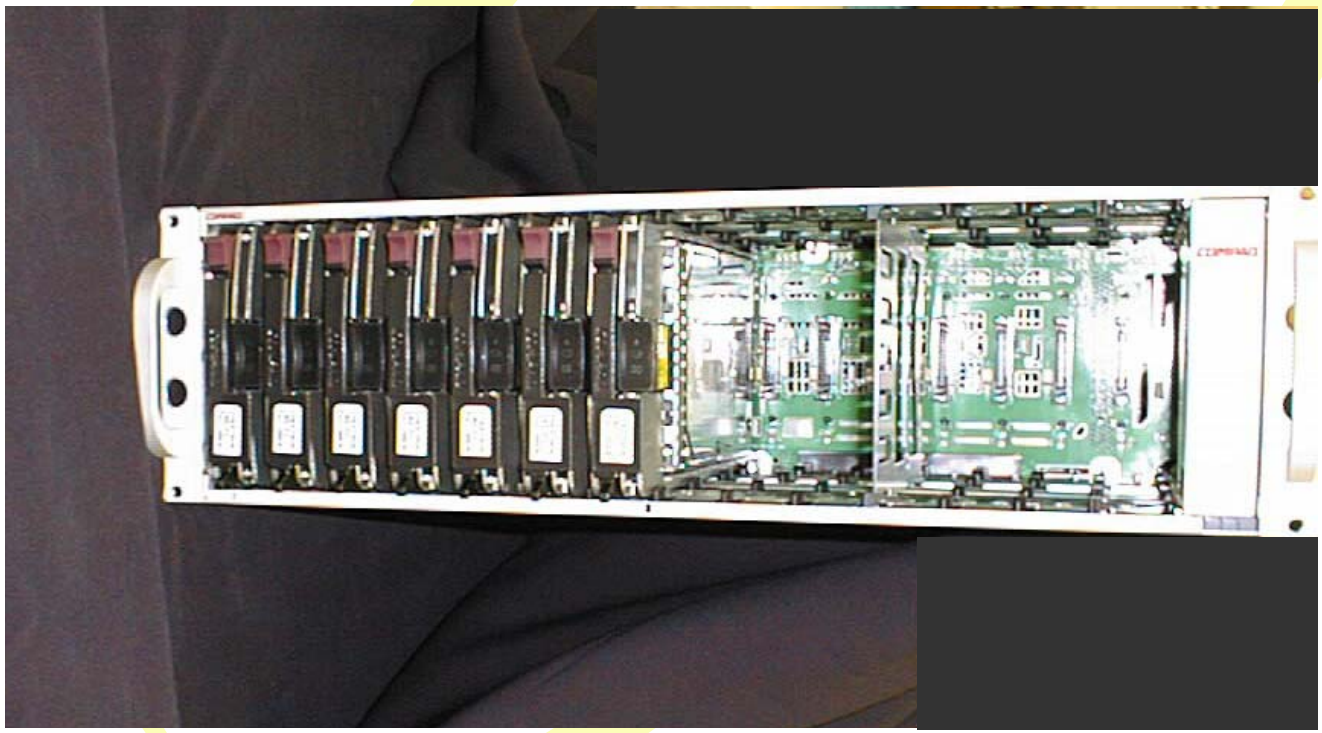


Controller Enclosure - Front View, Fans and Cache Batteries Access Panels



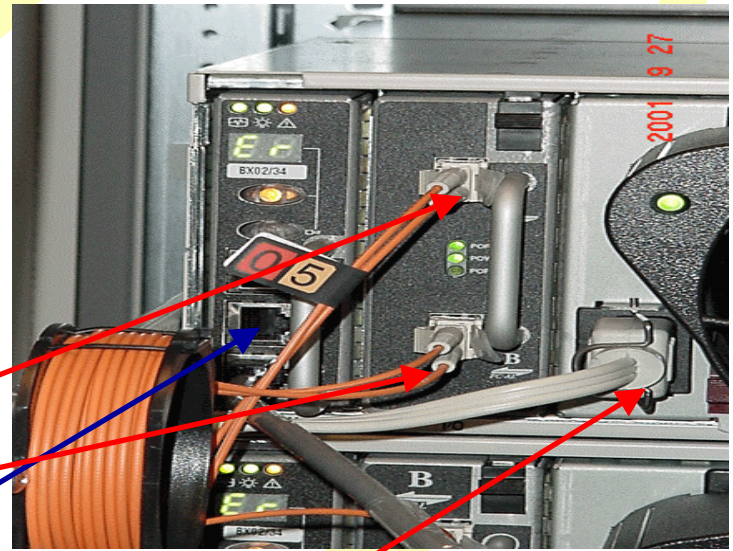
M5214—FC Drive Enclosures - Front View

- 3U disk enclosure
- Dual redundant active-active 2Gb/s FC busses
- Fourteen 1-in. FC disks per enclosure (4 drive minimum)

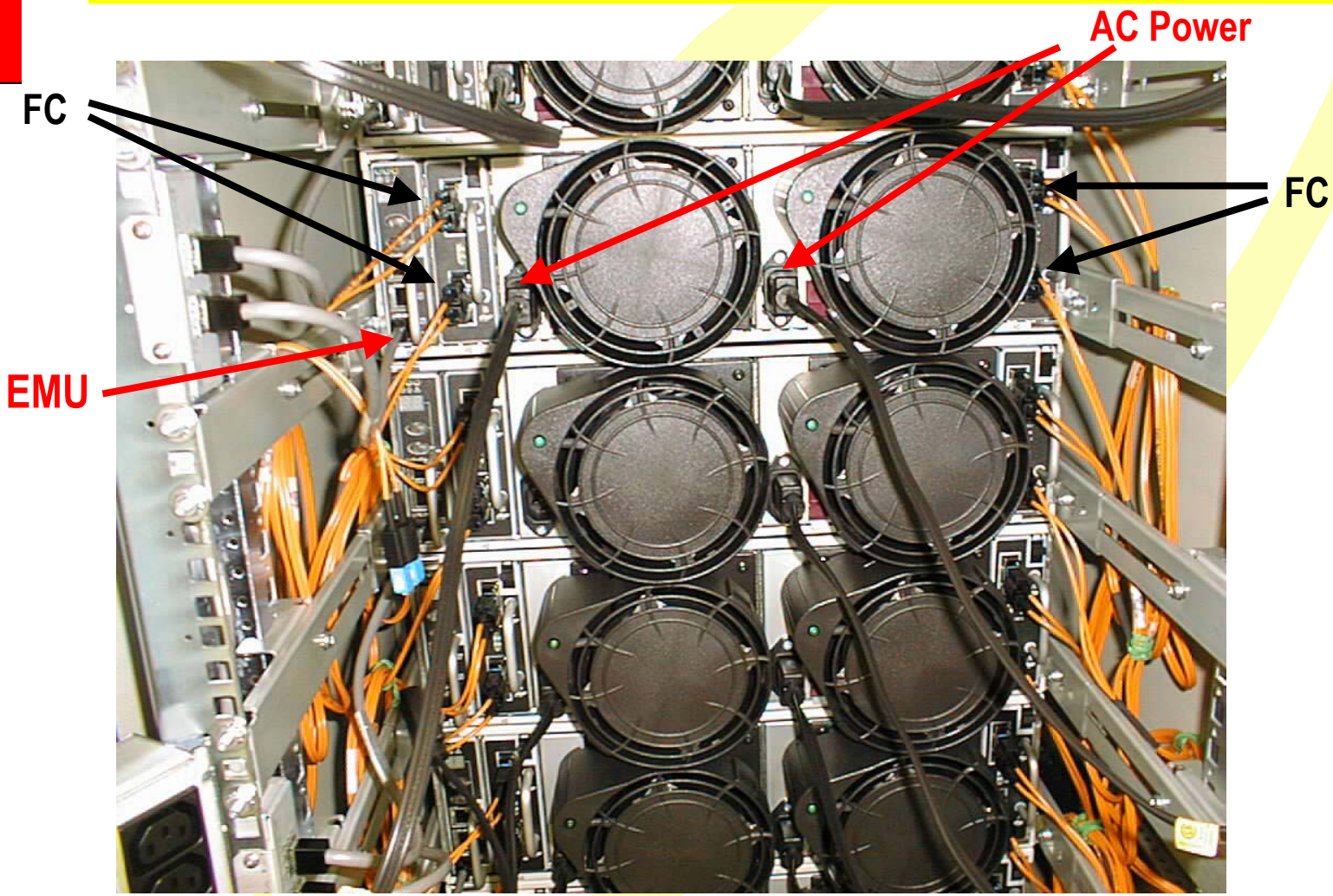


FC Drive Enclosure - Back View

- Environmental Monitor Unit
- Dual 2Gb/s FC I/O module
  - B (left-side) A (right-side)
- Dual 500 watt redundant hot plug power supplies and fans

