Accelerating Performance of Microsoft SQL Server 2000 Using VI Technology

Rob Davis

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HP WORLD 2003
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HP Published Record breaking TPC-C results

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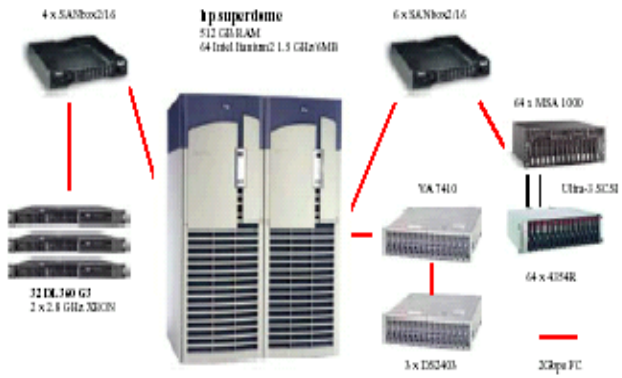
HP Server IA-64
Superdome
64 Way

Windows
Server 2003
IA-64

Storage Area
Network HBA

Fibre Channel

HP Superdome Client/Server				TPC-C Revision 5.1
Total System Cost	TPC Throughput	Price/Performance	Report Date	Availability Date
$5,967,033	707102.32 tpmC	$8.44 per tpmC	June 30, 2003	October 23, 2003
Processors	Database Manager	Operating System	Other Software	Number of Users
64 Intel Itanium2 1.5GHz - Server 64 x Intel Xeon 2.8GHz - Client	Microsoft SQL Server 2000 Enterprise Edition 64-bit	Microsoft Windows Server 2003, Datacenter edition (64-bit)	Microsoft Visual C++ Microsoft COM+ Transaction Monitor	560,480



System Components	Server		Each Client	
	Qty	Type	Qty	Type
Processors Cache Memory	64	Intel Itanium 2 6M CPUs at 1.5GHz 6 MB iL3 cache	2	2.8 GHz Intel Xeon 512kbyte L2 Cache
Memory	128	4 Gbyte	4	256 Mbyte
Disk Controllers	64	HP StorageWorks MSA 1000	1	Embedded Smart Array 5i+
Disk Drives	1792 60 2	HP 18GB 15KRPM U320 HP 73GB, 10krpm FC hot-swap disk HP 18GB 15KRPM for OS	1	36 Gbyte disk
Total Storage		34586.4 Gbyte		36 Gbyte
Tape Drives	1	HP Surestore DAT40e		
Terminals	1	Console Terminal	1	Console Terminal

