

digital

OpenVMS Clusters

The world's leader in clustering



24x365

Providing highly available, unlimited high-end computing for your critical business needs

Expanding the limits of the world's leading clusters

Digital Equipment Corporation—the pioneer of cluster technology since 1984 and industry leader ever since—continues to develop more reliable, faster, and affordable systems, while ensuring that existing systems are compatible within new OpenVMS™ Clusters.

With more than 50,000 clusters installed and supported worldwide, Digital's support for OpenVMS clustering capabilities keeps getting better.

Building on bullet-proof, 24x365 OpenVMS

Digital recently announced V7.0 of the robust OpenVMS operating system which boasts significant technical advances. These advances include support for 64-bit addressing and Very Large Memory (VLM) capabilities—features that allow an *entire* database application to be loaded into memory—and run at speeds nearly 300 *times* (not percent!) faster than 32-bit based systems!

Apply this high speed technology to your business-critical computing needs—the ones that keep your orders flowing, money moving, and customers happy. Then relax knowing that your OpenVMS Cluster system has the high availability or disaster tolerance capabilities that you need to stay in business.

What is an OpenVMS Cluster?

An OpenVMS Cluster is a highly integrated organization of Alpha and/or VAX™ computer systems, application and operating system software, and storage devices. The systems can be connected to each other and storage components in a variety of ways, depending on the needs of your business. OpenVMS Cluster systems are the ultimate solution in a highly available, scalable, and flexible computing environment. The OpenVMS Cluster also allows you to connect systems of all sizes and capacities and achieve an easy-to-manage, single virtual system.

OpenVMS Clusters offer a wide range of potential configurations. Any sized business—from the smallest office to the largest enterprise—can profit from the benefits of clusters.

The unlimited high-end server for OpenVMS and Windows NT environments

Digital recently joined forces with Microsoft Corporation to deliver the mission critical, bet-your-business capabilities of OpenVMS to Windows NT™ applications. Using OpenVMS Clusters as the server system for Windows NT clients provides the bullet-proof, high availability computing advantages for which OpenVMS Clusters are legendary.

24x365 computing

If your business demands that your computer system is *always* available, OpenVMS is your only choice. Digital supports a wide range of approaches to high availability to meet your specific computing requirements—24 hours a day, 365 days a year. All of our solutions

have been designed and tested to work in today's multivendor client/server environment.

In a traditional single-system computing environment or many other "cluster systems," when a single system shuts down, no other system on the network can access the information on its disks—resulting in costly downtime. With OpenVMS Cluster configurations, you can connect storage subsystems to I/O interconnects that are accessible by multiple systems. This means that if a node does shut down, all remaining nodes in the OpenVMS Cluster still have access to its applications and data.

Scalable and flexible

With OpenVMS Clusters, you can expand your server configurations from the low-end to the high-end without having to trade in or retire your hardware investments. Start with a single existing VAX or Alpha system and when you need to increase computing power, simply add another system to the cluster—without replacing existing systems or applications. They all work together running the powerful, business-critical OpenVMS operating system.

**"(Open)VMS Remains King of the Clusters
Digital's technology is still the high bar
against which other clustering schemes
are measured."**

Datamation August 15, 1995

"The high-availability characteristics of OpenVMS and clusters are very important to us...the scalability and clustering capability of OpenVMS allow us to provide our clients with technology as they need it."

*Scott Fancher, Vice President and Product Line Executive
Cerner Corporation*

Since Digital's clustering capabilities range from clusters of two systems to 96 systems, they scale to meet your needs. And with numerous connection capabilities, you can be assured that the correct technology will be applied to your business needs—whether your business requires extraordinarily fast I/O, massive storage capabilities, or the need to add new systems to current OpenVMS Clusters.

Affordable for any business

Affordability is another major benefit of OpenVMS Clusters. Simply purchase the system that meets your short-term needs—and that your business can afford—and add other systems as the business growth requires. There's no need to buy more system capacity than your requirements dictate. And you can't outgrow an OpenVMS Cluster!

