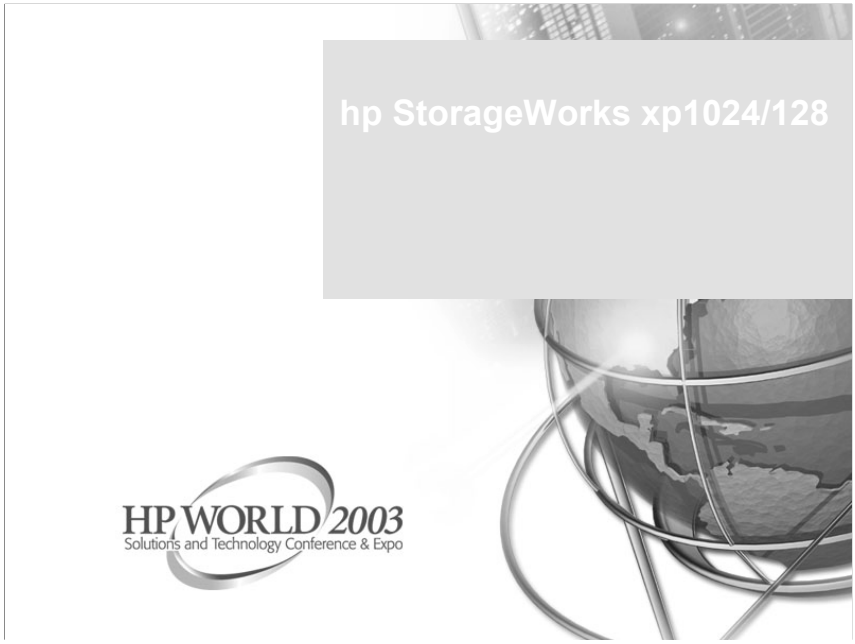

hp StorageWorks xp1024/128
HP WORLD 2003
Solutions and Technology Conference & Expo

s38

xp1024/128 – Agenda

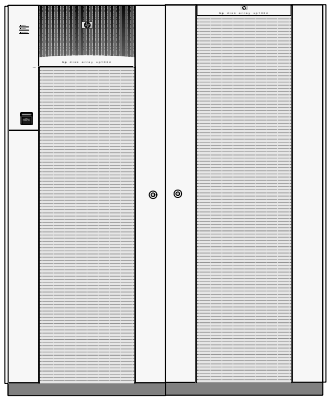
- **Hour 1**
- HP and Hitachi Partnership
- XP1024/128 Architecture
  - Cache
  - Crossbar Switch
  - Shared Memory
  - Supported Drive Types
  - Supported Emulation Types
  - LUSE
  - CVS
  - OPEN-V Emulation

- **Hour 2**
- Command View
- Disaster Tolerant Features
  - Business Copy
  - Continuous Access
- Performance

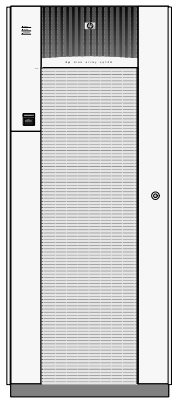
hp StorageWorks xp1024/128

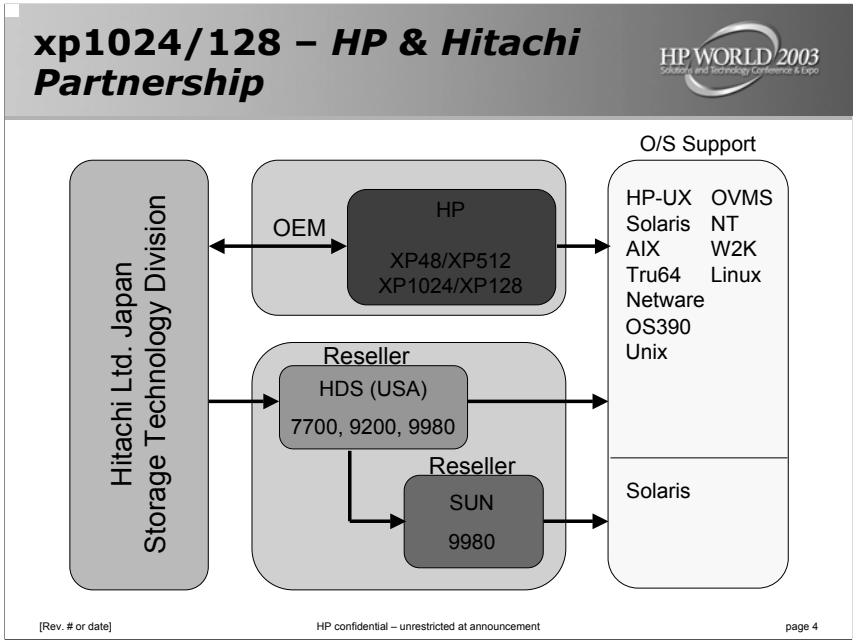
HP WORLD 2003
Solutions and Technology Conference & Expo

hp StorageWorks xp1024



hp StorageWorks xp128





Student Notes:

HP and Hitachi Relationship:

The agreement between HITACHI and HP is an OEM/ R&D relationship. Hitachi manufactures the array and HP is the OEM partner. HP XP is a superset of the core HITACHI platform plus HP's software investment. HDS and other companies sometimes do contract work for HP to ship the product. Just because they may ship HP products does not mean that HDS has access to HP intellectual property or HP support. HDS and XP hardware are the same! However, there is unique HP firmware written for XP arrays called the open systems kit, which allows the XP array to take advantage of HP invented value-add software and business continuity storage solutions. This firmware is only available on XP, which is why if you buy HITACHI from HDS or SUN, HP software will not work.

HDS and Hitachi Relationship:

HDS is just another channel HITACHI uses to get the product to market. HDS is comprised of a sales force, marketing, factory system level assembly and distribution and support functions.

SUN and HDS Relationship:

The agreement between SUN and HDS is a reseller relationship. Sun is reselling the HDS box, so it is identical in software and hardware. Sun will remarket the HDS Lightning 9970 and 9980 with associated software. The resulting product will have a SUN and HDS label on the box. Sun will not provide significant engineering to enhance the product for Sun Solaris environments.

HDS 7700 = XP256

HDS 9200 = XP48

HDS 9970 = XP128

HDS 9980 = XP1024

HDS 9980v = XP1024 (w/ heterogeneous CHIP port option)

xp1024/128 – *HP & Hitachi Partnership*

HP WORLD 2003 Solutions and Technology Conference & Expo

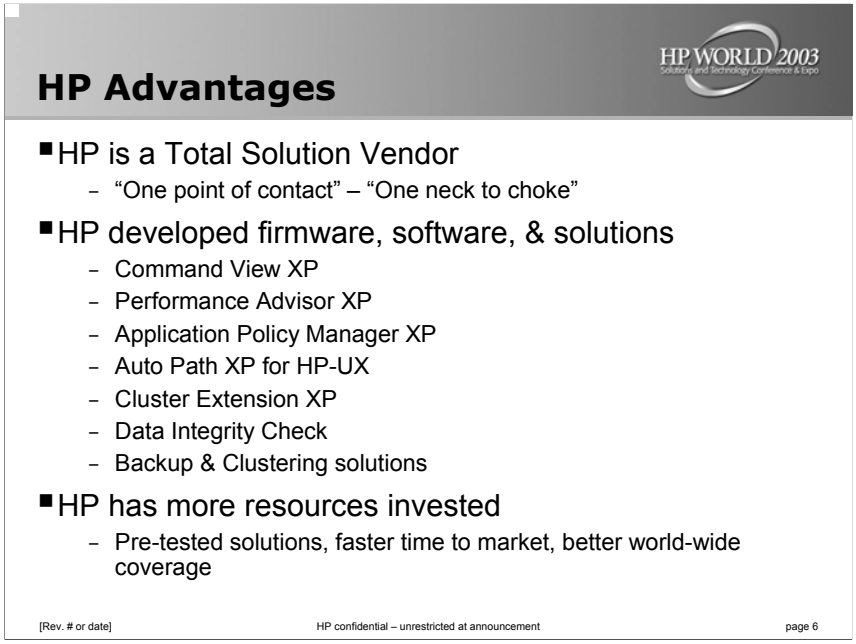
Which software does HP OEM?

- OEM from HDS:
  Performance Manager (blind CPL only)
- OEM from Hitachi:
  LUN and Security Manager XP
  Cache LUN XP
  Auto LUN XP
  Business Copy XP
  Continuous Access & Extension XP
  Auto Path AIX
  Resource Manager & Data Exchange (for mainframe only)

Student Notes:

HP OEM's specific array firmware based software titles from HDS as listed on the slide. There is an HP differentiator/advantage even for our OEM s/w titles. HP includes these OEM titles in our end-to-end solution integration testing and certification programs. Each OEM s/w title goes through extensive compatibility/regression testing by HP. This ensures that when you buy from HP the entire solution from device mgmt to large SAN configurations have all been tested prior to customer delivery. Our complete testing leads to savings in time to implement and configure simple up to complex disaster recovery configurations.

Note: the names for HP XP software listed on this slide are HP generated names. These names are not the same names marketed for the same functionality by HDS or Hitachi!



Total Solution Vendor – "one point of contact"

HP - One vendor– end to end data center management, products, consulting, and services

"one neck to choke"

Competitors - Multiple vendors in the data center – as many as 6 in a SAN (storage, server, tape, HBA, management software, and cluster software)

HP has developed firmware, software, and solutions that is unique to XP arrays. These key features are not available to HDS or any other vendor that resells HDS arrays including SUN. HP unique firmware provides hooks into the XP allowing the HP developed software and solutions to work their best. HP unique firmware tightly integrates XP software and XP solutions and HP OpenView Software modules tie them together so that the resources are simple to manage

HP value-added software

Command View XP - Simplified device management that provides a common interface with a common device launcher for XP software. Command View XP has multi-levels of security and even can provide encryption via a Secure Socket Layer (SSL) across the data path for business information protection.

Performance Advisor XP - HP unique software that troubleshoots performance problems quickly

Application Policy Manager XP – HP unique software that lets you borrow, fence and limit storage resources that directly affect application and user performance

Auto Path XP for HP-UX – Adds HP-UX support to Auto Path

Cluster Extension XP - Anybody can claim disaster recovery solutions, but an API does not mean you can configure and set up the array for true disaster recovery. A rapid implementation from HP.

OpenView SAM - when Command View XP & OpenView SAM are installed together the OV SAM products have the unique capability to gain access to the entire suite of array device management functionality.

Data Integrity Check - compatible with raw disk configurations, in addition to key volume manager environments. It also supports Serviceguard high availability server clustering for HP-UX solutions.

HP value-added solutions

Backup Solutions – Data Protector, Zero Downtime Backup, and HP libraries

Cluster Solutions - Serviceguard, Metrocluster, Cluster Extension, Continentalclusters

HP StorageWorks XP disk arrays

- HP Adaptive Infrastructure offerings include the HP StorageWorks XP disk arrays
- HP StorageWorks XP disk arrays help you
  - Manage costs
  - Increase quality
  - Mitigate risk
  - Improve agility
  - Improve your return on IT investment

xp128

Fast, Flexible, and Reliable Enterprise Storage

xp1024

[Rev. # or date] HP confidential – unrestricted at announcement page 7

The XP family of disk arrays provides stress-free, high-end storage with the following features:

•scalable technology at great price/performance

•multiple arrays and hundreds of terabytes managed from a single station, managed by existing staff, no increase in staffing required

•increased productivity via higher throughput speeds and zero downtime

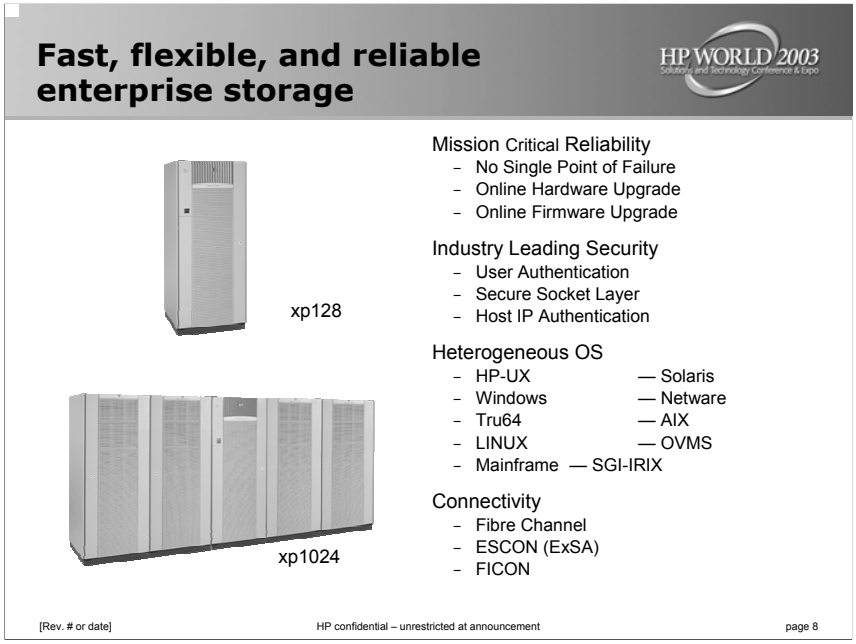
•compact footprint to conserve floor space Continuous operation with no single point-of-failure and rapid disaster recovery

•Maintenance and upgrades can be performed while the systems are online, with no interruption of service

•Overall lower TCO due to negligible downtime, ease of management, and reduced data center space

•And, of course, both products support a wide range of operating environments for full heterogeneous connectivity.

