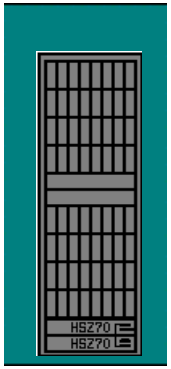
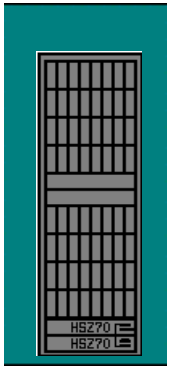
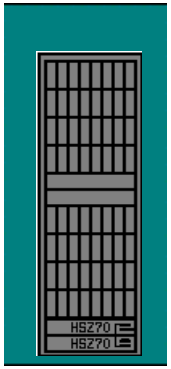


Overview of the HSG80 StorageWorks Fibre Channel RAID Controller



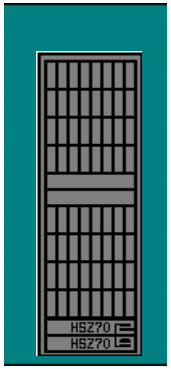
HSG80 Controller Topics

- Features
- Architecture
- Caching Techniques
- ACS Operating System Software
- Subsystem Components
- Options



StorageWorks RA/ESA MA/EMA Features

- Modular components
- No single point of failure (redundant system level architecture plus storage software)
- Redundant, Hot-swappable components
- 512MB Battery-Backed-up cache per controller
- Up to 84 drive configuration scalability
- Support for Tru64 Unix, OpenVMS, Windows NT, NetWare, IBM AIX, Sun Solaris, HP-UX, SGI IRIX, Linux
- Optical Fibre Channel Interface (FC-AL or switched fabric)
- Controller based Snapshot and Clone
- Controller based Selective Storage Presentation
- Data Replication Manager for NT, OpenVMS, Tru64 and Sun Solaris
- Array Controller Software (ACS)

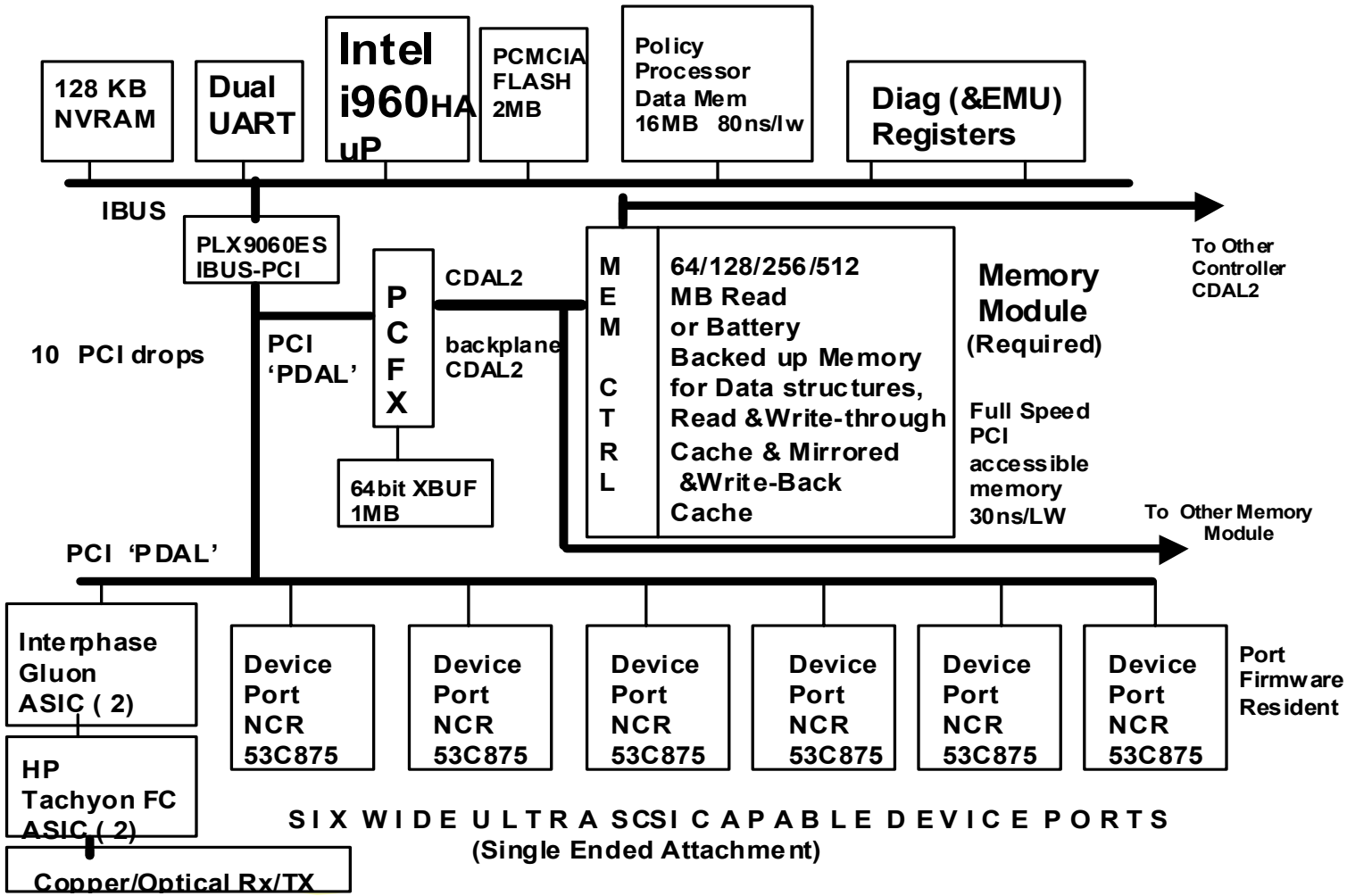


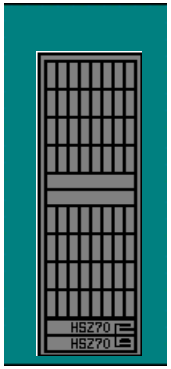
StorageWorks ACS Functions

- Host Interconnect and Protocol Services
- Cluster Support
- Support for 84 drives per storage system
- Dual Redundant Controller Operation
- Testing and Diagnosis of the HSG80 array controller
- SCSI device control
- Transparent Controller Failover support
- Multiple Bus Failover support
- Asynchronous Disk Swap (Hot Swap)
- ACS system management services
- Local program support
- Mirrored Write-Back Cache support
- Read-ahead Cache support
- Disk Mirroring capability (RAID 1)
- Disk Striping capability (RAID 0)
- RAID capability (RAID3/5)
- Storageset Expansion
- Disk Partition capability

HSG80 Architecture

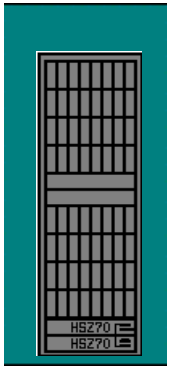
FibreChannel HSG80 Controller Architecture





HSG80 Architecture (cont.)

- Policy Processor
  - Coordinates, controls, and executes the controller software
    - ACS (HSG80 Array Controller Software)
  - Uses Intel i960 microprocessor
  - 16MB Data Memory
- Program Card
  - 2MB for ACS
- Nonvolatile Memory
  - 128KB to store
    - Controller configuration (SCSI targets, preferred ID's
    - Subsystem configuration (names and locations of disk drives)
    - Last failure entries

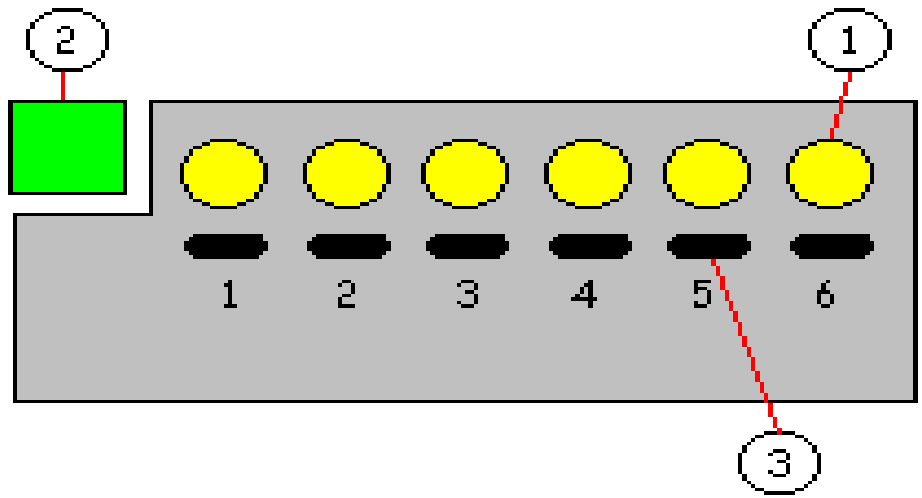


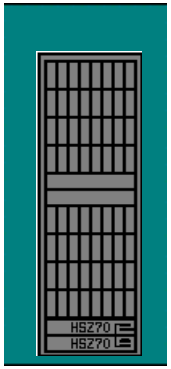
HSG80 Architecture (cont.)

- Dual UART
  - Supports serial communication between controllers
- Timer
  - Controlled by and interrupts the i960
- Diagnostic Registers
  - 2 write and 2 read registers
  - Used by diagnostics to control devices and the controller

HSG80 Architecture (cont.)

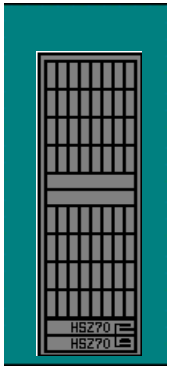
- Operator Control Panel (OCP)
  - Contains 6 device port LEDs (1)
  - Contains a "RESET" button (2)
  - Contains 6 port quiesce buttons (3)
    - to quiesce a port - push its port button until LED is lit continuously
    - push the button again to resume I/O activity





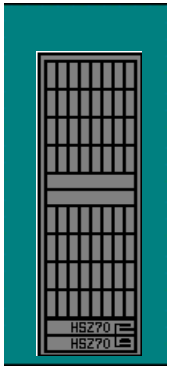
HSG80 Architecture (cont.)

- Busses
  - IBUS
    - Transfers code and text from the program card, code and data from the policy processor's I/D cache, and configuration information to the controller's nonvolatile memory
  - CDAL
    - Transfers data to the surviving controller during failover
  - MDAL
    - Conveys data to and from addresses in the local buffer memory
  - NBUS
    - Transfers data to and from addresses in any of the NBUS components: host ports, device ports, value added functions chip
  - Bus Exchanger
    - Facilitates high speed communication between the local memory and devices on the IBUS, CDAL, MDAL, and NBUS
    - Is a 4-way crossover switch



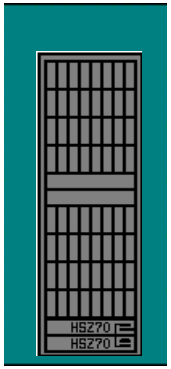
HSG80 Architecture (cont.)

- Local Memory
  - During controller initialization the policy processor loads and stores the PCMCIA software into local memory
  - Consists of dynamic RAM controller, arbitration engine, a gate array controller, and 16MB of dynamic RAM
- Value Added Functions Chip
  - Generates parity for the RAIDsets when data is written to them
  - Also regenerates parity to recover stored data in the event that a member of a RAIDset fails
  - Performs XOR parity



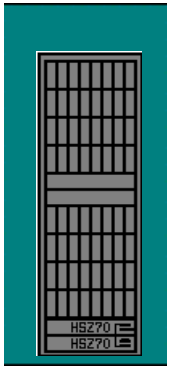
HSG80 Architecture (cont.)

- Host Port
  - 2 Fibre Channel host ports per HSG80 controller
  - Connection to hub or switch via single mode GLM
  - FC-AL or Switched (but not both at same time)
- Device Ports
  - The controller communicates with the devices and modules in the subsystem through 3 backplane connectors
  - Each connector contains 2 ports to give the controller access to 6 Wide Ultra SCSI-2 busses.
  - Each device port contains a Wide Ultra SCSI processor



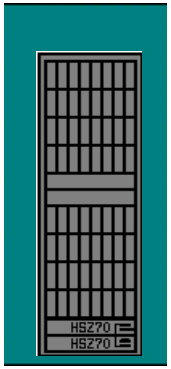
HSG80 Caching Techniques

- Read Caching
  - Used to decrease the subsystem's response time for a read request
  - When the controller receives a read request from the host, it reads the data from the disk drives and delivers it to the host, and also stores it in cache memory
  - By default, enabled for all storage units
- Write-Through Caching
  - Used to decrease the subsystem's response time to a read request
  - Called "Write-Through" because data passes through - and is stored in - the cache memory on its way to the target disk drives
  - If read caching is enabled for a storage unit, write-through caching is also enabled



HSG80 Caching Techniques (cont.)

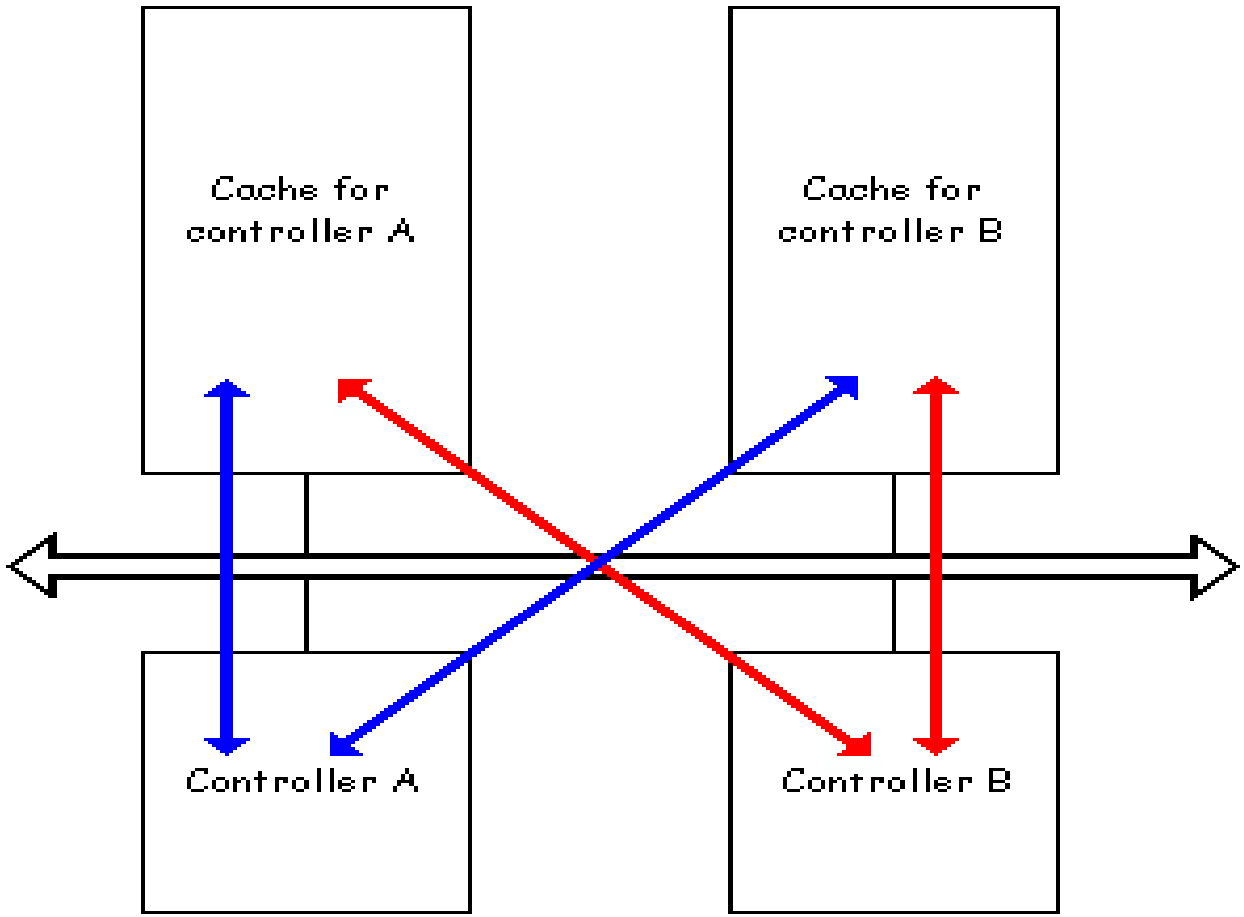
- Write-Back Caching
  - Used to decrease the subsystem's response time for write requests
    - Allows controller to declare write "complete" as soon as the data reaches its cache memory
    - Data is written to the disks later
  - Disabled by default for all storage units
- Fault Tolerance for Write-Back Cache
  - The cache module supports the non-volatile memory, mirrored caching, and dynamic caching policies to protect the availability of its unwritten (write-back) data
  - The controller cannot provide write-back caching to a unit unless its cache memory is non-volatile
    - By default the controller expects to use the ECB (External Cache Battery) as its cache module backup power source



