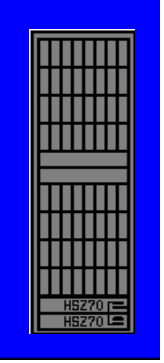
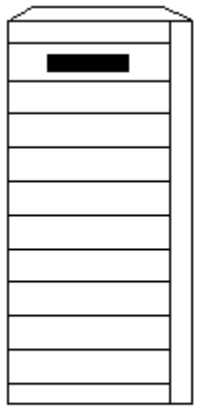


HP StorageWorks Secure Path

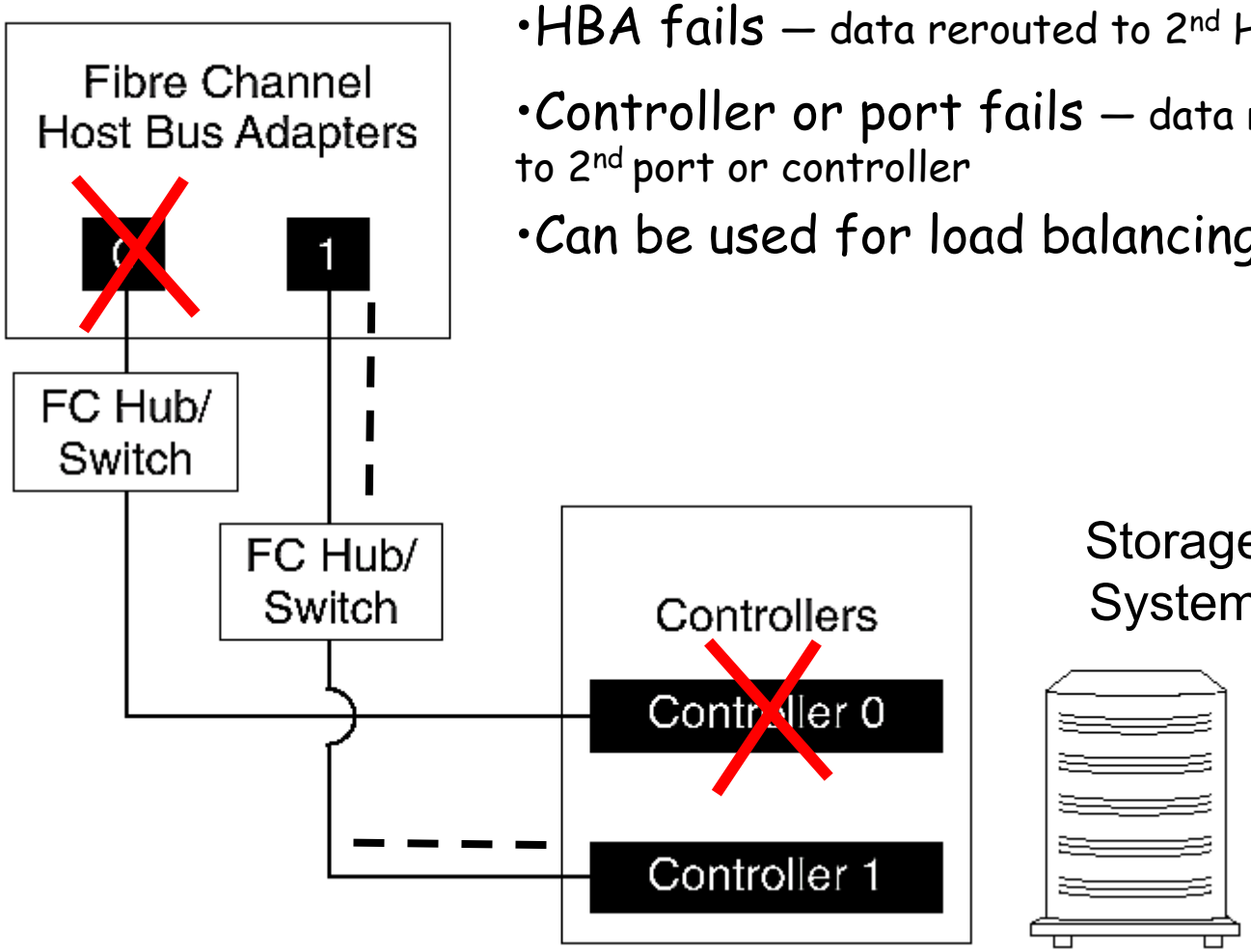
StorageWorks Secure Path Overview

- Secure Path Overview
  - Current Products
  - http://h18006.www1.hp.com/products/sanworks/secure-path/index.html
- Secure Path Specifics
  - *Windows*
  - Netware
  - *Sun*
  - IBM
  - *HP-UX*

Secure Path Overview



Server

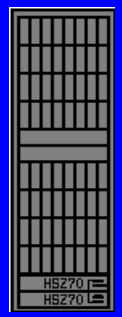


Storage System

- HBA fails – data rerouted to 2nd HBA
- Controller or port fails – data rerouted to 2nd port or controller
- Can be used for load balancing

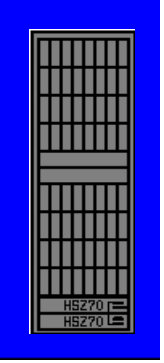
What is Secure Path?