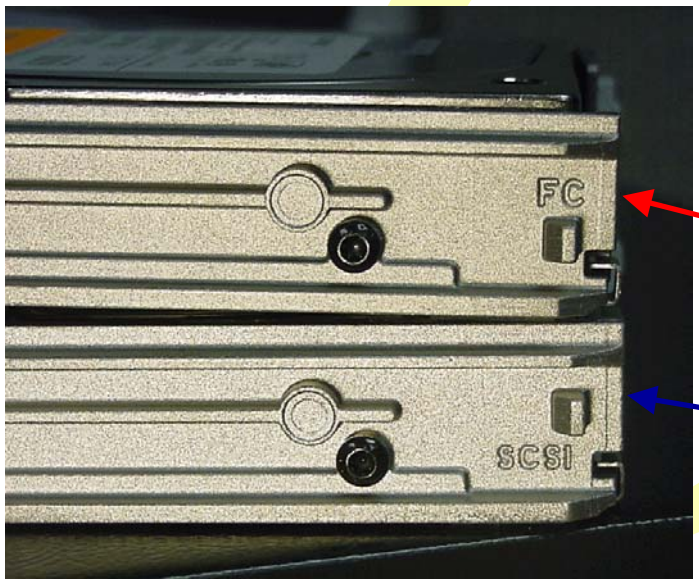


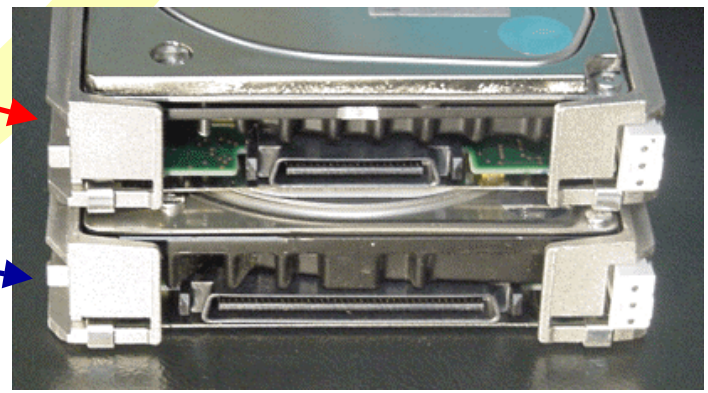
FC Drive Enclosures - Rear Cabinet View



FC Disk Drives

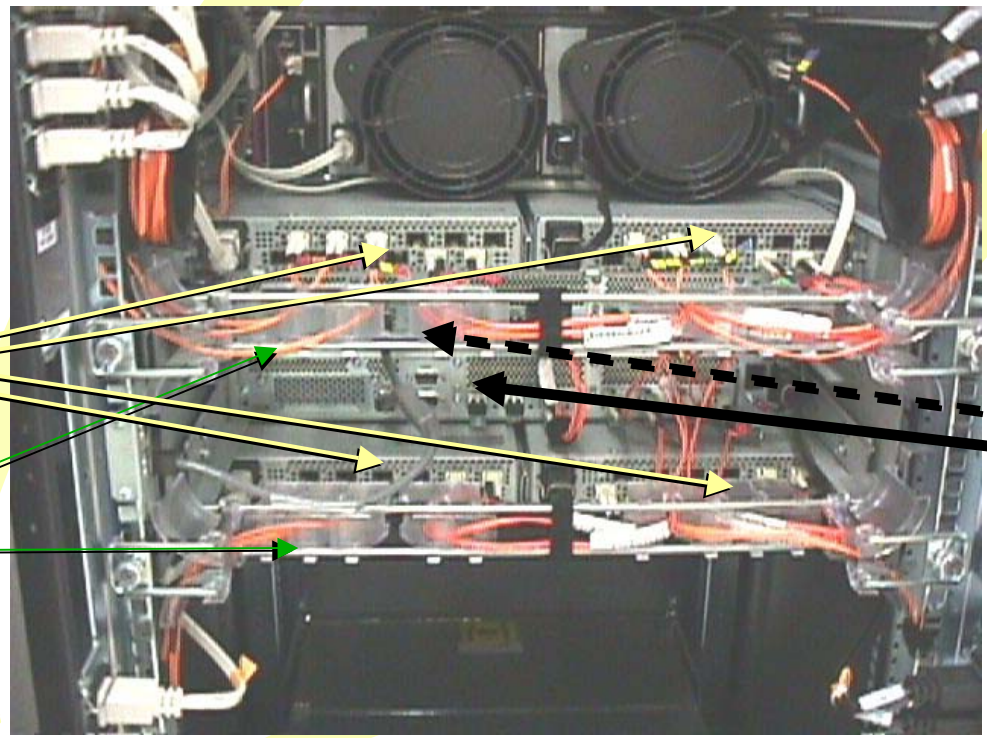
- Dual-ported 2Gb/sec FC-AL
- 72B and 146GB 10K rpm
- 36GB and 72GB 15k rpm
- Up to 120 drives to be supported per FC-AL pair





backend FC loop switches

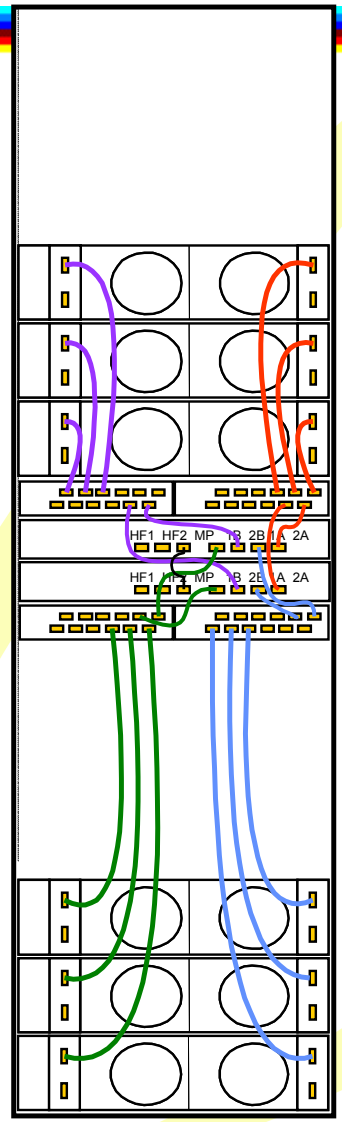
- (4) four 1u half-rack-wide 12-port (11 utilized with expansion cab) FC loop switches
- improves diagnostic/service ability:
  - ability to add or remove shelves
  - ability to add expansion cabs



cable routing – EVA-2 cabinet

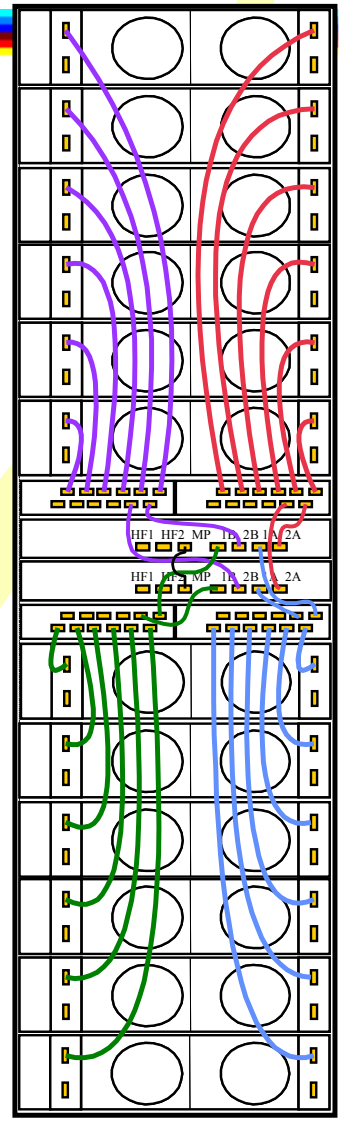
E2 2C6D-A, -B Config

- 2 controllers
- 6 drive shelves
- up to 84 drives
- 2 0U PDUs
- 42 U cabinet
- **4 FC loop switches**



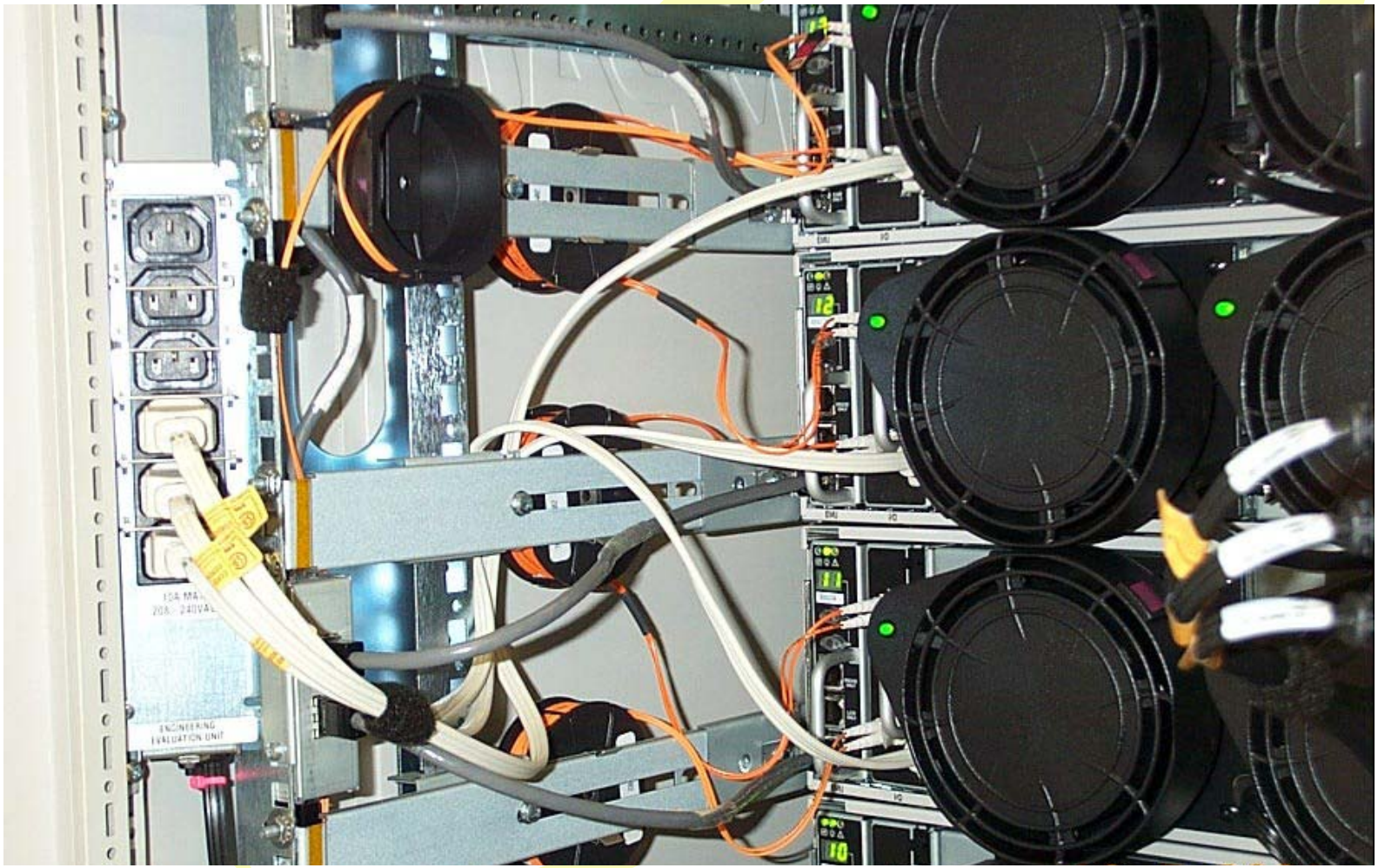
E2 2C12D-A, -B Config

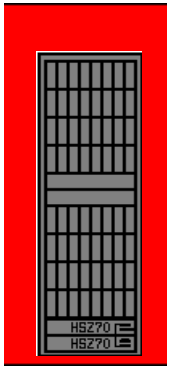
- 2 controllers
- 12 drive shelves
- up to 168 drives
- 2 0U PDUs
- 41U cabinet
- **4 FC loop switches**



Cabinet Cabling

- Fibre Channel, Power, and Cabinet Area Network (CAN)