The latest generation of the XP family consists of the xp1024 and the xp128



Continuous availability is an important requirement for most companies today. The costs associated with system downtime are skyrocketing. The xp128 and xp1024 enable 24×7 operation in several ways.

RAID technology and redundant hardware paths ensure that there is no single point-of-failure, minimizing the likelihood of unplanned shutdown. If one of the two data paths fails, the other path takes over automatically. The remote support center is alerted to the problem, and they can fix it quickly with a minimum of stress because the data is still accessible while the problem is being addressed.

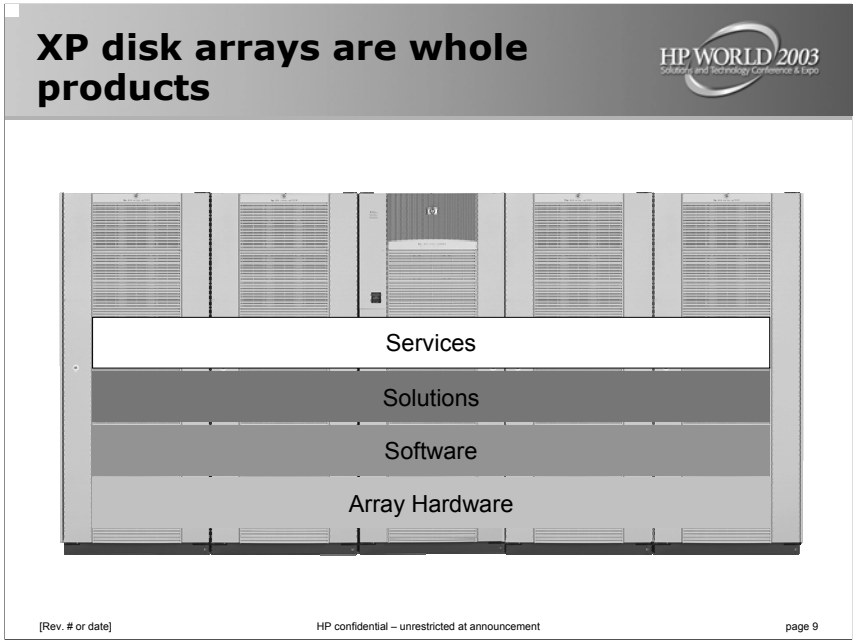
Both the xp128 and xp1024 offer a painless growth path; they can be upgraded without taking the system down, so you can add more capacity as required without disrupting business operations. In addition, HP's management software makes it easy to manage several additional arrays from a single console, so your storage capacity can grow without increasing demands on administrative staff.

Zero-downtime backup solutions and Instant Recovery solutions and online upgrade enable data protection and scaling with no service disruption.

In case you need to restore data after a physical disaster, data-mirroring techniques of HP's Business Copy and Continuous Access software with full integration within HP OpenView Data Protector backup management software ensures that you can rapidly restore your data and return to normal operation quickly and efficiently.

Command View, HP's industry-leading management software, provides data security to meet any need. Unauthorized access is prohibited through use of encrypted passwords. Command View configures the authentication in the array, while the Security Layer module manages secure communication between the server and the array.

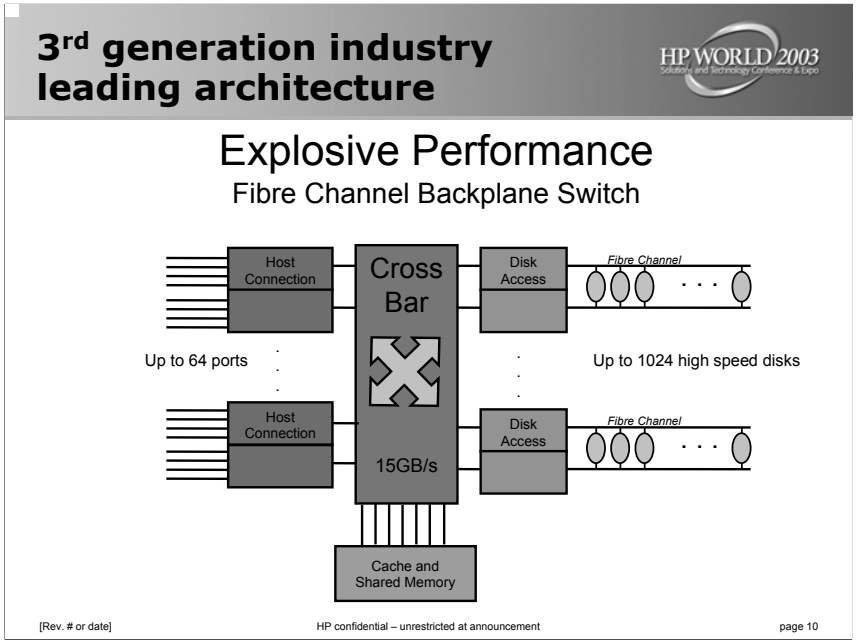
A wide variety of servers and operating systems can be connected to an XP disk array



The XP disk arrays are not just racks full of hardware.

The xp128 and xp1024 are whole products made up of all the hardware, microcode, software, solutions, and services that you might need to implement a complete storage infrastructure.

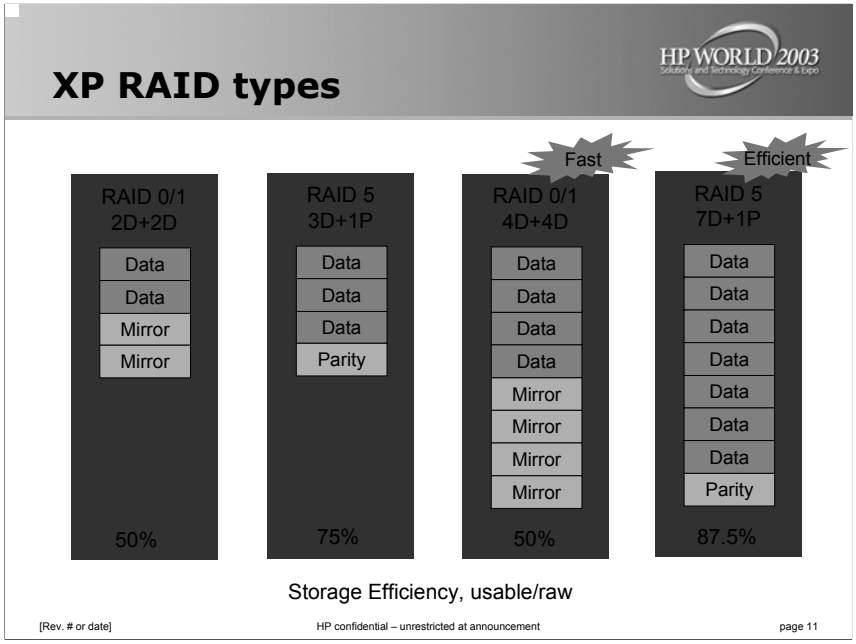
We will look at each of these components of the complete XP product in more detail.



This is the 3rd generation of XP technology -- 2nd generation using crossbar switch technology. Industry proven reliability -- now 2X the performance!

The key to the XP high performance is the crossbar architecture. With 15GB/sec of available throughput the crossbar allows the XP performance to scale as disk array processors, host connections and cache memory are added.

This crossbar architecture eliminates bus contention, creating a high bandwidth path from server to disk. This is the next-generation architecture and accounts for the outstanding performance achieved by the XP.



One of the exciting new technical features of the xp128 and xp1024 is the support for new RAID stripe sizes. These new stripe sizes offer more performance, more configurability and more net usable storage space. These features deliver a better performance and lower cost of ownership to the user.

Earlier versions of the XP supported four disk stripes.

RAID 0/1 uses a 2 data + 2 mirrored data configuration. We refer to this configuration as 2data plus 2data because the array can read from either set of identical information. The array is first set up as a group of mirrored pairs (RAID 1), then striped (RAID 0). A RAID level 0/1 array done in this manner can sustain multiple drive failures, as long as both drives of a mirrored pair do not fail at the same time. The probability of this occurring is very low.

RAID 0/1 results in 50% efficiency of usable storage compared to raw capacity.

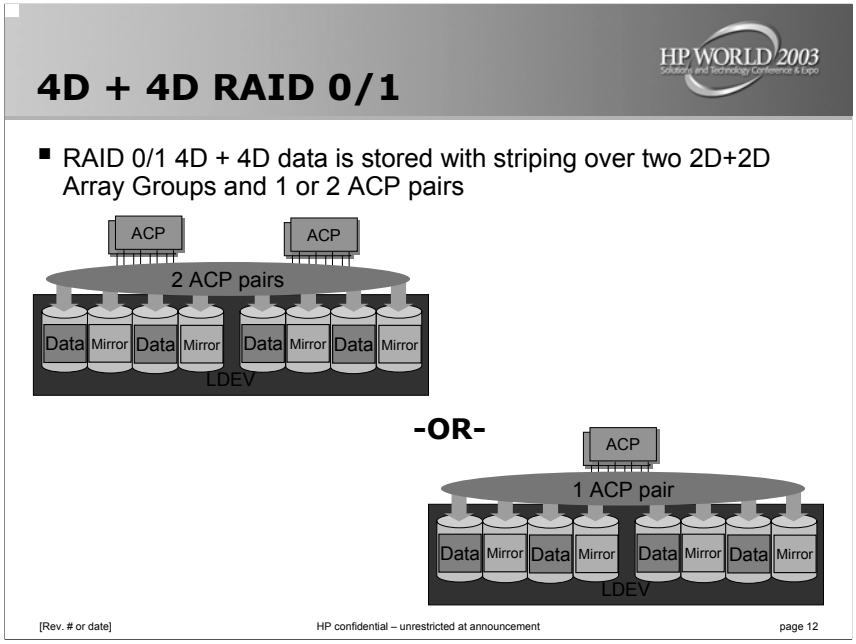
RAID 5 uses a 3 data plus 1 parity drive configuration. This results in 75% efficiency of raw storage. Given the outstanding performance of the XP family, RAID 5 performance has been widely used by our customers, to get both the better efficiency and excellent performance. RAID 5 uses block level striping and distributed parity. RAID 5 distributes the parity over all of the drives to increase performance by decreasing the bottleneck to a single drive. RAID 5 parity is used for fault tolerance. If one of the disk drives in the RAID 5 array goes down, data can be recovered from the remaining drives. In this case, the RAID 5 array is said to be "degraded". A degraded RAID 5 array is not fault tolerant until the failed drive is replaced and the RAID 5 array is rebuilt.

The xp128 and xp1024 introduced two additional RAID striping options. With RAID 0/1 4 data plus 4 data, we now deliver more performance and more configuration flexibility. The 4D + 4D configuration provides up to double the performance in reading from or writing to a single logical unit. Also, for certain operating systems, having a smaller number of larger capacity stripes makes configuring the storage easier and simpler. RAID 0/1 4D+4D is available with both xp1024 and 128 arrays.

Both the xp1024 and 128 support true RAID 5 in a 7data +1parity configuration. This configuration improves the storage efficiency to 87.5% of usable compared to raw storage. With the excellent performance of the XP RAID 5 implementation, and the many data protection features of the XP, we expect many customers to choose this highly efficient RAID 5 striping option to minimize cost of storage while delivering excellent system performance. RAID 5 7D+1P and 3D+1P configured storage can be used in the same XP array at the same time.