- Current platform support
  - HP StorageWorks Secure Path v4.0B for Windows
  - HP StorageWorks Secure Path v4.0B for Windows Workgroup Edition
  - HP StorageWorks Secure Path v3.0B for SUN Solaris
  - HP StorageWorks Secure Path v3.0B for HP-UX
  - HP StorageWorks Secure Path v2.0C for IBM-AIX
  - HP StorageWorks Secure Path v3.0C for NetWare
  - HP StorageWorks Secure Path v3.0C for NetWare Workgroup Edition
  - HP StorageWorks Secure Path v3.0 for Linux
  - HP StorageWorks Secure Path v3.0 for Linux Workgroup Edition



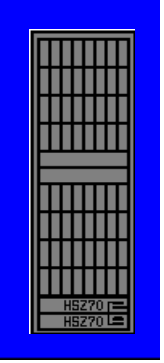
What is Secure Path?

- hosts supported
  - HP-UX v11.0, v11i (32/64 bit mode)
  - Microsoft Windows Server 2003, Windows NT v4, Windows 2000, Datacenter
  - IBM-AIX v4.3.3, v5.1
  - Novell NetWare v5.1, v6.0
  - SUN Solaris v2.6, v7, v8, v9 (32/64 bit mode)
  - Linux Red Hat 7.2, Linux Red Hat Advanced Server 2.1, SuSE Linux Enterprise Server 7
- storage devices
  - HP StorageWorks EVA
  - HP StorageWorks msa1000
  - HP StorageWorks MA/EMA
  - HP StorageWorks ra4000 / ra4100



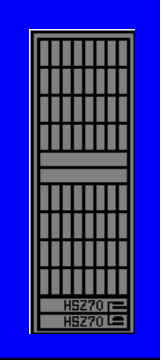
What is Secure Path

- Secure Path is an Application that adds an Operating System Feature called "Multi-Path Capability"
- Multi-Path Capability works in conjunction with the Storage Array Feature called "Multibus Failover Mode"
- Some Operating Systems like VMS and Tru64 UNIX V5.x have Multi-Path Capability built into the OS and do not need a "Secure Path" Application.



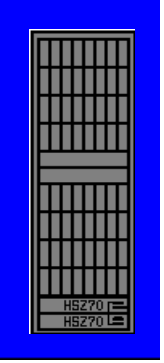
What Is Secure Path

- NT 4.0, Windows 2000, Sun Solaris, AIX and other OS's need Secure Path in order to take advantage of Multibus Mode in a storage array.
- Multi-Path Capability and Multibus Mode combined gives the OS the capability of Path Failover
- Supports Fibre Channel and UltraSCSI (WNT=Z70, Sun=Z80)
- Simple Software Installation procedure



What is Secure Path

- Eliminates the I/O bus as a single point of failure
- Local & Remote Management via TCP/IP (Windows)
- I/O Performance Considerations
  - Dynamic load distribution across both controller host ports of the same controller
  - Manual load balance across adapters / buses
  - Manual load balance across RAID controllers
  - Manual load balance across hosts (MSCS)
- Device Management to balance I/O

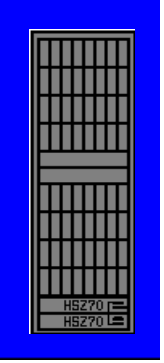


What is Secure Path

- Requires redundant host bus adapters and cabling for fully redundant operation.
- Requires Storage to be set to Multibus Failover.
- Secure Path is one component in a high availability solution and can be used in:
  - Standalone Configurations
  - MSCS Clusters
  - Disaster Tolerant Solutions
  - SAN Configurations
  - OPS Configurations

Theory of Operation

- Enables dual StorageWorks RAID controllers to operate in an active/active implementation
- Storage controller
  - Set PREFERRED_PATH attribute
  - Move storage units between paths with management utility
  - Secure Path controls ports through which storage unit is presented
- Secure Path detects I/O failure and automatically reroutes traffic to other available paths
  - Seeks alternate paths through available SCSI buses, Fibre Channel switches, controllers and ports, and HBAs
- Management utility can fail back to original path