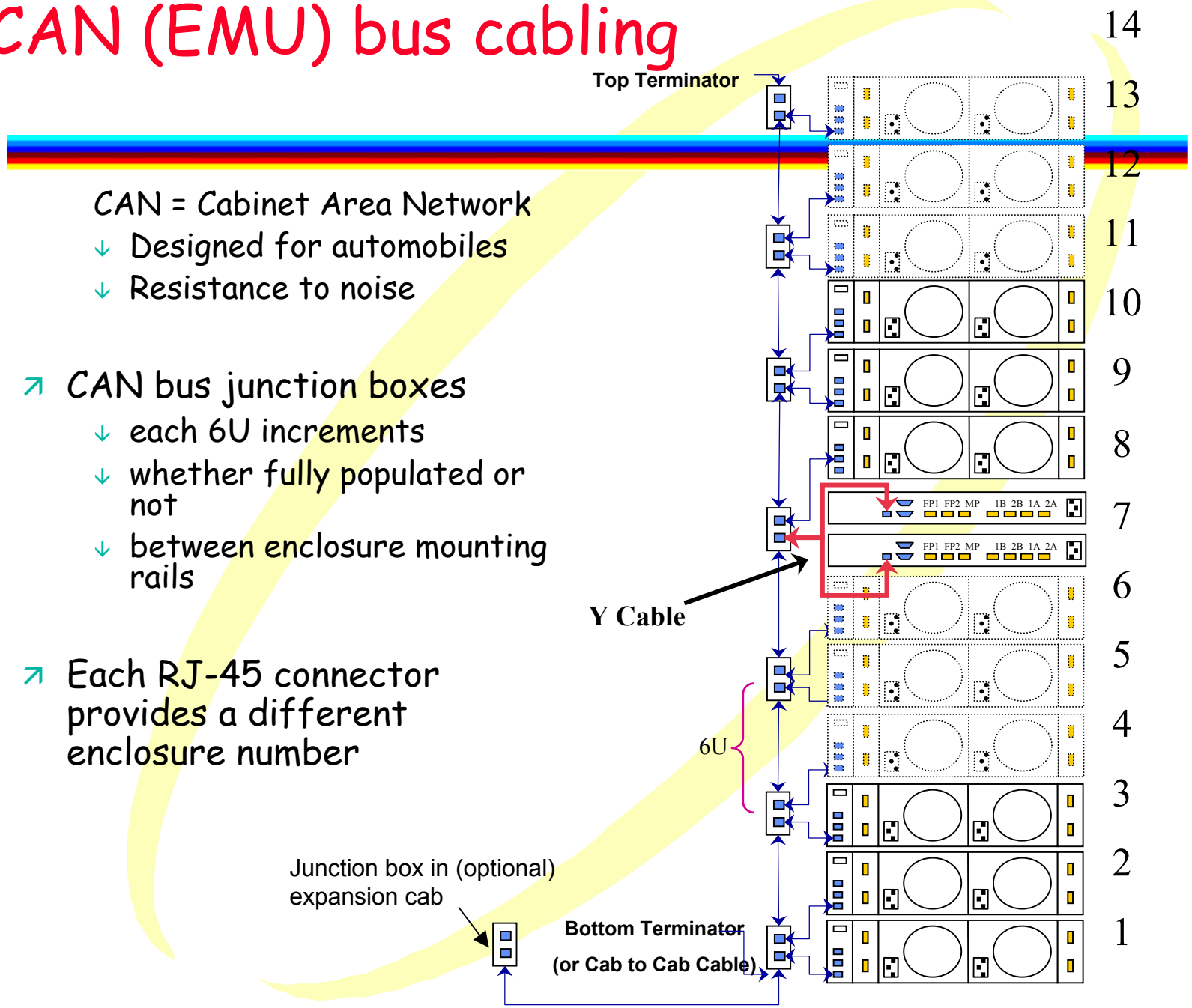


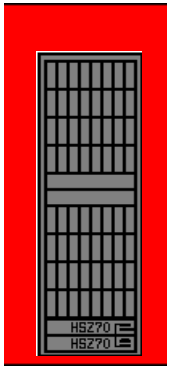
HSV Storage System - Cabinet Bus

- Cabinet Area Network (CAN)
- Requires Terminator at top and bottom of bus
- Provides interconnection for Environmental Monitoring Units (EMU's) and Controllers
- Assigns Enclosure Number / Address to the EMU's
- Provides support for FC-AL addressing
- Provides common path for event logging

CAN (EMU) bus cabling

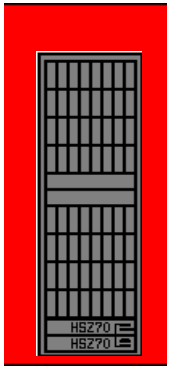
- CAN = Cabinet Area Network
  - Designed for automobiles
  - Resistance to noise
- CAN bus junction boxes
  - each 6U increments
  - whether fully populated or not
  - between enclosure mounting rails
- Each RJ-45 connector provides a different enclosure number





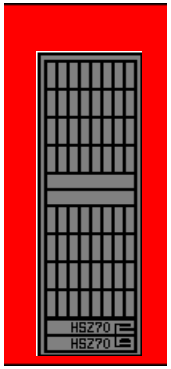
EMU Monitors & Controls

- Disk Drives
- Power Supplies
- Fibre Channel Transceivers (GBICs)
- EMU
- Fans
- I/O Modules
- Temperatures (Alerts and Errors)
- Voltage Sensors (Alerts and Errors)
- Current Sensors (Alerts and Errors)



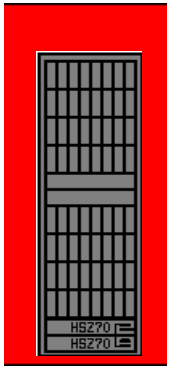
What is SES?

- SCSI-3 Enclosure Services (SES)
- SCSI-3 Specification:
  - A family of documents
  - SES is a member of the family
- SCSI-3 Primary Commands (SPC) referenced by SES



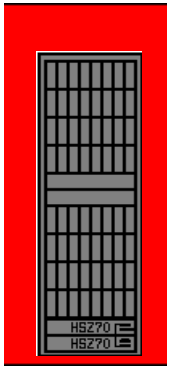
SES EMU Monitors

- Disk Drives
  - Fibre Channel link rate (1G vs. 2G)
  - Fibre Channel addresses relative to physical location
  - Presence vs. absence
  - Faults reported by drives
  - Bypass state
  - Drive WWN
- Power Supplies
  - Presence vs. absence
  - AC presence vs. absence
  - Emergency shutdown status



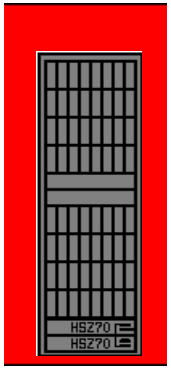
SES EMU Monitors

- Fibre Channel Transceivers (GBICs)
  - Presence vs. absence
  - Faults
  - Missing cables
- EMU
  - Internal hardware diagnostics
  - Enclosure number conflicts
  - Environmental data validation
  - Enclosure WWN and serial number
  - Power shutdown
  - Error code translation to text
  - Code load



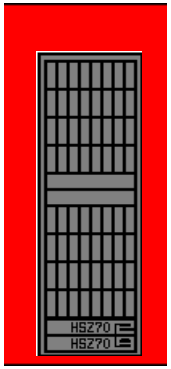
SES EMU Monitors

- Fans
  - Presence vs. absence
  - Speed
- I/O Modules
  - Presence vs. absence
  - Enclosure link rate (1G vs. 2G)



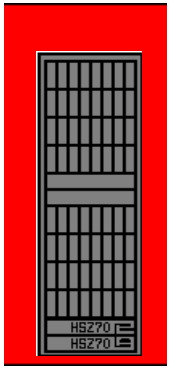
SES EMU Monitors

- Temperatures (Alerts and Errors)
  - Inlet temperature (at EMU)
  - Power supplies
  - Drives
  - Meltdown protection Voltage Sensors (Alerts and Errors)
  - Supply output voltages for 5V
  - Supply output voltages for 12V
- Current Sensors (Alerts and Errors)
  - Supply output currents for 5V
  - Supply output currents for 12V



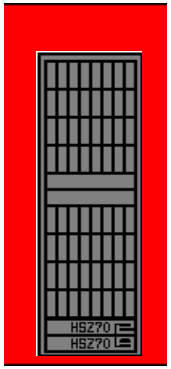
SES EMU Controls

- Disk Drives
  - Bypass state
  - Element identification (location)
  - Drive spinup
- Power Supplies
  - Emergency shutdown
  - Element identification (location)



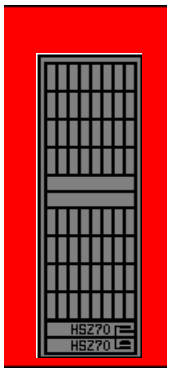
SES EMU Controls

- Fibre Channel Transceivers (GBICs)
  - Element identification (location)
- EMU
  - Power shutdown
  - Error code translation to text
  - Code load
  - Element identification (location)
- Fans
  - Speed
  - Element identification (location)



SES EMU Controls

- I/O Modules
  - Element identification (location)
- Audible Alarm
  - Severity
  - Muting



SES EMU Operator Interface

Heartbeat – Flashing is good

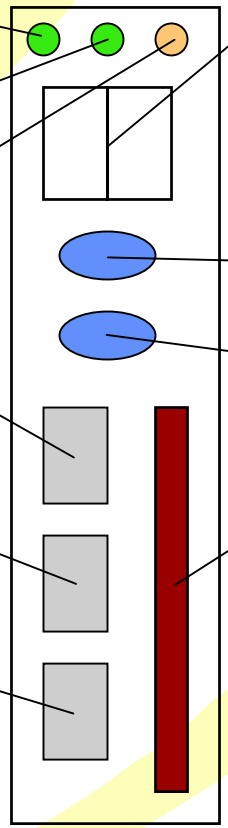
Power – On is good

Fault – Off is good

RJ-45 connector – RS232 Only

RJ-45 connector – LCD Only

RJ-45 connector – Can Only

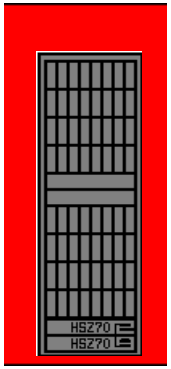


Two-character display – A two-digit number is good
Er indicates an error

Top push button with backlight

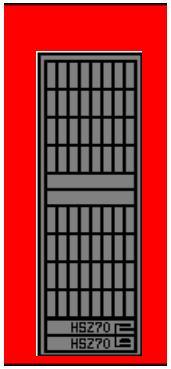
Bottom push button with backlight

Handle



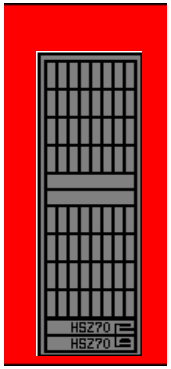
SES EMU Operator Interface

- Push button terminology
  - Push and hold
    - Push the button and hold it depressed until the operator interface changes (within about 2 sec.)
    - Release the button
  - Push (and release)
    - Push the button
    - Release the button immediately



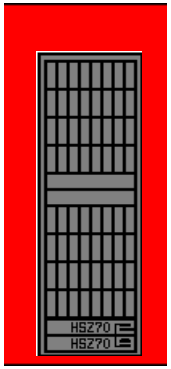
SES EMU Operator Interface

- Push the bottom button to cycle among the following choices:
  - **En** – Examine the enclosure number
  - **Li** – Modify the enclosure's loop id
  - **rG** – Modify the enclosure's reporting group #
  - **Au** – Enable or disable the audible alarm
  - **Er** – Examine the currently active alarm(s)
    - **Er** is not available when there are no currently active alarms



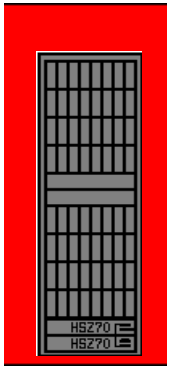
SES EMU Operator Interface

- **Er** – Examine the currently active alarm(s)
  - Push and hold the top button to select the next currently active alarm
    - When the top button's backlight goes out, the last active alarm has been selected
    - Push the bottom button to return to the **Er** display
  - Push the top button to cycle among the digits of the alarm's numbers
  - Represented as **#.#.##.##**



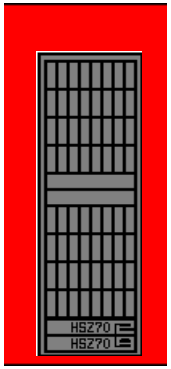
SES EMU Alarm Codes (Example)