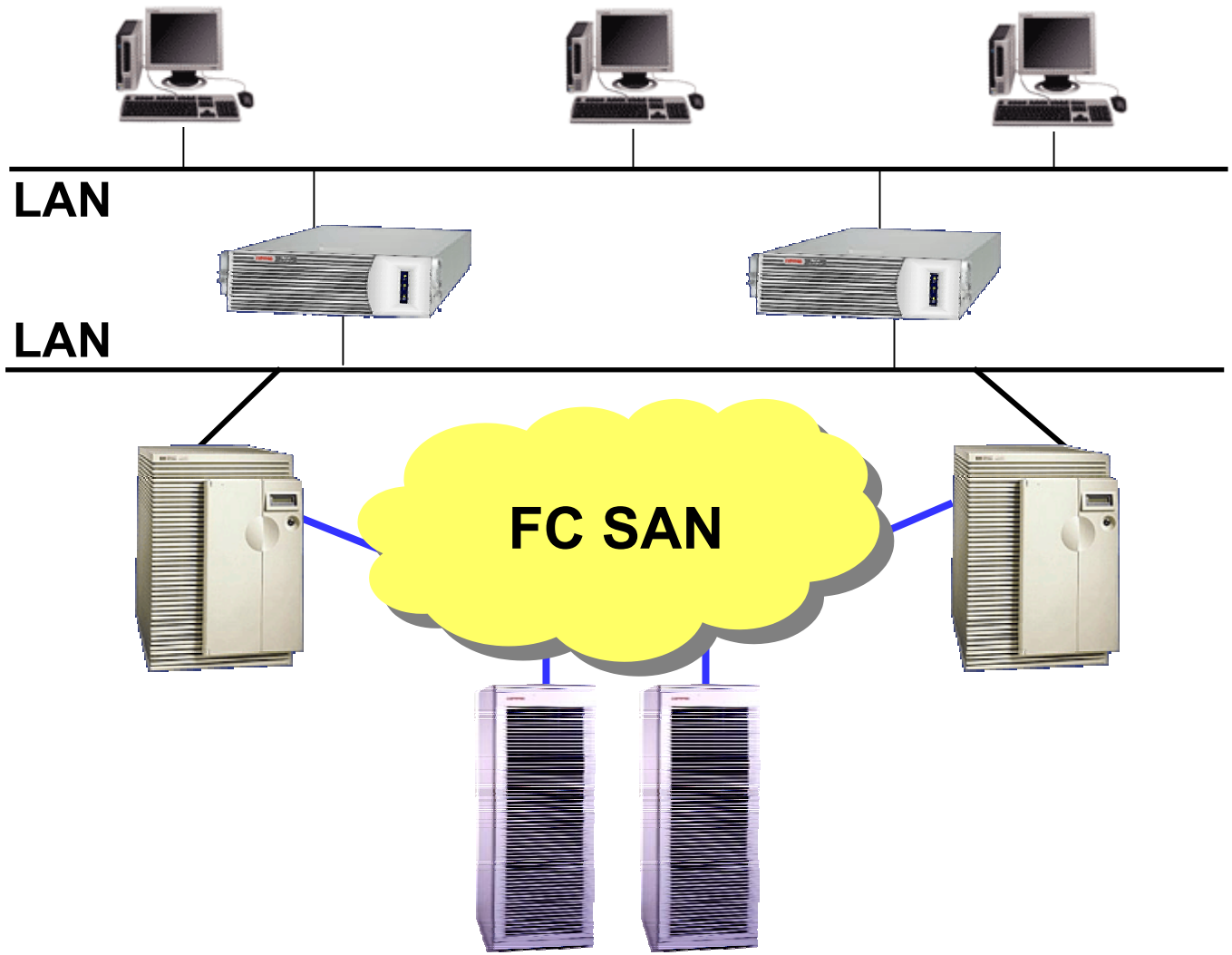
SQL 64 bit
Version

Server Area
Network HBA

Fibre Channel

"**Microsoft SQL Server 2000 Service Pack 3 offers customers several enhancements including support for the QLogic Virtual Interface protocol**," said James Hamilton, general manager for SQL Server at Microsoft Corp. "The VI technology in the SQL Server networking layer reduces CPU consumption per transaction on the server and client systems, and improves performance."

Today: Data Center Environment



Clients

Application Servers

Database Servers and/or NFS Servers

FC Storage

Performance Problem: TCP/IP Interconnect Within Data Center

- Very High CPU Utilization
  - Protocol processing with any size message
  - Receive data copy overhead for medium to large message size
- High Memory Bandwidth Required
  - Same data is copied 2 to 3 times to make it to user buffer
- OS Infrastructure for TCP/IP Offload Technologies Still Under Development
- RDMA over TCP/IP Specifications Under Development

Solution - VI

- VI Connections
  - Direct sessions established between end application nodes
  - No TCP/IP processing required
- RDMA (Remote DMA) Capabilities
  - Data moves directly into application buffer
  - No double buffering of data needed
- Proven Technology with Proprietary Interconnects
  - Database acceleration
    - SQL, Oracle, DBII
  - File oriented storage
    - DAFS, NFS - Netapp
  - High performance computing
    - Various MPI libraries in market