Note: 7D+1P require at least two ACP Pairs in the configuration, which assures excellent performance by spreading disk accesses across the system.

4D+4D may be implemented using one or two ACP Pairs.



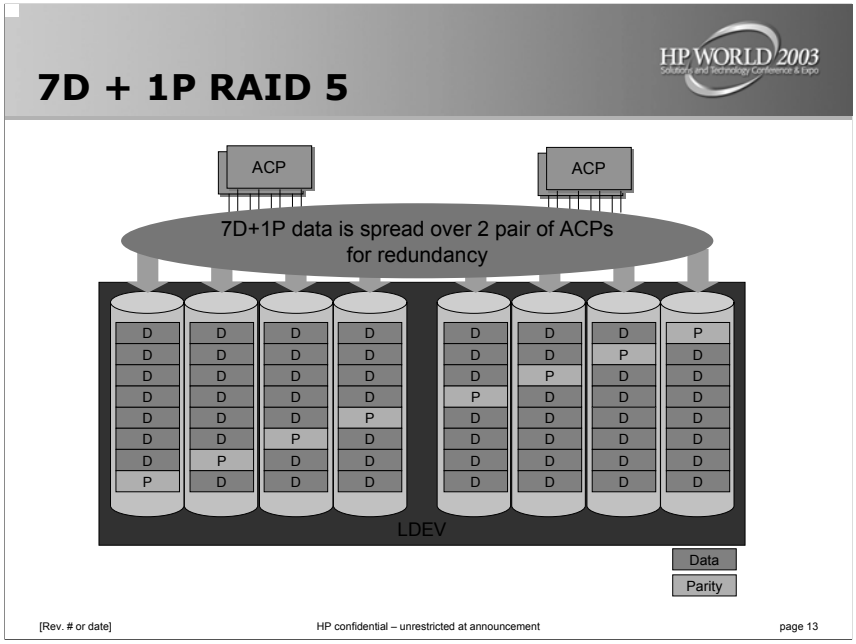
Raid 0/1 (4D+4D) is supported by both the xp128 and xp1024

RAID level 0/1 is a combination of RAID levels 0 and 1.

The array is first set up as a group of mirrored pairs (RAID 1), then striped (RAID 0). A RAID level 0/1 array done in this manner can sustain multiple drive failures, as long as both drives of a mirrored pair do not fail at the same time. The probability of this occurring is very low.

Performance is very good with RAID 0/1 arrays, and redundancy is also very high, but it comes at the cost of additional disk drives.

Fibre Channel acronyms for ACP are DKF & DKA



RAID 5 uses block level striping and distributed parity. The RAID 5 parity is used for fault tolerance. If one of the disk drives in the RAID 5 array goes down, data can be recovered from the remaining drives. In this case, the RAID 5 array is said to be "degraded". A degraded RAID 5 array is not fault tolerant until the failed drive is replaced and the RAID 5 array is rebuilt.

RAID 5 distributes the parity over all of the drives to increase performance by decreasing the bottleneck to a single drive.

The usable capacity of a RAID 5 array is equal to the number of drives in the array minus 1 x the capacity of the drives

For example, a RAID 5 array with 8 drives uses only 12.5% (1/8) of its capacity for parity protection.

RAID 5 is one of the most popular RAID levels being used today. RAID 5 is an excellent combination of performance, redundancy, and storage efficiency.

Fibre Channel acronyms for ACP are DKF & DKA

HP StorageWorks xp1024

xp1024	
Max Disk Drives	1024
Max Capacity	149 TB raw 129 TB usable
Max Aggregated Crossbar Throughput	15 GB/s total 10 GB/s data 5 GB/s control
Max Sequential Data Transfer Rate	2 GB/s sustained 3.2 GB/s peak from cache
Max Random IOPS from Cache	500,000
Maximum LDEVs	8192

Unprecedented Performance, Scalability, and Reliability for the Enterprise

[Rev. # or date] HP confidential – unrestricted at announcement page 14

The xp1024 is the “flagship” product of the XP family.

The xp1024 offers up to 1024 disks in a system and is the highest performing XP system. The xp1024 stores twice as many disks in 90% of the space of competing systems. The small footprint of the xp1024 enables efficient use of data-center space, letting you achieve cost savings by providing more storage capacity in the same amount of space.

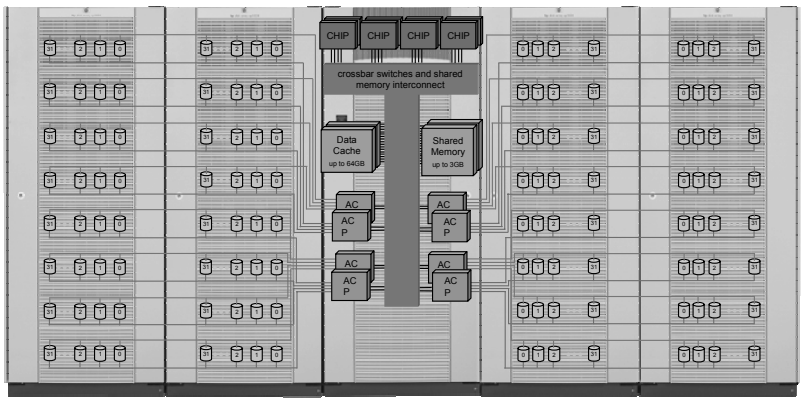
The xp1024’s main features are:

- Capacity growth of up to1024 drives, as much as 129 TB of usable data
- Up to 500,000 IOPs from cache
- Up to 2.0 GB/sec of sustained sequential throughput
- 24x7 uptime for mission-critical environments with built-in redundancy and online upgrade features
- Superior performance features for data-intensive, HA-critical applications such as data mining and data warehousing applications. The xp1024 is also well suited for OLTP, ISPs, and telecommunications customers with high storage and growth expectations.
- Uninterrupted operation, which is essential in mission-critical environments, is ensured with no single point of failure in the array. The system remains available even while components are being replaced. The XP family also supports array-to-array local and remote copying of data. When one array becomes unavailable due to a disaster, the data is still available from the other array in a remote location. Also, the XP family supports zero downtime back up, providing continuous availability to the data.

The xp1024 provides a low total cost of ownership when all factors are considered (purchase, support, ease of management, reduced data-center space requirements, etc.)

xp1024 scalability

Start at the size you need, scale to the highest usable capacity of any array on the planet



[Rev. # or date] HP confidential – unrestricted at announcement page 15

NOTES

This slide is animated, each step depicts the XP scaling up.

ACP pairs, DKUs, and disk drives can be added in different order than what is shown by animation

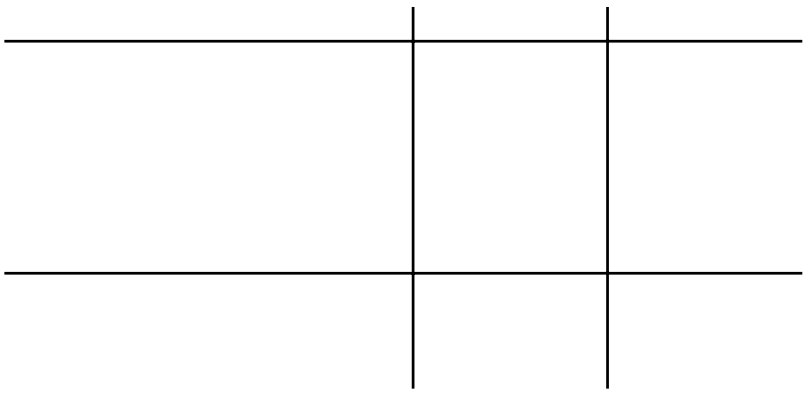
Order depends on performance/cost preferences of the customer

The xp1024 allows you to start with the size you need today and scale as your need grow.

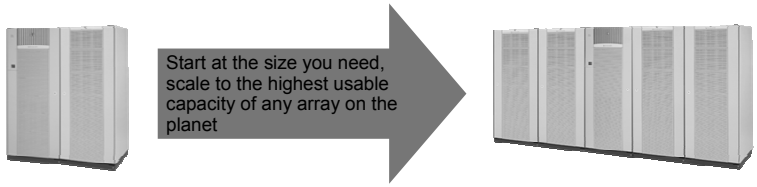
The smallest xp1024 consists of one DKC (control cabinet) and one DKU (disk cabinet)

It can contain as little as

- One CHIP pair
- 4 Gigabytes of Cache Memory
- 512 Megabytes of Shared Memory
- One ACP pair
- And 8 disk drives



HP StorageWorks xp1024 scalability



	Min	Increment	Max
Data Drives	8	4	1024
Capacity	288 GB raw 144 GB usable	-	149 TB raw 129 TB usable
Spare Drives	1	1	16
Cache	4 GB	2 GB	64 GB
ACP Pairs	1	1	4
Shared Memory	512 MB	512 MB	3 GB
Host Ports	8	8/16	64
Controller Frames	1	-	1
Disk Frames	1	1	4

[Rev. # or date] HP confidential – unrestricted at announcement page 16

The xp1024 allows you to start with the configuration you need today and scale of the highest usable capacity of any disk array as your needs grow!

With the xp1024, you can mix drives of various capacities and speeds in the same array to achieve an optimal balance of performance and capacity for your particular application demands.

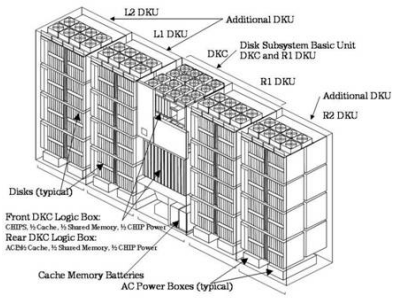
The xp1024 also allows you to size the cache, ACP pairs, shared memory, and the number of host ports and spare drives to meet your particular requirements.

The xp1024 is an excellent choice when initial storage needs are greater than 3–4 TB and are expected to grow substantially in the near future.

The xp1024 is the right choice if you need the very best performance.

With its high performance and storage capacity the xp1024 is ideally suited for business intelligence, that is a combination of data warehousing, data mining and information generation.

HP StorageWorks xp1024



The xp1024 hardware consists of
- One central cabinet (DKC)
  - Array Control Processor (ACP) pair(s)
  - Crossbar Switch
  - Cache Memory
  - Shared Memory (SM)
  - Service Processor (SVP)
  - Client Host Interface Processors (CHIPs)
  - Control Panel
  - Redundant Power
  - Batteries for cache and shared memory backup (BU).
- One to Four disk cabinets (DKU)
  - Each cabinet holds up to 256 Disk Drives.
  - Power Supplies

[Rev. # or date] HP confidential – unrestricted at announcement page 17

xp1024 Hardware

The xp1024 hardware consists of a cabinet for the controller (DKC) and one to four cabinets for the disks (DKUs). The controller cabinet contains the control panel, service processor (SVP), cache modules, shared memory modules, crossbar switch, batteries for cache and shared memory backup, Client-Host Interface Processors (CHIPs) and Array Control Processors (ACPs). There is space in each disk cabinet for up to 256 disk drives.

Features

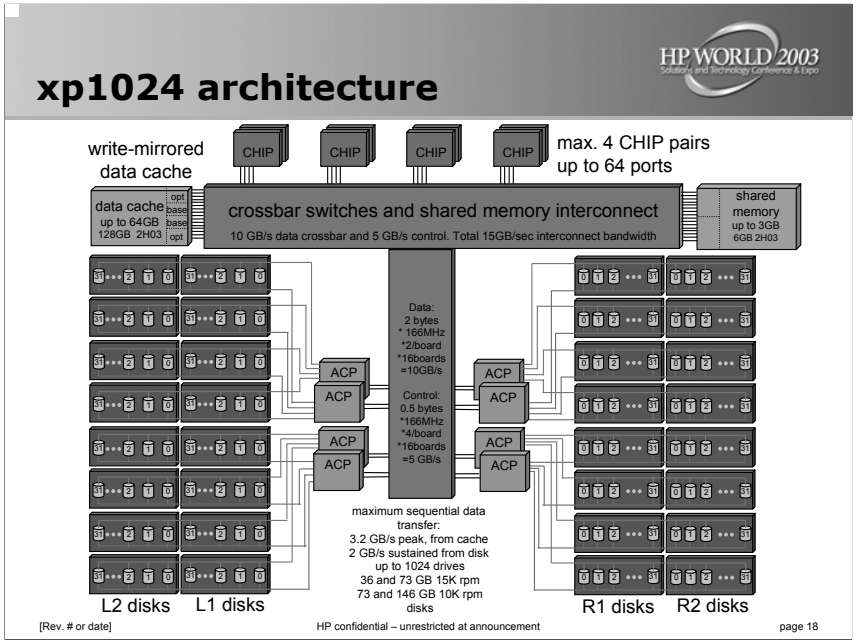
Fully redundant components, with no single point of failure

Dynamically-duplexed cache with battery backup (BU)—cache is expandable from 4 GB up to 64 GB total capacity in 2-GB increments. Beyond 32 GB, or when the cache is configured in high performance mode with the optional cache platform boards (A7919A or A7919U) the cache is upgraded in 4-GB increments.