- **0.3.02.01 N** Fan speed alert; replace fan soon
  - **0.3.02** indicates fan #2
  - **01** indicates fan alarm #1
  - **N** indicates that the severity is Non-Critical
    - **U** – Unrecoverable (most severe)
    - **C** – Critical
    - **N** – Non-Critical
    - **I** – Informational (least severe)
  - Alarm description; remedy



SES EMU Unusual Displays

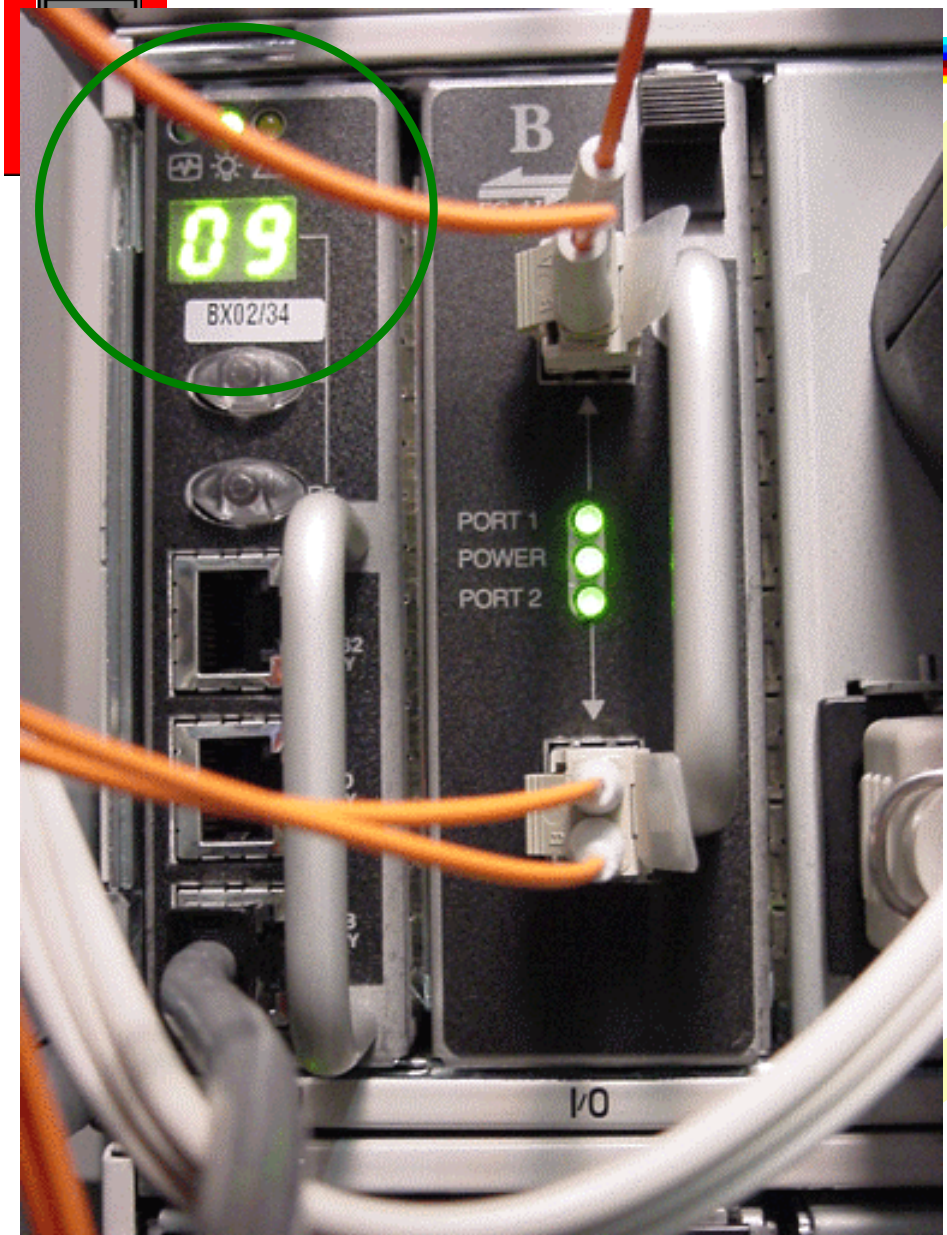
- **Ld** – Code load in progress or incomplete
  - Removing power disables the EMU – RS232 cable required for repair!
- **-A** – EMU firmware application code is missing
  - RS232 cable required for repair!
- **--** – Both push buttons inadvertently held/pushed while inserting the EMU
  - Remove and reseat the EMU without pushing buttons
- **8.8.** – EMU is not completely seated
  - Remove and reseat the EMU



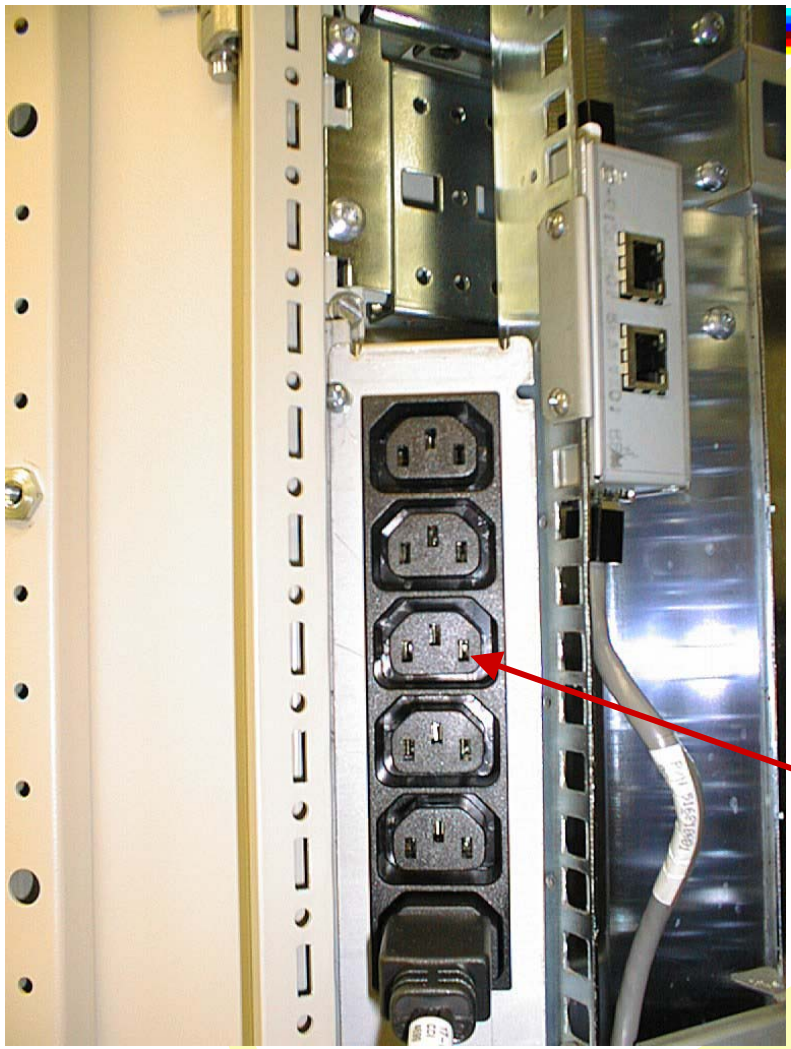
EMU error code

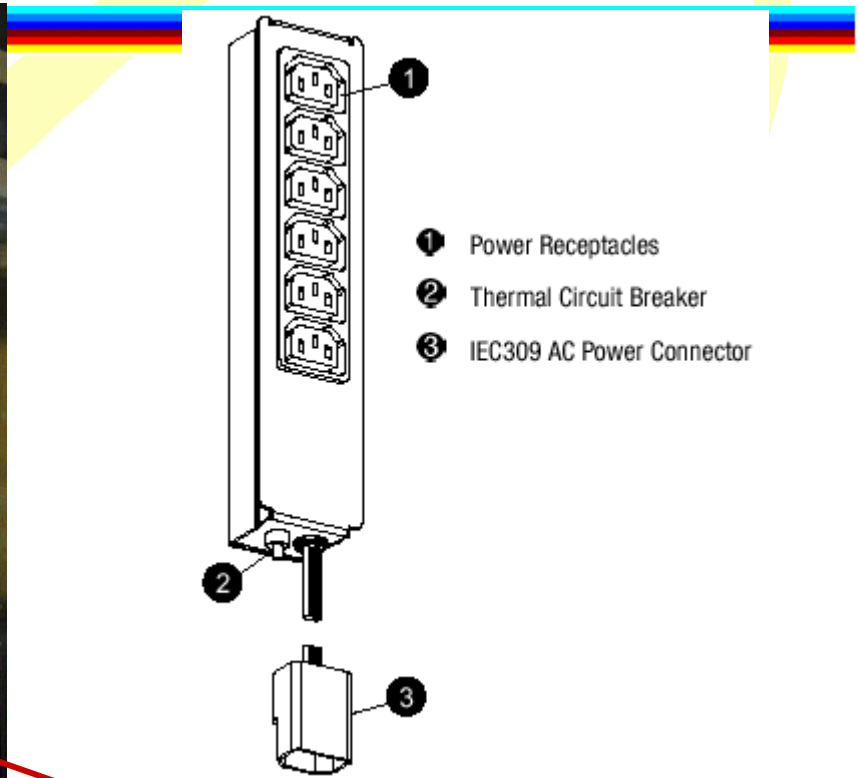
- Current Errors
  - Audible—beeping
  - Code available on EMU display
  - 3 part error code xx-xx-xx
  - May have multiple errors available
- Error log
  - Available through HSV Element Manager event page
  - 62 entries per EMU (enclosure)

EMU error code



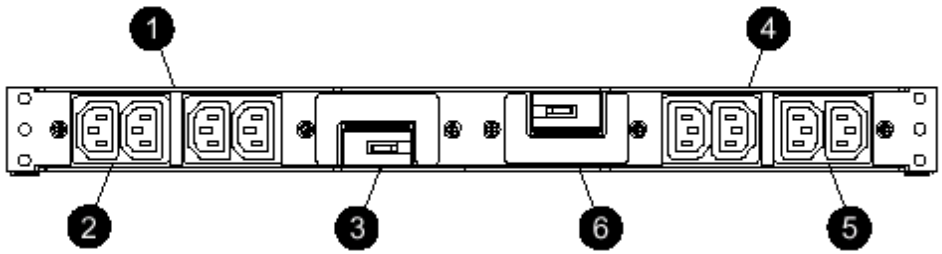
Power Distribution Modules (PDMs)