Disaster tolerance

OpenVMS Clusters can be configured into disaster tolerant multisite clusters located up to 500 miles (800 kilometers) apart. With distances of this magnitude, natural or man-made disasters that could potentially put you out of business are no longer threats. Regional disasters such as earthquakes, power outages, floods, and fires are virtually eliminated as interruptions to your business. Within your OpenVMS cluster, CPUs retain their independence—yet greatly benefit from common resources such as shared processing resources, data storage, tape drives, and batch and print queues. No single point of failure can bring an application down.

A wide variety of interconnects

OpenVMS Clusters offer you a choice of interconnects in virtually any mix: SCSI, Memory Channel™, CI™, Ethernet, FDDI, and DSSI™. You benefit from flexibility in the distribution of cluster systems and choices that reflect your needs in performance and cost.

A choice of packaging minimizes floorspace

When space is at a premium, OpenVMS Clusters can be constructed using rackmountable AlphaServers™ and StorageWorks™ components to fit within your computer room constraints.

OpenVMS Clusters provide the best clustering features in the industry!

- *Highest availability—guarantees access to your data and applications*
- *Easy expansion—lets you grow your cluster to the size you want, when you want, how you want—without having to shut down your cluster and interrupting your business!*
- *Accessibility to all resources—lets all your users access the resources in an OpenVMS Cluster*
- *Easy-to-manage—lets you manage your entire OpenVMS Cluster of multiple systems as a single system*
- *Seamless integration with existing systems and new technologies—allows you to integrate your current equipment into the same OpenVMS Cluster along with new Alpha and VAX systems*



Evolution of OpenVMS Clusters

1984

VAXclusters™ are born! Early version supports high bandwidth Computer Interconnect (CI), Hierarchical Storage Controller, Distributed Lock Manager and File System Cluster wide operator control

1985

Up to 16 VAX processors supported in a VAXcluster

OpenVMS Clustering interconnect choices

Select one that meets your needs, or mix interconnects when your needs change!

Systems and storage in an OpenVMS Cluster exchange information by means of physical communication links known as interconnects. OpenVMS Clusters offer a range of interconnect choices including:

- Small Computer Storage Interconnect (SCSI)
- Memory Channel
- Computer Interconnect (CI)
- Local Area Network infrastructures: Ethernet and FDDI (Fiber Distributed Data Interface)
- Digital Storage Systems Interconnect (DSSI)

SCSI—the Small Computer Storage Interconnect Standard

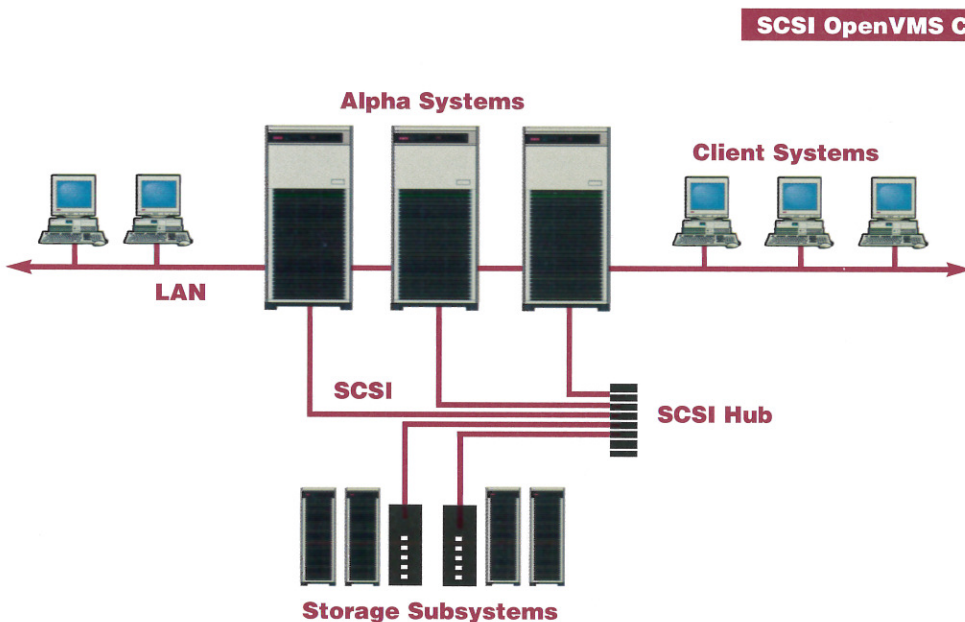
The ideal starting point for configuring a low-end, affordable cluster solution

With SCSI-based clusters, you can use commodity-priced storage devices directly in OpenVMS Clusters of Alpha systems. SCSI is an industry-based standard bus based on the work of the American National Standards Institute

(ANSI). It defines the ways in which peripheral devices can access a standard, general-purpose bus and has become the key design standard for increasingly small, fast, reliable, and low-cost storage devices.