Crossbar switch—fast, efficient, switching with direct point-to-point connections at 15 GB/sec.

Shared memory with battery backup (BU —stores command and control data so that the entire amount of cache memory is available for quick access to user data. Shared memory is expandable from 512 MB to 3.0 GB in 512-MB increments.

Power redundancy—multiple connections to AC power which can be connected to different power sources, using single-phase or three-phase in 50- or 60-Hz



The elegant design and extreme scalability of the xp1024 means that it can deliver outstanding, unmatched storage and transfer of data. This array will allow applications to reach new levels of performance and user satisfaction. Key to this amazing level of performance is the xp1024's crossbar architecture.

In simplified terms, the "crossbar" provides literally two (2) switches in the xp1024 (two for redundancy) that enable all data paths to remain open without any contention. This translates to an aggregation of backplane throughput of 15 GB/s.

The XP architecture is highly redundant with no single point-of-failure. Redundant components, online capacity upgrades and true online firmware upgrades keep the array up and running, and ensure that critical data is available for use. As one user described it, the XP is a "boot once" array.

Channel Host Interface Process (CHIP) is a PCB used for data transfer control between the host and cache memory.

This architecture is also highly efficient. The host side (CHIP) processes cache hits, checks access rights, and links protocols, so server requests are processed and handled quickly.

Array Control Process (ACP) is a PCB used for data transfer control between disk drives and cache memory. Four ports per PCB are mounted. Ports are controlled by their respective dedicated microprocessors and data is transferred concurrently between ports and disk drive.

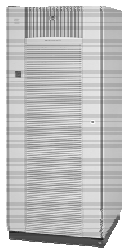
Cache memory is nonvolatile memory (battery backed up) and write data is duplicated so that data loss is not caused even when a failure of one component occurs in power supply or PCB.

Shared memory is nonvolatile memory (battery backed up) used to store cache directories and disk control information. The required shared memory varies with the size of cache and number of LDEVs.

HP StorageWorks xp128

xp128	
Max Disk Drives	128
Max Capacity	18 TB raw 16 TB usable
Max Aggregated Crossbar Throughput	7.5 GB/s total 5 GB/s data 2.5 GB/s control
Max Sequential Data Transfer Rate	1.1 GB/s sustained 2.4 GB/s peak from cache
Max Random IOPS from Cache	375,000
Max LDEVs	8192

Enterprise Performance, Capacity, and Reliability in a Small Footprint



[Rev. # or date] HP confidential – unrestricted at announcement page 19

The xp128 offers up to 128 disks in a single cabinet system. With all the software functionality of the larger xp1024, it is a true enterprise system with the smallest footprint in the industry. The small footprint enables efficient use of data-center space, letting you achieve cost savings by providing more storage capacity in the same amount of space.

The main features of the xp128 are:

Support for up to 128 drives.

Small footprint. The xp128 is a single-cabinet system housing both DKC and DKU in one cabinet. The xp128 is well suited for data centers where space is at a premium.

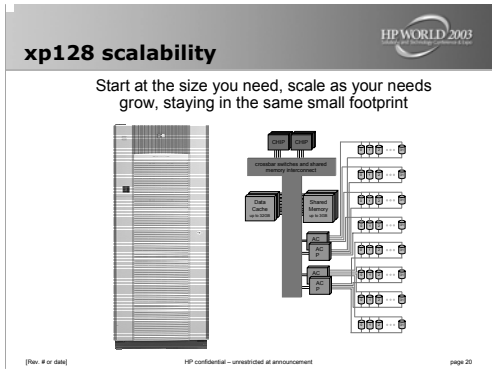
24x7 uptime for mission-critical environments with built-in redundancy and online upgrade features.

Rapid disaster recovery. In case of disaster, a mirror site seamlessly takes over and the customer operation continues with minimal disruption.

Uninterrupted operation, which is essential in mission-critical environments, is ensured through no single point of failure. The system can remain available even while components are being replaced or upgraded.

Customers will use the xp128 in applications such as On Line Transaction processing (OLTP), mid-size data center storage consolidation, business intelligence and data warehousing, e-commerce, telecom call data tracking, and Internet. High-performance features for applications such as telecommunications, OLTP, and data warehousing.

The xp128 provides a low total cost of ownership when all factors are considered (purchase, support, ease of management, reduced data-center space requirements, etc.)



NOTES

This slide is animated, each step depicts the XP scaling up.

ACP pairs and disk drives can be added in different order than what is shown by animation

Order depends on performance/cost preferences of the customer

The xp128 allows you to start with the size you need today and scale as your need grow.

The smallest xp128 consists of one cabinet that contains both the control systems and the disk drives

It can contain as little as

One CHIP pair

2 Gigabytes of Cache Memory

512 Megabytes of Shared Memory

One ACP pair

And 4 disk drives

As your needs grow you can continue to add disk drives

Up to 64 disk drives per ACP pair

You can also add additional infrastructure. The xp128 will hold up to:

3 CHIP pairs (2 CHIP pairs if two ACP pairs are present)

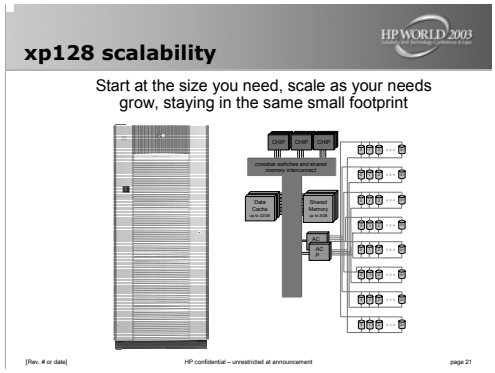
32 Gigabytes of Cache

3 Gigabytes of Shared Memory

Additional ACP pairs and disks can be added (limiting the max number of CHIP pairs to 2)

Up to 128 drives

Scale as your needs grow while staying in the same small footprint!



NOTES

This slide is animated, each step depicts the XP scaling up.

ACP pairs and disk drives can be added in different order than what is shown by animation

Order depends on performance/cost preferences of the customer

The xp128 allows you to start with the size you need today and scale as your need grow.

The smallest xp128 consists of one cabinet that contains both the control systems and the disk drives

It can contain as little as

One CHIP pair

2 Gigabytes of Cache Memory

512 Megabytes of Shared Memory

One ACP pair

And 4 disk drives

As your needs grow you can continue to add disk drives

Up to 64 disk drives per ACP pair

You can also add additional infrastructure. The xp128 will hold up to:

3 CHIP pairs (2 CHIP pairs if two ACP pairs are present)

32 Gigabytes of Cache

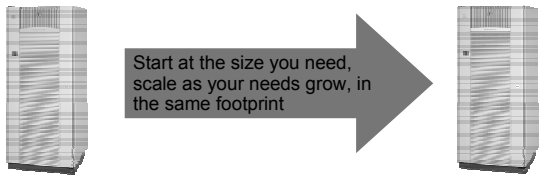
3 Gigabytes of Shared Memory

Additional ACP pairs and disks can be added (limiting the max number of CHIP pairs to 2)

Up to 128 drives

Scale as your needs grow while staying in the same small footprint!

HP StorageWorks xp128 scalability



	Min	Increment	Max
Data Drives	4	4	128
Capacity	144 GB raw 72 GB usable	-	18 TB raw 16 TB usable
Spare Drives	1	1	4
Cache	2 GB	2 GB	32 GB
ACP Pairs	1	1	2
Shared Memory	512 MB	512 MB	3 GB
Host Ports	8	8/16	48
Controller/Disk Frames	1	-	1

[Rev. # or date] HP confidential – unrestricted at announcement page 22

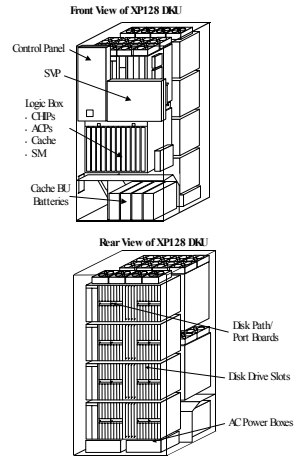
The xp128 allows you to scale up as your needs grow while staying in a small footprint.

With the xp128, you can mix drives of various capacities and speeds in the same array to achieve an optimal balance of performance and capacity for your particular application demands.

The xp128 also allows you to size the cache, ACP pairs, shared memory, and the number of host ports and spare drives to meet your particular requirements.

The xp128 is most appropriate for customers whose near-term storage capacity needs range from 1 to 9 TB.

HP StorageWorks xp128



The xp128 hardware consists of a single cabinet for controller and disks

- Controller section (DKC)
  - Array Control Processor (ACP) pair(s)
  - Crossbar Switch
  - Cache Memory
  - Shared Memory (SM)
  - Service Processor (SVP)
  - Client Host Interface Processors (CHIPs)
  - Control Panel
  - Redundant Power
  - Batteries for cache and shared memory backup (BU).
- Disk drive section (DKU)
  - Holds up to 128 Disk Drives.
  - Power Supplies

[Rev. # or date] HP confidential – unrestricted at announcement page 23

xp128 Hardware

The xp128 hardware consists of a single cabinet for controller and disks. The controller cabinet contains the control panel, service processor (SVP), cache modules, shared memory modules, crossbar switch, Client-Host Interface Processors (CHIPs) and Array Control Processors (ACPs). There is space in the cabinet for up to 128 disk drives.

Features

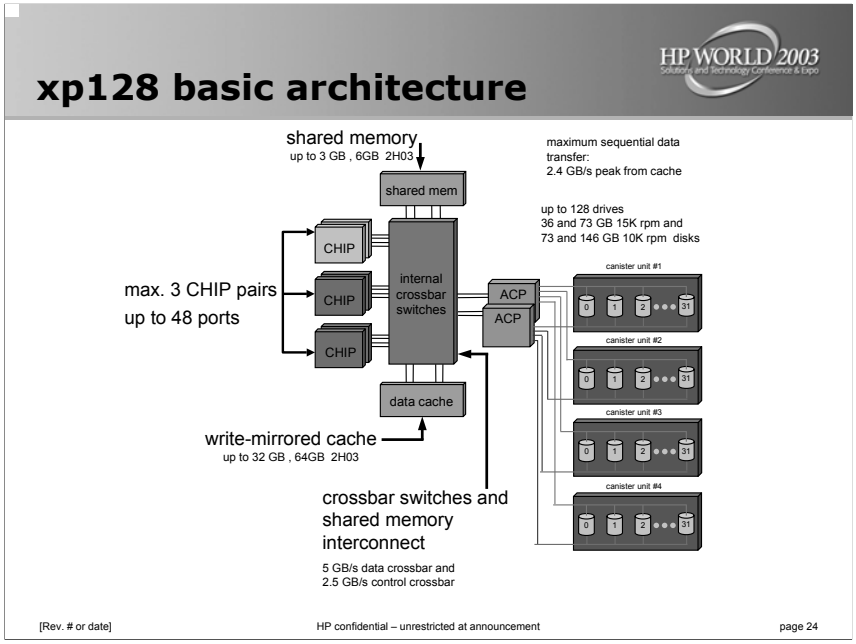
Fully redundant components, with no single point of failure

Dynamically-duplexed cache with battery backup (BU)—cache is expandable from 2 GB up to 32 GB total capacity in 2-GB increments.

Crossbar switch—fast, efficient, switching with direct point-to-point connections at 7.5 GB/sec.

Shared memory with battery backup—stores command and control data so that the entire amount of cache memory is available for quick access to user data. Shared memory is expandable from 512 MB to 3.0 GB in 512-MB increments.