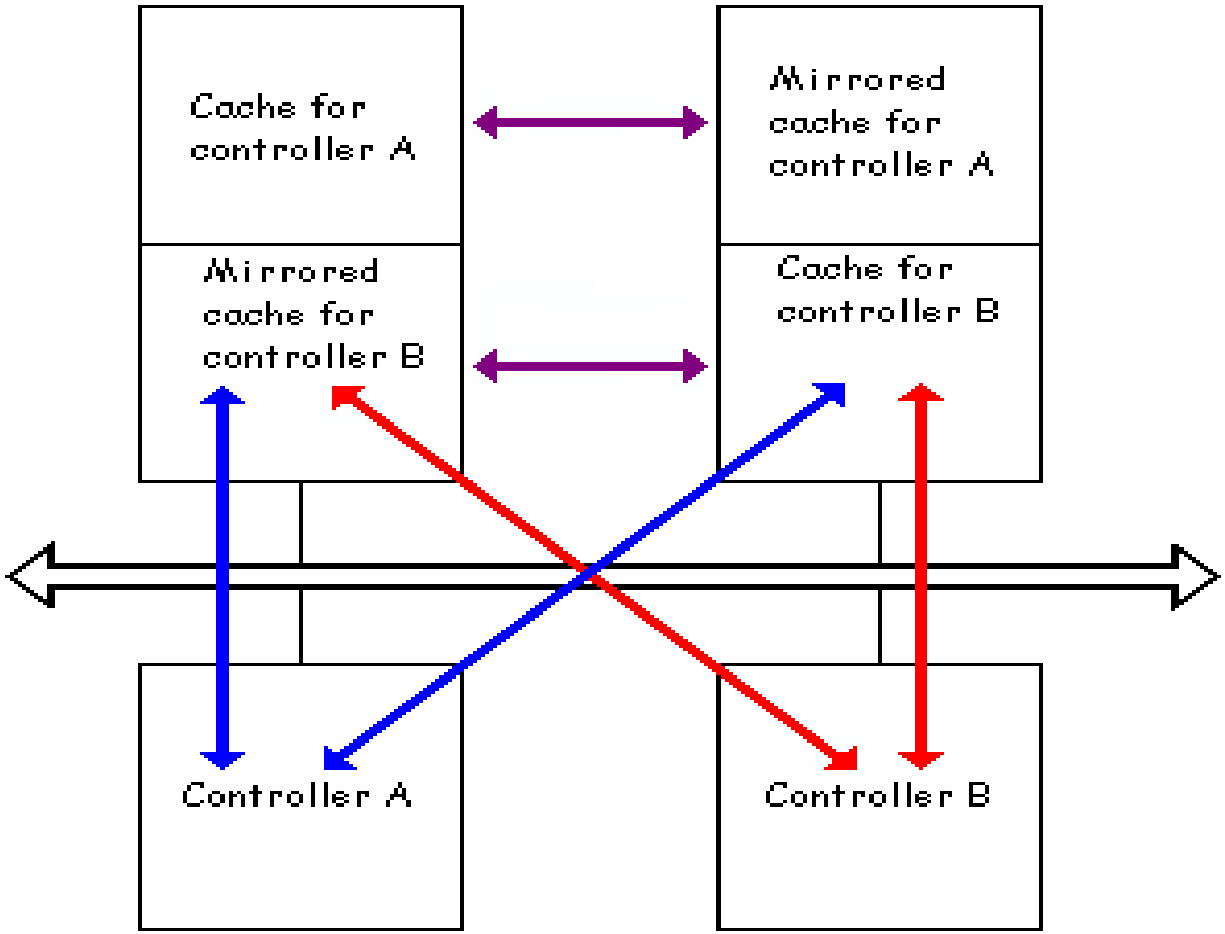
HSG80 Caching Techniques (cont.)

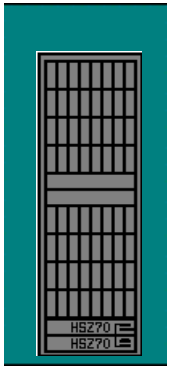
- Read-ahead Caching
  - Enables controller to keep track of read I/Os
  - If controller detects sequential read I/Os from host, it will try to keep "ahead" of the host by reading the next sequential blocks of data (the host has not requested) and put them in cache
  - controller can detect multiple sequential I/O requests across multiple units

HSG80 Caching Techniques (normal)



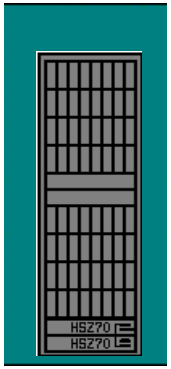
HSG80 Caching Techniques (mirrored)





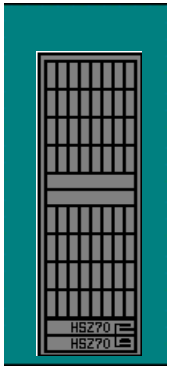
HSG80 Caching Techniques (cont.)

- Cache Policies Resulting from Cache Module Failures
  - Way too much detail for this slide
  - See HSG80 Maintenance Manual for details
- Cache Policies for ECB Failures
  - Too much detail for slide
  - See HSG80 Maintenance Manual for details



HSG80 External Cache Batteries

- ECB diagnostics are run on every controller restart
  - If batteries are fully charged, the controller reports them as "good" and rechecks them every 24 hours
  - If the batteries are charging, the controller checks them every 4 minutes
  - batteries are reported as being either above or below 50 percent in capacity
  - batteries below 50 percent in capacity are referred as being "low"
  - The four minute polling continues for up to 10 hours
    - the maximum time it should take to recharge the batteries
  - If the batteries have not been charged sufficiently after 10 hours, the controller declares them to be failed

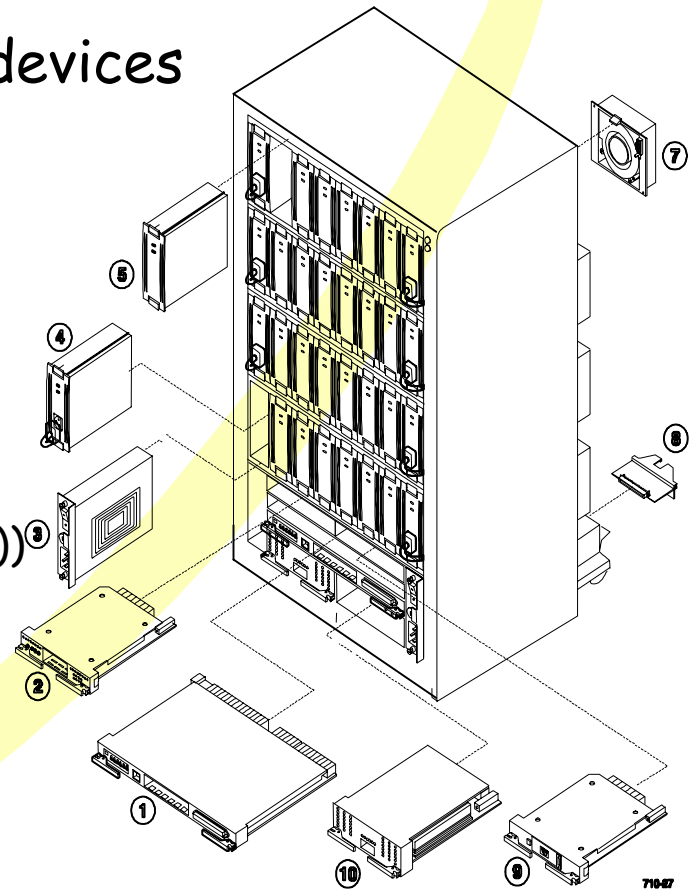


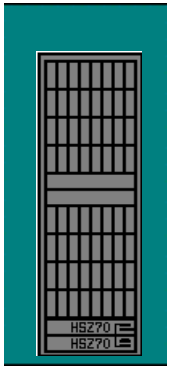
ACS Operating System Software

- Array Controller Software for HSG80 controller
  - Current version - V8.7
  - See SPD in "Supplemental Handouts"
  - All versions support Clone and Selective Storage Presentations (SSP)
  - V8.7G
    - FC-AL only
  - V8.7F
    - Switched or FC-AL
  - V8.7S
    - Switched only, snapshot support
  - V8.7P
    - Data Replication Manager, switched only, snapshot
  - V8.7L
    - HSG60 only, Switched or FC-AL

RA/ESA Subsystem Components

- DS-BA370-AA enclosure
- Supports up to 24 - UltraSCSI devices
  - 6 Ultra Wide SCSI channels
- Packaging
  - HSx controller (1)
  - Environmental monitoring unit (2)
  - AC power distribution (3)
  - 180-watt power supply (4)
    - N+1 or 2N power
  - ECB (external cache battery (not shown))
  - Storage building block (SBB) (5)
  - Cooling fans (7)
  - I/O module (8)
  - Power Verification and Addressing (9)
  - Cache module (10)



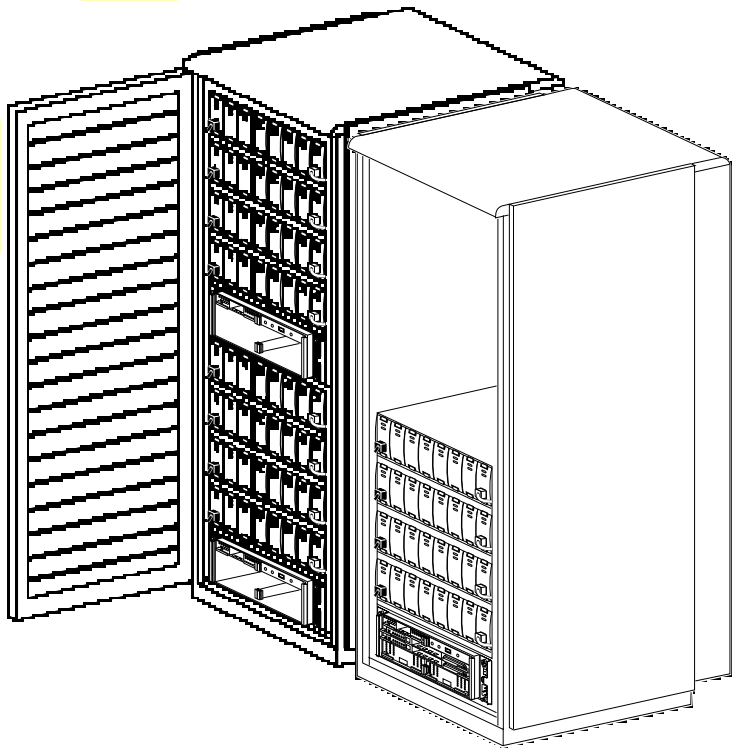


RA/ESA Options

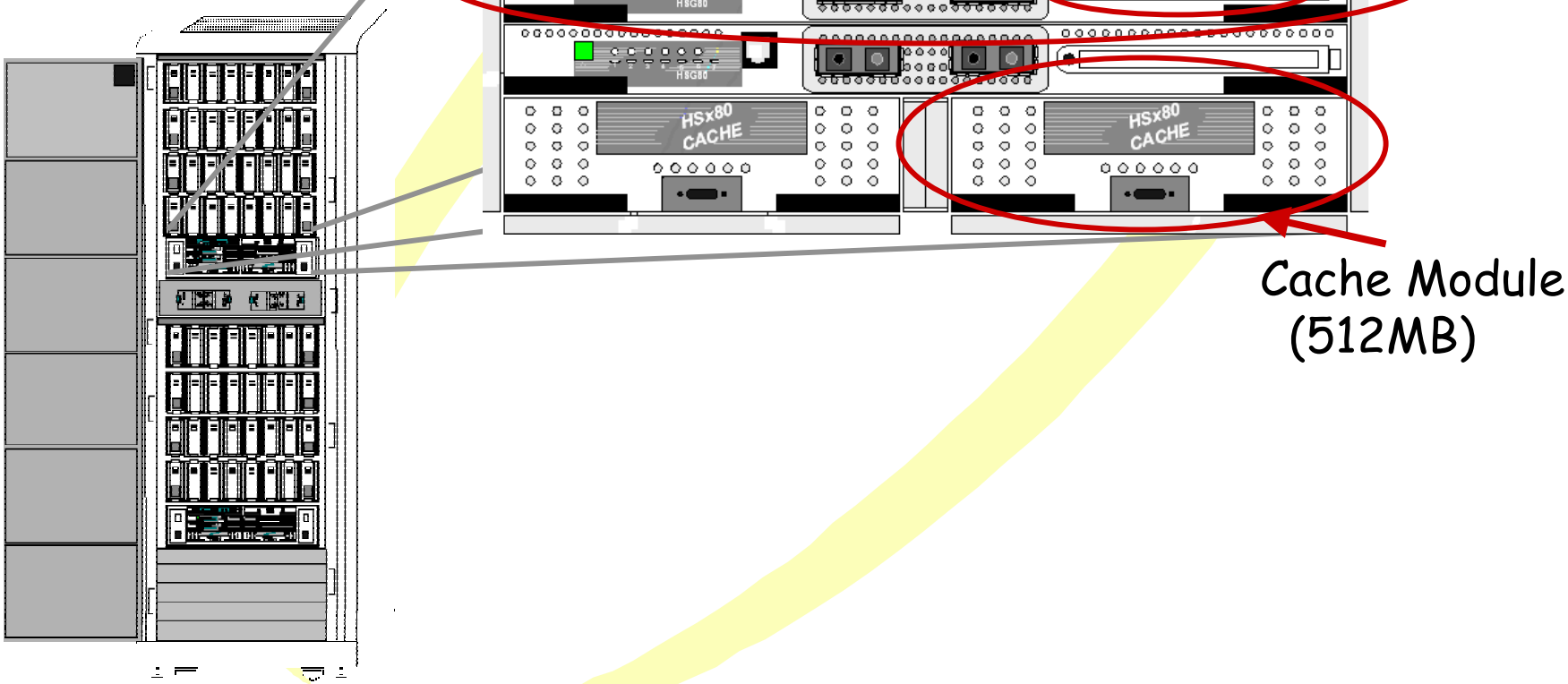
- Dual redundant controllers
- Dual redundant cache
  - up to 512MB/controller HSx80
- N+1 power
  - Requires an additional AC power distribution
  - Requires 3 additional 180-watt power supplies
  - May require additional AC power controller (depending on cabinet)
- 2x external cache batteries

ESA Options

- Up to 2 additional BA370s can be daisy-chained behind a controller (or dual-redundant pair)
- This configuration supports up to 72 SBBs