PDM

Zero-U PDUs

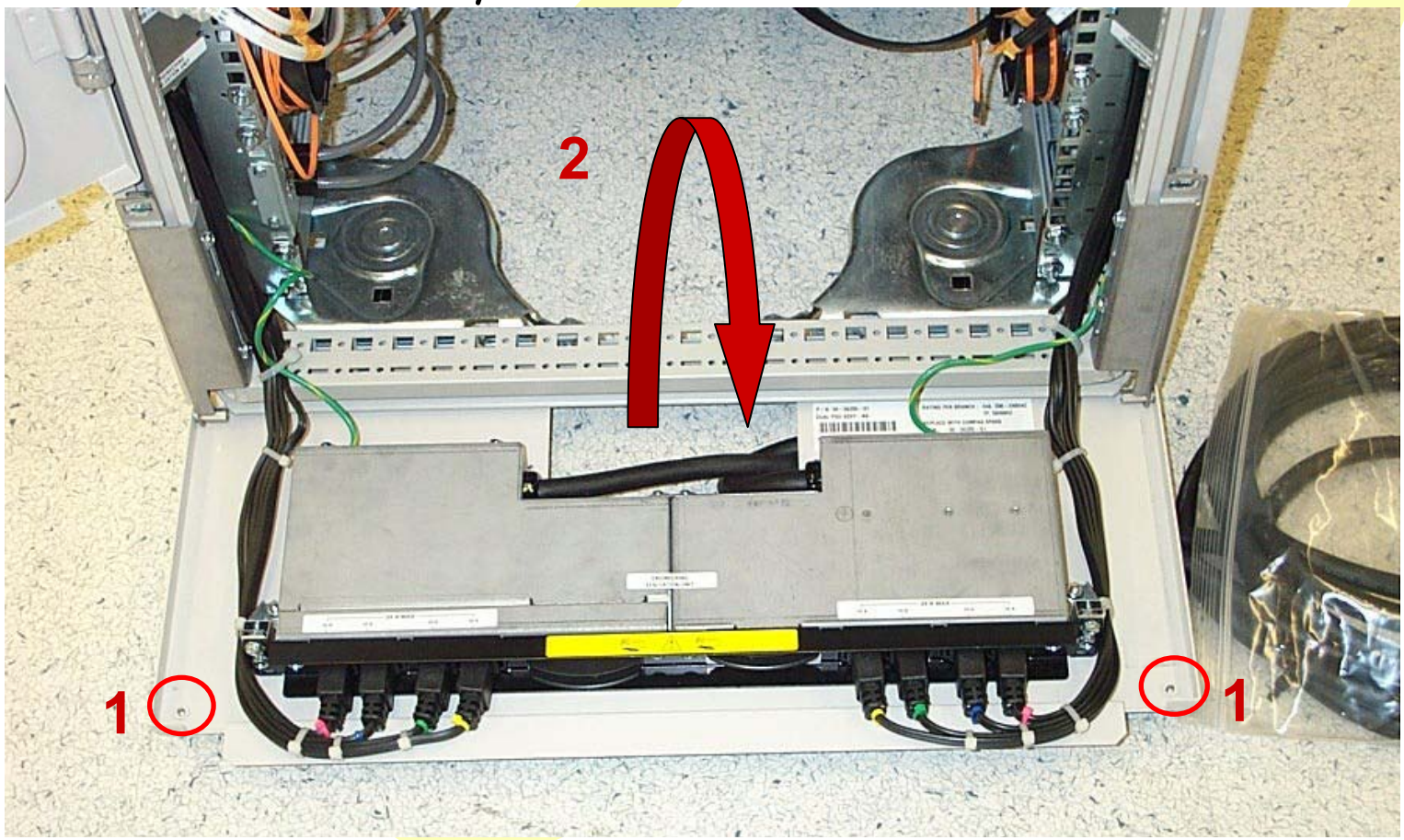


1. PDU 1
2. PDU 1 AC receptacles
3. PDU 1 Circuit Breaker
4. PDU 2
5. PDU 2 AC receptacles
6. PDU 2 Circuit Breaker

- New Zero-U PDU saves valuable cabinet space
- Dual power provides independent and redundant power paths (220-240v, 30amp)

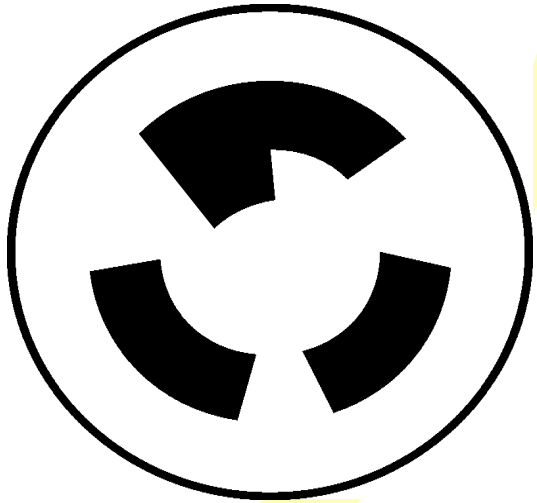
Zero-U PDUs

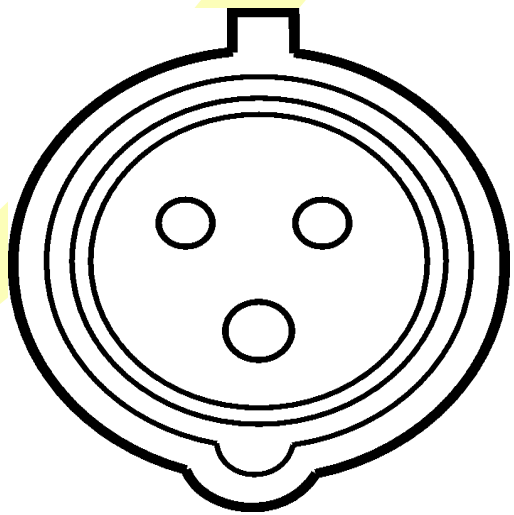
1. Unscrew the spring-loaded screws
2. Fold PDU away from the rack towards the floor

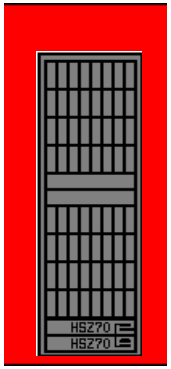


Power Supply and Cooling Requirements

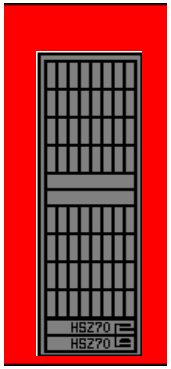
- North America
  - Single phase
  - NEMA L6-30R receptacle
  - 3 wire
  - 208V to 240V 60Hz 30A
- Europe
  - Single phase
  - 2 pole IEC 309
  - 3 wire
  - 220V to 240V 50Hz 32A
- Heat Dissipation
  - 12,708 BTUs per hour





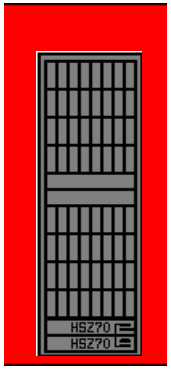


Feature Comparison to HSG80



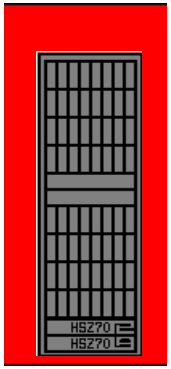
Enterprise Systems Overview: Feature Comparison with HSG80

- HSV110
  - FC-SW protocol
  - 2 Host ports per controller
  - Max. Hosts: 1024 connections
  - Minimum: 2 controllers (always redundant)
  - Multibus failover (host assisted)
  - 2GB Mirrored Write-Back Cache (MWBC), read ahead, adaptive read
- HSG80
  - FC-SW and FC-AL protocol
  - 2 Host ports per controller
  - Max. Hosts: 96 (connections)
  - Minimum: 1 controller (2 for redundancy)
  - Transparent and multibus failover (host assisted)
  - 1GB MWBC, read ahead



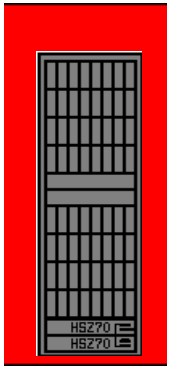
Enterprise Systems Overview: Feature Comparison with HSG80

- HSV110
  - 512 Virtual Disks
  - 240 FC-AL 2Gb/s drives
  - Management: SWMA
  - Distributed sparing
  - Snapshots:
    - 7 per Virtual Disk
    - Each counts as 1 Virtual Disk
    - Fully allocated and on demand
- HSG80
  - 128 LUNs
  - 84 UltraSCSI drives
  - Management: Serial connection, SWCC or SWMA
  - Dedicated spare drives
  - Snapshots:
    - 1 per Unit
    - 4 per Controller pair
    - Fully Allocated only

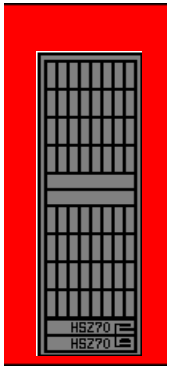


Enterprise Systems Overview: Feature Comparison with HSG80

- HSV110
  - Customer data resides on Virtual Disks, which are part of a pool of disks (Disk Group)
  - Dynamic on-line virtual disk expansion
  - SCSI-3 mode only
- HSG80
  - Customer data resides on storagesets that can be physically located in the cabinet
  - Concatenate RAIDsets (only one time per RAIDset)
  - SCSI-2 and SCSI-3 mode

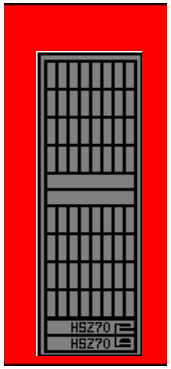


eva Software Overview



Sizing HSV Disk Groups

- Hardware versus software capacities
  - Physical 1000 000 000Bytes = 1GB
  - Software 1073 741 824Bytes = 1.07GB Physical (2^{30})
  - ~ 7% Variance → 1GB Physical = 0.93GB Software
- System metadata overhead — 0.2%
  - System metadata
  - MLD—HSV Element Manager metadata
  - Virtual Disk metadata
- Vraid overhead
  - Vraid0 — 0% (1 block for every 1 block usable)
  - Vraid1 — 50% (2 blocks for every 1 block usable)
  - Vraid5 — 20% (1.25 blocks for every 1 block usable)
- Snapshot working space
  - Snap — depends on rate of change of original data
  - Snapclone — same physical capacity as virtual disk
- Spare capacity
  - 2 X physical capacity of the largest physical disk X protection selected

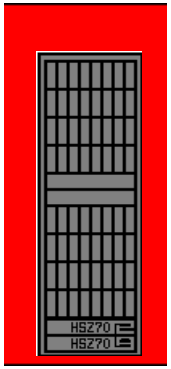


Virtualization Controller Software (VCS)

- Software (Firmware) for the HSVx0 controllers
- Virtualization is integrated throughout VCS:
  - Provides improved performance by spreading data volumes (LUNs or Virtual Disks) across many more disk drives or spindles
  - Load leveling of data across a LUN / Virtual Disk is automatic and helps eliminate "hot spots" which could otherwise become performance bottlenecks
  - Dynamic expansion
    - LUNs / Virtual Disks can be expanded on the fly for OSs that support it
    - Disks can be added to disk pools on the fly
  - Distributed sparing
    - Allows allocation of space per disk group to recover from physical disk failures

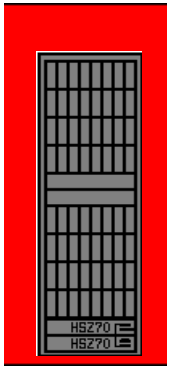
VCS Versions

- V2.xxx
  - Current version for both eva3000 and eva5000
  - Snapshot and Snapclone support
- V3
  - Current version for eva5000
  - Remote replication support