Power redundancy—multiple connections to AC power from different sources, using single-phase or three-phase in 50- or 60-Hz



The xp128 is a scalable system for entry level to mid-range capacity enterprise storage requirements. Each of the components in the xp128 can be increased or enhanced to provide more performance and capacity as requirements change.

This slide shows an entry level configuration of the xp128. The entry level configuration contains 1 ACP pair, leaving room for 3 CHIP pairs. The following slide shows a full configuration of the xp128 which contains 2 ACP pairs, thus supporting more disk drives, but leaving room for only 2 CHIP pairs.

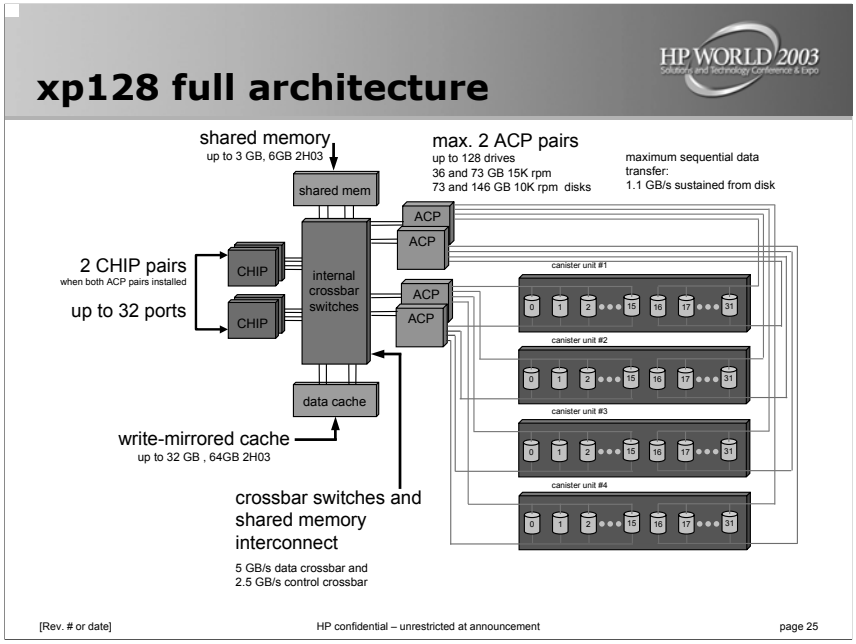
The individual components of the xp128 include the following major assemblies and their functions:

The xp128's crossbar architecture eliminates bus contention, creating a high-bandwidth path from server to disk.

In simplified terms, the "crossbar" provides literally two (2) switches in the xp128 (two for redundancy) that enable all data paths to remain open without any contention. This translates to an aggregation of backplane throughput of 7.5 GB/s. Having a fast crossbar means the performance of the array will increase as components are added.

The XP architecture is highly redundant, with no single point-of-failure. Redundant components and online firmware upgrades keep the array up and running, and ensure that critical data is available for use. Having a high redundant architecture means that if one part fails, the array will continue to operate. Data will not be lost, and availability to the data will not be interrupted.

There are a total of four available slots for CHIP and ACP pairs, so if a customer decides to use two ACP pairs, then the number of CHIP pairs is limited to two. In this case, the maximum number of ports will be 16. However, if only one ACP pair is required, then three CHIP pairs can be installed, providing up to 24 ports. This means customers can customize the system to meet their requirements for connectivity to a large number of hosts or to meet higher performance needs.



The xp128 is a scalable system for entry level to mid-range capacity enterprise storage requirements. Each of the components in the xp128 can be increased or enhanced to provide more performance and capacity as requirements change.

This slide shows an full configuration of the xp128. The full configuration of the xp128 which contains 2 ACP pairs, thus supporting more disk drives, but leaving room for only 2 CHIP pairs.

The previous slide shows an entry level configuration that contains 1 ACP pair, supporting fewer disks, but leaving room for 3 CHIP pairs.

All other details are as described in the notes for the previous slide.

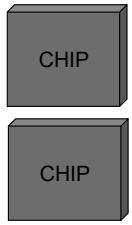
Client Host Interface Processors (CHIPs)

- CHIPs provide connections to hosts or servers and come in pairs
  - Maximum of three pairs per xp128 system
  - Maximum of four pairs per xp1024 system

Fibre Channel
- 8-, and 16-port 1- to 2-Gbit Auto sensing short-wave Fibre Channel with Continuous Access support
- 8-port 1- to 2-Gbit auto-sensing long-wave Fibre Channel with Continuous Access support
- 8-port 1-Gbit Fibre Channel with Continuous Access support

ESCON
- 8-port ExSA Channel (ESCON compatible)

FICON
- 8-port 1- to 2-Gbit auto-sensing FICON in both short- and long-wave versions



[Rev. # or date] HP confidential – unrestricted at announcement page 26

Client Host Interface Processors (CHIPs)

Client Host Interface Processors provide connections to host or servers that use the xp1024 for data storage. CHIPs come in board pairs with a minimum of one pair and up to a maximum of four pairs of CHIPS per xp1024 (three pairs of CHIPS per xp128) system.

CHIP pairs available for use in the xp1024 include:

8-port 1- to 2-Gbit Auto sensing short-wave Fibre Channel with Continuous Access support

16-port 1- to 2-Gbit Auto sensing short-wave Fibre Channel with Continuous Access support

8-port 1- to 2-Gbit auto-sensing long-wave Fibre Channel with Continuous Access support

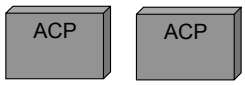
8-port 1-Gbit Fibre Channel with Continuous Access support

8-port ExSA Channel (ESCON compatible)

8-port 1- to 2-Gbit auto-sensing FICON 1 Gb in both short- and long-wave versions

Array Control Processor (ACP)

- The ACP performs all data movement between the disks and cache memory
- The ACP also provides data protection through RAID 0/1 mirroring and RAID 5 parity generation
- Each ACP provides 4 redundant FC-AL loops (8 loops total per pair) and supports up to 256 dual ported drives
- ACPs are configured in pairs for redundancy
  - Minimum of one pair per XP system
  - xp128 - maximum of two pairs
    - Choice of standard performance or high performance ACP pairs
  - xp1024 - maximum of four high performance pairs



[Rev. # or date] HP confidential – unrestricted at announcement page 27

Array Control Processor (ACP)

The ACP performs reads and writes to the cache as well as cache reads and writes to the disks

The ACP also provides data protection through the use of RAID 0/1 mirroring and RAID 5 parity generation

The ACP is configured in pairs for redundancy

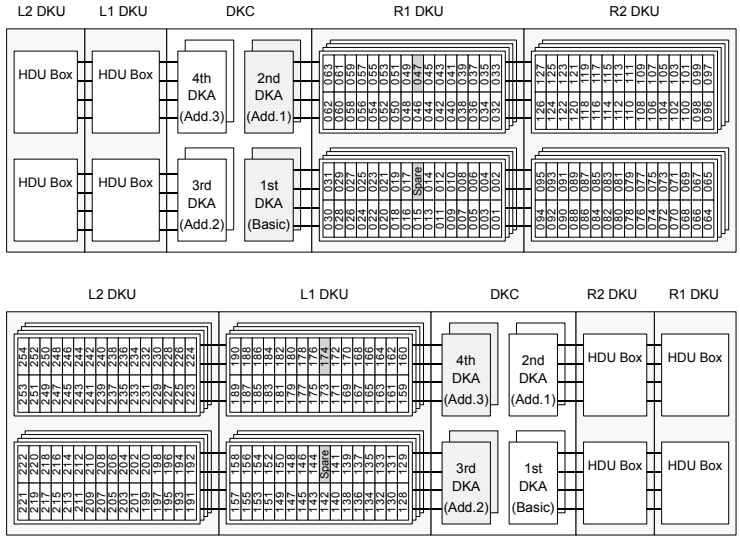
The xp1024 can have one, two, three or four pairs of ACPs.

The xp128 can have one of the following ACP configurations:

one or two standard-performance ACP pair

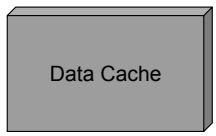
one or two high-performance ACP pair

xp1024 – *4 ACP Pairs*



Cache memory

- Cache memory is used to temporarily store data from the host until it is written to disk, also to stage data requested by the host from the disk
- All cache is backed up by a fully redundant 48-hour battery
- XP disk arrays have global ECC mirrored cache
- Cache utilization is governed by user-established, performance based policies, not physical partitions
- xp128 base product contains 2-GB of cache and is expandable up to 32 GB in increments of 2 GB
- xp1024 base product contains 4-GB of cache and is expandable up to 64-GB in increments of 2 GB



[Rev. # or date] HP confidential – unrestricted at announcement page 29

Cache Memory

Cache memory is used to temporarily store data from the host until it is written to disk, or to stage data requested by the host from the disk.

All cache is backed up by a fully redundant 48-hour battery. In case of extended power outages, the redundant batteries can be replaced one component at a time to extend the available backup time indefinitely.

The xp128 base product comes standard with 2-GB cache and is expandable up to 32 GB in increments of 2 GB

The xp1024 base product comes standard with 4-GB cache and is expandable up to 64-GB in increments of 2 GB.

Above 32 GB, the cache should be installed in increments of 4 GB.

XP disk arrays contain global mirrored cache.

Global means that the cache memory is not hard configured into partitions that can only be used for a single purpose. XP cache can be configured in sections based on customer rules.

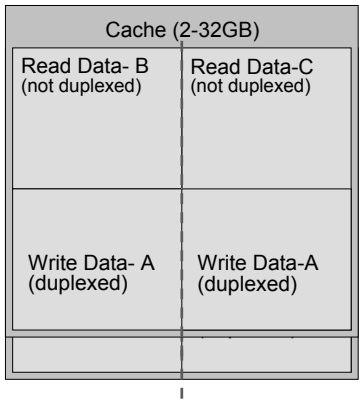
Mirrored means that all write data is written in cache twice, once time each on two separate battery backed-up cache memory boards. This insures that even if one cache board fails that the data is still in the other one until it is safely written to disk.

The minimum amount of cache memory required is determined by the usable capacity of disk storage configured. When the Cache Platform Board is configured, the cache must be configured in 4-GB increments. The Cache Platform Board is required for all configurations above 32 GB. The Cache platform board adds bandwidth to the cache, which will increase performance of the array. Therefore the cache platform board may be desired for configurations less than 32 GB.

The configured amount of cache memory for an XP must be at least the minimum shown in the configuration table, and can be up to the maximum. To determine the minimum amount of cache required, calculate the total amount of usable disk to be configured. For higher performance, additional cache may be configured.

If selected cache memory exceeds 32 GB, including 4 GB in the base A7906A, then you must configure the A7920A Additional Battery for Cache Memory.

hp XP Family – *Cache*

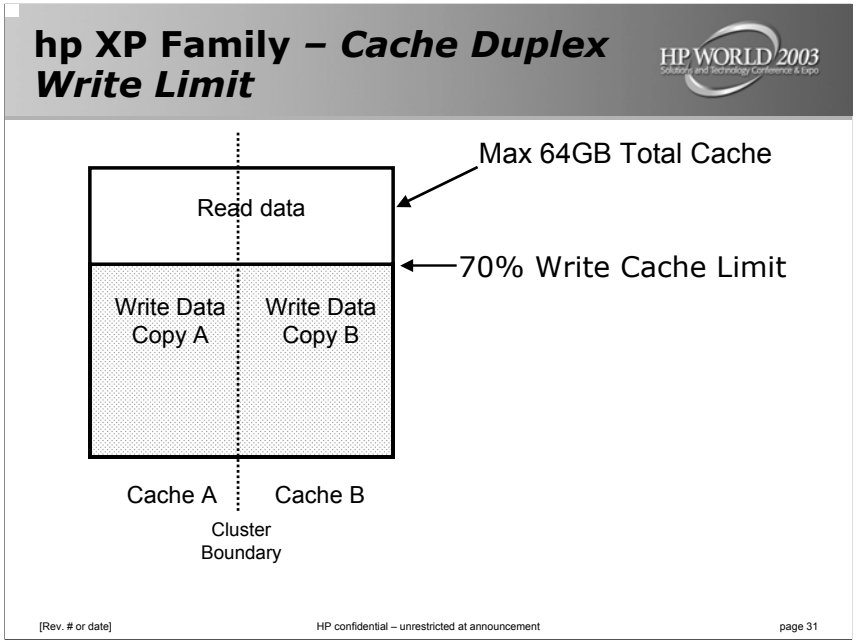


- Total Cache is divided equally on two separate cluster boundaries
- All write data is written to both cache segments. If one copy in cache is defective or lost the other copy is immediately de-staged to disk and cache is disabled.