Current Architectures

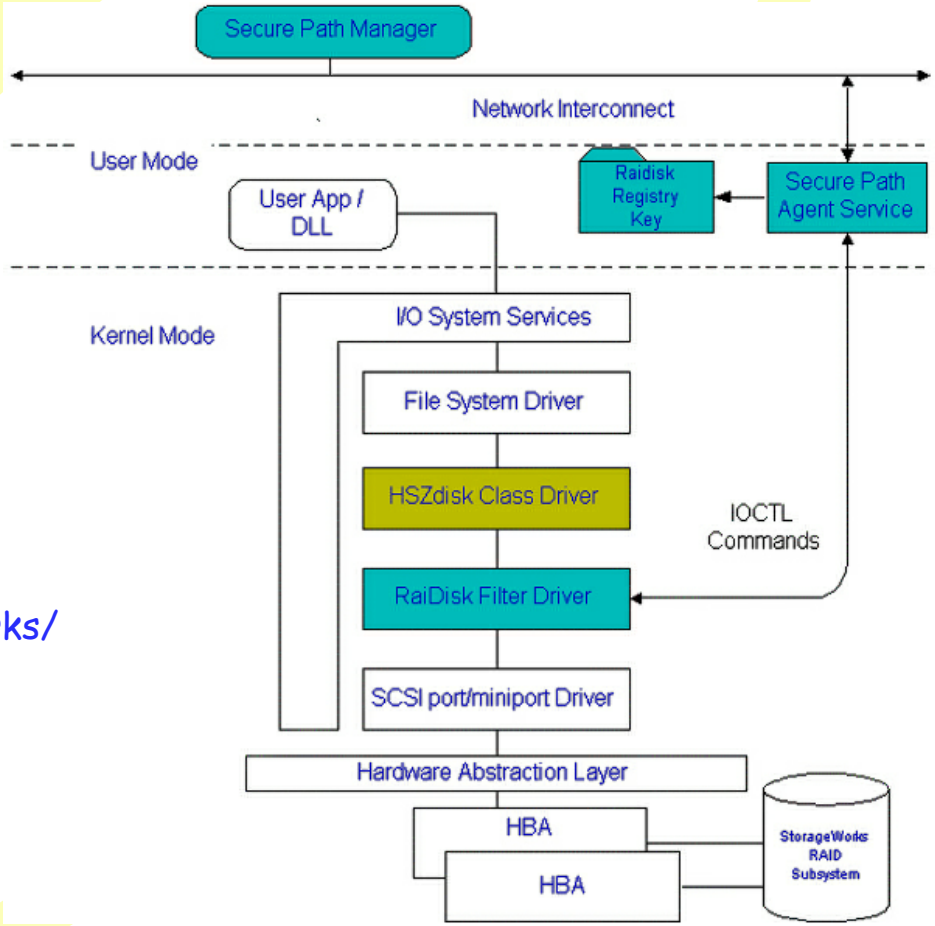
- Separate development on different platforms has lead to a series of cross platform differences.
  - Different driver implementations
  - Different set of features
  - Different behaviors for some features
  - Different solutions for the same problems

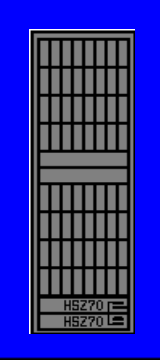
Secure Path Architecture

- Software Components
  - Secure Path Setup Utility
    - Driver installation and removal
    - Check required components prior to installation
  - Secure Path Driver
    - Filter driver for multiple-bus operation
  - Secure Path Agent
    - Enables communication between driver and Secure Path Manager
  - Secure Path Management
    - Manages paths

Current Architecture - Windows

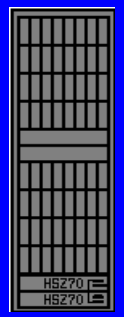
- Multi-path support
- Layered driver
- Web based application for management
- Event notification to management application
- Current version is 4.0B
- http://h18006.www1.hp.com/products/sanworks/secure-path/spwin.html