Virtualization Controller Software

- Data Protection techniques (optional purchase)
  - Two Versions of Snapshot:
    - Virtually Capacity Free (**On-Demand**) — Which can save customers a lot of disk space and money
    - Traditional (**Fully Allocated**) — Reserves exact space size as original LUN / Virtual disk
  - Virtually Instantaneous Snapclone:
    - Starts as a snapshot and becomes over time a clone
    - Gives access to the clone immediately without waiting for the clone copy "completion"
    - Can save customers time and money

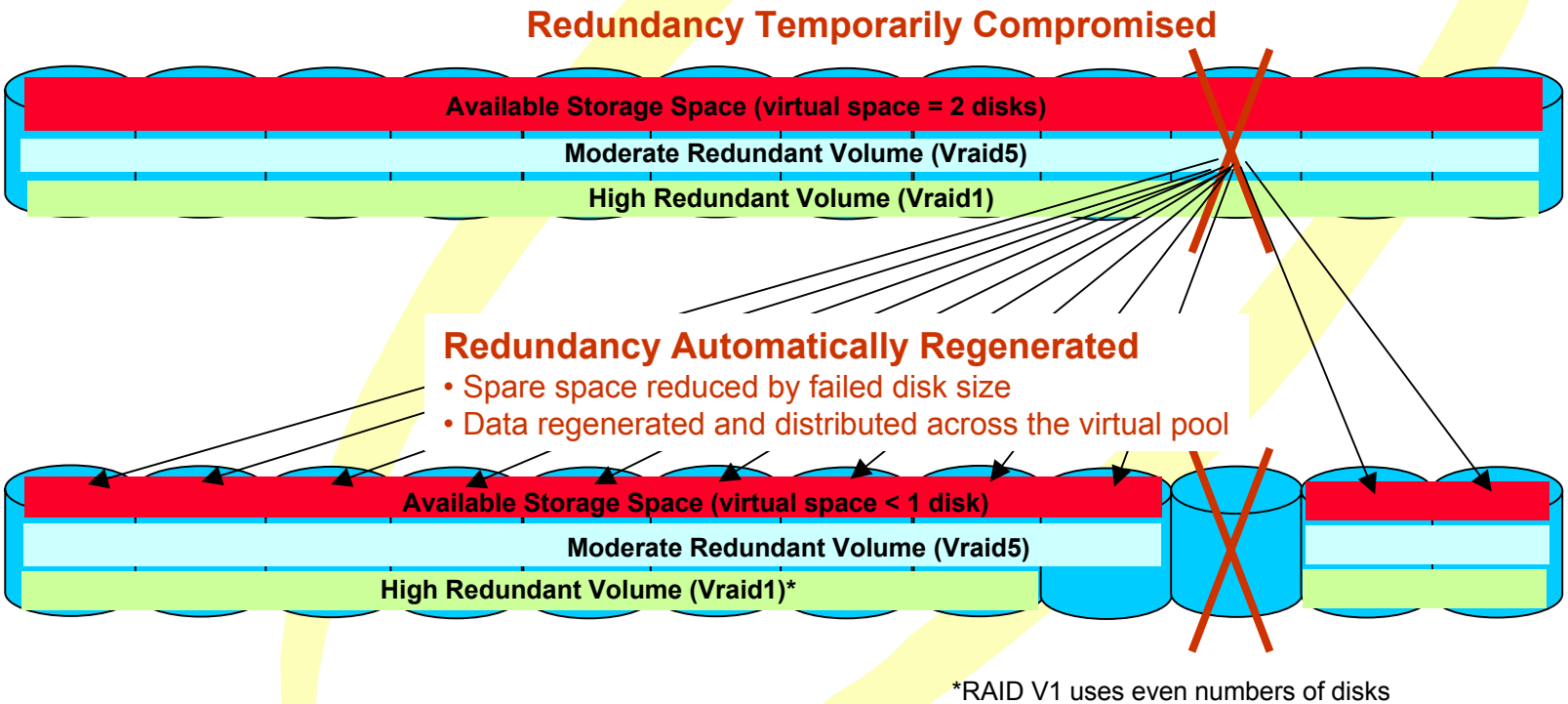


snapshot versus snapclone

	Description	Pro's	Con's
Snapshot Space efficient	Pointer based Copy before Write Allocate space on demand	Space efficient (allocated on demand)	Overcommit problem
Snapshot Space guaranteed	Pointer based Copy before Write PreAllocate space on creation	No Overcommit problem	Space inefficient (allocated right away)
Snapclone	Same as Snapshot space guaranteed, but now with background process to separate VD.	No Overcommit problem Repeatable, separate VD's	Space inefficient Consumes some background process time

virtual storage pools (virtual spare)

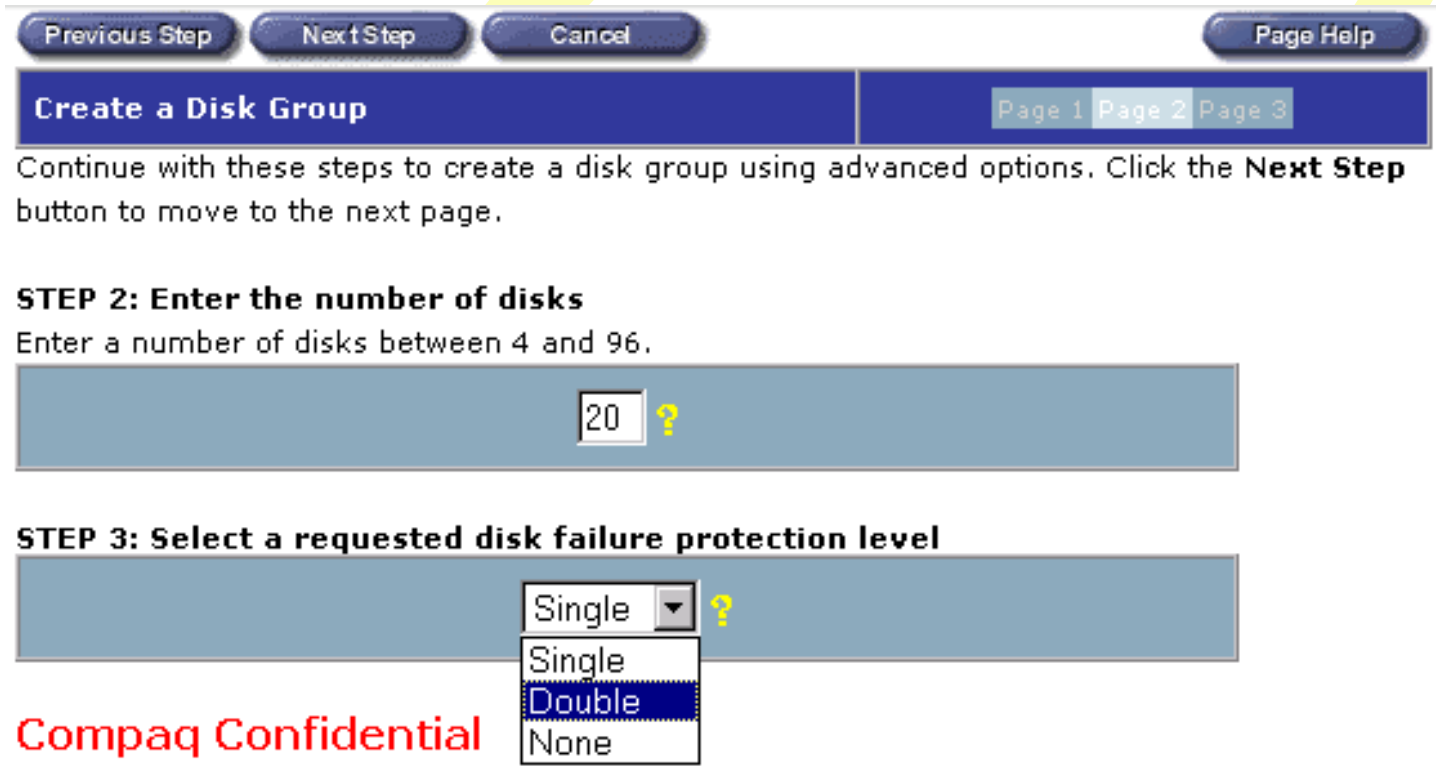
- Virtual Disk blocks automatically regenerated to restore redundancy

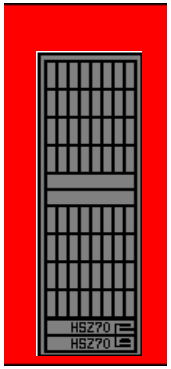


*RAID V1 uses even numbers of disks

distributed sparing

- Allocated space per Disk Group to recover from physical disk failure(s) in that Disk Group
- Choices—None, Single, Double





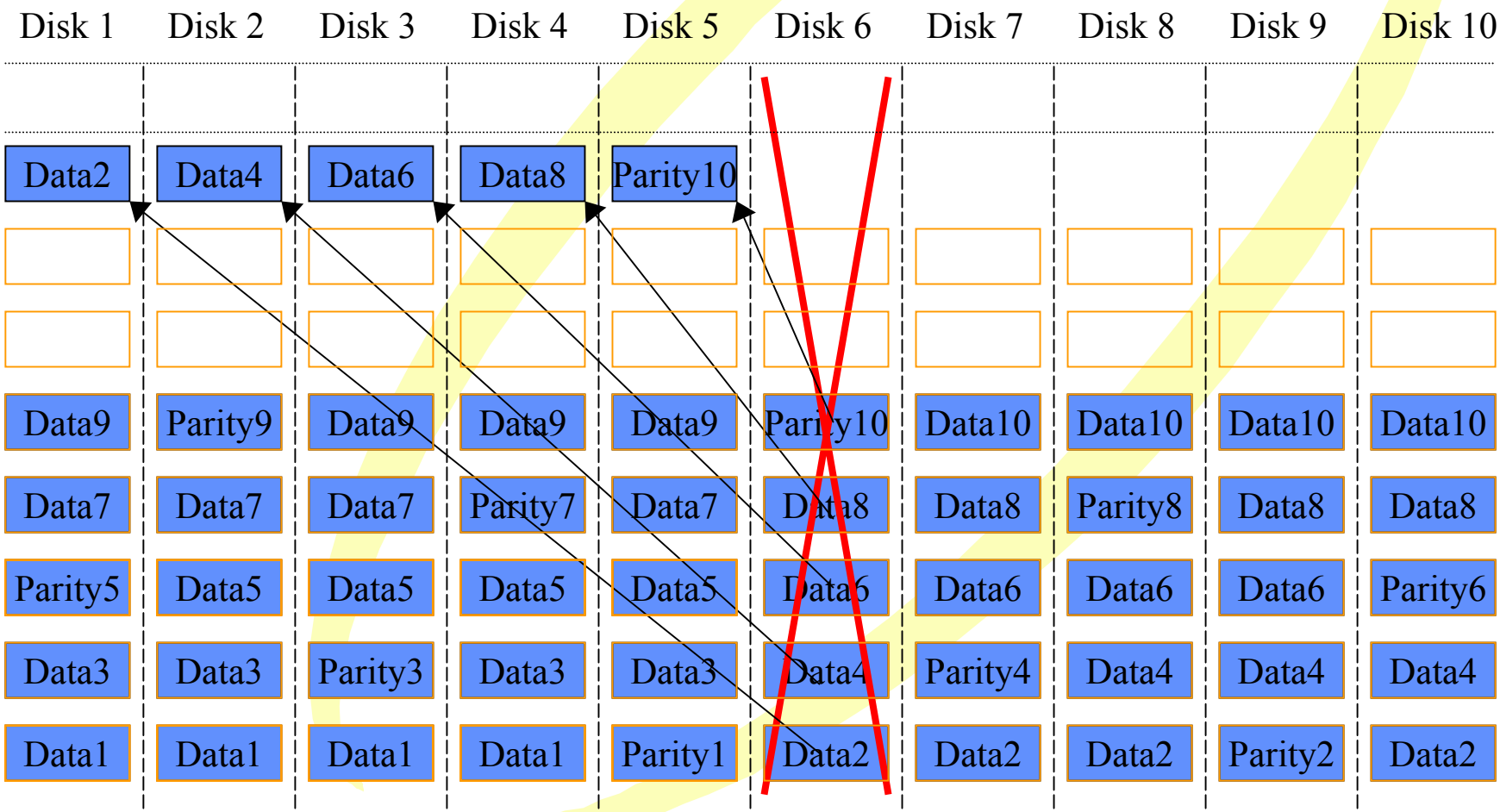
distributed sparing

- No longer spare in separate spindles
- Chunks allocated, but not dedicated as spares, on all disk drives of disk group to survive 1 or 2 disk drive failures.
- Allocation algorithm
  - Single (1) = capacity of 2 * largest spindle in disk group
  - Double (2) = capacity of 4 * largest spindle in disk group