Student Notes:

All read and write data passes through cache. All write data is written to two WRITE cache segments with one CHIP write operation (thus the data is duplexed across power boundaries after it reaches the CACHE). Because READ data is already on disk there is no need for the XP1024 to duplex this information in CACHE. A major cache failure may reduce performance, but data integrity is maintained. The CHIP never reads or writes data directly to the disk, instead it only reads/writes data from cache.

If one or both cache segments fail, cache is no longer used. If power fails, batteries can maintain cache for at least 48 hours. Batteries should be replaced at regular scheduled intervals to maintain this 48 hour uptime.



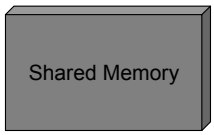
Student Notes:

This slide illustrates the dynamic duplex cache and the duplex write line (DWL). The dynamic duplex cache is the area of cache that is dynamically allocated for write operations. The DWL is the amount of dynamic duplex cache expressed as a percentage of total cache. The amount of fast-write data stored in cache is dynamically managed by the cache control algorithms to provide the optimum amount of read and write cache based on workload I/O characteristics.

Note: If the DWL limit is ever reached, the HP XP sends fast-write delay or retry indications to the host until the appropriate amount of data can be destaged from cache to the disks to make more cache slots available.

Shared memory

- Shared memory is separate from the cache memory and is used to store control information, thus freeing up the cache memory exclusively for user data
- Shared memory is also used to store system configuration information (system components mapping, LUN maps, cache pointers, and RAID levels)
- All shared memory is backed up by a fully redundant 168-hour battery.
- The base xp128 and xp1024 configurations contains 512 MB of shared memory and are expandable up to 3 GB in increments of 512 MB



Shared Memory

Shared memory is independent of the cache memory and is used to store tables, side files, and other information, thus freeing up the cache memory for user data

Shared memory is also used to store system configuration information (system components mapping, LUN maps, cache pointers, and RAID levels). Service personnel cannot access customer data using the support and management tools.

All shared memory is backed up by a fully redundant 168-hour battery.

The base xp128 and xp1024 configurations contains 512 MB of shared memory and are expandable up to 3 GB in increments of 512 MB

The amount of shared memory required increases depending on the volume of cache memory, the number of LDEVs configured and whether Business Copy (BC), Auto LUN, Continuous Access (CA) or Application Policy Manager (APM) are enabled.

Configuring additional shared memory does not enhance the performance of the array and is not recommended by HP. If the customer desires to configure more than the recommended amount of shared memory, HP recommends that the full 3 GB of shared memory be configured, which configuration will support all possible LDEV and software combinations.

hp XP Family – *Shared Memory Contents*

HP WORLD 2003 Solutions and Technology Conference & Expo

Table of what is stored in the cache, by 16KB block	***Grows with size of cache***
Table of information on each LDEV	***Grows with # of LDEVs***

Information on each CHIP and ACP in the array, and other service information: relatively small, and is included in the values shown in the table.

Disk drives

- The number and type of disk drives installed in an XP array is flexible
  - Disks must be added in groups of four
- Additional capacity can be installed over time as capacity needs grow
  - New technology (faster/larger) disks may be become available for future upgrades
- All disks use the industry standard dual ported Fibre Channel Arbitrated Loop (FC-AL) interface
  - Each disk is connected to both the primary and secondary ACP by separate Fibre Channel arbitrated loops
- Spare drives are automatically used in the event of a disk drive failure

Disk Drive Specifications	36 GB, 15K	73 GB, 10K	73 GB, 15K	146 GB, 10K
Raw capacity (User area)	35.76	72.91 GB	72.91 GB	143.76 GB
Disk diameter	2.5 inches	3 inches	3 inches	3 inches
Rotation speed	14,904 rpm	10,025 rpm	15,000 rpm	10,025 rpm
Mean latency time	2.01 ms	2.99 ms	2.01 ms	2.99 ms
Mean seek time (Read/Write)	3.8-4.2 ms	4.9 to 5.7 ms	4.9 to 5.7 ms	4.9 to 5.7 ms
Internal data transfer rate	68.5 to 88.3 MB/sec	44.2 to 74.0 MB/sec	68.5 to 88.3 MB/sec	57.3 to 99.9 MB/sec

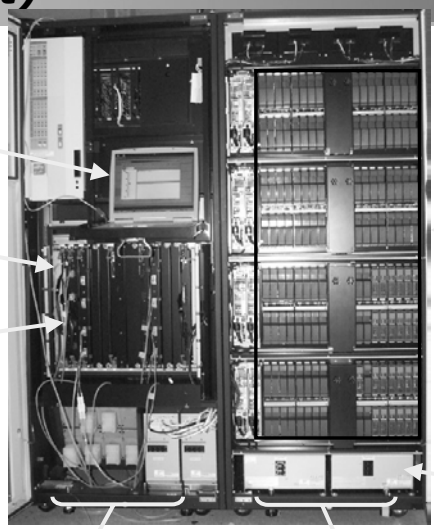
[Rev. # or date] HP confidential – unrestricted at announcement page 34

The disks drives are connected to both the primary and secondary ACP channels by separate Fibre Channel arbitrated loops.

Each XP must include at least one spare disk drive for every type of disk configured in the array. For larger configurations, and especially configurations where RAID 5 7D+1P is implemented, more than one spare disk is strongly recommended of the type used in the RAID 5 7D+1P.

Additional spares can be configured in the field by ordering additional array groups and configuring the drives as spares. The maximum number of spares configurable is 4 for the xp128 and 16 drives for the xp1024.

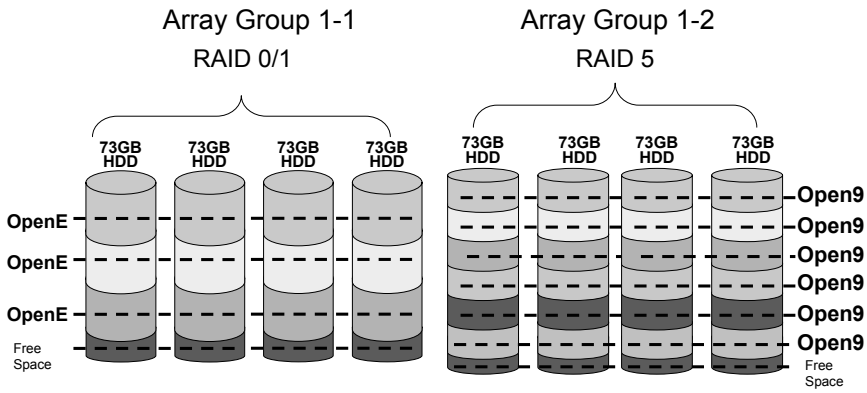
hp XP1024 – *Physical View (front)*

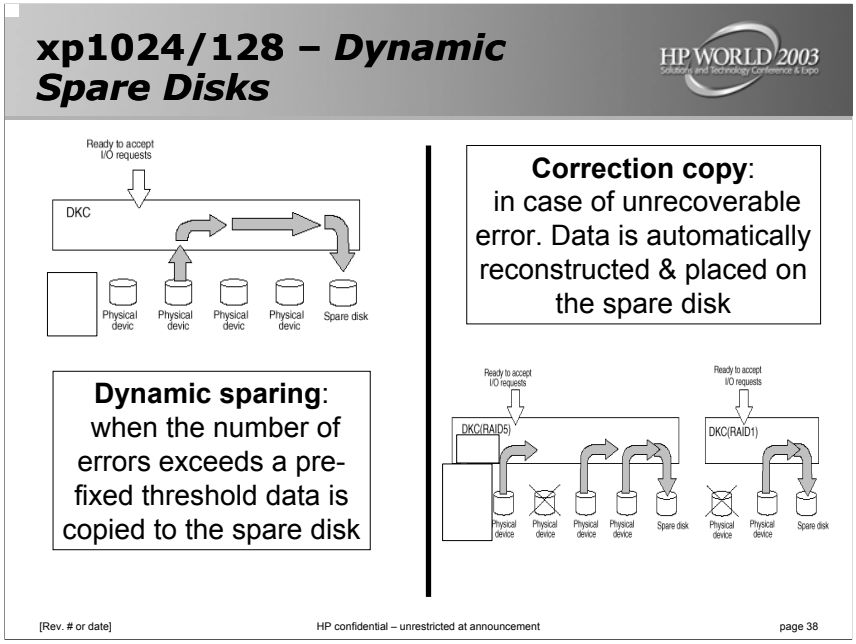


xp1024/128 – *Emulation Types*

- XP Normal Volumes come in a predetermined "Emulation" sizes.
  - Normal Volume Emulation Types: OPEN-3/8/9/E/L/V
    - OPEN-3 = 2.3GB
    - OPEN-8 = 7.3GB
    - OPEN-9 = 7.4GB
    - OPEN-E = 14.5GB
    - OPEN-L = 36.5GB
    - OPEN-V = Variable sized volumes (More on this later…)

xp1024/128 – *Array Groups*





Student Notes:

1. Dynamic sparing

This system keeps track of the number of errors that occurred for each drive when it executes normal read or write processing. If the number of errors occurring on a certain drive exceeds a predetermined value, this system considers that the drive is likely to cause unrecoverable errors and automatically copies data from that drive to a spare disk.

This function is called dynamic sparing. Dynamic sparing operates the same for RAID 0/1 and RAID5 array groups.

HP will be notified via modem (C-Track) of disk errors and Dynamic Sparing operations. HP will also be notified when the Correction Copy process has completed so that the drive can be replaced.

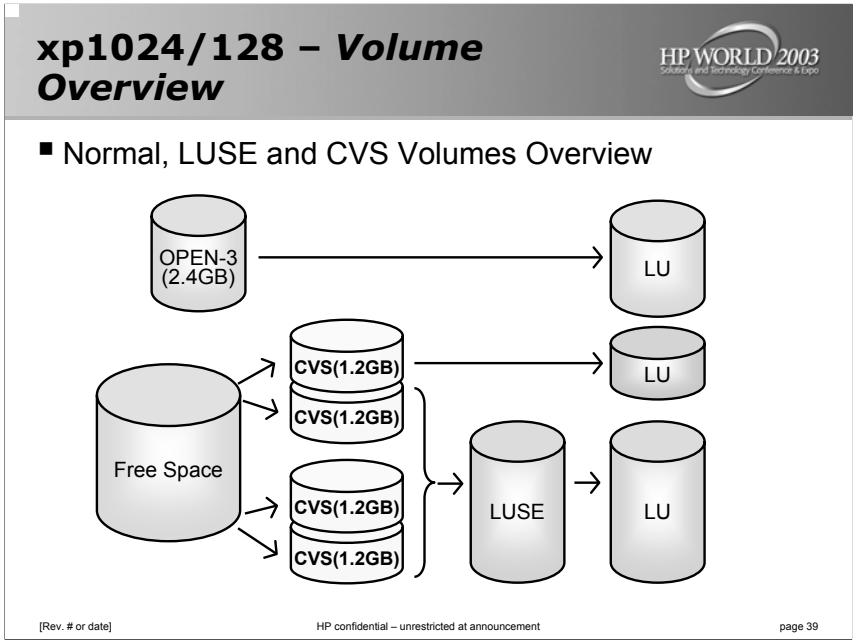
2. Correction copy

When this system cannot read or write data from or to a drive due to an error occurring on that drive, it regenerates the original data for that drive using data from the other drives and the parity data, and copies it onto a spare disk.

Rules for Sparing:

Drives must be of same capacity or larger (18GB → 18GB, 73GB or 146GB spare, not 73GB → 18GB spare) and the same spindle speed (73GB 10K → 73GB 10K, not 73GB 10K → 73GB 15K).

Sparing can occur across ACP boundaries (Global Sparing).



Student Notes:

LU is Logical Unit and refers to the Volume being mapped to a port of the array and visible to a server as a logical disk device (not a real disk, but a logical disk); hence a Logical Unit.