SCSI clusters can range from desktop and deskside to the largest configurations. They can even be configured with no single point of failure.

Digital contributed extensively to the development of this standard and takes fullest advantage of the current protocol (SCSI-2) in SCSI-based OpenVMS Clusters to deliver high performance and availability.



Choices in distance, cost, and performance

The SCSI interconnect in an OpenVMS Cluster provides a balance of distance, price, performance, and storage capacity. Transfer rates now range from 10 to 20 megabytes/second as the SCSI bus has been improved over the years. The maximum length of the SCSI interconnect is 25 meters using differential devices.

1986

Local Area VAXclusters enable low priced workstations to participate
Up to 42 systems in a cluster

1987

Symmetric Multiprocessors added to the family of systems in a VAXcluster

1988

Mixed Interconnect VAXclusters enable low-priced workstations to cluster with high performance CI-based systems.

10x power of original cluster

DSSI supported as cluster interconnect; high performance for departmental clusters at affordable price.

100,000th system running in an OpenVMS Cluster

1989

Support increased to 96 systems

Q-bus based MicroVAX systems connect to DSSI; high performance clustering for low priced MicroVAX systems...investment protection

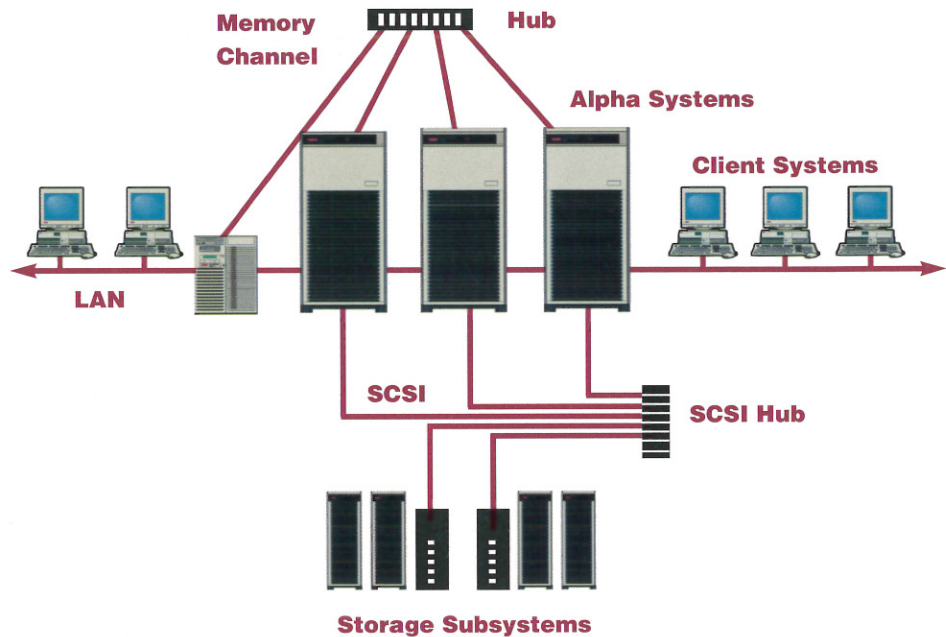
OpenVMS Memory Channel (MC) interconnect

Memory Channel™ is a new high performance interconnect for PCI-based Alpha systems in OpenVMS Clusters. Memory Channel supports all cluster features—as do all existing cluster interconnects—without any changes required to your existing software.

Memory Channel is dedicated to delivering very high performance node-to-node communication—while a separate interconnect, such as CI, SCSI, or DSSI is used to provide access to storage.

Digital developed Memory Channel to provide high performance OpenVMS lock manager capabilities for today's VLDB (Very Large Database) fast database implementations.

Memory Channel and SCSI OpenVMS Cluster



"...OpenVMS Clusters allow our clients to come in on the low-end and upgrade to a midrange or high-end system, depending on their needs, with the swap of a board. Their initial investment is protected...that's the best we can offer anyone."