Current Architecture - Solaris

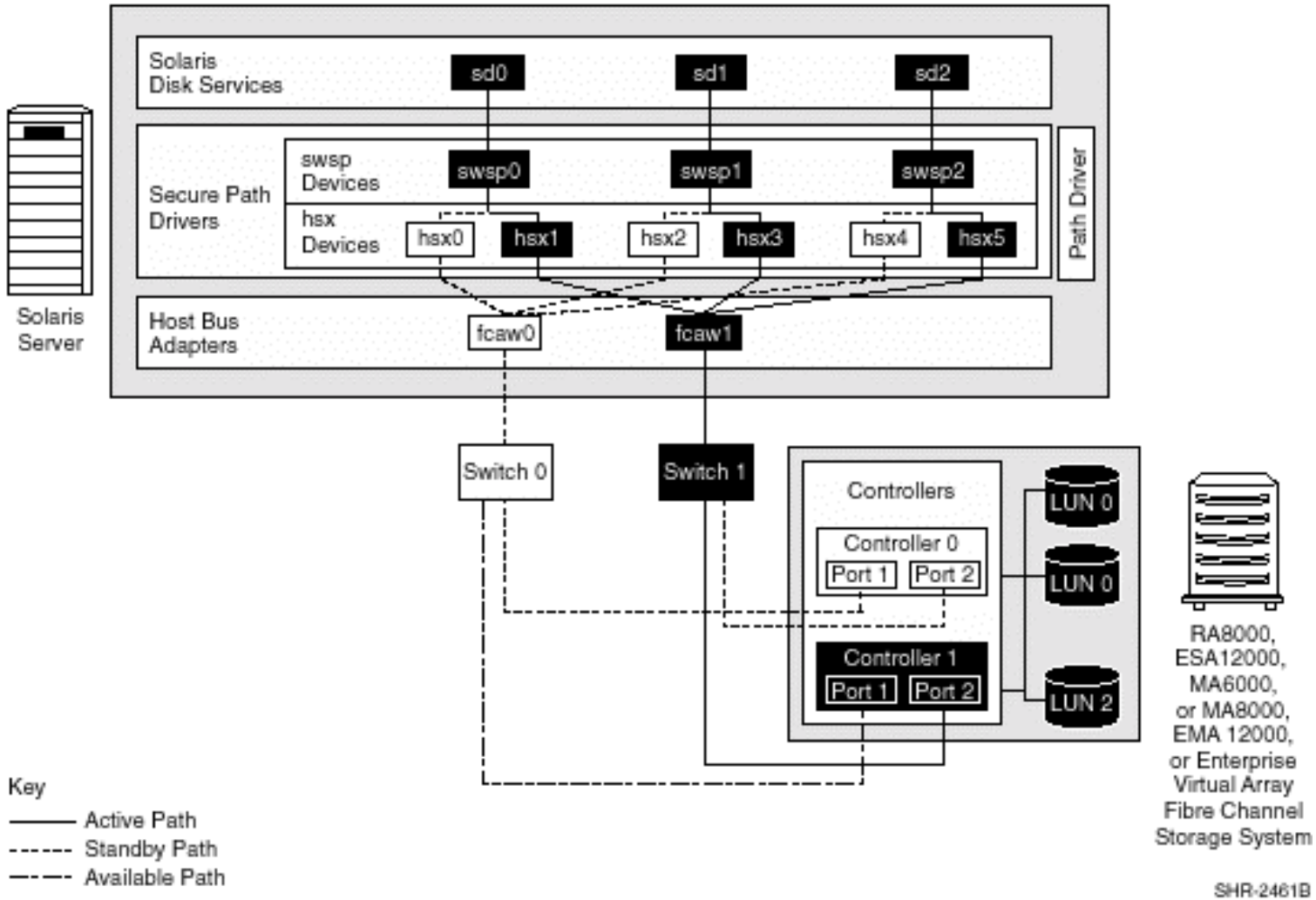
- Multiple-path support
- Layered driver
- Command line management interface
- Event notification via email

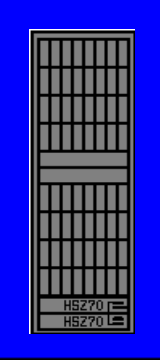


Secure Path for Solaris

- swsp driver — Failover driver presented as pseudo-HBA driver to SCSI disk drivers
  - Presents multiple paths as single device
  - Initiates path failover
- hsx driver — Provides paths from HBA driver for specific arrays to swsp
  - Manages separate paths to a LUN
  - Supports HSG and EVA controllers
- path driver — Allows hsx and swsp to communicate in the kernel