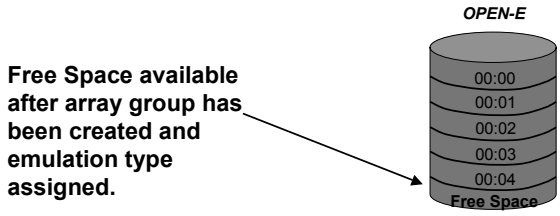
A regular OPEN volume is a of a fixed size. The specified capacity of the OPEN Volume is the Logical Unit size presented to the host.

To create a smaller volume, a user would normally start with a normal Volume of fixed size and then go through the CVS process.

To create a larger volume, a user would normally start with a group of identical volumes (example: same RAID type and size) and then use LUSE to group them together into a larger volume.

xp1024/128 – *Custom Volume Size*

- **Valid CVS volume sizes range from 35MB → size of defined emulation type and are created from "free space".**



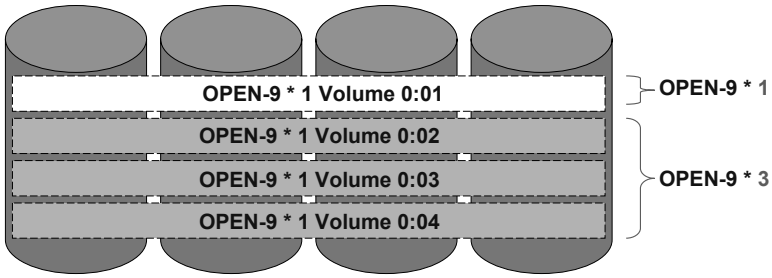
Student Notes:

RAID group "free space" can also be created by deleting a defined volume (CU:LDEV, e.g. 00:01). This process is called converting a volume to free space and is an option in the CVS menu.

xp1024/128 – *Logical Unit Size Expansion*

HP WORLD 2003 Solutions and Technology Conference & Expo

- XP Logical Unit Size Expansion (LUSE) volumes are created by combining 2 → 36 volumes to create a larger volume than the defined emulation for the array group.



Student Notes:

LUSE Volumes can be made up of either contiguous or non-contiguous volumes, but must be in the same CU and of the same RAID type, size (such as CVS or OPEN-V), and emulation type.

xp1024/128 – *OPEN-V Emulation*

HP WORLD 2003 Solutions and Technology Conference & Expo

- OPEN-V is a new emulation type supported with the 21.04.04 (Feb, 2003) release of firmware.
  - OPEN-V stands for “Variable”, not “Virtual”
  - Provides a Custom Volume Size without past constraints.
  - Is an extension/combination of CVS & LUSE functionality
  - Requires CVS & LUSE products (licenses)
  - Volume sizes from 46.8MB →720GB
  - Capacity can be specified in either MB or Cylinder
  - Minimum Cache Memory (CM) & Shared Memory (SM) requirements must still be met

Student Notes:

OPEN-V is very different than other Volume types. OPEN-V is really a process to create a custom volume rather than a new normal Volume. OPEN-V Volumes are always Custom Volumes and not normal Fixed Volumes.

Volumes with a capacity of 62 GB or less are created by OPEN-V automatically using the CVS process. Volumes with a capacity greater than 62 GB are created with a combination of both the CVS and the LUSE processes. All this is hidden from the user, simplifying the volume creation process.

Cache Memory (CM) requirements are based on available formatted capacity. There are tables providing this information, for various formatted capacity break points. CM requirements will probably be easily met. Shared Memory (SM) requirements may be more elusive to determine since they are partially based on the number of Volumes created. With OPEN-V implementations, it may be more difficult to determine the numbers of Volumes that will be created. For example, with normal Volumes, there is a predetermined number of Volumes that can be created (dependent on the disk size, the RAID level, and the Parity Group configuration); and hence the amount of SM needed will be known. With OPEN-V Volumes, the customer may not use all the Free Space initially, but may wait some time before creating additional needed Volumes. In this case, the number of Volumes being created my violate the amount of available SM that would be necessary for storing the Volume maps.

xp1024/128 – *OPEN-V Emulation*

Functions Supported:

Functions		Contents
CVS		OPEN-V includes CVS capability.
LUSE		Supported
Cache LUN		Supported
Continuous Access		Supported (Pair volume must also be OPEN-V and same size)
Business Copy		Supported (Pair volumes must both be OPEN-V and same size)
AutoLun		Supported (Source/Target volumes must both be OPEN-V and same size)
Data Exchange	oto	Supported
	mto, otm	Not Supported

[Rev. # or date] HP confidential – unrestricted at announcement page 43

Student Notes:

CVS & LUSE licenses are required for OPEN-V functionality and are supported with OPEN-V.

CA & BC are supported as long as both pair members are OPEN-V and the same size.

AutoLun is supported as long as both source and target are both OPEN-V Volumes and the same size.

Data Exchange support for OPEN-V is only between Open systems (Open To Open = oto). Mainframe To Open (mto) and Open To Mainframe (otm) are not supported with OPEN-V

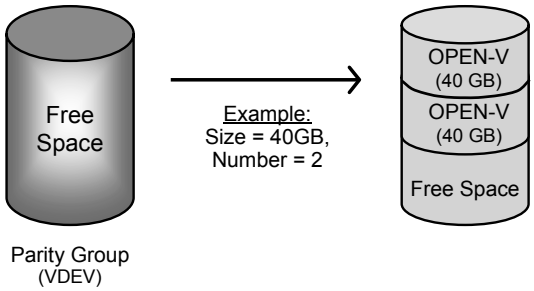
xp1024/128 – *OPEN-V Emulation*

- There are 3 ways to create OPEN-V Volumes
  - Specify Volume Size and Number of Volumes
  - Specify Number of Volumes
  - Specify the Size of the Volumes

xp1024/128 – *OPEN-V Emulation*

HP WORLD 2003 Solutions and Technology Conference & Expo

- OPEN-V Volume Creation:
  - Specify Volume Size and Number of Volumes

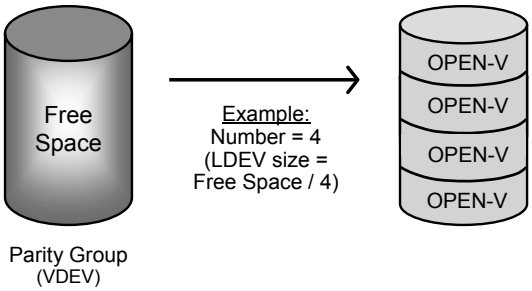


Student Notes:

1. Volume size can be defined by either cylinders or MBs.

xp1024/128 – *OPEN-V Emulation*

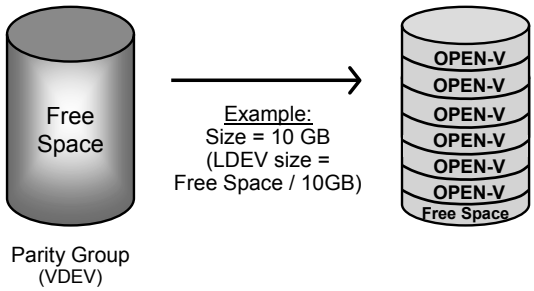
- OPEN-V Volume Creation:
  - Specify Number of Volumes



xp1024/128 – *OPEN-V Emulation*

HP WORLD 2003 Solutions and Technology Conference & Expo

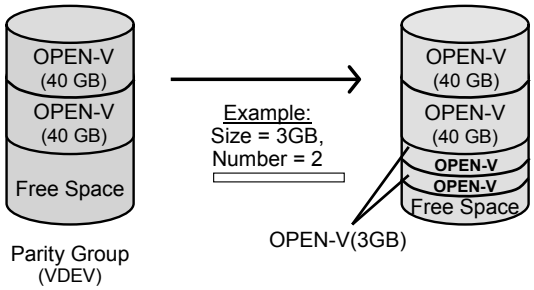
- OPEN-V Volume Creation:
  - Specify the Size of the Volumes



xp1024/128 – *OPEN-V Emulation*

HP WORLD 2003 Solutions and Technology Conference & Expo

- Adding OPEN-V Volumes to a Parity Group with existing OPEN-V Volumes.



[Rev. # or date] HP confidential – unrestricted at announcement page 48

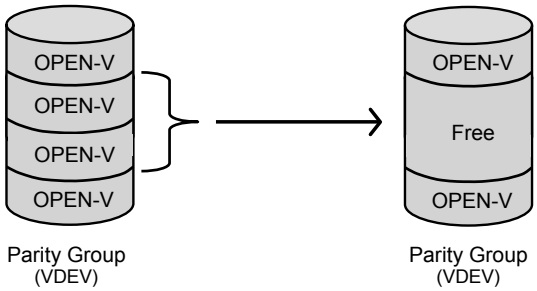
Student Notes:

After initial creation of OPEN-V Volumes, additional OPEN-V Volumes can be added, just as in CVS product functionality. To do this, the array uses available Free Space to create the additional OPEN-V Volumes per user requirements and space availability.

Example: If the parity group already contains some OPEN-V Volumes, and Free Space is available above the minimum OPEN-V size (46.8 MB), then at least one OPEN-V Volume can be created and added to the pool of available OPEN-V Volumes that may be mapped to a port for customer usage.

xp1024/128 – *OPEN-V Emulation*

- OPEN-V Space Recovery:
- OPEN-V allows the user to recover contiguous volumes and re-create free space.



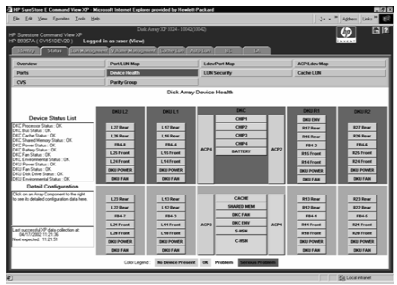
Command View XP

Features

- common interface for device value add applications
- graphical representations and diagnostics of fibre channel I/O paths
- supports xp128/xp1024 & legacy platforms from single console

Benefits

- common management across XP storage devices
- graphical visualizations speed up problem resolution
- multiple security layers ensure information is safe & secure
- manage storage anytime, from any where



[Rev. # or date] HP confidential – unrestricted at announcement page 50

HP StorageWorks Command View XP provides the common user interface for all XP disk array management applications. You and your staff only need to learn a single user interface, reducing the learning curve and increasing usage of the tool. It's web-based so you can monitor your storage resources any time, from anywhere with a web browser. Using the web, your storage expert can participate in problem resolution across multiple installations or easily train junior staff. The tabular user interface in HP Command View XP gives you access to information quickly, and the graphical representations of your storage resources reduce the amount of time your staff will spend troubleshooting problems.

The Command View User Interface is being used by enterprise, modular, tape and virtualization products. In the future, HP will be merging these solutions to enable management of all these products and services from a single management console.

A clear differentiator contained within Command View is Path Connectivity. This module provides customers with a series of reports detailing and configurations, connections and paths being used by hosts, switches into the XP array. This module eliminates the need for the customer to maintain their own binder with printed reports that they have to manually update. Command View updates the configuration automatically eliminating this tedious task. Path Connectivity also provides diagnostic capabilities for the fibre channel connection between hosts and the XP. This feature will identify if a particular connection has begun to degrade and then provide diagnostic information to speed up the troubleshooting process by identifying potential causes.

LUN Configuration & Secure Manager XP

HP WORLD 2003 Solutions and Technology Conference & Expo

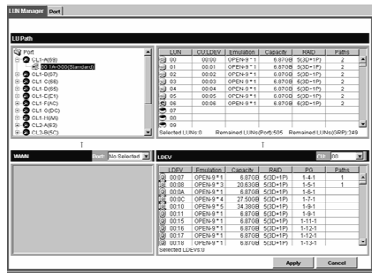
Features

- assignment of LUNs via drag 'n drop
- assignment of multiple LUNs with single click
- checks each I/O for valid security
- security enabled by port
- LUN and WWN group control

Benefits

- flexibility to configure the array to meet changing capacity needs
- permissions for data access can be changed with no downtime
- every I/O is checked to ensure and maintain secure data access

Easy-to-use menus for defining array groups, creating logical volumes and configuring ports



[Rev. # or date] HP confidential – unrestricted at announcement page 51

HP StorageWorks LUN Configuration Manager and Security Manager XP lets you add or delete paths, set the host mode, set and reset the command device, and configure Fibre Channel ports. LU Size Expansion (LUSE) lets you create volumes that are larger than standard volumes. Volume Size Configuration (VSC) allows configuration of custom size volumes that are smaller than normal volumes—improving data access. Security Manager is your LUN security watchdog that gives you continuous, real-time, I/O-level data access control of your XP array. It allows you to restrict the availability of a single LUN or group of LUNs to a specified host or group of hosts. Secured LUNs become inaccessible to any other hosts connected to the array. Unauthorized hosts no longer have access to data that is off-limits.