Distributed Sparing

HSV110 Virtualization :

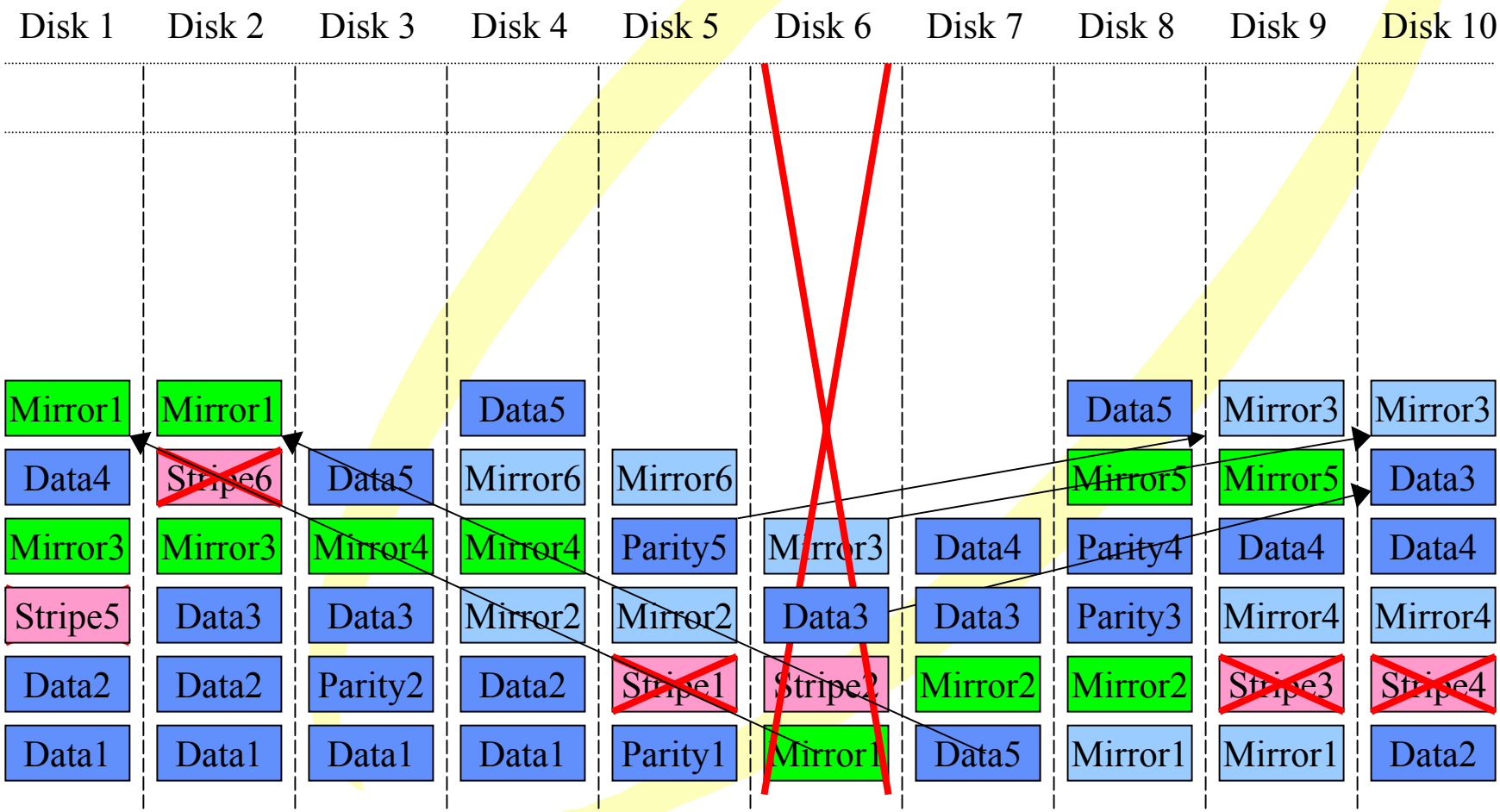
The Easy to Understand scenario

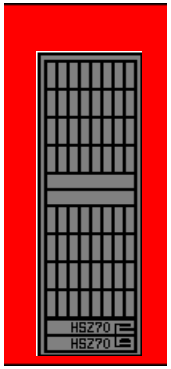


distributed sparing

HSV110 Virtualization :

The Closer to Reality scenario



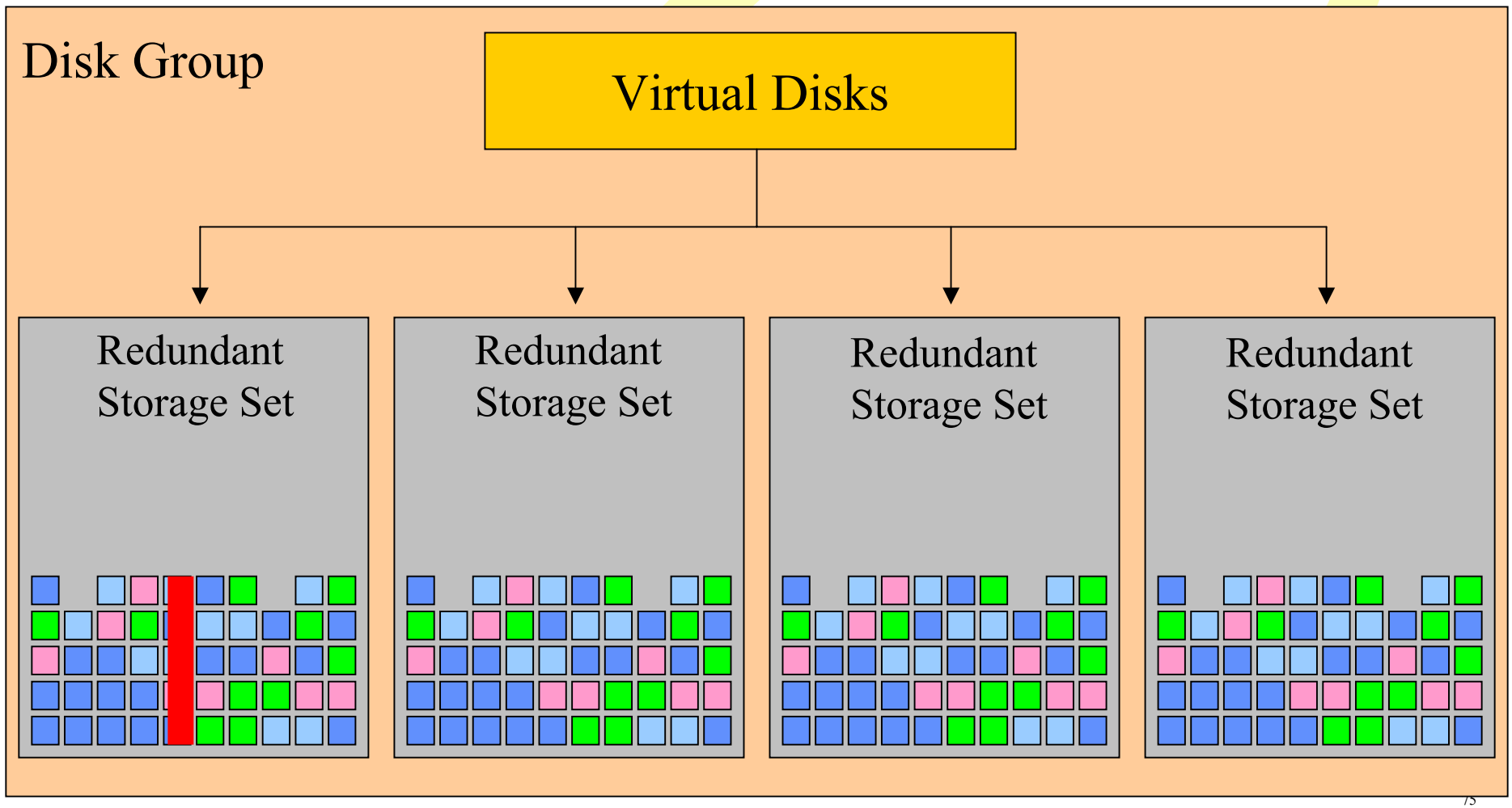


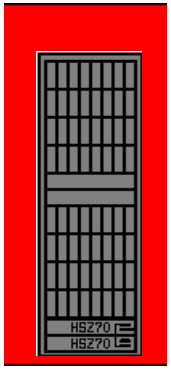
Redundant Storage Sets (RSS)

- Reduces chance of data loss in large (> 12 physical disks) disk groups
- Not visible to user through Interface
- Complete managed by the HSV controllers
- Typical size for disk group: 8 - 12 physical disks
- If RSS equals 12 physical disks, it splits into 2 RSS of 6 disks each
- Failed disk drive recovery restricted to affected RSS only
  - Reduces access to number of disks, more efficient

- Example: Disk Group with 28 disks
  - # of disks – 6, repeat until the remainder is 12 or less
    - 28-6=22, 22-6=16, 16-6=10 stop
    - RSS configured as 6+6+6+10