Secure Path for Solaris





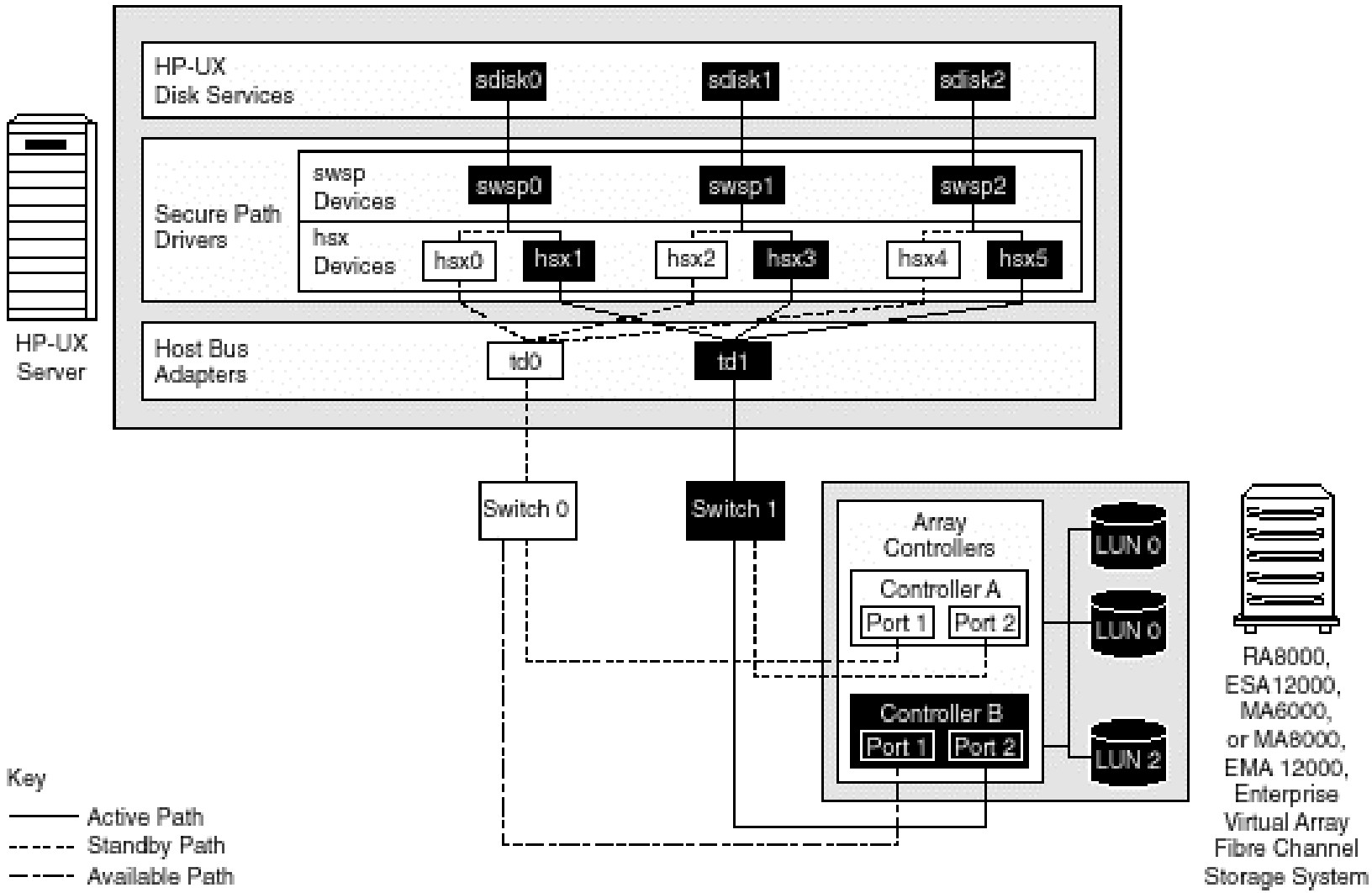
Current Architecture – HP-UX

- Multiple-path support
- Layered driver
- Command line management interface
- Event notification via email

Secure Path for HP-UX

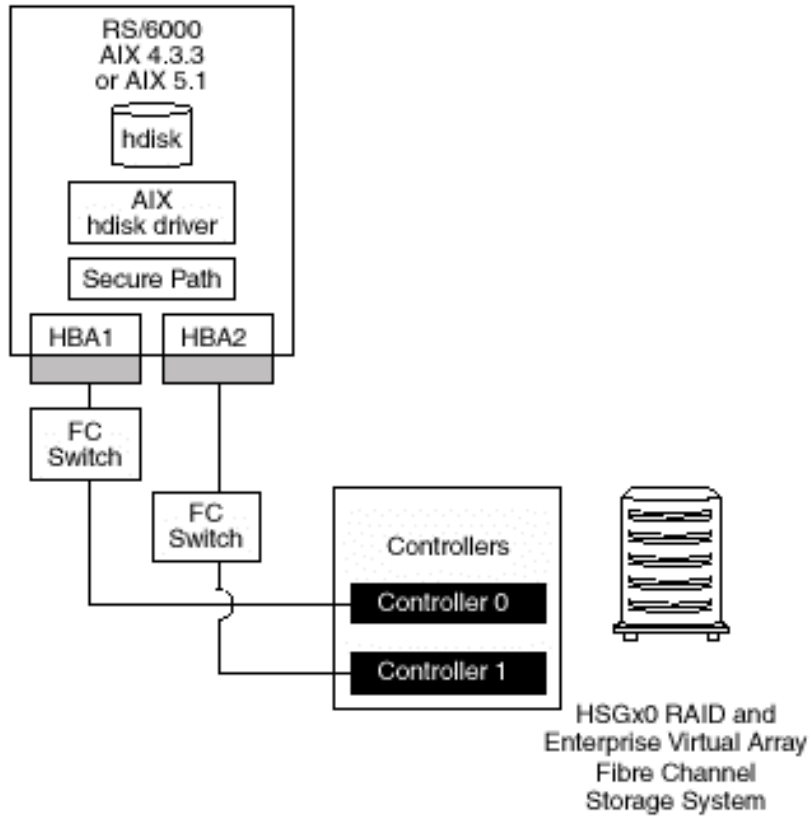
- swsp driver — Failover driver presented as a pseudo-HBA driver to SCSI disk drivers
  - Presents multiple paths as a single device to the host SCSI disk driver
  - Initiates path failover when necessary and manages all kernel threads related to failover.
- hsx driver — Provides paths from an HBA driver for specific arrays up swsp driver
  - Manages separate paths to a LUN and encapsulates array-specific knowledge
  - Supports HSG and EVA controllers

Secure Path for HP-UX



Secure Path for AIX

- hdisk
  - SCSI and FC disk driver
  - Installs at boot or during cfgmgr operations
- PC1000SP
  - HBA driver that manages multiple adapters
  - Enables the AIX system to perform failover
  - Used with the Secure Path Status and Management Utility (cbxfcsm)