*David Becker, President
re:Member Data Services*

1990

Volume Shadowing Phase II greatly increases availability of large amounts of data

Support for multiple CI adapters greatly increases bandwidth for high performance systems with load balancing.

250,000th system

1991

Support for multiple Ethernets—higher bandwidth and reliability

Support for FDDI—very high bandwidth interconnect that spans great distances; enables Fault Tolerant VAXclusters

1992

Software enhancements for Dynamic Lock Remastering; volume shadowing, disk fragmentation.

100x power of original cluster

1993

OpenVMS Clusters support Alpha systems. VAX systems and Alpha systems run in the same OpenVMS Cluster!

400,000th system

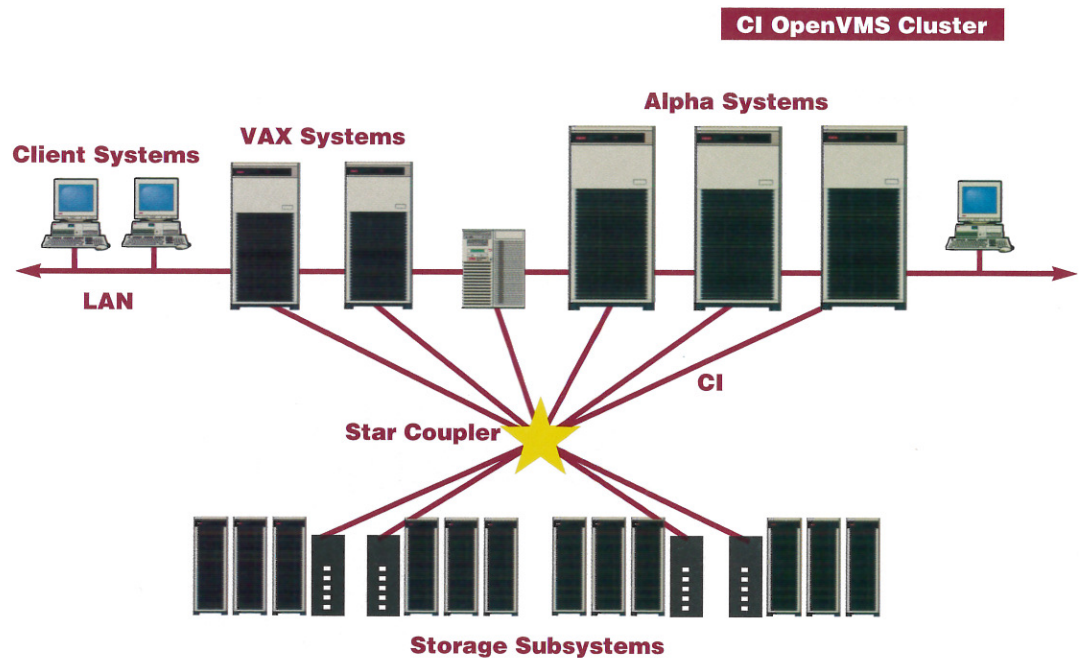
Computer Interconnect (CI)

Gain fast, efficient access to large amounts of data

When connecting datacenter VAX systems, Alpha systems, and independent storage devices to form a cluster, CI allows for extremely high-speed, dual-path communications for large systems and I/O-intensive applications. It permits efficient access to huge amounts of data while providing redundant data paths (140 megabits per second). CI clusters offer the highest levels of availability and throughput since systems and storage devices are dual pathed. A CI component, the Star Coupler, allows center connection of up to 32 nodes (systems or storage devices) in a "star-shaped" OpenVMS Cluster.

"Digital's OpenVMS is the most reliable and secure operating system around. It's the best on the market for what we're doing...OpenVMS is a workhorse and it's bug-free."