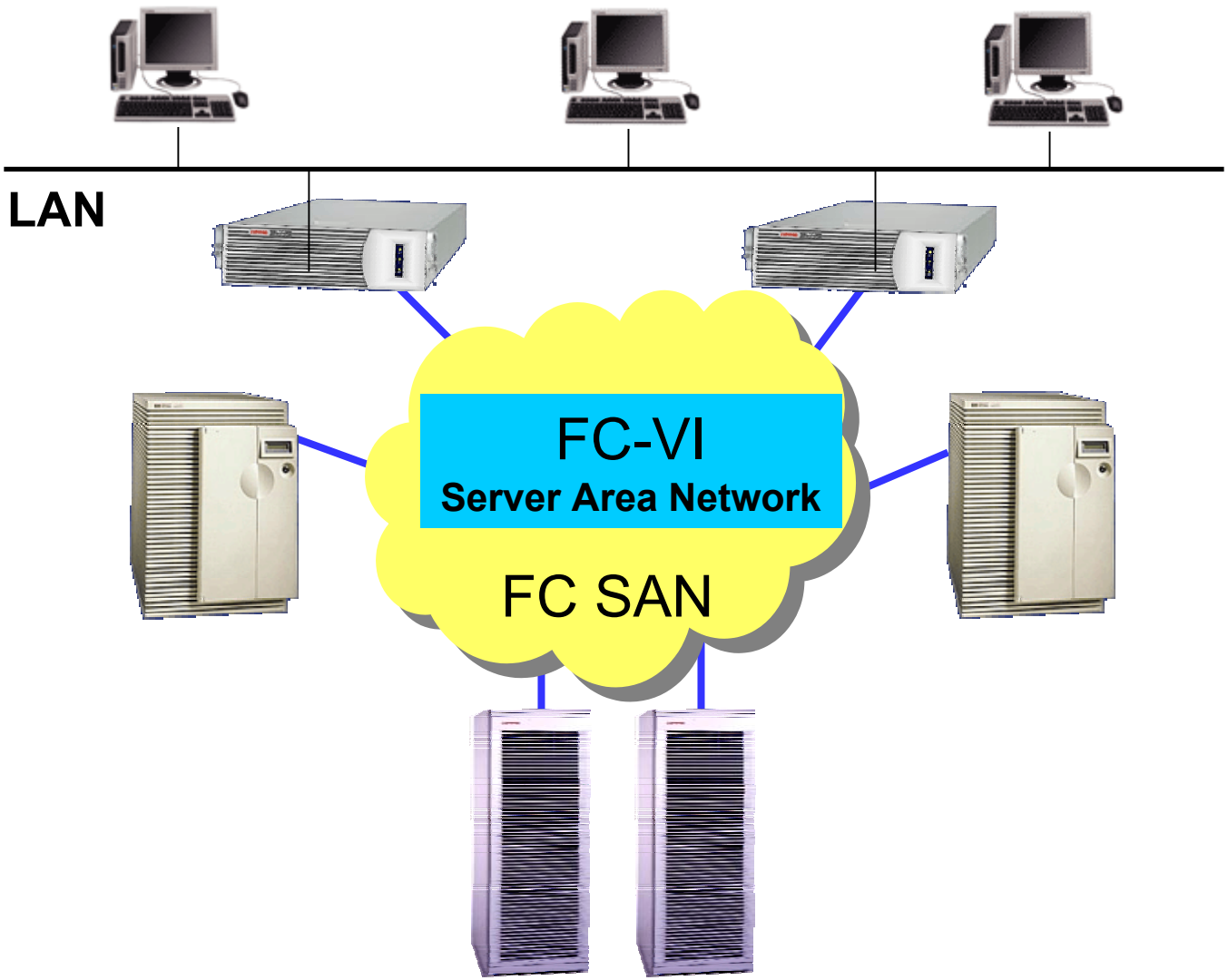
Problem with Proprietary VI Interconnects