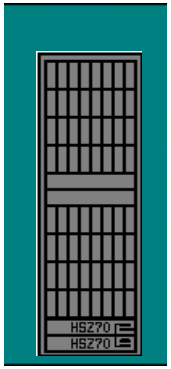


ESA12000 Elements



Modula

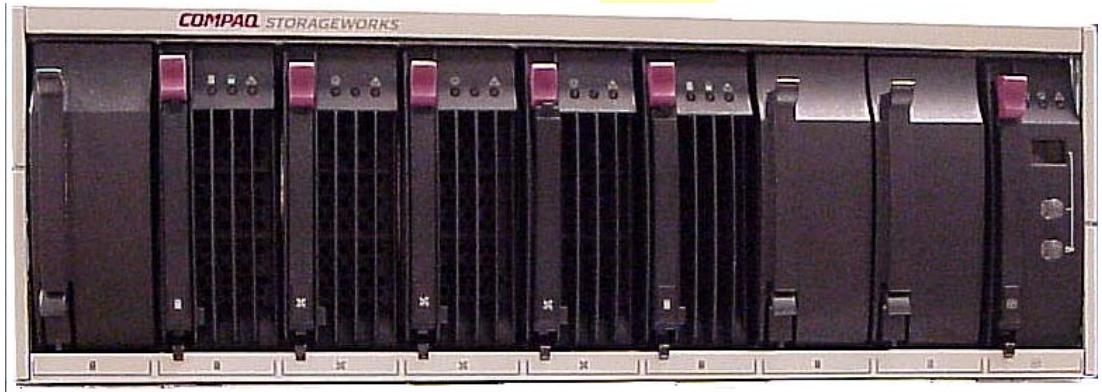
- Last architecture for MA/EMA product set
- Uses new "Universal" drives
- Common package for all platforms



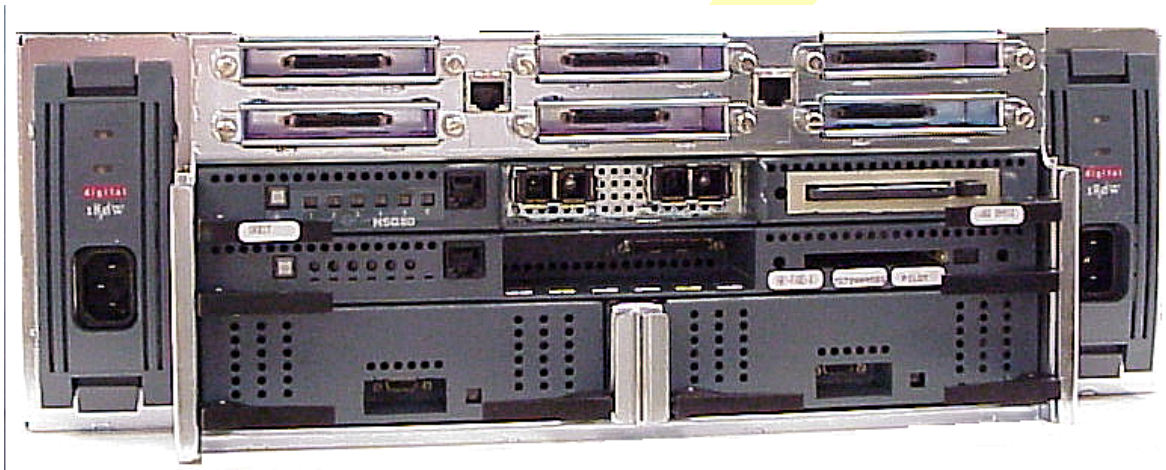
StorageWorks MA8000 and EMA12000

- Modular components: Separate controller and drive enclosures
- 10 or 14 drives per SCSI bus (higher capacity/spindle count)
- No single point of failure (redundant system level architecture plus storage software)
- Redundant, Hot-swappable components
- Supports Universal Drive
- 512MB Battery-Backed-up Cache Standard per Controller
- Up to 84 drive configuration scalability. Additional subsystems can be attached for limitless capacity
- Support for NT, NetWare, Unix, and OPS clusters; simultaneous access by non-clustered dissimilar/similar hosts
- Windows NT, NetWare, IBM AIX, Sun Solaris, SGI IRIX, Tru64 Unix, OpenVMS, HP-UX support
- Optical Fibre Channel Interface
- Data Replication Manager for NT, OpenVMS, Tru64 and Sun Solaris, and Netware
- Configured to order

M2200 Controller Shelf

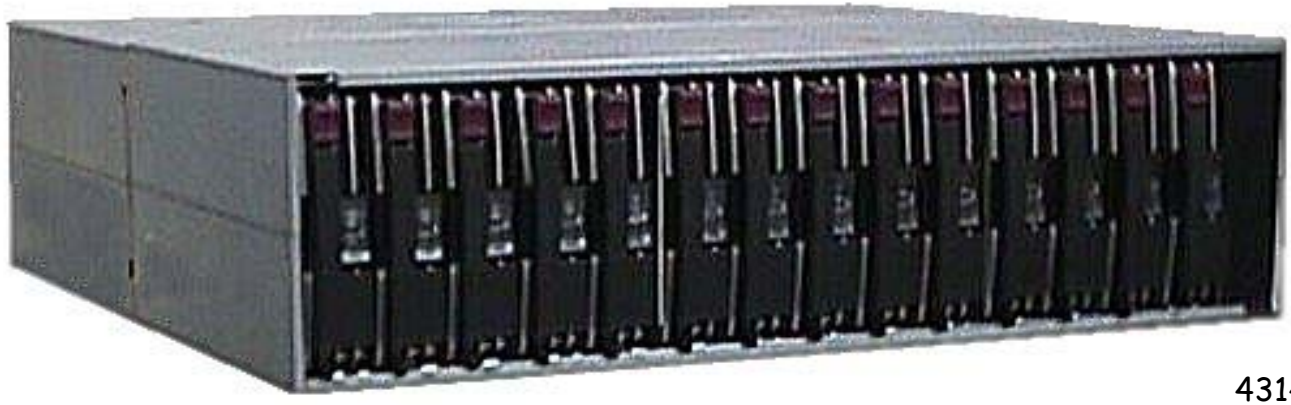


M2 Front View



M2 Rear View

14 (1") Disk Drive Enclosure



4314 front view

4314 rear view

* Can be configured in "Single Bus"(4314) or "Split Bus" (4354) mode

10 (1.6") Disk Drive Enclosure (obsolete)

4210 front view

4210 rear view

Universal Drive Carrier

Carriers both for 3.5" disk drives

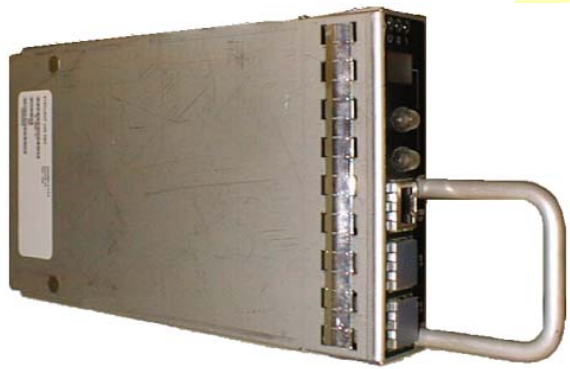
1.0" carrier

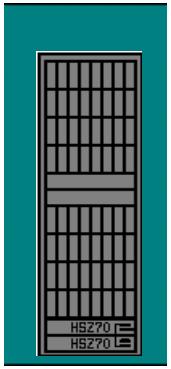
1.6" carrier (obsolete)

- EMI containment
- Activity, fault and in use LEDS on front
- SCA II direct connect interface
- Cam mechanism locks carrier in place
- Designed to absorb higher vibrations and dissipate heat

Environmental Monitoring

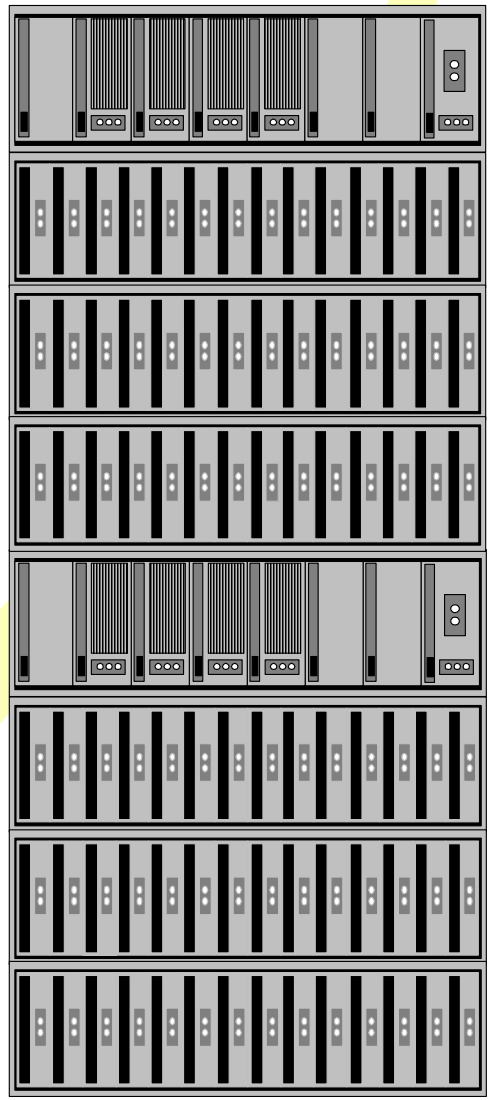
- SWCC/Insight Manager Reporting
- Physical to logical mapping
- FRU identification
- Three temperature sensor
- Shelf status LED
- In-band reporting
- EMU hot swap
- Monitor fan and power supply presence and status
- Sets multiple fan speeds on high temperature and power or fan fault

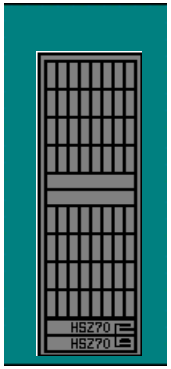




Configuring Modula - Best Practices

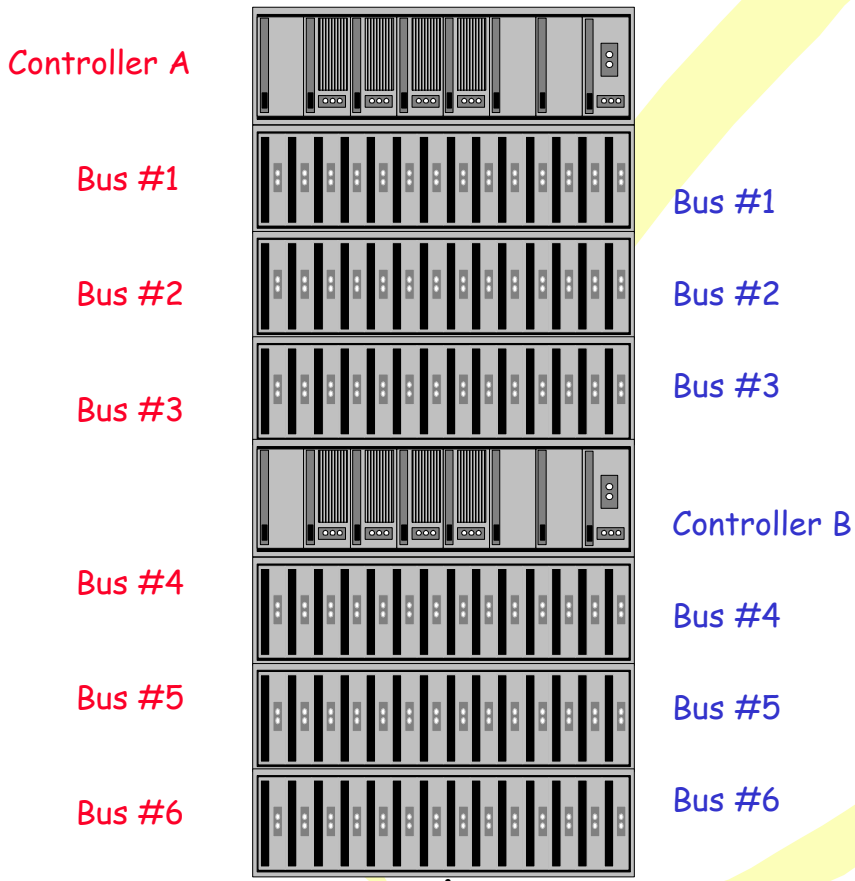
- Use all six buses for best performance
- Use all six drive shelves in "Single Bus" mode connected to one M2200 controller shelf for highest capacity (84 disks)
- Use 3 drive shelves in "Split Bus" mode for highest performance, medium capacity (42 disks), medium availability
  - shelf failure could take out 2 channels
  - low probability with dual redundant power
- Use all six shelves in "split bus" mode between two M2200 controller shelves for highest availability, highest performance, medium capacity (84 disks)
- Spread stripes across channels

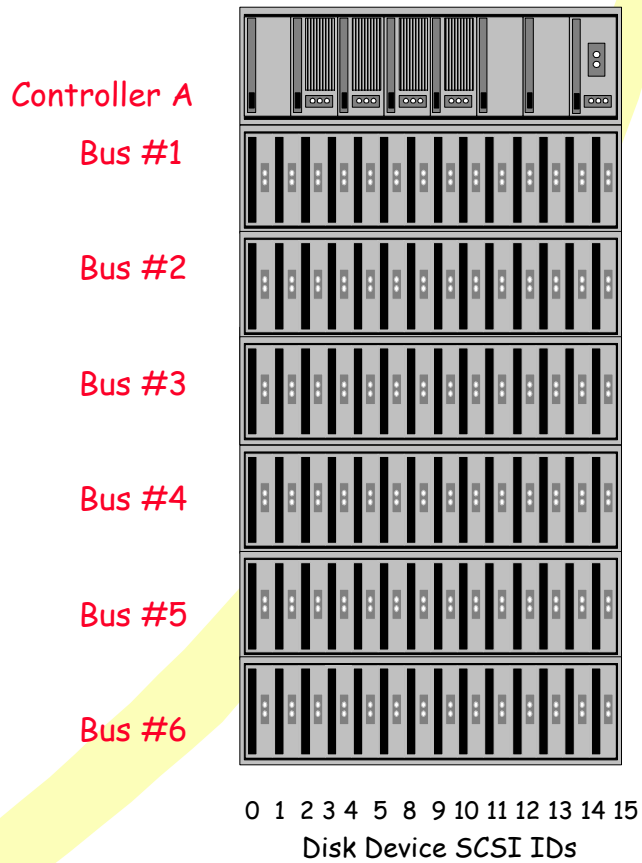




Configuring Modula - Best Practices

→ 2 controller pairs, 6 Split Bus shelves (84 Devices)





→1 controller pair, 6 Standard Bus shelves (84 Devices)

MA8000/EMA12000 Fibre Channel Product Set

May 12, 2000

Model 2200 (M2) Controller Shelf - 4U

Front

Back

135820-B21

Includes: (2) 180W Power Supplies, (3) Fans, (6) UltraSCSI I/O Modules, EMU, (2) IEC C13-C14 Power Cords, RETMA mounting kit

Model 42xx Device Shelf - 3U

103381-001

4214R - Single Bus, 14 Bay Device Shelf, RETMA mounting kit, (2) Blower, (1) Power Supply, (1) IEC-C13 to NEMA 5-15P Power Cord, (1) 3.7M VHD - VHD SCSI Cable

138151-001

4254R - Dual Bus, 14 Bay Device Shelf, RETMA mounting kit, (2) Blowers, (2) Power Supplies, (2) IEC-C13 to NEMA 5-15P Power Cords, (2) IEC-C13 to IEC-C14 Power Cords. (2) 3.7M VHD - VHD SCSI Cables

FC Storage Area Network Components

FC SAN Switches

158223-B21 FC SAN Switch 16 ports
158222-B21 FC SAN Switch 8 port
167365-B21 8/16 SAN Switch Bracket
160407-B21 8/16 SAN Switch Power option

GBICs, Connection Kits

380561-B21 Optical Short Wave GBIC
380579-B21 Kit 3 SW GBIC, 2-2M cables
380596-B21 Kit 2 SW GBIC, 2-2M cables
127508-B21 Optical Long Wave GBIC

Platform kits 1 required per platform, **adapters** 1 per host connection.

Platform kits 1 required per platform, **adapters** 1 per host connection.