*Mike Randall, Information Services Bureau Chief
Montana Department of Transportation*



1994

DEC Availability Manager for Distributed Systems included in OpenVMS Cluster software greatly enhances manageability of clusters

1,000x power of original cluster

1995

**64 bit
SCSI clusters
Kernel Threads
Spiralog**

1996

**Memory Channel
PCI to CI adaptor
High-end SCSI Cluster**

**Local Area Network (LAN)
interconnects: Ethernet
and FDDI**

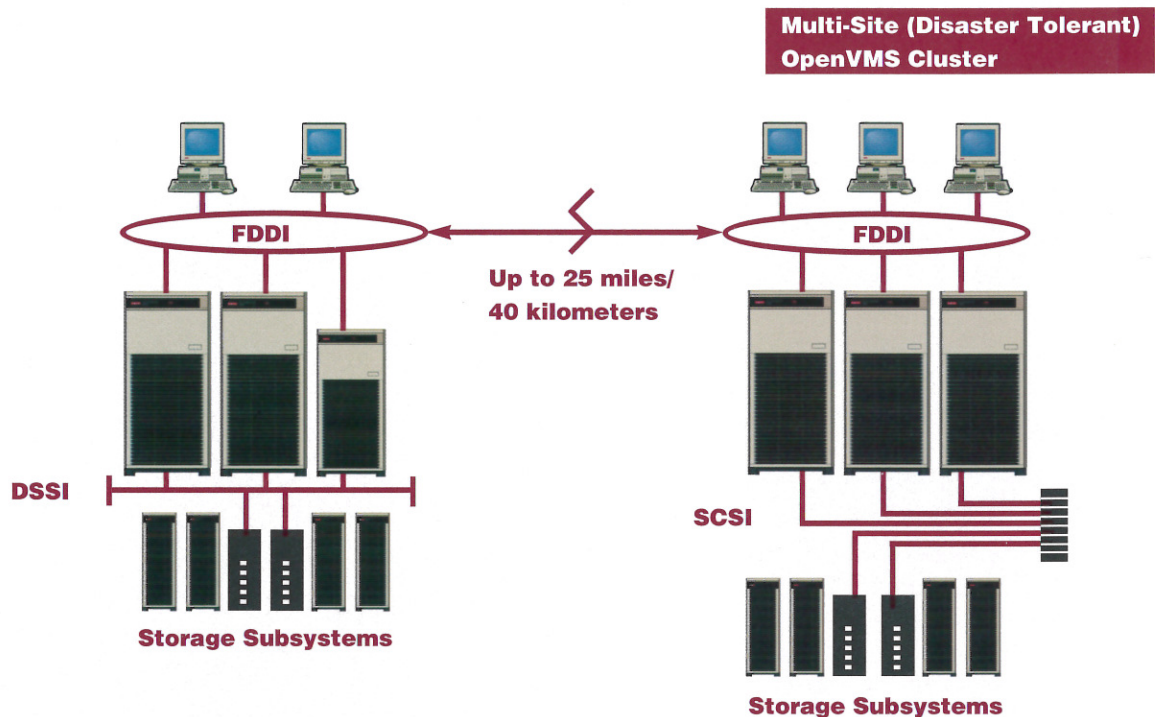
**Ethernet: an affordable,
flexible, network medium**

The Ethernet, an industry-standard network interconnect of single path connections, provides the backbone for low-cost OpenVMS Clusters or local area networks. Ethernet-based OpenVMS Clusters can connect up to 96 systems.

**FDDI: links multiple sites into a
single operating environment**

An ANSI and IEEE standard for high-speed, multivendor networking interconnections, FDDI extends cluster availability to multiple physical sites (up to 25 miles/40 kilometers apart) to form a single operating environment consisting of up to 96 systems. FDDI uses high-speed fiberoptic cable as a transmission medium. Computing resources that are currently physically located outside your data center can now be tied into it using FDDI.

FDDI can be used to create disaster-tolerant OpenVMS Clusters. Linking sites using DS3, Asynchronous Transfer Mode (ATM), and microwave technology is possible using FDDI in conjunction with Digital's Gigaswitch bridging product. Multi-sites that are separated by distances of up to 500 miles/800 kilometers can be linked using these interconnection methods.