- Ties IT Customer to Single Server Vendor
  - Compaq ServerNet, Dell GigaNet
  - Rely on a single vendor for future upgrades
  - Limited support
- Products EOL
  - Low performance because of older technology
  - Did not gain enough traction in the industry
  - IB was suppose to be the future and now questionable
- Very High Cost of Ownership
  - High deployment cost
  - Difficult to manage

FC-VI Solution:

- Available Today
  - No new investment needed
  - Evolutionary change
- Widely Adopted Standards-Based Technology
- High Performance
  - Fabric-based for scalable bandwidth
  - 2Gb today, going to 4Gb and 10Gb in CY04
- Fibre Channel Already in the Data Centers
  - Single fabric can run FCP-SCSI, FC-IP & FC-VI
  - Re-use existing infrastructure – cables, HBA and switches
  - Re-use of existing management tools

FC-VI: Data Center Environment



Clients

Application Servers

Database Servers

NFS Server

FC Storage

FC-VI Products

- Concurrent Support for Standards-based
  - FCP-SCSI
  - FC-IP
  - FC-VI - 1.82
- Highly Integrated Fibre Channel HBAs & ASICs
  - Cost effective solutions
  - Deployed on server motherboards and Bladed servers
  - Low profile PCI-X single-channel and dual-channel HBAs
- Low Latency Switches with VI Preference
  - Less than 400 nanosecond switch latency
- Supported by Microsoft SQL
  - IA-32 SQL Service Pack 3
  - IA-64 with initial IA-64 SQL release

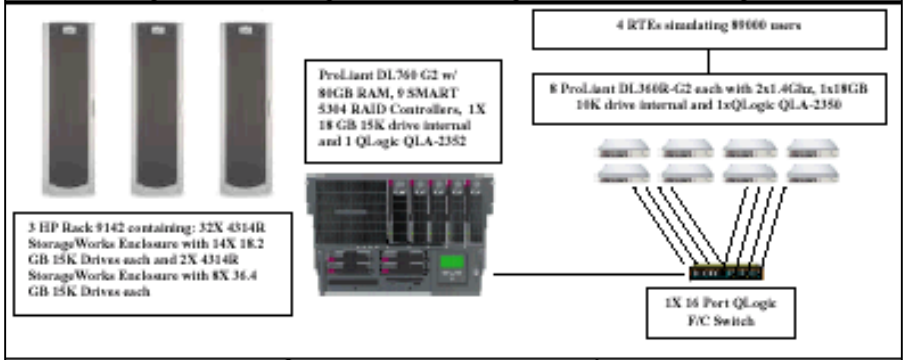
HP Solutions

- HP Proliant DL 760-G2 8P
- HP Superdome
- HP rx5670
- SANblade 2350 HBAs
  - VI protocol support
  - Native W2K, SQL
- SANbox2 switches
  - Prioritizes VI packets

Hewlett Packard Company	HP Proliant DL760-G2 8P C/S with 8 ProLiant DL360-G2	TPC-C Rev. 5.0 Report Date: Nov.4, 2002

Total System Cost	TPC-C Throughput	Price/Performance	Availability Date
$890,207	111805.22	$7.97	May 4, 2003

Processors	Database Manager	Operating System	Other Software	Number of Users
8 x Intel Xeon MP Processors – Server 16 x Pentium III 1.4GHz – Client	Microsoft SQL Server 2000 Enterprise Edition (SP3)	Microsoft Windows .NET Datacenter Server	Microsoft Visual C++ Microsoft COM+	89000