O.S. Versions Support	G80 SFT Kit	FC Adapters(AKA);Bus	ACS	Multi Path	HA	FC
WNT X86 NT4.0/W2K	380551-001	176479-B21(DS-KGPSA-CB);PCI	8.5G,F,S	Secure Path V2.2.2	MSCSV1.0	Switch, Loop
NT/I 4.0	128696-B21	380574-001 (KGPSA-BC);PCI	8.5P	Secure Path V2.2.2	MSCSV1.0	Switch
Tru64 4.0F	380553-001	168794-B21(DS-KGPSA-CA);PCI	8.5G,F,S	in Tru64 5.0A	TruCluster 1.6	Switch
Tru64 UNIX 4.0F	(Configured and ordered through CSS only)		8.5P			Switch
Tru64 UNIX 5.0A	**128693-B21**	**168794-B21(KGPSA-CA);PCI**	**8.5P**	**in OS (NOT YET AVAILABLE)**		**Switch**
OpenVMS 7.2-1	380555-001	168794-B21(DS-KGPSA-CA);PCI	8.5G,F,S	in OS	OpenVMS Clusters	Switch
OpenVMS 7.2-1	128694-B21	380574-001(KGPSA-BC);PCI	8.5P	in OS	OpenVMS Cluster	Switch
Solaris 2.6, 7.0	380554-001	123503-001(DS-SWSA4-SC); SBU 380576-001(SWSA4-PC);PCI	8.5G,F,S	Secure Path V2.1	FirstWatch onV2.6 VCS V1.01 on V2.6,7.0	Switch, Loop
NetWare 4.2,5.0	380559-001	120186-B21	8.5G,F,S		NCSV1.0	Loop
SGI IRIX 6.5.3	380556-001	Origin 2000 SGI XT-FC-2P:XIO Origin 200 SGI PCI-FC-IP;PCI (requires X-F-OE-KIT (MIA))	8.5G,F			Loop
HP-UX 10.2, 11.0	380557-001	HP9000/800 K Class A3404A;HSC HP9000/800 D Class A3591A;GSC	8.5G,F	Pvlinks in HP-UX 10.2	MC Service Guard	Switch,Loop
IBM AIX 4.2.1, 4.3	380558-001	149841-B21 PCI for RS/6000	8.5G,F		HACMP V4.3	Loop

CTO orders require Part Number118102-888 on the first line

HSG80 Array Controller Software (1 per controller)

380577-001 ACS V8.5G FC-AL Software
128697-B21 ACS V8.5F FC-AL/SW Software
160091-B21 ACS V8.5S FC/SW Software w/CLONE+SNAPSHOT
128698-B21 **ACS V8.5P** FC/SW Data Replication Software

Multi-path Software

165989-B21 Secure Path V3.1 for WNT
165991-B21 Secure Path V2.1 for SUN

HA/F500 Clusters

Basic 103250-B21

Storage controllers, cache, batteries:

176622-B21 HSG80 RAID Array Controller w/ 256MB Cache
380674-B21 HSx80 256MB cache (2*128MB)
176623-B21 HSG80 Cache bulkhead upgrade
135823-B21 Single external cache battery

Shelf options

119826-B21 4214R Redundant power supply
119829-B21 4214R Dual Bus I/O Module

Supported Hard Drives

328939-B22	9.1GB Ultra2 SCSI 10K RPM 1”
142671-B22	9.1GB Ultra3 SCSI 10K RPM 1”
128418-B22	18.2GB Ultra2 SCSI 10K RPM 1”
142673-B22	18.2GB Ultra3 SCSI 10K RPM 1”
123065-B22	9.1GB Ultra2 SCSI 7200 RPM 1”
388144-B22	18.2GB Ultra2 SCSI 7200 RPM 1”

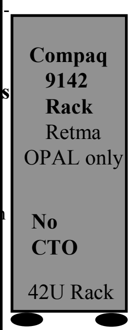
SCSI Cables - VHDCI to VHDCI

168256-B21 1Meter, 168257-B21 2M, 189505-B21 3M, 400983-005 5M, 400985-010 10M

FC Cables 50 Micron Short Wave Multi mode

234457-B21/B22/B23/B24/B25 Optical cables (2/5/15/30/50m)

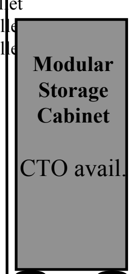
Compaq 9142 Rack, options:



120663-B22 9142 42U Cab (opal) No PDU- Shock Pallet
120664-B22 9136 -36U Cab (opal) No PDU- Shock Pallet
120665-B22 9122 -22U Cab (opal) No PDU- Shock Pallet
120670-B21 Side Panel
120673-B21 Rack Stabilizer
120669-B21 Multi-Bay Kit
120677/678-B21 Fan Kit 110/220V
169940-B21 Blank Panel Kit (Qty 4)
295363-002 PDU DOM 16 Amp - Zero U 6-20P Pdu supports 6 p/s
295363-003 PDU DOM 32 Amp - Zero U 12 ft L6-30P Pdu supports 6 p/s

Order 91xx with 1 or 2 PDU
Note: Not all options shown

Modular Storage Cabinet



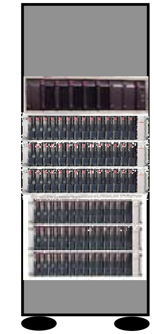
180311-B21 42U (opal) 60Hz w/ (26) IEC320-C13 - C14 Power Cords
180312-B22 42U (opal) 50Hz w/ (26) IEC320-C13 - C14 Power Cords
180313-B21 36U (opal) 60Hz w/ (22) IEC320-C13 - C14 Power Cords
180314-B22 36U (opal) 50Hz w/ (22) IEC320-C13 - C14 Power Cords
180315-B21 22U (opal) 60Hz w/ (12) IEC320-C13 - C14 Power Cords
180316-B22 22U (opal) 50Hz w/ (12) IEC320-C13 - C14 Power Cords
180317-B21 41U (blue) 60Hz w/ (26) IEC320-C13 - C14 Power Cords
180318-B22 41U (blue) 50Hz w/ (26) IEC320-C13 - C14 Power

All Modular Storage Cabs include:
Front & back doors, Side panels, (2) 2U 24Amp PDUs each with (1) 15' L6-30P input Power Cord, (16) IEC320-C13 receptacles

MA8000

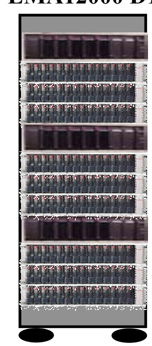
175992-B21/60Hz
(1) 22U Modular Storage Cab.
(1) M2200 Shelf
(3) 4254 Shelves
(6) SCSI VHD-VHD Cables
Controllers, Batteries and Disks ordered separately

EMA12000 S14



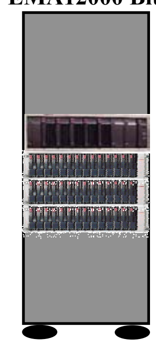
175991-B21/60Hz
(1) 36U Modular Storage Cab.
(1) M2200 Shelf
(6) 4214 Shelves
(6) SCSI VHD-VHD Cables
Controllers, Batteries and Disks ordered separately

EMA12000 D14



175990-B21/60Hz
(1) 42U Modular Storage Cab.
(3) M2200 Shelves
(9) 4254 Shelves
(18) SCSI VHD-VHD Cables
Controllers, Batteries and Disks ordered separately

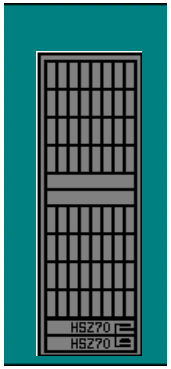
EMA12000 Blue



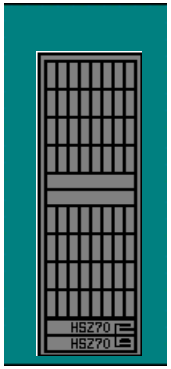
175993-B21/60Hz
(1) 41U Modular Storage Cab.
(1) M2200 Shelf
(3) 4254 Shelves
(6) SCSI VHD-VHD Cables
Controllers, Batteries and Disks ordered separately

Power Cord: IEC320-C13 to IEC320-C14

BN35S-02 2.5M IEC cable, black

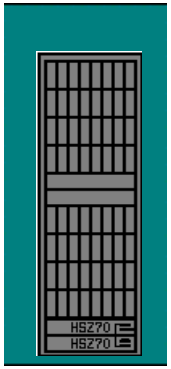


Setting Up the HSG80 Using the Command Line Interface



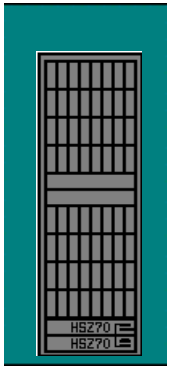
Setting Up the HSG80 Using the CLI

- Initial Controller Setup (HSG80)
- Creating Storagesets
- Creating Spares
- Creating Partitions
- All CLI Commands Listing



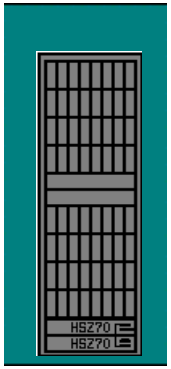
HSG80 Setup

- Connect console cable from controller maintenance port to VT terminal or emulator
  - Maintenance port accepts standard RS-232- jack from any EIA-423 compatible terminal
  - Port support serial communications with default values of 9600 baud using 8 data bits, 1 stop bit, no parity
  - If possible use "good" emulator (ie Keaterm, Powerterm, etc..)
    - Hyperterm has limitations
  - Press "Enter" or "Return" key - CLI prompt appears
  - When entering commands in a dual-redundant controller configuration, remember that the controller to which you are connected is "this_controller" and the remaining controller is the "other_controller



HSG80 Setup

- If configured for dual-redundant controllers, set the controllers CLI prompts. This may eliminate any confusion later
  - **HSG> set this_controller prompt="HSGtop> "**
    - commands may be abbreviated
  - **HSGtop> set other prompt="HSGbottom> "**



HSG80 Setup

- At command prompt type

```
HSG> show this_controller
```

- Note condition of cache and batteries both should be good. If cache is invalid - CLI will be reduced
- Note that controller is configured for dual redundancy

```
HSG> show other_controller
```

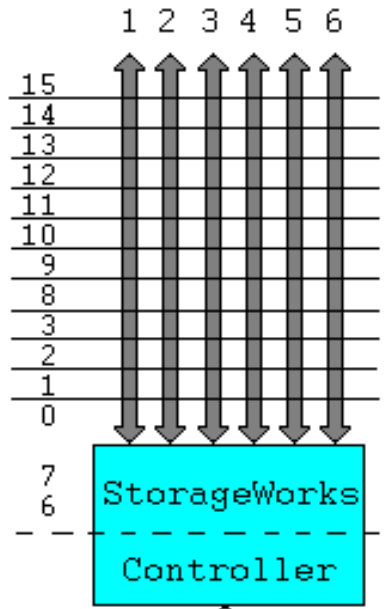
- If error accessing other controller then move the CLI cable to the other controller

  (This could occur if the controllers are not configured for dual redundancy or cache is invalid)

HSG80 Setup

Device Domain

6 UltraSCSCI buses
16 SCSCI IDs per bus
Controller takes IDs 7and 6
Devices take IDs
0,1,2,3,8,9,10,11,12,13,14,15

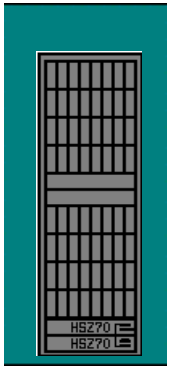


Host Adapter

Host Adapter

Host Domain

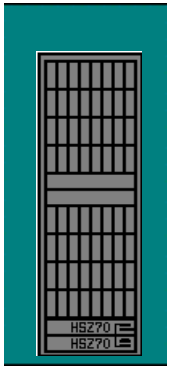
2 fibre optic host ports per controller
FC-AL or switched fabric
World Wide Names are used for addressing



HSG80 Setup

HSG> show this_controller full

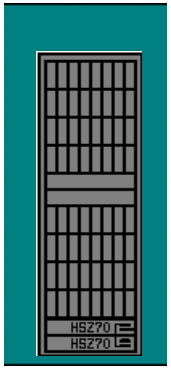
```
Controller:
   HSG80 (C) DEC ZG7400120 Software R052G-0, Hardware 0000
   Node_ID = 5000-1FE1-FF00-00B0 (set this node_id = 5000-1fe1-ff00-00b0 fc)
   ALLOCATION_CLASS = 0 (set this allocation_lass=1)
   SCSI_VERSION = SCSI-2 (set this scsi_version=scsi-2)
   Not Configured for dual-redundancy (set failover copy=this)
   Device Port SCSI address 7
   TIME: NOT SET (set this time= dd-mmm-yyyy:hh:mm:ss)
   Command Console LUN is 0 (set this command_console_lun)
Host PORT_1:
   Reported PORT_ID = 5000-1FE1-FF00-00B1
   Port_1_PROFILE = PLDA
   PORT_1_TOPOLOGY = LOOP_HARD (loop up) (set this port_1_topology = loop_hard)
   PORT_1_AL_PA = 71 (set this port_1_alpa=71)
Host PORT_2:
   Reported PORT_ID = 5000-1FE1-FF00-00B2
   Port_2_PROFILE = PLDA
   PORT_2_TOPOLOGY = LOOP_SOFT (loop up)
   PORT_2_AL_PA = 02 (negotiated)
```



HSG80 Setup

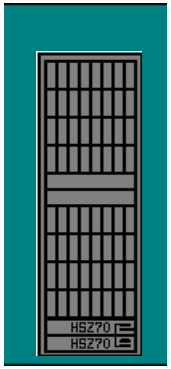
- **HSG> show this_controller full** (continued)

```
Cache:
   256 megabyte write cache, version 0012
   Cache is GOOD
   No unflushed data in cache
   CACHE_FLUSH_TIMER = DEFAULT (10 seconds) (set this cache_flush_timer=65535)
   NOCACHE_UPS (set this nocache_ups)

Mirrored Cache:
   Not Enabled (set this mirrored_cache)

Battery:
   MORE THAN 50% CHARGED
   Standby Capacity: Less than one hour
   Time to full charge: 31 hours
   Expires: 23-AUG-1957
   WARNING: BATTERY AT END OF LIFE WITHIN ONE WEEK, REPLACE BATTERY SOON!

Extended Information:
   Terminal speed 19200 baud, eight bit, no parity, 1 stop bit
   Operation control: 00000001  Security state code 33506
   Configuration backup disabled
   Other controller not responding - RESET signal NOT asserted -
   Temperature within optimum limit
```



HSG80 Setup - Host Name

- Host domain for fibre channel uses World Wide Names
  - Use SHOW THIS command to see the controller World Wide Name
  - If the controller reports a node WWN of all zeros (0000-0000-0000-0000) set the subsystem WWN to the IEE WWN that came with the controller located on a sticker on the frame
  - If replacing a failed controller in a dual-redundant configuration, the remaining controller remembers the subsystem WWN
  - All ports on controllers have unique World Wide Names
  - Save the configuration to a storageset or disk (especially in a single controller configuration)



HSG80 Setup Host Ports

- The HSG80 has 2 host ports
- Set the port topology for each port

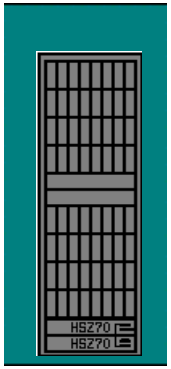
```
SET THIS_CONTROLLER PORT_1_TOPOLOGY = "topology"
```

- Topology settings:
  - Loop_hard - allows you to pick the ALPA
    - Specify the ALPA for the host ports

```
set this_controller port_1_ALPA="address"
```

  - Loop_soft - the controller will pick the ALPA
  - Fabric - for switched fabric environments
  - Offline - specify when the port is not to be used
- Examples:

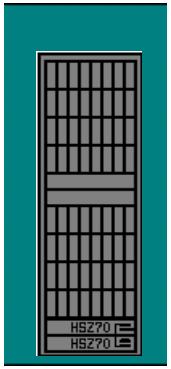
```
HSG80> set this_controller port_1_topology =
  fabric
```