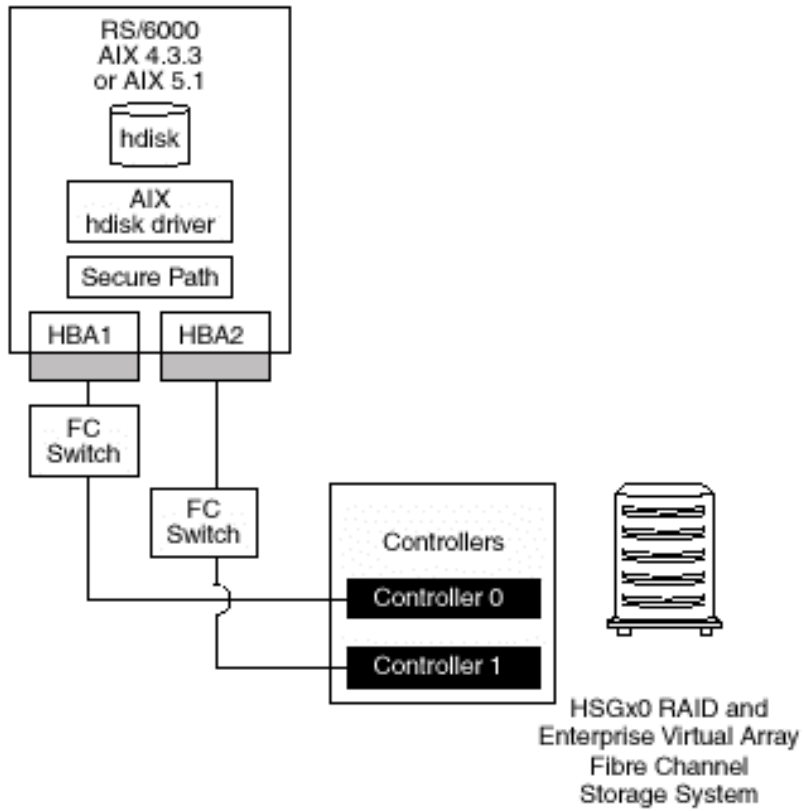


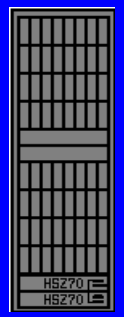
Current Architecture - Novell

- cpqfc.ham
  - Provides primary failover capability
  - Supports multiple path access

Current Architecture - AIX

- Dual-path support
- HBA failover driver
- Command line management interface
- Event notification via system logging





Secure Path Agents

- Windows
- NetWare
- Solaris
- HP-UX

Secure Path Agent

- Windows
  - Windows service
  - Using TCP/IP and Winsock communicates with
    - Secure Path driver
    - Secure Path Manager
  - Posts errors and information to application event log

Secure Path Agent

- NetWare
  - NetWare Loadable Module (cpqspagt.nlm)
  - Communicates with cpqfc.ham driver
  - Communicates with Secure Path Manager
  - Installs on host server with cpqfc.ham

Secure Path Agent

- Sun Solaris
  - spdaemon—daemon process
    - Signaled by mda when failure event detected
  - mda
    - Activates standby request
    - Reissues pending and subsequent I/Os to new path
    - Signals spdaemon that failover successful
  - spdaemon
    - Logs event to console and system log
    - Sends email notification
  - Both transparent to applications

Secure Path Agent

- HP-UX
  - *spagent*—daemon process
    - Interface for SP applications and utilities to communicate to multipath drivers
    - Provides notification of path change events through email
    - Not required to be running for SP drivers to configure and provide failover
    - Must be running for email notification
  - Only supported method to start/ stop SP agent — *spinit* script

Secure Path Management

- Windows and Netware
  - Secure Path Manager
- Solaris, AIX, HP-UX
  - Command line

Secure Path Management Tools

- Windows/NetWare
  - Installed on Appliance or standalone server
  - Web-based cross-platform SP configuration utility
  - Multiple path configurations
  - Enables
    - Continuous availability of storage systems
    - Display of current path states
    - Remote notification of critical events
    - Ability to select load distribution policy

Secure Path Management Tools

- Element Manager
  - Component of SPM — communicates directly with SP agents
  - Client/server application — manages multi-path Array configurations
  - Graphical representation of multi-path environments status
  - Local to managed servers or remote at management workstation
- Notification Utility
  - alerts designated recipients to Secure Path Manager events

Secure Path Management Tools

- Sun Solaris
  - spmr — Manages paths, displays status, and permits CLI access to the controller
  - spconfig — Manages spdaemon that detects path event and sends an email notification
- IBM AIX
  - Cbxfcsm — utility that
    - Displays information
    - Moves a LUN from one path to another (load balancing, etc)
    - Transitions path to online or standby state