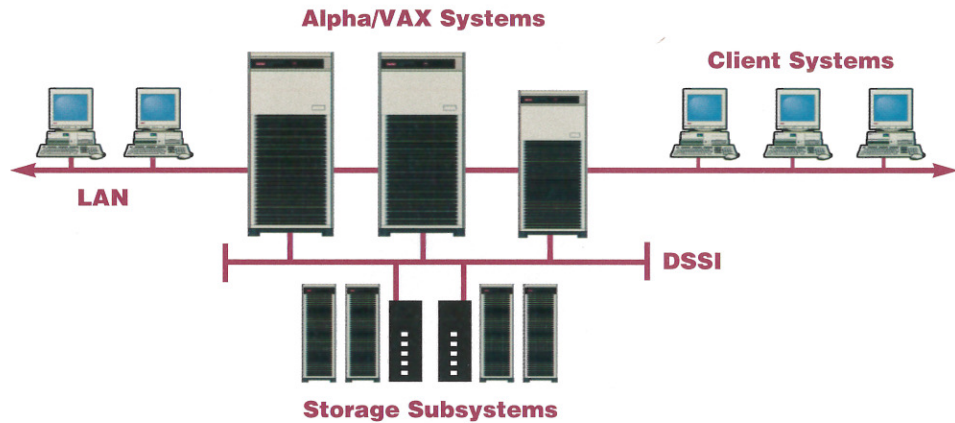
"When a power failure occurred, one entire site dropped out of the cluster. But...the major business processes could continue on the remaining site. Two minutes later, main power returned to the failure site. As the site was rebooting into the cluster, all 400 users just continued their work as usual, while the rebooted site added processing power to the entire computing environment. Not only was power restored, people hardly noticed there had been changes in the environment."

*Wim van Deurzen, Data Center Manager
GVB (Amsterdam's Metropolitan Transit Company)*

Digital Storage Systems Interconnect (DSSI)

Providing a low-cost connection for clusters containing Alpha and VAX systems

Used in office and datacenter environments, DSSI links VAX systems, Alpha systems, and intelligent storage devices into multihost configurations through a low-cost DSSI bus. DSSI permits systems to communicate directly with each other, and can connect up to four nodes in an OpenVMS Cluster. Most DSSI clusters utilize multiple buses.



"We absolutely could not do what we are doing without OpenVMS."

The fourth largest reinsurance broker in the world, Willis Corroon Group made a strategic decision to build its corporate-wide computer infrastructure around the OpenVMS operating system. The Director of Technical Services, Rod Pettinato, attributes that decision to two key factors—OpenVMS Clusters and the operating system's client/server orientation.

Pettinato divided his data center into three OpenVMS Clusters—a server cluster, a client cluster, and a development cluster. The clusters communicate with users in Nashville through FDDI backbones and with more remote users via four wide area networks.

Each cluster consists of multiple VAX computers that behave as if they were one. The server clusters run INGRES® relational databases, and the clients run line-of-business applications.

"Except for the increased performance, no one notices when you hook up another CPU to the system. You can manage a cluster of seven VAX 6630 computers as easily as a single workstation sitting on your desk. On the flip side, if one of the CPUs goes off line for some reason, users are immediately switched to one of the other CPUs."

"The only way we could get this level of performance, other than with a cluster, is on a mainframe. And if we did have a mainframe, we would also have to have five times as many systems people as we do now. And what would we do when we wanted to add performance—buy another mainframe?"