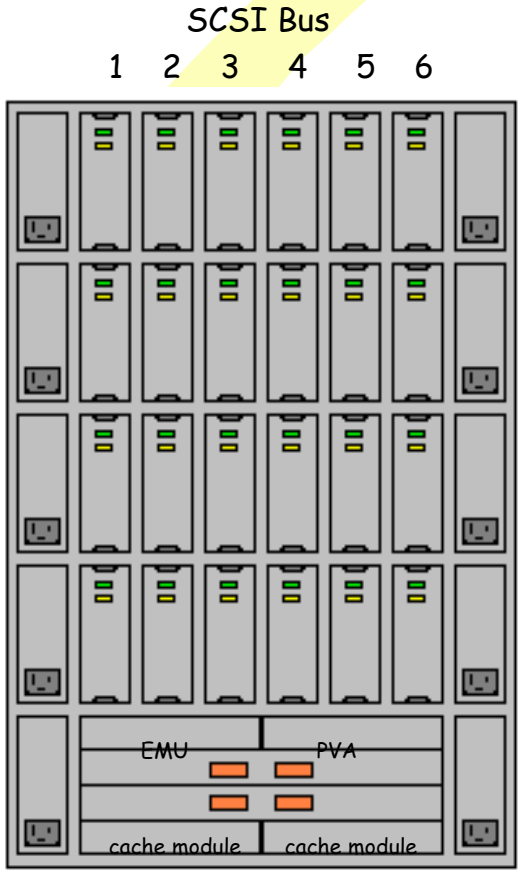
HSG80 Setup - Finding Devices

- Run the "config" program which will will add all the disks to the configuration

```
HSG> run config
CONFIG LOCAL PROGRAM INVOKED
CONFIG IS BUILDING ITS TABLES AND DETERMINING WHAT DEVICES EXIST ON THE
   SUBSYSTEM. PLEASE BE PATIENT
ADD DISK10000 1 0 0
ADD DISK10100 1 1 0
ADD DISK20000 2 0 0
ADD DISK20100 2 1 0
ADD DISK30000 3 0 0
ADD DISK30100 3 1 0
ADD DISK40000 4 0 0
ADD DISK40100 4 1 0
ADD DISK50000 5 0 0
ADD DISK50100 5 1 0
ADD DISK60000 6 0 0
ADD DISK60100 6 1 0
CONFIG NORMAL TERMINATION
```



BA370 SCSI Device Domain



Device address
3/11/15

Device address
2/10/14

Device address
1/9/13

Device address
0/8/12

PVA address 0/2/3
Device address 6
Device address 7

BA370 Device Port Target LUN (PTL)

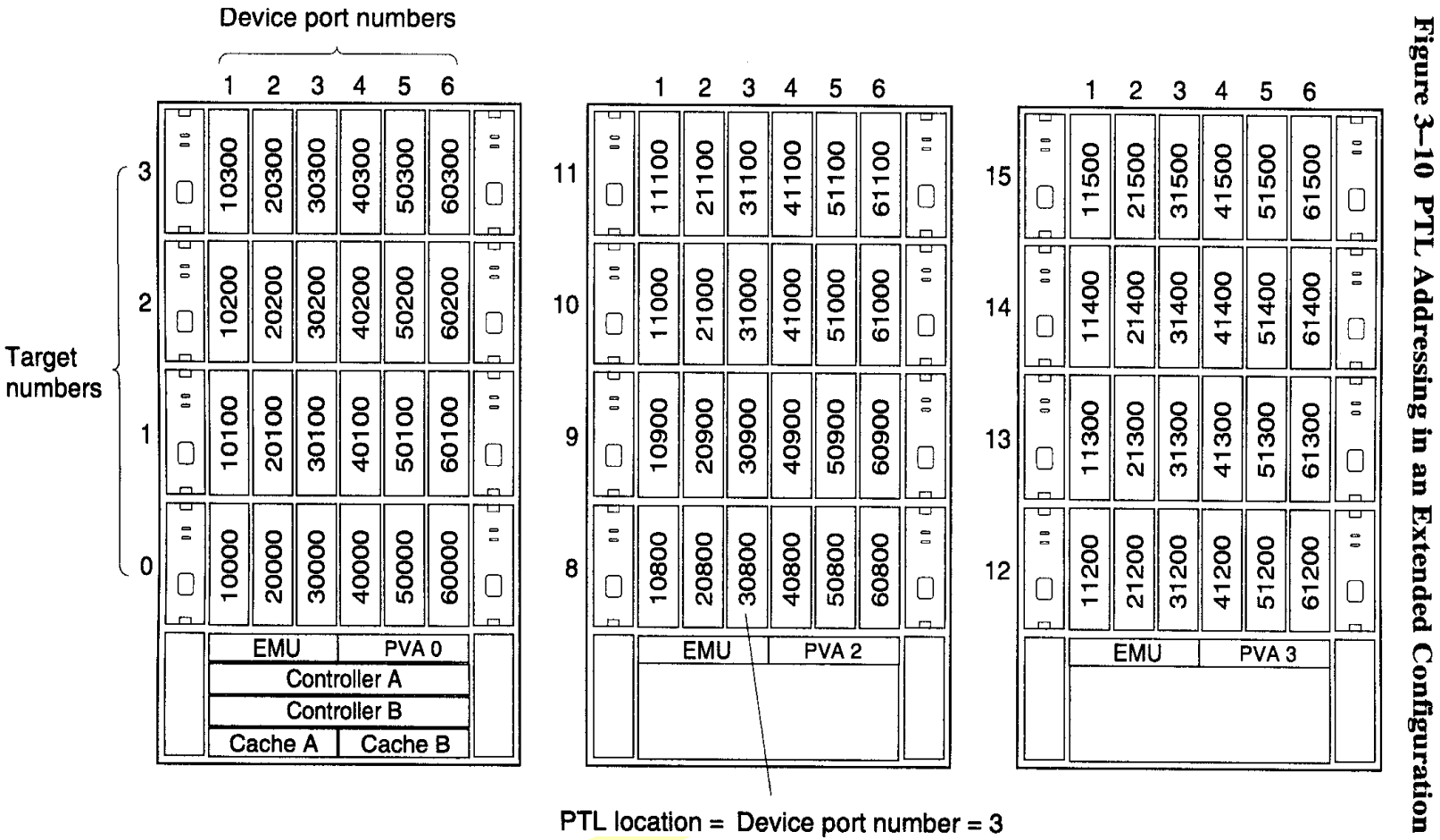
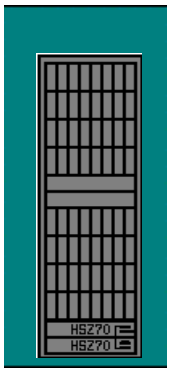


Figure 3–10 PTL Addressing in an Extended Configuration



BA370 - Setting the PVA Switch

TARGET ID
(Cabinet Shelf)

DISK10200

LUN

DEVICE PORT
(UltraSCSI Bus#)

1 03 00					6 03 00
1 02 00					6 02 00
1 01 00					6 01 00
1 00 00	2 00 00	3 00 00	4 00 00	5 00 00	6 00 00

PVA 0

Single Enclosure PVA switch setting 0 enables SCSI target ids 0 - 3

1 11 00					6 11 00
1 10 00					6 10 00
1 09 00					6 09 00
1 08 00	2 08 00	3 08 00	4 08 00	5 08 00	6 08 00

PVA 2

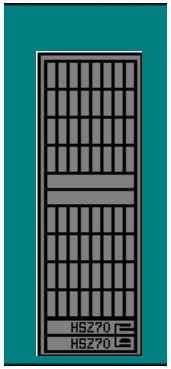
Expansion Enclosure PVA switch setting 2 enables SCSI target ids 8 - 11

1 15 00					6 15 00
1 14 00					6 14 00
1 13 00					6 13 00
1 12 00	2 12 00	3 12 00	4 12 00	5 12 00	6 12 00

PVA 3

Expansion Enclosure PVA switch setting 3 enables SCSI target ids 12 - 15

PVA switch setting 1 must not be used as this would assign target ids 4, 5, 6, & 7 to the device shelves. This would cause a conflict with the HSG80 controller target Ids of 6 and 7.

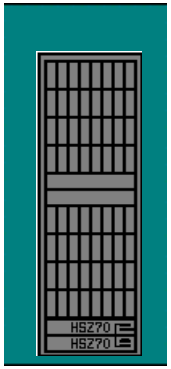


Creating Storagesets

- Decide how many and what type of storage sets to create based on customer/application requirements.
- What are storagesets?

  Raid 0 = Stripeset
  Raid 1 = Mirrorset
  Raid 0+1 = Striped Mirrorset
  Raid 3/5 = Raidset

  JBOD = Just a Bunch of Disks
- All stripes should (but don't have to) go across SCSI channels.



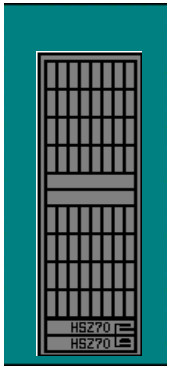
Creating Storagesets - Stripeset

- You can have up to 24 disks in a stripeset
- There are no stripeset switches
- Syntax

ADD STRIPESET *stripeset-name container-name1 container-name2 [container-nameN]*

- Examples:

```
HSG> add stripeset stripe1 disk10000 disk20000
HSG> add stripe s2 disk11200 disk21200 disk31200
```



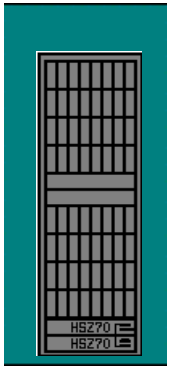
Creating Storagesets - Mirrorset

- You can have up to 6 disks in a mirrorset
- Mirrorset switches:
  - copy=fast, normal (default)
  - policy=best_fit, best_performance (default)
  - nopolicy
  - read_source=*disk-name*, least_busy (default), round_robin
- Syntax

ADD MIRRORSET *mirrorset-name disk-name1 [disk-nameN]*

- Examples:

```
HSG> add mirrorset mirror1 disk10000 disk20000
```



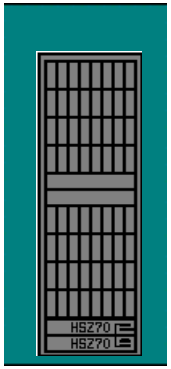
Creating Storagesets - RAIDset

- You can have up to 14 disks in a RAIDset
- RAIDset switches:
  - reconstruct=fast, normal (default)
  - policy=best_fit, best_performance (default)
  - nopolicy
  - reduced
  - noreduced (default)
- Syntax

ADD RAIDSET *raidset-name disk-name1 [disk-nameN]*

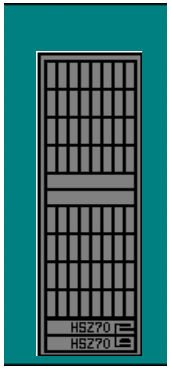
- Examples:

```
HSG> add raidset raid1 disk10000 disk20000
  disk30000
```



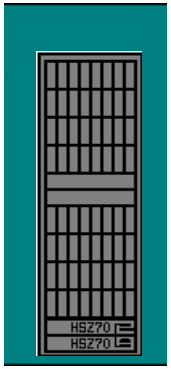
Creating Storagesets - Initializing

- Use INITIALIZE command when:
  - Creating a unit from a newly installed disk
  - Creating a unit from a newly created RAIDset, stripeset, or mirrorset
  - Initializing the data structure of a previously partitioned container
- Do not use the INITIALIZE command when:
  - Creating a unit from the same disks previously initialized, such as when a RAIDset is moved
  - Creating a storageset from deleted members
  - Adding a RAIDset with the REDUCED switch



Creating Storagesets - Initializing

- Switches:
  - chunksize=default,n
    - specifies the block chunk size to be used for stripesets and RAIDsets
    - the default chunksize for storagesets with less than 9 members is 256 blocks, or 128 kbytes.
    - the default chunksize for storagesets with more than 9 members is 128 blocks, or 64 kbytes
    - a chunksize less than 64k is not recommended
    - accept the default for most applications
    - see HSx Configuration Manual for information regarding recommended chunk size settings
    - does not apply to mirrorset
  - destroy (default)
  - nodestroy
    - to preserve forced error metadata during init
    - use only when a unit is to be created from disks reduced from mirrorsets
    - valid only with stripesets and mirrorsets



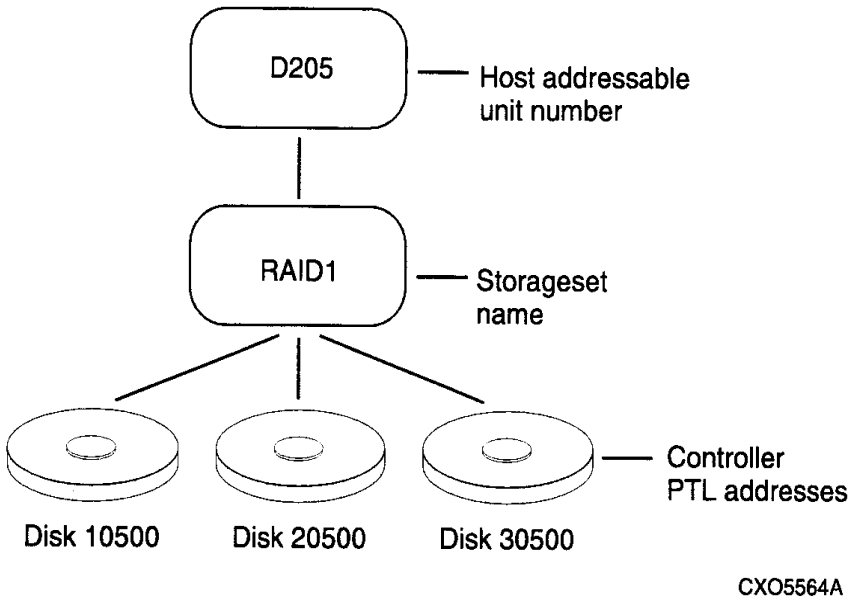
Creating Storagesets - Initializing

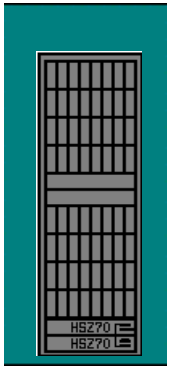
- Switches:
  - save_configuration
    - instructs the controller to save the controller's configuration information to the container being initialized
    - intended for use with a single controller
    - if specified for multi-device storageset, the complete controller configuration is stored on each member of the storageset
    - a disk initialized with the save_configuration will have slightly less storage available for data
  - Syntax:
  - INITIALIZE *container name*
  - Examples:

```
HSG> initialize disk30300 save_configuration
```

Creating Storagesets - LUNS

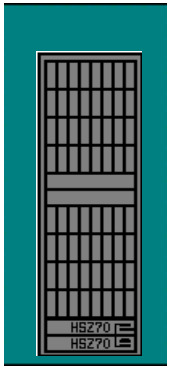
- Logical Units (LUNs) are created from storagesets. Storagesets are created from disks.