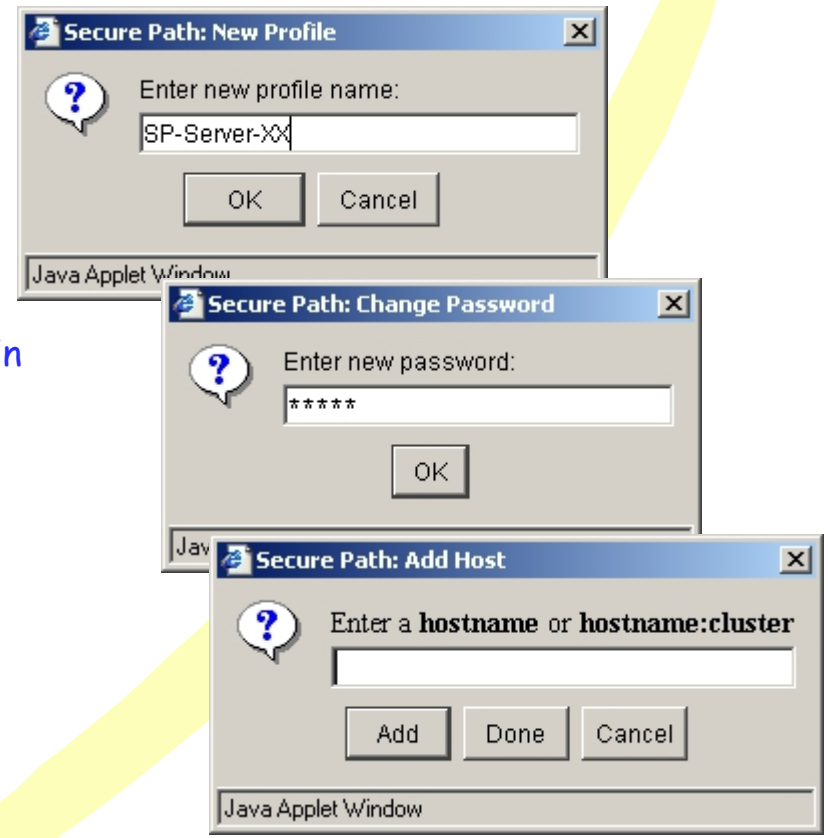
Secure Path Management Tools

HP-UX

- **spmgr** — Utility that monitors and manages devices, storage systems, paths to units in a SP configuration
  - Lets you modify the configuration to repair, replace, or reconfigure
  - Relies on *spagent* to handle calls to the driver *(sws*p)
- **spagent** — Interface for SP applications to communicate with SP drivers
  - *spagent* is started at system boot time
  - Must be running for the *spmgr* utility to operate.
- **spinit** — Script that starts/stops SP agent

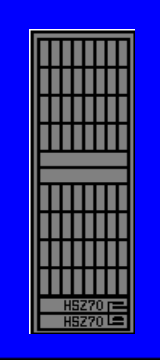
profiles

- Manage configurations with single instance of SPM
  - Managed entity or profile
  - Maximum 128 servers sharing up to 128 storage systems
    - Configure and connect storage system in multi-bus failover
    - Host systems — standalone servers or clusters
  - Multiple profiles



interpreting path status

- Modes
  - Preferred Paths — user-specified paths for host to storageset communication
  - Alternate Paths — redundancy when the preferred paths fail
  - Two offline modes
    - Includes original mode and indicates user specified that path should never be used for I/O
    - Marked offline by user
- State
  - Active — currently servicing or capable of servicing I/O
  - Available — belongs to the set of redundant storageset paths that could be used during failover
  - Failed — path has encountered errors



load distribution

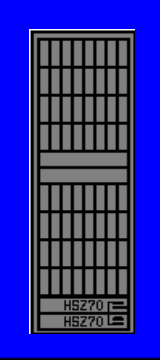
- Multiple paths between host and storageset for parallel I/O
  - I/O dispatched through appropriate paths
  - Spreads load across all ports
  - Three types of load distribution
    - Round
    - Least I/O
    - Least Bandwidth
- Requires a SAN configuration w/4 paths from host storage
- SP marks all paths to owning controller Preferred by default
- User can modify the operational mode of individual paths
- Only available in OS that supports four active ports

antithrash filter

- Avoid indefinitely moving a device back and forth in intermittent failure
- Path Verification, which is enabled by default, must be disabled

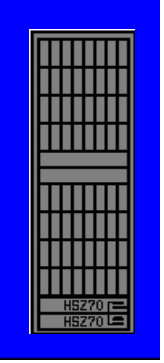
path verification

- SP periodically tests viability of all paths to all storagesets
  - For paths marked Available, Failed, or Active
- Useful for detecting failures that affect overall path redundancy before they affect failover capability
- Path failover occurs if
  - Preferred path fails path verification
  - Alternate path fails path verification
- If a path marked Failed passes path verification, the Path State is set to Available
  - If auto-failback is enabled, the Preferred path becomes Active



failover and failback

- Automatic substitution of a functionally equivalent system component for a failed one
- Failover only when user I/O is active