*Rod Pettinato, Associate Director of Technical Services
Willis Corroon Group*

Mixed Interconnect

Combine interconnects the way you want...the way you need

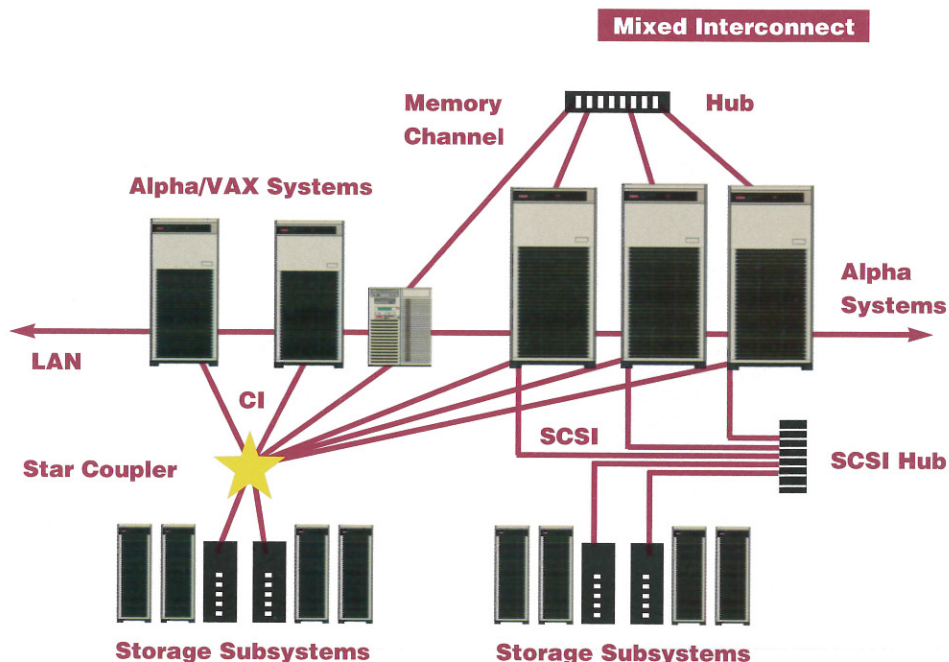
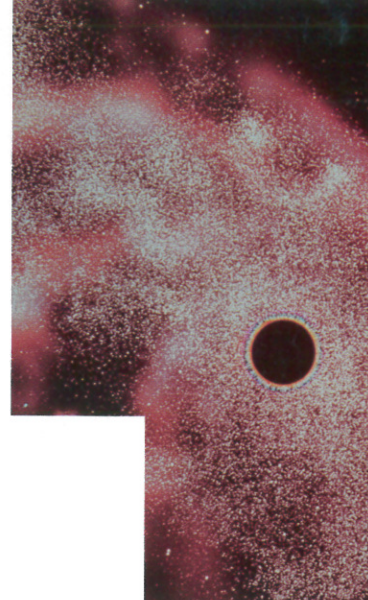
One of the advantages of an OpenVMS Cluster is that it allows you to mix interconnects to meet your needs. The best choice depends upon your performance requirements. Four of the most critical factors to consider are:

- (1) Throughput—What are the data requirements to be placed on the interconnect? Between specific systems in a cluster? Between specific systems and specific storage devices in the cluster?

- (2) Availability—Does your computing environment require that no communication path be a single point of failure for communication among specific systems and specific storage disks?

- (3) System Distribution—Do all systems reside in a single computer room? Or are they spread throughout a building, a small complex of buildings, or distributed over a very large geography?

- (4) Scalability—How much computing power and storage capacity growth are you likely to need as your business and application requirements increase?



"OpenVMS Clusters give our clients total flexibility. For instance, we can split a cluster into two separate facilities for a client in California. The clusters can run simultaneously, and downtime from backup is no longer a problem."

*David Becker, President
re:Member Services*

When it comes to benefits, nothing comes close to OpenVMS Clusters

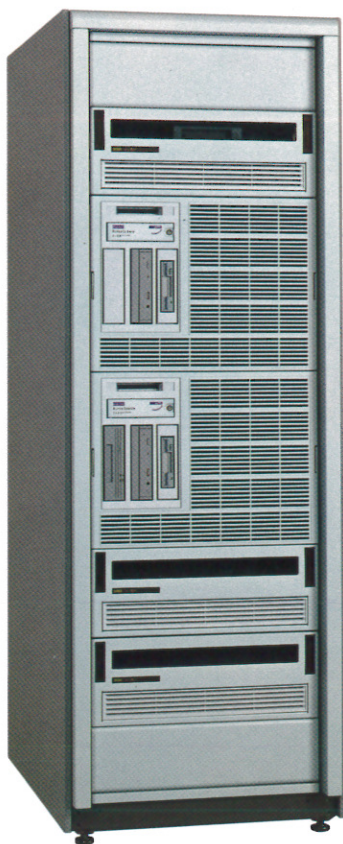
Digital's OpenVMS Clusters give you the confidence that your business will stay up and running no matter what problems you encounter, whether they are for planned maintenance, or unplanned failures. Your business will be secure with high-performance systems that deliver constant, disaster-proof access to your applications and data. And as your requirements change and expand, OpenVMS Cluster technology will accommodate your growth and shifting needs without disrupting day-to-day business functions.

Contact us!