Creating Storagesets - LUNS

- Use the ADD UNIT command to create the LUN
- Switches for Units
  - enable_access_path/disable_access_path (WWN of host that can see this LUN)
  - identifier/noidentifier
  - maximum_cached_transfer (default =32, max=1024)
  - preferred_path/nopreferred_path (this_controller or other_controller, used in mulitibus failover mode)
  - read_cache/noreadcache
  - run/norun (availability to host)
  - write_protect/nowrite_protect
  - readahead_cache/noreadahead_cache
  - writeback_cache/nowriteback_cache



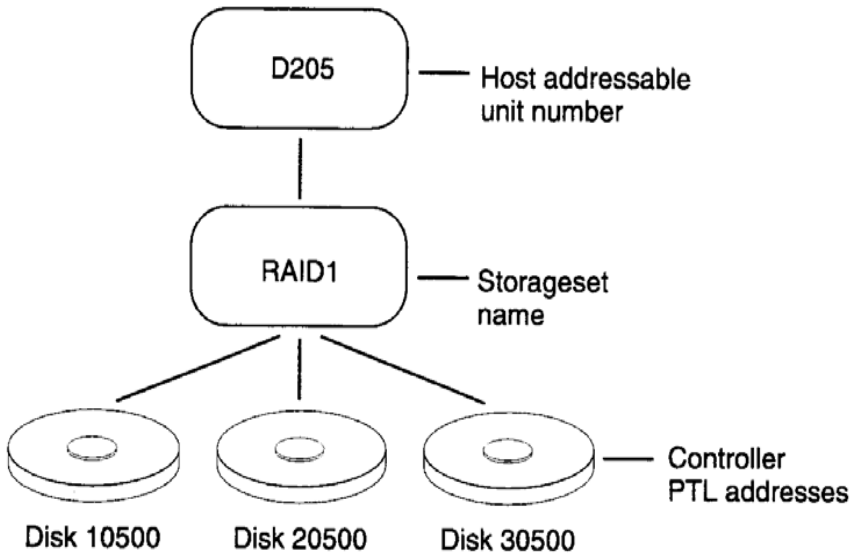
Creating Storagesets - LUNS

- Examples:

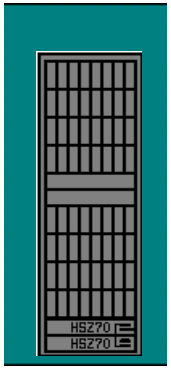
```
HSG> add unit d102 disk10000
  preferred_path=this_controller
HSG> add unit d0 raid3 writeback_cache
  maximum_cached_transfer=1024
HSG> add unit d100 stripe3
  enable_access_path=(!newcon11,!newcon12)
```

Creating a RAIDset and LUN

```
HSG> add raidset raid1 disk10500 disk20500 disk30500
HSG> init raid1
HSG> add unit d105 raid1 writeback_cache
```



* Units are available for use while RAID sync is occurring



Creating a Stripe Mirrorset and LUN

- Create the mirrorsets

```
HSG> add mirror m1 disk10100 disk20000
HSG> add mirror m2 disk20100 disk30000
HSG> add mirror m3 disk30100 disk40000
```

- Create the stripeset

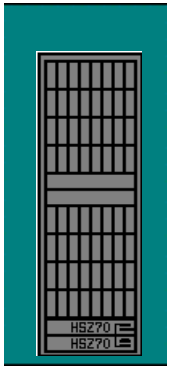
```
HSG> add stripe s0 m1 m2 m3
```

- Save configuration data (to at least one storageset)

```
HSG> init s0 save_configuration
```

- Create the LUN

```
HSG> add unit s0 d0 writeback_cache
```



Creating Spares

- Create the spare from available disks
- Use ADD SPARESET command
  - no switches
- **Syntax:**

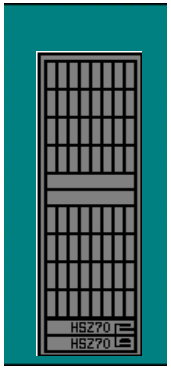
ADD SPARESET *disk-name*

- Examples:

```
HSG> add spareset disk20300
HSG> add spareset disk40300
```

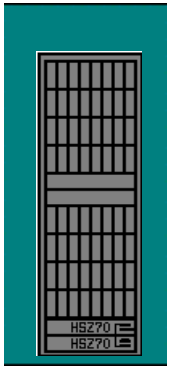
- Sparing policies are specified by storagesets
- Specify "best fit" or "best performance"

```
HSG> add raidset r1 disk40200 disk50200
  disk60200 policy=best_performance
```



Creating Partitions

- The CREATE_PARTITION command
  - divides a non_transportable disk drive or multiple disk storageset into several, separately addressable storage units
  - marks a specified percentage of a disk drive or storageset to be used as separate units
  - you can create up to 8 partitons per storageset
  - the individual units can be presented back to different hosts
  - Supported in "multi-bus failover" mode (sometimes).



Creating Partitions

- Switches:

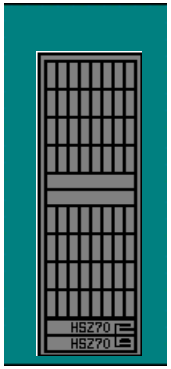
size=percent, largest

- Syntax:

CREATE_PARTITION *container-name* SIZE=*percent*

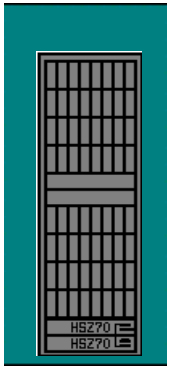
- Examples:

```
HSG> add raidset raid9 disk10000 disk20000 disk30000
init raid9
HSG> create_partiton raid9 size=25
HSG> create_partiton raid9 size=25
HSG> create_partiton raid9 size=25
HSG> create_partiton raid9 size= largest
HSG> add unit d0 raid9 partiton=1
HSG> add unit d1 raid9 partiton=2
HSG> add unit d2 raid9 partiton=3
HSG> add unit d3 raid9 partiton=4
```



Failover Modes

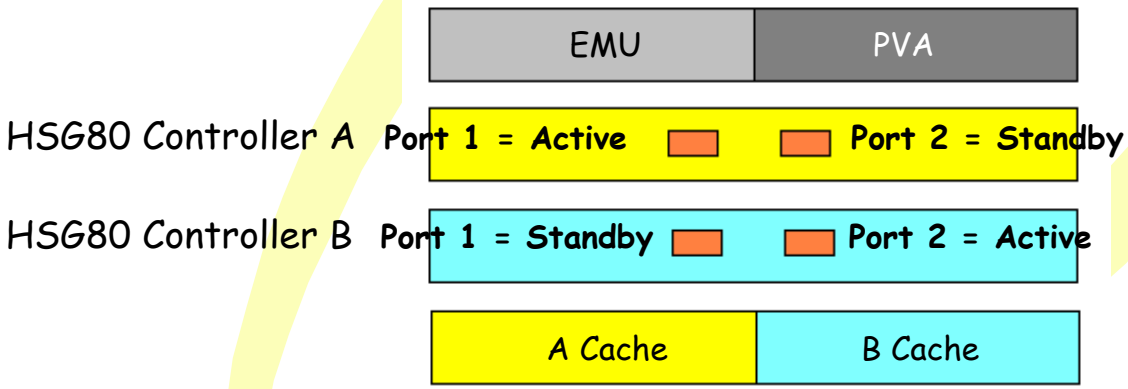
- Dual-redundant HSG80 pairs must operate in one of two failover modes.
  - Transparent
  - Multiple Bus
- Does not apply to single controller configurations



Failover Modes - Transparent

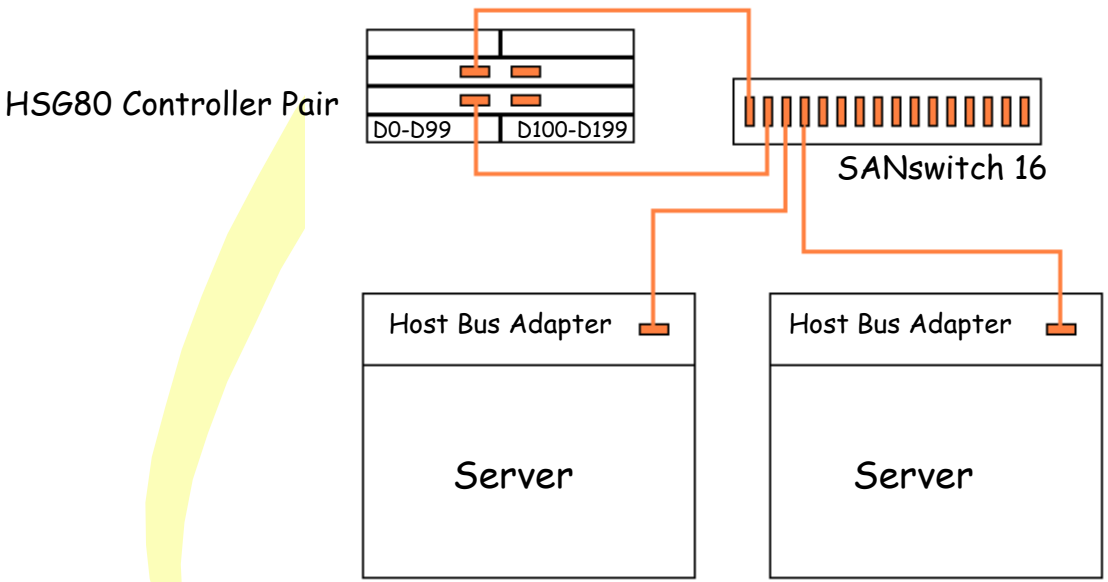
- Transparent
  - LUNs (transparently to the host) failover to the surviving controller in the event that a controller is taken offline or has failed.

```
HSG80> set failover copy=this_controller
```



Transparent Failover

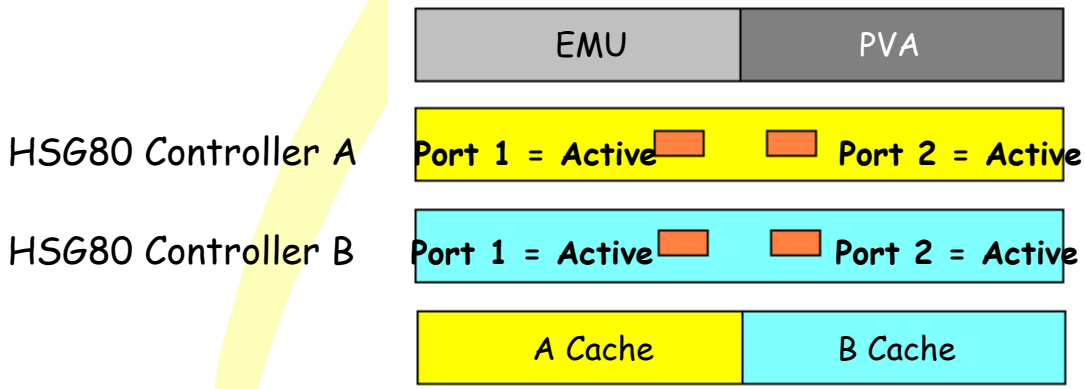
- If using "Transparent Failover"
  - Set your controllers for transparent failover before configuring devices
  - When creating LUNS, D0-D99 "appear" on port 1 and D100-D199 "appear" on port 2



Failover Modes - Multiple Bus

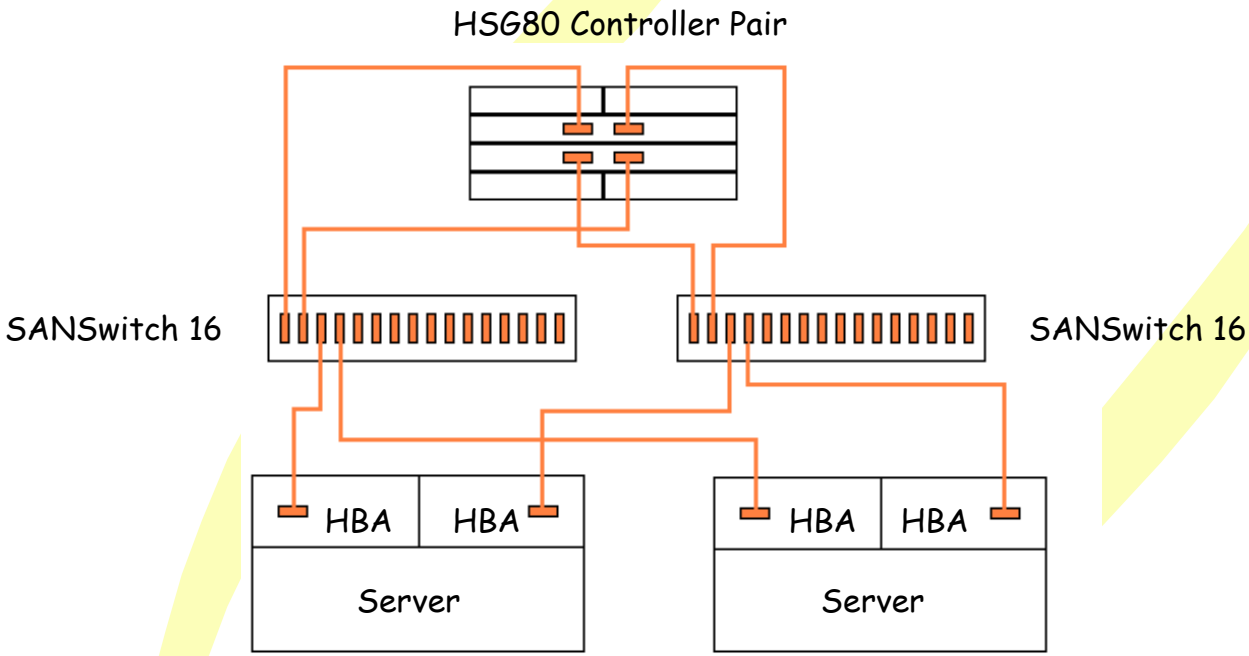
- Multiple Bus bus
  - Also known as Host Assisted failover
  - The host controls failover of the LUNs
  - The host must have 2 host bus adapters
  - All 4 host ports are "active"

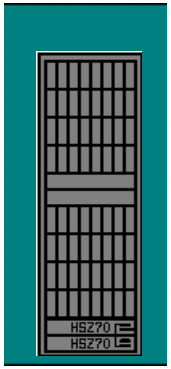
```
HSG80> set multibus_failover copy=this_controller
```



Failover Modes - Multiple Bus

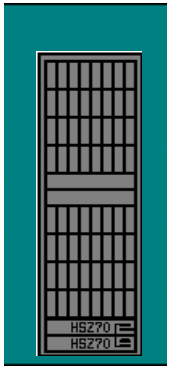
- Multiple Bus bus cabling (one example)





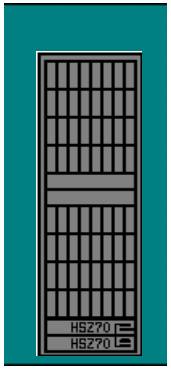
Load Balancing LUNS

- If using "Multi-bus" or host assisted failover
  - Set your controllers for multi-bus failover before configuring devices
  - All LUNs appear on all ports
  - The host distributes the I/O between controllers and available ports
  - Load balancing may be "Static" or "Dynamic"
  - The host should have at least 2 fibre channel adapters as well as operating system software support
    - Secure Path for Windows NT
    - Secure Path for Sun Solaris
    - Secure Path for AIX
    - Secure Path for Netware
    - Native support built in to Tru64 UNIX and OpenVMS



Selective Storage Presentation (SSP)

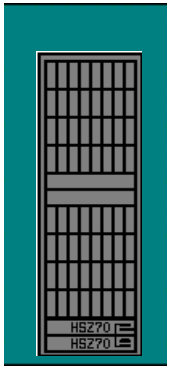
- SSP is provided as part of the ACS
- Allows LUNs to be "selectively" presented to hosts based on the WWN of the host bus adapter
- Uses connection table in the HSG80
- Connection table holds 96 entries
- Table provides a map for WWN to user specified name
- Connection names appear dynamically as the hosts logs into the fabric unless you've locked the connection table (8.7 new feature).
- Default format for name in connection table is !NEWCONxx (where xx gets incremented for every new connection)
- Re-name the connection to something more logical



Selective Storage Presentation (SSP)

- Displaying the Connection Table and re-naming connections

```
HSG80> show connections
Host Name     Operating  Controller Port  Address  Status    Offset
                System
!NEWCON00     WINNT         THIS      1    000000   OFFLINE        0
        HOST_ID=1000-0000-C920-273E          PORT_ID=1000-0000-C920-273E
!NEWCON01     WINNT         OTHER     2    000000   OFFLINE        0
        HOST_ID=1000-0000-C920-345F          PORT_ID=1000-0000-C920-345F
!NEWCON02     VMS           THIS      1    000000   ONLINE         10
        HOST_ID=1000-0000-C920-0591          PORT_ID=1000-0000-C920-0591
!NEWCON03     VMS           OTHER     2    000000   ONLINE         10
        HOST_ID=1000-0000-C920-0655          PORT_ID=1000-0000-C920-0655
HSG80> rename !newcon00 NTSQL1_A
HSG80> rename !newcon01 NTSQL1_B

HSG80> rename !newcon02 VMSCLS1_A

HSG80> rename !newcon03 VMSCLS1_B
```



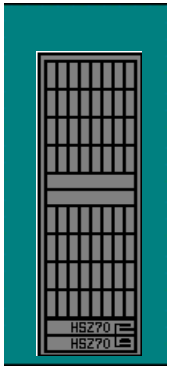
Selective Storage Presentation (SSP)