HP LUN Configuration Manager XP allows a system administrator to set up and configure LUNs and assign them to ports.

Additionally there are two programs that allow LUNs to be created which are smaller and larger than the available open emulation types. For example, many smaller LUNs can be combined to form a single large LUN using LUN size expansion (LUSE), which is important in environments where there are restrictions on the total number of LUNs supported.

Custom-size volumes are smaller than the standard emulation types and can be easily created using Open Systems Custom Volume Size (OCVS). This is important when LUNs may need to be downsized in capacity to avoid wasting disk space. A good example here is when there is a need to create a command device for an XP application.

This sample screen shot shows part of the process involving LUN setup and shows a table mapping SCSI ID, and LUN number, volume and emulation type.

HP Surestore Secure Manager XP restricts access to LUNs or groups of LUNs to a specific host or group of hosts by checking every I/O. Permissions to access data can be changed on-the-fly with no downtime.

Create LUN groups and WWN groups to simplify the configuration and management of data.

Integrated into HP Command View and accessible from the same management station.

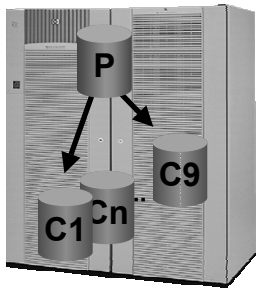
Security is enabled at the port level for flexible deployment with all host server environments supported by the XP disk array family.

Business Copy XP

Features
- real-time local data mirroring within XP disk arrays
- enables a wide range of data protection data recovery and application replication solutions
- instant access to copy volumes
- instant access to data restored from offline backup systems
- flexible host agent for solution integration

Benefits
- powerful leverage of critical business data for secondary tasks
- allows multiple mission-critical storage activities simultaneously

High-speed, real-time data replication



[Rev. # or date] HP confidential – unrestricted at announcement page 52

HP StorageWorks Business Copy XP is a local mirroring product that maintains one or several copies of critical data through a split-mirror process. Asynchronous copy volume updates ensure I/O response time for primary applications is not adversely affected.

Problem

Several workloads or processes may require the same set of data across multiple applications. However, in order to run one application, the “competing” application cannot be run and is therefore unavailable. A simple example of this is the backup of a database. To ensure a coherent database backup, all online transactions need to be halted. The database is therefore unavailable during this backup process.

Solution

HP Business Copy XP provides a solution by supporting multiple copies of the production data. (Up to nine copies). Each copy of the data can be used for various purposes—backup, new application testing, or data warehousing loading—without any disruption to the primary application and primary data, and most importantly, all without any disruption to your business operations. At the same time, you will be creating faster implementation of new requirements and capabilities so that your business will succeed.

Additional note

May be used in conjunction with Continuous Access XP to maintain multiple copies of critical data at local and remote sites. Note: Continuous Access XP is only supported with Data Protector on HP-UX servers. Both HP Data Protector and VERITAS NetBackup products have been tightly integrated with HP Business Copy XP to provide Zero Downtime and Split-Mirror Backup solutions for the HP Surestore XP disk arrays on multiple server platforms.

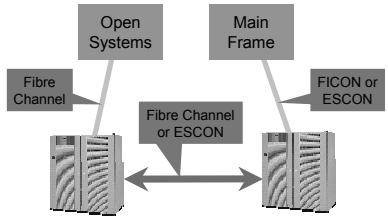
Continuous Access XP and Continuous Access Extension XP

HP WORLD 2003 Solutions and Technology Conference & Expo

Features
- real-time remote data mirroring between local and remote XP disk arrays
- fast failover/failback for seamless, reliable mirroring recovery operations
- flexible host agent for solution integration
- enables a wide range of remote mirroring solutions
- synchronous and asynchronous copy modes

Benefits
- reliable and easy to manage
- offers geographically dispersed disaster recovery

High-performance real-time remote data mirroring



[Rev. # or date] HP confidential – unrestricted at announcement page 53

HP StorageWorks Continuous Access XP and HP StorageWorks Continuous Access Extension XP are high-availability data and disaster recovery solutions that deliver host-independent real-time remote data mirroring between XP disk arrays. With seamless integration into a full spectrum of remote mirroring-based solutions, Continuous Access XP and XP Extension can be deployed in solutions ranging from data migration to high availability server clustering — available over ESCON or fibre channel.

remote mirroring solutions with Continuous Access XP--the ultimate in remote data mirroring between separate sites

maintains duplicate copy of data between two XP arrays

ensures data integrity between two XP arrays

eliminates storage and data center cost of “multi-hop” solutions

OS-independent

High availability cluster integration: leverage advanced features like fast failover/failback for seamless interoperation in high availability server clustering solutions for HP-UX, Microsoft Windows NT, Sun Solaris, and IBM AIX. Works with Cluster Extension, Metrocluster and Continentalclusters for full long-distance clustering solution

Synchronous or asynchronous copy modes to meet stringent requirements for data currency and system performance while ensuring uncompromised data integrity

highest data concurrency with synchronous copy

highest performance and distance using asynchronous copy

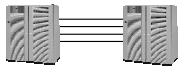
Deploy Continuous Access XP remote mirroring using a wide range of remote link technologies, including pure fiber/DWDM, and high performance WAN/LAN Converters for ATM (OC-3), DS-3 (T3), and IP, cross-town, or all the way across the globe

Continuous Access connection between XP disk arrays can be Fibre Channel (can use multiple channels) or ESCON

For best performance, Fibre Channel is recommended between xp512/48s and xp128/1024s. ESCON is primarily used to connect with older xp256 XP disk arrays that don’t support Fibre Channel Continuous Access

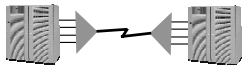
Continuous Access connectivity

HP WORLD 2003 Solutions and Technology Conference & Expo



Synchronous

- Host writes are not acknowledged until the data is in both arrays for maximum data integrity
- Flexible interconnect
  - Fibre Channel up to 10 km
  - ESCON with repeaters up to 43 km
  - DWDM up to 100 km



Asynchronous

- Improved performance over longer distances as writes are acknowledged as soon as the data is in the primary array
- Remote Connections Over Common Carrier (T3,OC3, etc)

The XP is the first array capable of running nearly full speed with remote mirroring of the entire contents of the array

	Read IO/sec	Write IO/sec	Write MB/sec
No Continuous Access	40K	19K	590
Synchronous Continuous Access	40K	15K	460
Asynchronous Continuous Access	40K	17K	280

[Rev. # or date] HP confidential – unrestricted at announcement page 54

Multiple connections can be made to provide redundancy and to improve performance.

Synchronous Mode

Write command acknowledgement is not sent to the host until the data is safely in the cache of both disk arrays. This guarantees that the two disk arrays are always synchronized. The tradeoff is that the latency time to response to the remote array increases as the distance increases, thus lowering I/O performance.

Asynchronous Mode

Write command acknowledgement is sent to the host as soon as the data is safely in the cache of the local array. The data is moved to the remote disk in the background. This improves host write I/O performance, however, the two disks do not stay perfectly synchronized.

Direct connection – for campus/metropolitan distances up to 3 km

excellent performance

synchronous/asynchronous

Repeaters/directors – for campus/metropolitan distances

Fibre Channel up to 10 km

ESCON with repeaters up to 43 km

DWDM up to 100 km

good/very good performance

synchronous/asynchronous

WAN/LAN through converters - for extended/continental distances

switched circuit up to 100 km

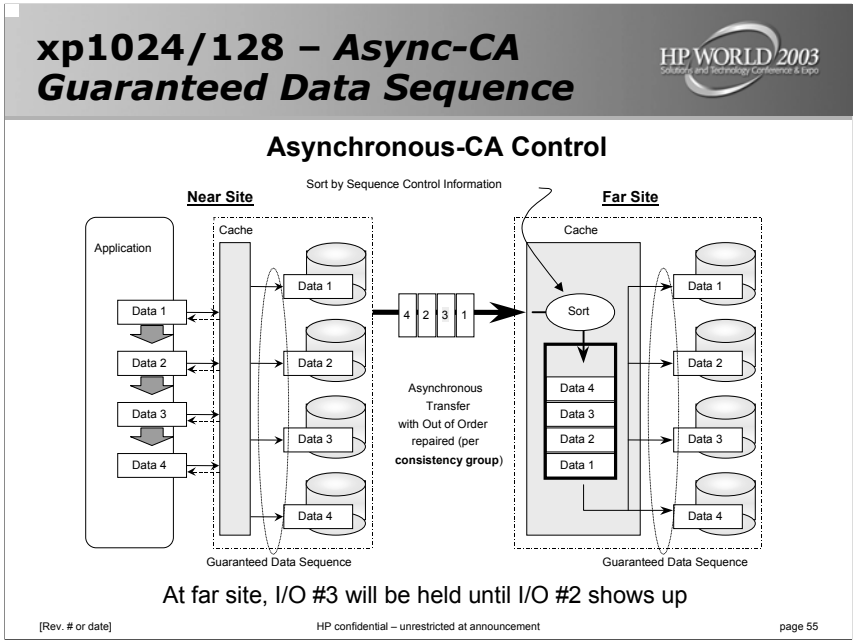
switched packet for unlimited distances

very good performance

asynchronous only

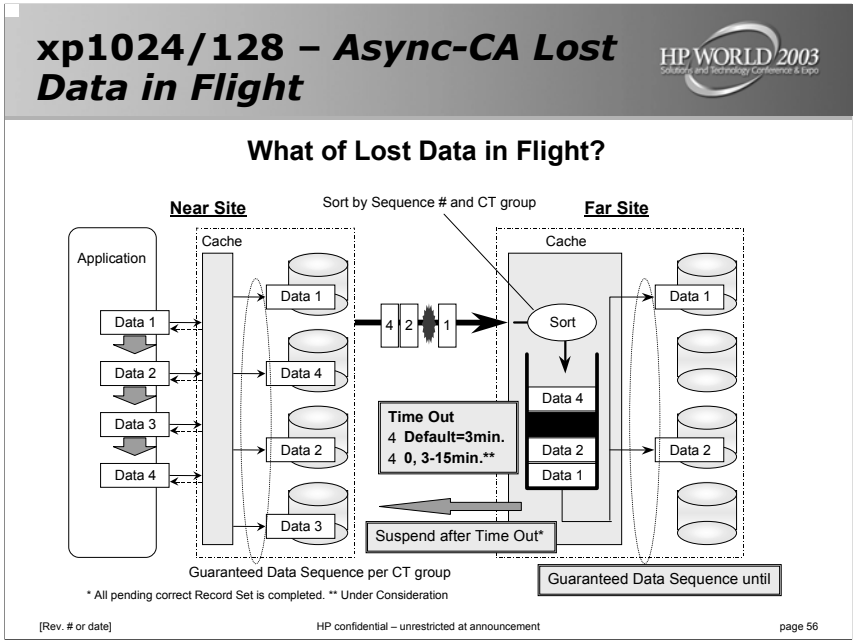
Gigabit Ethernet support

Performance numbers in the table are for a pair of xp1024 arrays with 400 disks and 8 array to array connects. Performance will vary with application, network, and array configuration.



Student Notes:

Out of order transfer resolved at the far site.



Student Notes:

Writes 1 and 2 make it to Write cache and disk. Write #3 has until a timeout to show up. If the timer pops, the link is suspended until operator intervention (pairresync command). Converters like CNT do automatic re-transmission which should help.

XP disk array behavior must be overlaid with expected FC driver and LVM behavior so that proper Threshold and timeouts are purposefully chosen. For example,

if the FC driver receives a response within 10 seconds, all is OK. If not, it waits 2 seconds and retries.

LVM watches all this with a 60 second timeout. If I/O completes in that time (up to 5 FC driver retries), all is OK. If not, the port is considered down and LVM switches to a pvlink.

While the link is suspended, both sides start using a bit map (#4 in RCU goes into a bit map, all new and unsent sidefile writes go into an MCU bitmap. After the reason for the link problem is rectified (and possibly after a data consistent BC copy is made at the far side) a pairresync command causes a non-ordered bitmap copy to bring the pairs back into synchronization.