For specific information about OpenVMS Clusters, please contact your local Digital sales office or Digital business partners, or visit Digital on the World Wide Web at <http://www.openvms.digital.com>. For rackmountable systems and configurations, check out <http://www.digital.com/info/css>.

Digital's Interconnects At-a-Glance

CI
Up to 16 systems
Max 17.5 Mbytes/sec
High performance
90M diameter
VAX and Alpha
Large storage capacity
SCSI
Up to 3 systems
Max 20 Mbytes/sec
Medium-high performance
25M length
Alpha only
Medium storage capacity
FDDI
Up to 96 systems
Max 12.5 Mbytes/sec
High performance
40KM length
VAX & Alpha
DSSI
Up to 4 systems
Max 4 Mbytes/sec
Medium performance
25 M length
VAX & Alpha
Medium storage capacity
MEMORY CHANNEL
Up to 4 PCI-based Alpha Systems
Extremely High Performance
100 MBytes/sec
3 Meter Diameter
Configured with another interconnect for storage
ETHERNET
Up to 96 systems
Max 10 Mbits/sec
Low-Medium performance
2KM length
VAX & Alpha



A space-saving rackmounted OpenVMS Cluster of two Alpha Servers with redundant SCSI buses.

OpenVMS Cluster Features

	CI	DSSI	SCSI	LAN Ethernet	FDDI	MEM CHAN
Maximum distance (meters)	90	20-27	3-25	2K	40K	3
Bandwidth Mbits/sec	140	32	80-160	10	100	800
Systems supported per bus	16	4	3	96	96	4
Service CPU online	Yes	Yes	Yes	Yes	Yes	Yes
Service storage online	Yes	Yes	Yes	N/A	N/A	N/A
Reconfigure cluster while online	Yes	No	No	Yes	Yes	Yes
Approx maximum and directly shareable storage per bus*	2.5TB	600GB	1.1TB	N/A	N/A	N/A

N/A = not applicable

*The number of buses in a cluster depends on the capabilities of the systems forming the cluster. Very large storage arrays can be formed if systems supporting many buses are configured into the cluster.

At Children's Hospital in Boston, the IBM 3090 mainframe was replaced with two OpenVMS VAX Clusters running a single operating system—OpenVMS—servicing 100 percent of the hospital's information management needs.

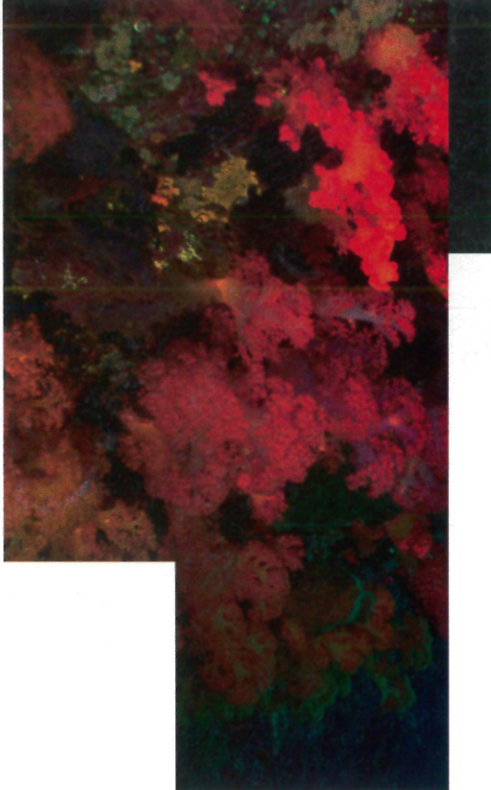
"The water-cooled mainframe was just too big a footprint in the expensive real estate of our data center, too expensive to run and maintain, and too inflexible to meet our changing needs."

"The clustering ability of OpenVMS allows for high CPU availability...Even with scheduled downtime, our system availability is 99.7%!"

"Some of the applications we use, including critical ones such as patient admissions, discharge and transfers, were written by companies that are no longer in business. We can't go back to those companies now and say, 'Hey, you need to upgrade your software to work with the latest version of the operating system.' By providing a consistent environment, Digital has protected our investment."

*Stuart Cohen, Manager of System and Production Control
Boston Children's Hospital*





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**"VMS remains King of
the Clusters."** *Datamation,*
August 15, 1995