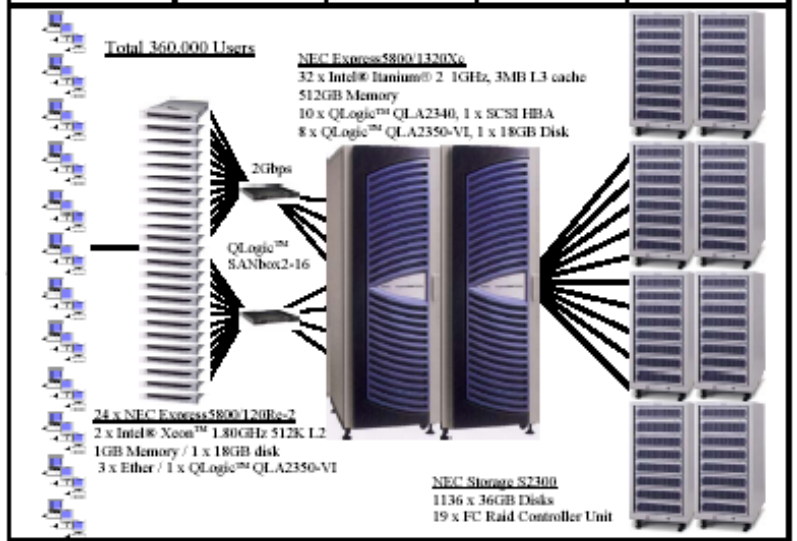
	Server		Each Client	
System Components	Quantity	Description	Quantity	Description
Processor	8	2GHz Xeon MP w/ 2MB Cache	2	1.4GHz Pentium III w/ 256K cache
Memory	40	2GB	2	1GB
Disk Controllers	9	SMART 5304/128 Array Controller	1	Integrated SMART 5i Controller
	1	Integrated SMART 5i Controller		
Disk Drives	1	18GB 10K SCSI Drive	1	18GB 10K SCSI Drive
	448	18GB 15K SCSI Drives		
	16	36GB 15K SCSI Drives		
Total Storage		8130.82 GB		18GB
Tape Drives	1	12/24 GB DAT		

Other Server Vendor Support

- Fujitsu-Siemens Primergy T850 8P
- NEC Express 5800/1320Xc
  - 32 x Intel® Itanium
- IBM x-series 440

NEC	NEC Express5800/1320Xc C/S with Express5800/120Re-2		TPC-C Rev.5.1 Reported Date Feb 20, 2003
Total System Cost	**TPC-C Throughput**	**Price/Performance**	**Availability Date**
$5,619,528	433,107.77 tpmC	$12.98 per tpmC	June 30, 2003

Processors	Database Manager	Operating System	Other Software	Number of Users
32 Intel® Itanium® 2 1GHz for Server 46 Intel® Xeon™ 1.80GHz for Client	Microsoft® SQL Server™ 2000 Enterprise Edition(64-bit)	Microsoft® Windows® Server 2003, Datacenter Edition for 64-bit Itanium-based Systems	Windows® 2000 Server Microsoft® VC++ Microsoft® COM+	360,000



System Component	Server		Each Client	
Processors Cache	32	Intel® Itanium® 2 1GHz 3MB L3 Cache	2	Intel® Xeon™ 1.80GHz 512KB L2 Cache
Memory		2 GB x 256		512MB x 2
Disk Controllers	10 1	QLogic™ QLA2340 SCSI HBA	1	On-board SCSI
Disk Drives	1 1136	18GB (16.6GB Usable) 36GB (33.2GB Usable)	1	18GB
Total Storage		40,914GB		18GB
Others	1 1 8	DVD-ROM Drive 1Gbps Ether NIC QLogic™ QLA2350-VI 2Gb NIC	1 2 1 1	CD-ROM Drive On-board Ether controller 100Mbps Ether NIC QLogic™ QLA2350-VI 2Gb NIC