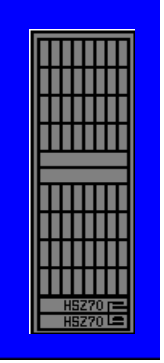


failover hierarchy

- Load distribution disabled
  - Preferred-Active path marked as failed—switches to next Alternate-Available path on same controller if it exists
  - Attempt to move device to Alternate-Available path on other controller
- Load distribution enabled
  - Marked path as failed—removes it from usable path list
  - If no Preferred-Active path remaining, uses Alternate-Available path on same controller activated if one exists
  - If no Alternate-Available paths on same controller
    - Attempts to move to an Alternate-Available path on other controller
    - Sets all Alternate-Available paths to Alternate-Active

failback options

- Restore load of a failed system component to a replacement
  - **Manual mode** — Devices are restored to their original path either through drag-and-drop operation (controller failback) or action menu items (repair
  - **Automatic mode** — SP tests a failed path at fixed intervals if I/O is in process for device
    - If path viable, Path State is set to Active and I/O routed through this path
    - In automatic failback, with path verification, SP enables failback to be performed automatically even if automatic not selected



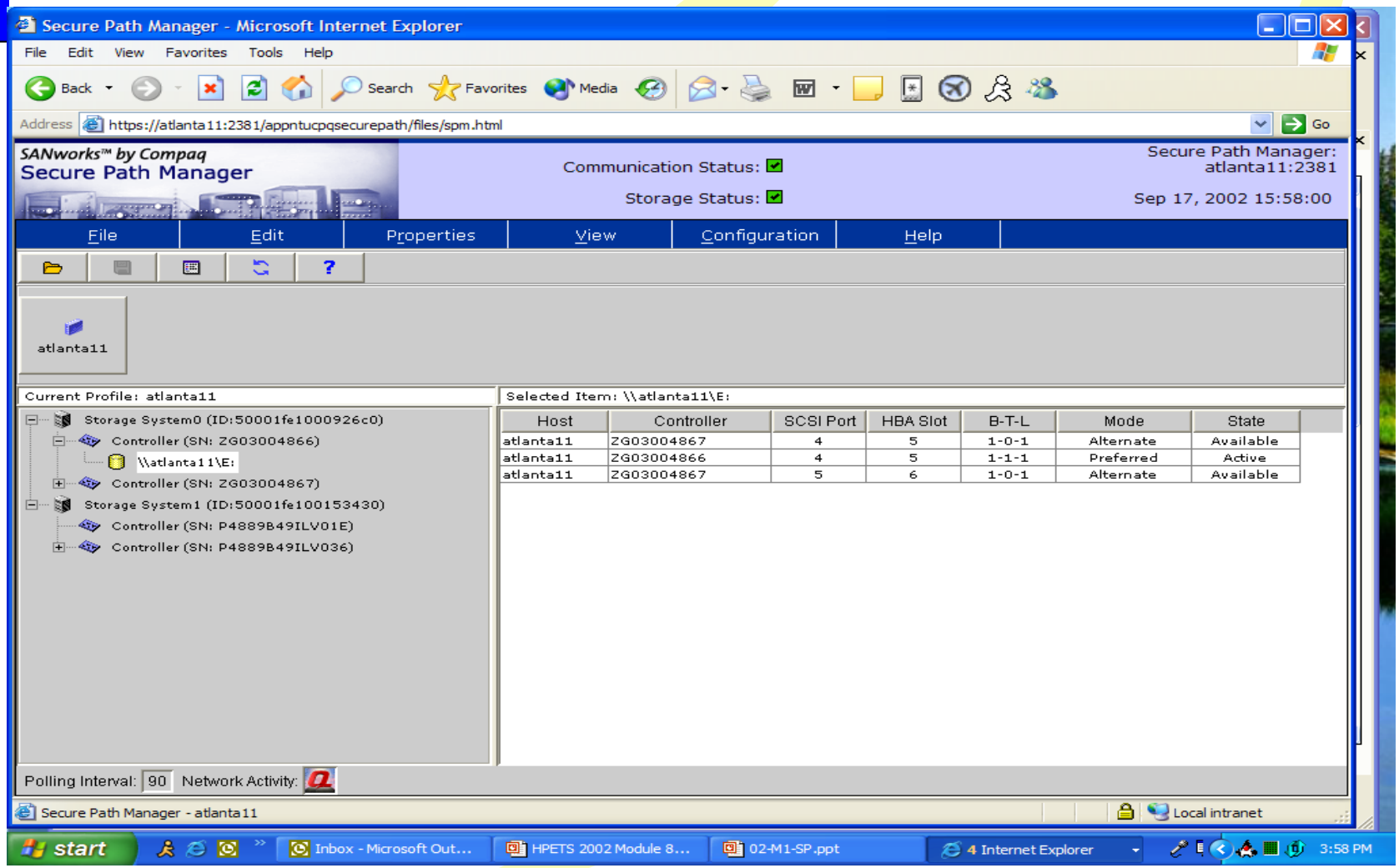
hardware partitions

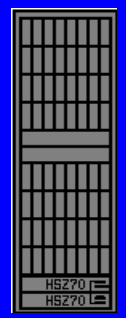
- Subdivisions of storage units that appears as a single disk to servers

- Multiple Bus Failover
  - All partitions must be in same group
  - Partitions cannot be split across controllers or cluster nodes

- Secure Path Implementation
  - Follows controller model, using groups for partitions
  - Partitions cannot be split across different connections (servers)
  - One partition in group fails, all partitions in group fail over

Secure Path Manager

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