- Assign access to the LUN by using the connection name

```
HSG80> set D0 disable_access=all
HSG80> set D0 enable_access=(ntsql1_a,ntsql1_b)
```

- Assign the operating system type to the connection

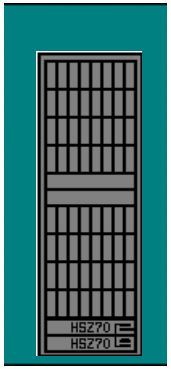
```
HSG80> set connection vmscls1_a
operating_system = vms
```



Selective Storage Presentation (SSP)

- Use "Offsets" with the connections for logical grouping of LUNS and hosts
  - i.e.. NTSQL1 offset = 0
    - use LUNs D0-D9
    - D0 becomes Logical Unit 0 to NT
  - VMSCLS1_A offset = 10
    - use D10-D19
    - D10 becomes Logical Unit 0 to VMS
- Relationship between LUN number, unit number, and offset is as follows:
  - LUN number = unit number - offset
  - Logical unit number or LUN number = the logical unit number presented to the host connection
  - Unit number = the number assigned to the unit in the ADD UNIT command

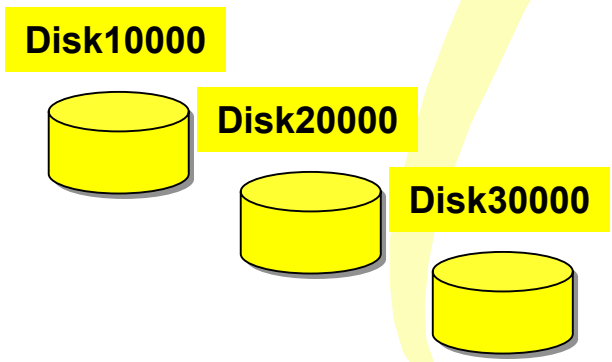
```
HSG80> set connection vmscls1_a unit_offset=10
```



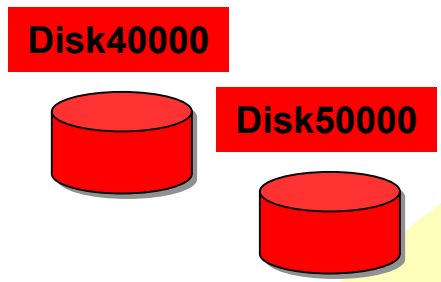
HSG80 Storagesets

- Created from individual disks
- Define underlying RAID level for logical units
- RAID 0 1-24 disks
- RAID 1 1-6 disks
- RAID 0+1 2-48 disks
- RAID 5 3-14 disks
- JBOD 1 disk

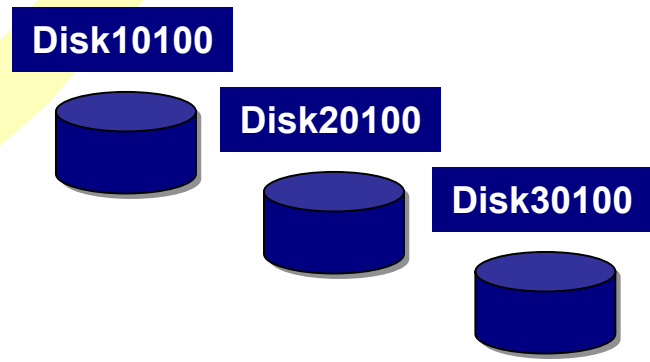
S1 (RAID 0)



M1 (RAID 1)

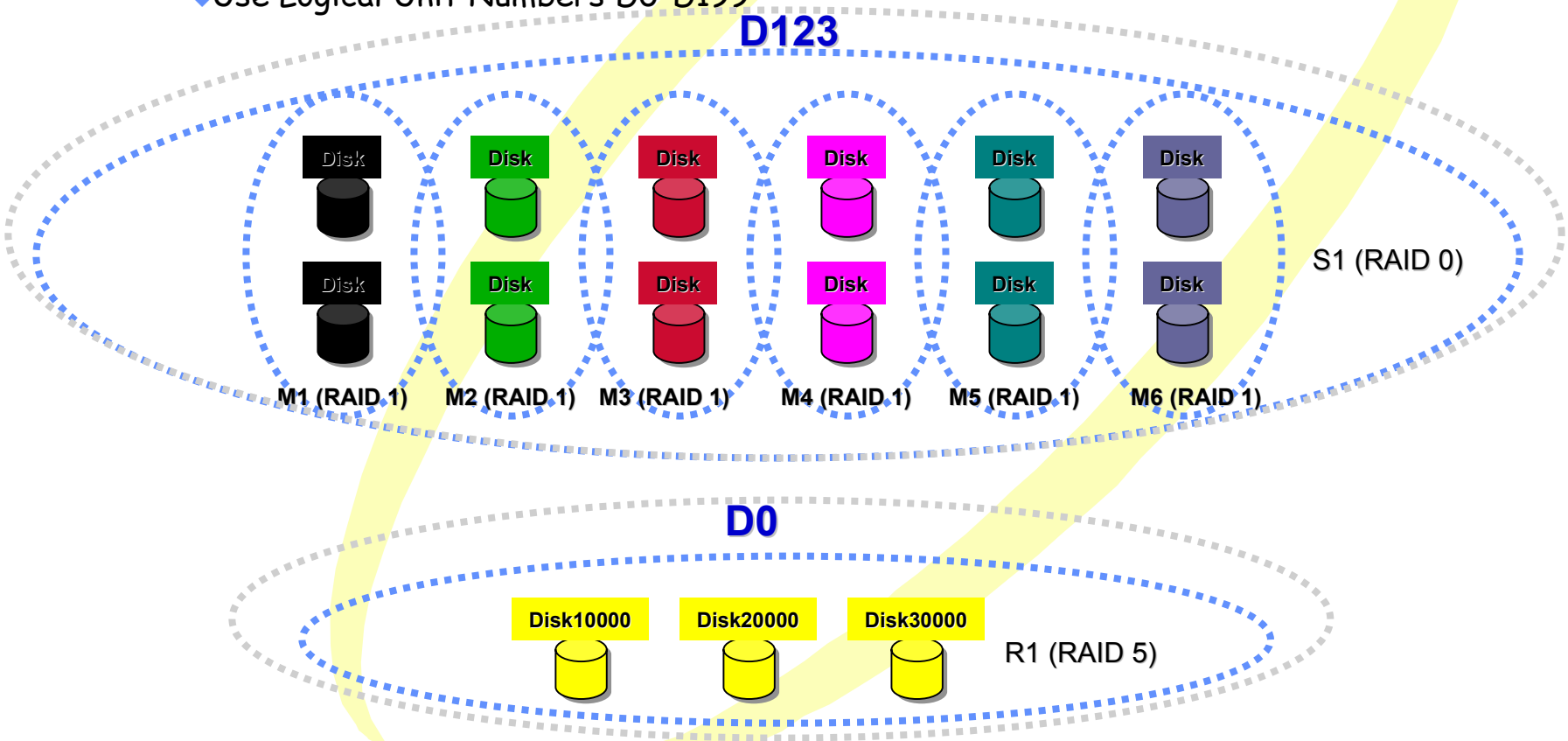


R3 (RAID 5)



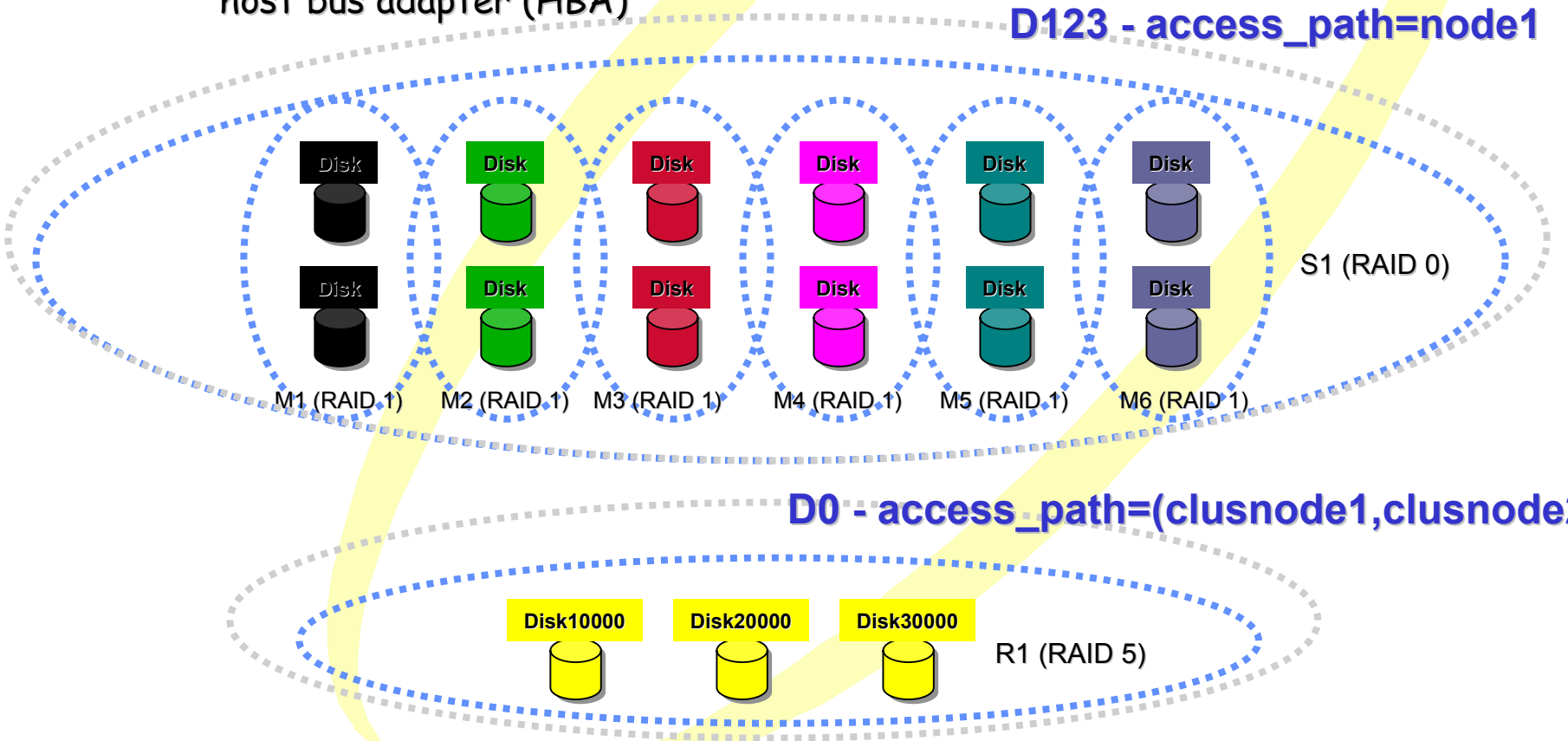
HSG80 Logical Units

- Created from storagesets
- Presented to host to be mapped as a SCSI disk device
- Presented as 128 bit WWID to hosts
- Use Logical Unit Numbers D0-D199



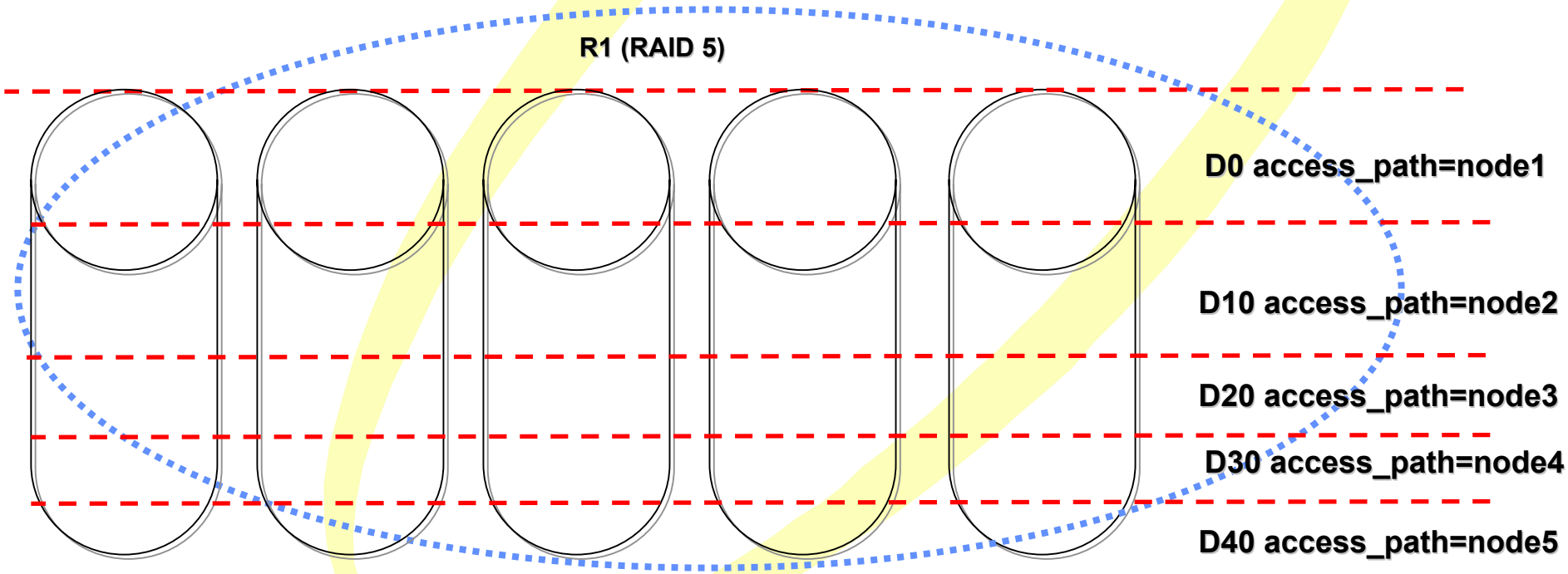
HSG80 Selective Storage Presentation

- Selective Storage Presentation (SSP) is used to select which host(s) can access (map) the LUN
- Access_path is based on the connection ID from the WWID of host bus adapter (HBA)

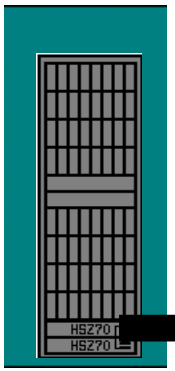


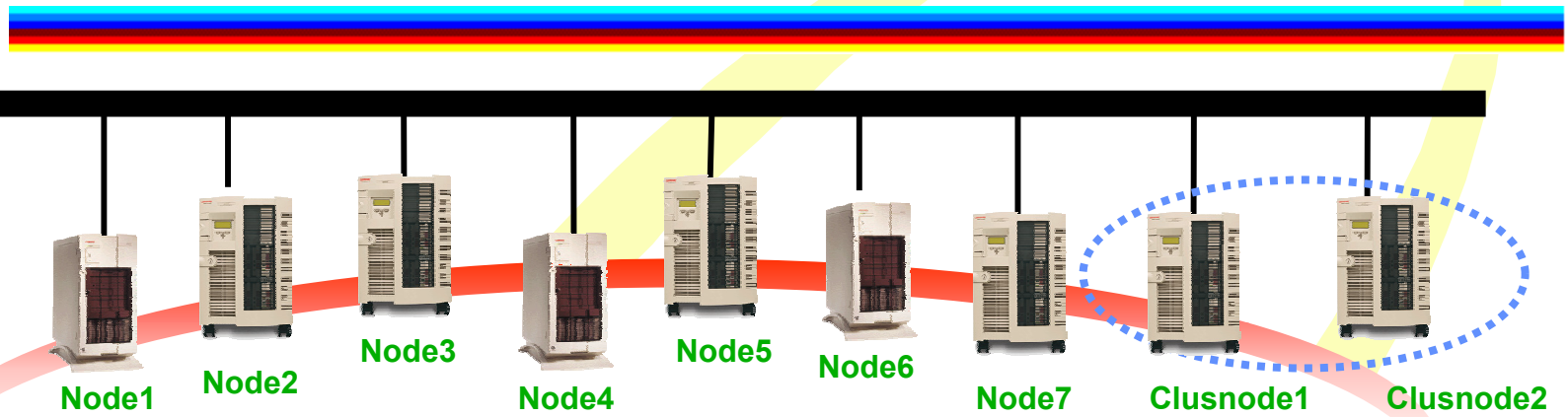
HSG80 Partitioned Storagesets

- Multiple LUNs can be created from one storageset (up to 8 partitions per storageset)
- Each LUN can be presented to a different host
- Minimizes RAID5 parity cost