HSV110 Virtualization : Redundant Storage Sets



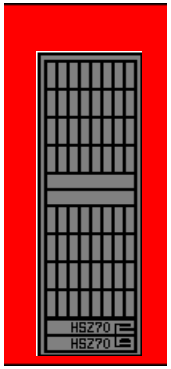


Food for Thought

- A virtual disk is a disk drive that is imaginary, but operational. It isn't really there but it works just fine
- And then there is a snapshot which is a non-existent, but operational copy of an imaginary (but operational) disk drive
- And then there is the console LUN, which is a pretend virtual disk — an imaginary disk drive that isn't operational but acts as if it might be

eva family - supported operating systems

	eva3000	eva5000
HP-UX	✓	✓
Tru64	✓	✓
Windows NT / 2000	✓	✓
Solaris	✓	✓
AIX	✓	✓
Open VMS	✓	✓
Linux (Intel)	✓	✓
Netware	✓	✓
Windows 2003 (.NET)	✓	✓



eva OS platforms

- HP/UX
  - MC Service Guard
  - v11.0 and v11.i (wo/EVM)
  - native HP 1 Gb/s HBAs (PCI & K-class)
  - native HP 2 Gb/s HBA (PCI)
  - secure path v3.0B
- IBM AIX
  - HACMP certification
  - v4.3.3 and v5.1 (wo/EVM)
  - Cambex 1 Gb/s HBA
  - Secure Path v2.0C
- SUN Solaris 2.6 (in addition to v7 & v8)
  - VERITAS Clustering v1.3
  - SUN Cluster v2.2
  - PCI & S-Bus HBAs only
  - secure path v3.0B
- Microsoft Windows 2000 & NT
  - secure path v4.0b

eva OS platforms (continued)

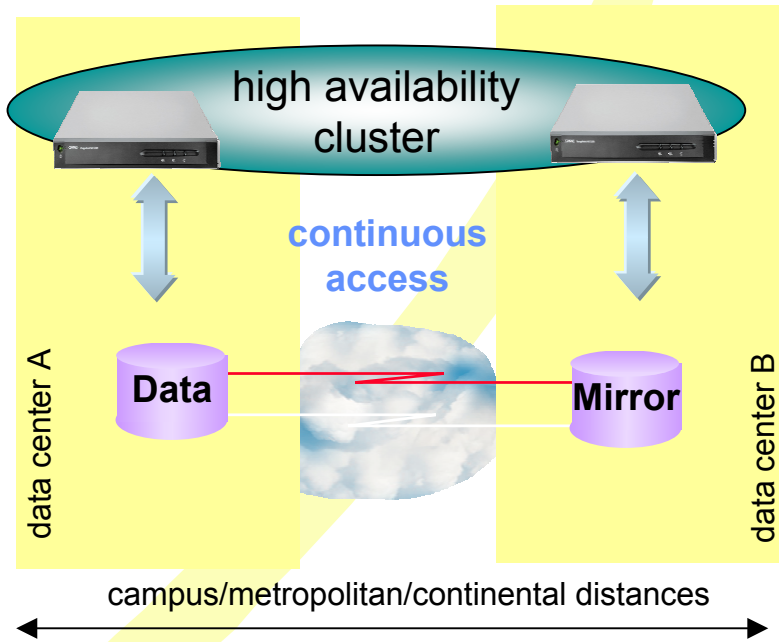
- Novell NetWare
  - 5.1
  - 6.0

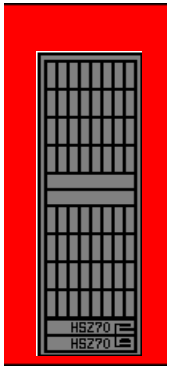
Novell.

- Linux - x86 only
  - Red Hat 7.2
  - Advanced Server 2.1
  - SLES 7

HP StorageWorks continuous access EVA

- Performs remote mirroring and disaster recovery
- Enterprise-class availability solution
- Up to the last I/O data integrity
- Fast consistent application recovery

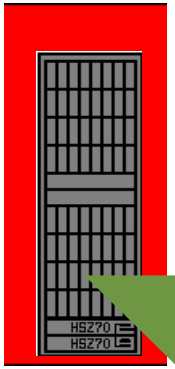




continuous access highlights

- Management solution automates mirroring functions
- Web based GUI
- Remote access
- Log reports
- Failover/fail back operations
- Engineered with robust, proven resilient technology
- Included with VCS V3, enabled via license key

Roadmap - continuous access EVA



release 1 May 2003

- initial release
- synchronous
- 64 copysets
- bi-directional
- peer-to-peer
- CA user interface
- snap/snapclone
- DT managed services

release 2 * spring 2004

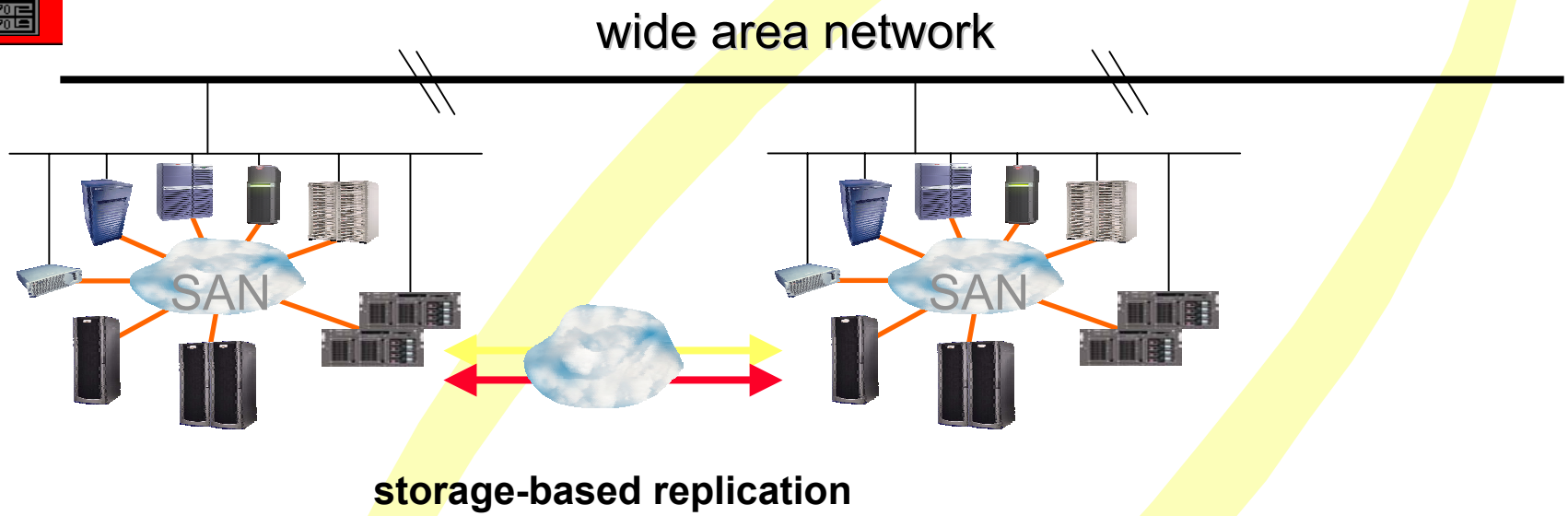
- asynchronous
- increased copysets
- multi relationships
- CA / BC combined GUI
- MC/Serviceguard, continental clustering solutions
- cluster extension by O/S solutions

release 3 * fall 2004

- increased copysets
- multiple sites - native XP & EVA fan-out, fan-in or cascade

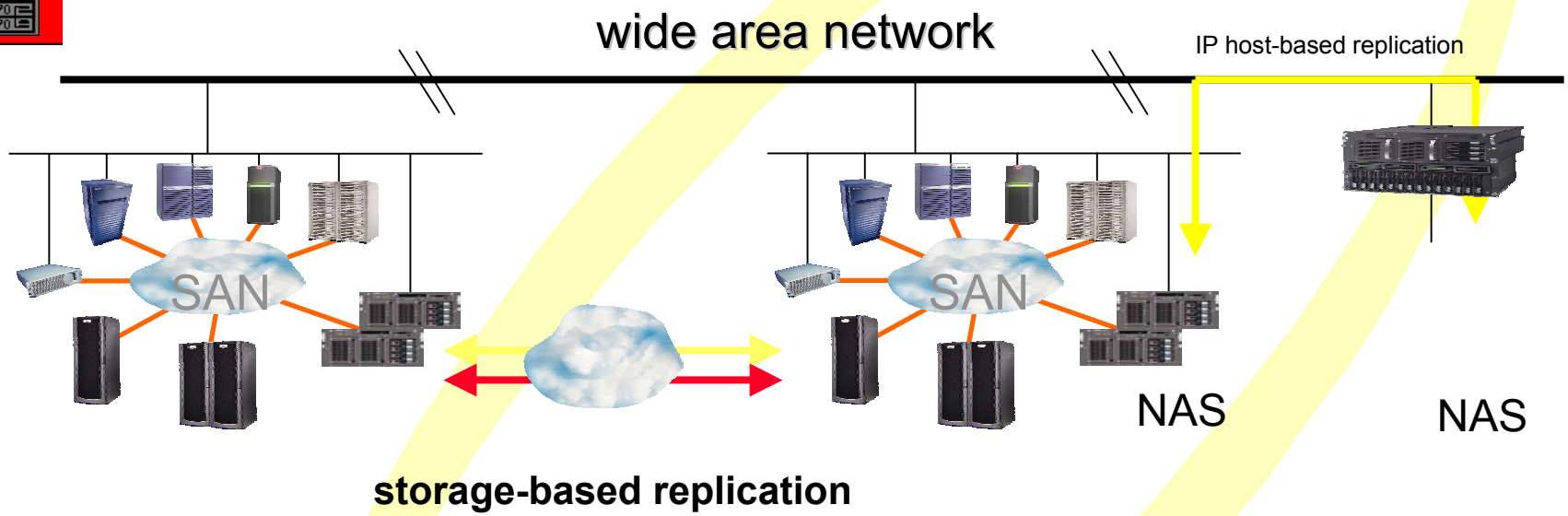
* releases 2, and 3 in planning

Data center – Data center implementation example



StorageWorks continuous access
data center – data center

Data center – Data center – Branch office implementation example



StorageWorks continuous access data center – data center

StorageWorks NAS data copy regional office - data center

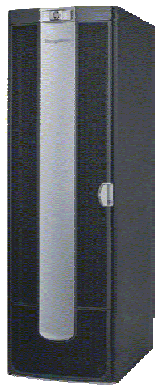
HP Array Portfolio

msa1000

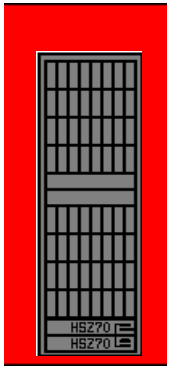
va7110
va7410

eva3000

eva5000



xp128
xp1024



Fibre Channel
SCSI

Six 5214 Device Shelves (with redundant power supplies) contain 50 x 72.8GB 10K RPM dual ported hot-swappable fibre drives. 3 TB usable with two hot spares.

All Components mounted in 9142 Rack with 4 110V PDUs

HSV110 Controller Shelf with dual HSV110 RAID controllers running VCS v 1.0 Base Software and VCS v 1.0 snapshot software.

SANworks Management Appliance for EVA

LVD MDR II

HP ESL9198SL Tape Library with 8 SDLT Drives

16 Port SANswitch w redundant power suppy

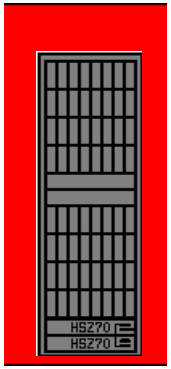
NAS Executor E7000 Model N902

NAS Executor E7000 Model N902

Veritas Netbackup Server

Application Servers

Customer x



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