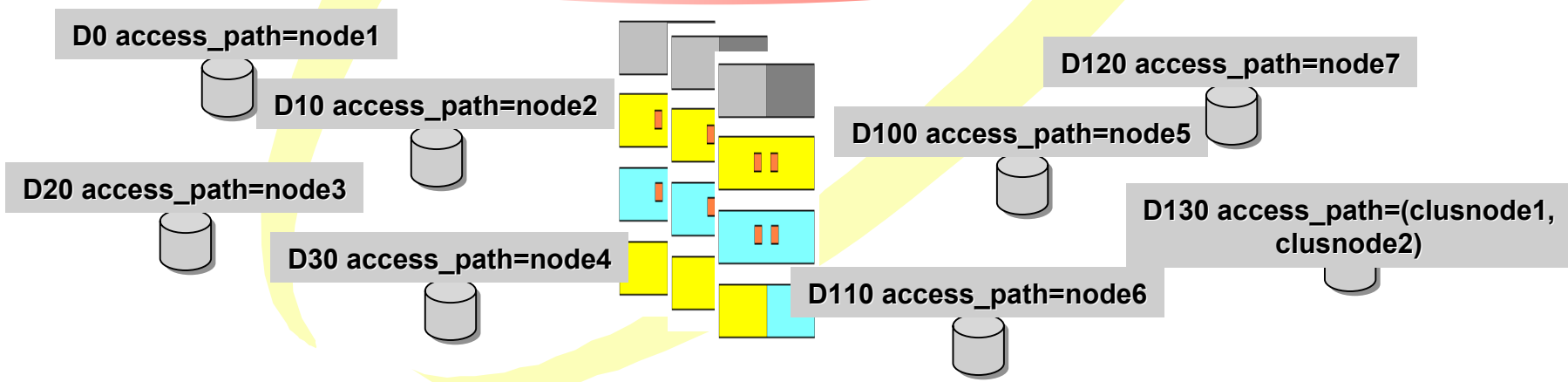


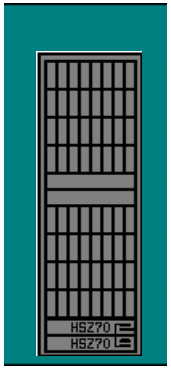
Presenting Logical Units to Hosts





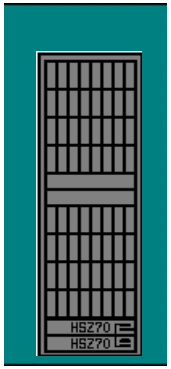
- Host WWIDs from HBA become connections to controller
- Controller uses connections for Selective Storage Presentation





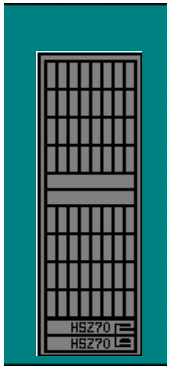
All CLI Commands

- ADD CDROM
- ADD DISK
- ADD MIRRORSET
- ADD PASSTHROUGH
- ADD RAIDSET
- ADD SPARESET
- ADD STRIPESET
- ADD UNIT
- CLEAR_ERRORS CLI
- CLEAR_ERRORS UNKNOWN
- CREATE PARTITION
- DELETE FAILEDSET



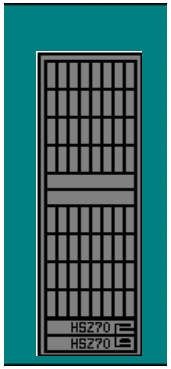
All CLI Commands

- DELETE SPARESET
- DESTROY PARTITION
- DIRECTORY
- HELP
- INITIALIZE
- LOCATE
- MIRROR
- REDUCE
- RENAME
- RETRY_ERRORS UNWRITEABLE_DATA
- RUN
- SET EMU

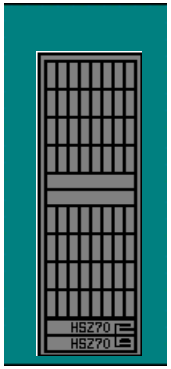


All CLI Commands

- SET FAILEDSET
- SET FAILOVER
- SET NOFAILOVER
- SHOW
- UNMIRROR

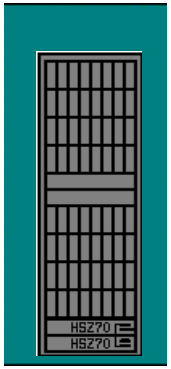


HSG Controller Utilities



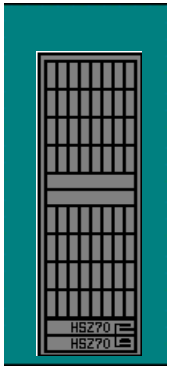
Topics:

- Overview
- Utilities
  - DILX
  - VTDPY
  - CONFIG
  - CLCP
  - FRUTIL
  - HSUTIL
  - CLONE
  - FMU



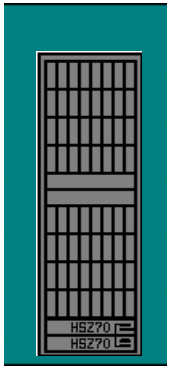
Hsx Utilities: Overview

- Used to perform maintenance, diagnostic, and performance monitoring on the HS series controllers
- Part of HSOF/ACS controller software
- Invoked from CLI using "RUN" command
  - Use "DIR" at CLI prompt to see what utilities are available
  - Not supported by remote CLI (SWCC)
    - Some utilities may work though
- Usage much too detailed for this seminar
  - See HS Controller Service Guide for more information



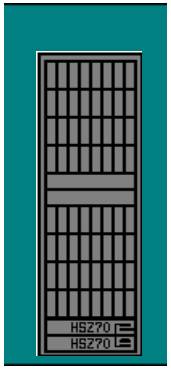
Utilities: DILX (Disk Inline Exerciser)

- Used to Check the data transfer capability of disk drives
- Used to initialize physical disk
  - Good way to wipe out NT signature
- Generates intensive read/write loads to the disk drive while monitoring the drives performance and status
  - Four tests available (read, write, data xfer, seek)
- Ability to test as many drives as available
- HP recommends stopping host based I/O during tests
  - Writes WILL destroy user data



Utilities: VTDPY (Video Terminal Display Utility)

- Use to monitor controller performance
  - Communication between controller and host
  - Communication between controller and devices
  - State and I/O activity of the logical units, devices,and device ports in the subsystem
- Detailed descriptions on how to interpret the display output can be found in the HSG80 Service Manual



Utilities: VTDPY (Video Terminal Display Utility)

↗To initiate VTDPY from a maintenance terminal at the CLI> prompt, enter the following command:

HSZ70> **RUN VTDPY**

Use the following control key sequences with the VTDPY display:

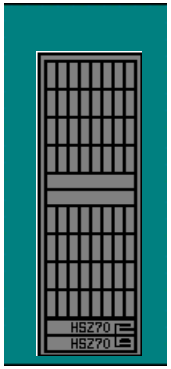
VTDPY control keys

Control Key Sequence	**Function**
Ctrl/C	Prompts for commands.
Ctrl/G	Updates the screen (same as Ctrl/Z).
Ctrl/O	Pauses or resumes screen updates.
Ctrl/R	Refreshes current screen display (same as Ctrl/W).
Ctrl/W	Refreshes current screen display (same as Ctrl/R).
Ctrl/Y	Terminates VTDPY and resets screen characteristics.
Ctrl/Z	Updates the screen (same as Ctrl/G).

While VTDPY and a maintenance terminal interface support passing all of the listed control characters, some host-based terminal interfaces restrict passing some of the characters.

Using the VTDPY Command Line

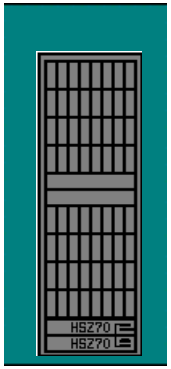
VTDPY contains a command line interpreter that you can invoke by entering Ctrl/C any time after starting the program. The command line interpreter is used to modify the characteristics of the VTDPY display.



Utilities: VTDPY (Video Terminal Display Utility)

VTDPY commands

Command String	Function
DISPLAY CACHE	Use 132 column unit caching statistics display.
DISPLAY DEFAULT	Use default 132 column system performance display.
DISPLAY DEVICE	Use 132 column device performance display.
DISPLAY STATUS	Use 80 column controller status display.
EXIT	Terminates program (same as QUIT).
INTERVAL <seconds>	Changes update interval.
HELP	Displays help message text.
REFRESH	Refreshes the current display.
QUIT	Terminates program (same as EXIT).
UPDATE	Updates screen display.

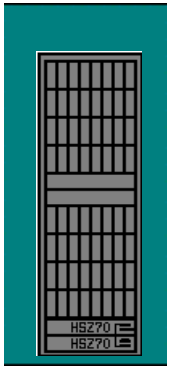


Utilities: VTDPY (Video Terminal Display Utility)

VTDPY NOTES:

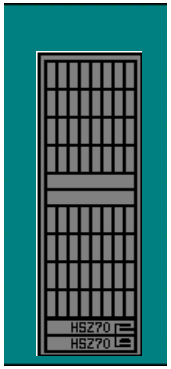
The keywords in the command strings can be abbreviated to the minimum number of characters necessary to uniquely identify the keyword. Entering a question mark (?) after a keyword causes the parser to provide a list of keywords or values that can follow the supplied keyword. The command line interpreter is not case sensitive, so keywords can be entered in uppercase, lowercase, or mixed case.

Upon successful execution of a command other than HELP, the command line interpreter is exited and the display is resumed. Entering a carriage return without a command also exits the command line interpreter and resumes the display. If an error occurs in the command, the user prompts for command expansion help, or the HELP command is entered, the command line interpreter prompts for an additional command instead of returning to the display.



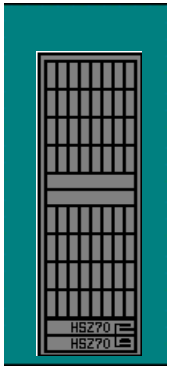
Utilities: CONFIG (Configuration Utility)

- Use to add one or more storage devices to the subsystem
- Utility checks the device ports for new disk drives then adds them to the controller's configuration automatically names them
- If you're adding new disk drives to a BA370 or a Modula shelf, just run CONFIG and it will automatically add the devices to the subsystem correctly



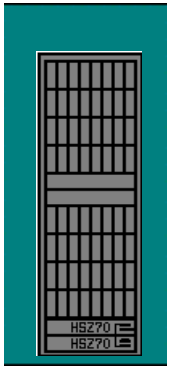
Utilities: CLCP (Code Load Code Patch)

- Use CLCP to download new software to the program card while it's installed in the controller
- Uses Kermit software
- If too complex for you, get a newer version PCMCIA card
- Steps:
  - Obtain image from customer services representative
  - Load the image onto a PC or workstation
  - From the host, quiesce all port activity and dismount the storage units in the subsystem
  - Remove the ESD cover
  - Disable write-protect switch on PCMCI card
  - Run CLCP



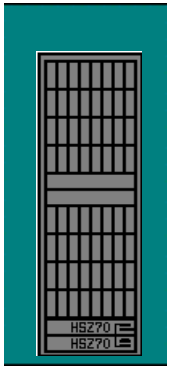
Utilities: FRUTIL (Field Replacement Utility)

- Use the field replacement utility to replace a failed controller, cache module, cache battery, EMU, or PVA module without shutting down the subsystem
- Dual-redundant controller configurations are assumed
- Allows quiescing of device SCSI buses during swap of failed module



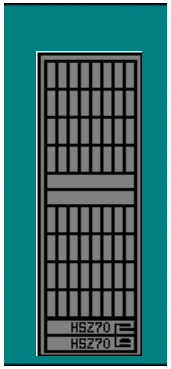
Utilities: HSUTIL (Hierarchical Storage Utility)

- Use HSUTIL to upgrade the firmware on disk and tape drives
  - Drives must not be members of units
  - Drives not available to the host during upgrade
- Use to perform low level format to disk drives



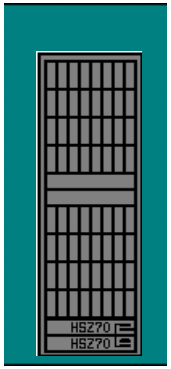
Utilities: CLONE

- Use to duplicate the data on any unpartitioned single-disk unit, stripeset, mirrorset, or striped mirrorset
- When the cloning operation is done, you can back up the clones rather than the storageset or single disk unit, which can continue to service its I/O load
- When cloning a mirrorset, CLONE does not need to create a temporary mirrorset. Instead, it adds a temporary member to the mirrorset and copies the data onto this new member



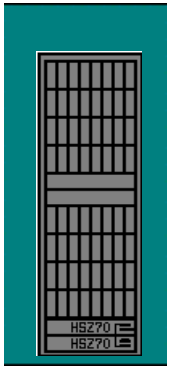
Utilities: CLONE

- CLONE creates a temporary, two member mirrorset for each member in a single-disk or stripeset
- After the CLONE utility copies the data from the members to the clones, it restores the unit to its original configuration and creates a clone unit you can backup



Utilities: FMU
Fault Management Utility

- Provides a limited interface to the controller's fault management software
- Use FMU to:
  - Display the last-failure and memory-system-failure entries that the fault management software stores in the controller's non-volatile memory
  - Translate many of the code values contained in event messages
    - For example, entries may contain code values that indicate the cause of the event, the software component that reported the event, the repair action, etc..
  - Control the display characteristics of significant events and failures that the fault management system displays on the maintenance terminal

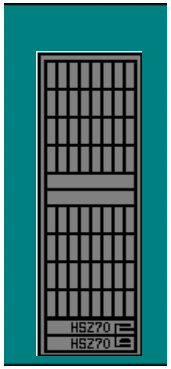


Utilities: FMU
Fault Management Utility

Using FMU to describe event log codes

The Fault Management Utility (FMU) has a DESCRIBE function you can use to interpret event codes produced by the controller. Use this function to understand events that have occurred in the subsystem (instance, codes) and to find the recommended repair action (repair action codes), as well as to interpret other codes.
The types of codes FMU can describe are:

- INSTANCE_CODE
- REPAIR_ACTION_CODE
- LAST_FAILURE_CODE
- ASC_ASCQ_CODE
- COMPONENT_CODE
- CONTROLLER_UNIQUE_ASC_ASCQ_CODE
- DEVICE_TYPE_CODE
- EVENT_THRESHOLD_CODE
- RESTART_TYPE
- SCSI_COMMAND_OPERATION_CODE
- SENSE_DATA_QUALIFIERS
- SENSE_KEY_CODE
- TEMPLATE_CODE



Utilities: FMU
Fault Management Utility

FMU Output Example

HSZ50> RUN FMU
Fault Management Utility
FMU> SHOW LAST_FAILURE MOST_RECENT
Last Failure Entry: 1. Flags: 000FF301
Template: 1.(01) Description: Last Failure Event
Occurred on 07-DEC-1995 at 09:21:44
Controller Model: HSZ50
Serial Number: ZG51909900 Hardware Version:0000(00)
Controller Identifier:
Unique Device Number: 01519090 Model: 40.(28) Class: 1.(01)
Firmware Version: W18J(FF)
Node Name: "HSZA3" CI Node Number: 12.(0C) Informational Report
Instance, Code: 01010302 Description: An unrecoverable hardware detected fault occurred.
Reporting Component: 1.(01) Description: Executive Services
Reporting component's event number: 1.(01) Event Threshold: 2.(02) Classification: HARD.
Failure of a component that affects controller performance or precludes access to a device connected to the controller is indicated.
Last Failure Code: 018800A0 (No Last Failure Parameters)
Last Failure Code: 018800A0 Description:
A processor interrupt was generated with an indication that the program card was removed.
Reporting Component: 1.(01) Description: Executive Services