IBM RTP Initiative – 15 Node VI Cluster

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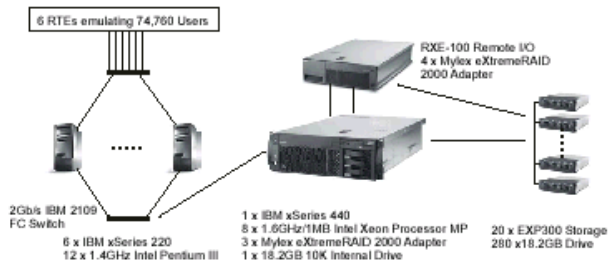
IBM	IBM @server xSeries 440 c/s with Microsoft SQL Server 2000		TPC-C Rev. 5.0 Report Date: July 22, 2002
Total System Cost	TPC-C Throughput	Price/Performance	Availability Date
$711,634	92,398.49 tpmC	$7.70 / tpmC	Jan. 21, 2003

Processors	Database Manager	Operating System	Other Software	Number of Users
Server: 8 Xeon Processors MP 1.6GHz Clients: 6 Pentium III 1.4GHz	Microsoft® SQL Server 2000 Enterprise Edition	Microsoft .NET Datacenter Server	Microsoft Visual C++ 6.0 Win32 Microsoft COM+	74,760



System Component	Qty	Server:	Qty	Each Client:
Processors	8	1.6GHz Xeon Processor MP w/1MB L3 Cache	2	1.4GHz Pentium III w/512KB L2 Cache
Memory	32	2GB ECC SDRAM	3	256MB
Disk Controllers	7	Mylex eXtremeRAID 2000 Adapter	1	Ultra160 SCSI Interface
Disk Drives	280	18.2GB (15000 rpm)	1	18.2GB Hard Disk
Total Storage		4757.33GB		
Tape Drive	1	20/40GB SCSI Tape Drive		

IBM Corporation	IBM @server xSeries 440 c/s with Microsoft SQL Server 2000		TPC-C Rev. 5.0 Report Date: July 22, 2002				
Description	Order Number	Third-Party Brand	Pricing	Unit Price	Qty	Ext. Price	3-Yr. Maint.*
Server Hardware							
IBM @server xSeries 440 Two 1.6GHz/1MB Xeon Processor MP	8686-3RX	IBM	1	$27,099	1	$27,099	$3,390
xSeries SMP Expansion Module	32P8340	IBM	1	5,199	1	5,199	0
1.6GHz/1MB Xeon Processor MP	32P8707	IBM	1	6,599	6	39,594	0
2GB PC133 ECC SDRAM RDIMM	31P8840	IBM	1	6,999	32	223,968	0
Mylex eXtremeRAID 2000 Adapter***	08P3834	Mylex	2	1,280	9	11,520	0
18.2GB 10K Ultra160 SCSI Drive	06P5754	IBM	1	275	1	275	0
QLogic 2350 Fibre Channel-VI Adapter***	QLA2350-BK	QLogic	3	2,568	3	7,704	0
Netfinity 4.2M Ultra2 SCSI Cable	03K9311	IBM	1	99	20	1,980	0
IBM UPS 500	33L3477	IBM	1	99	1	99	0
E54 14" (13.8" Viewable) Color Monitor*	6331147N	IBM	1	139	1	139	90
20/40GB Internal SCSI Tape Drive	00N7991	IBM	1	769	1	769	0
NetBAY42 Standard Rack Cabinet	9306421	IBM	1	1,439	2	2,878	800
Enterprise Rack Prep Fee	o6P5756	IBM	1	500	1	500	0
Enterprise Rack Installation Fee	06P7515	IBM	1	150	1	150	0
Option Integration Fee	58P8665	IBM	1	110	1	110	0
Image Load Fee	06P7505	IBM	1	150	1	150	0
Storage Hardware							
IBM EXP300 Rack Storage Enclosure*	35311RU	IBM	1	3,179	20	63,580	4,000
18.2GB 15K Ultra160 SCSI Drive	06P5767	IBM	1	439	280	122,920	0
IBM RXE-100 Remote Expansion	8684-1RX	IBM	1	4,569	1	4,569	1,050
3.5 Remote I/O Cable Kit	31P6102	IBM	1	599	2	1,198	0
					Subtotal	$514,401	$9,130
Server Software							
Microsoft SQL Server 2000 EE	810-00846	Microsoft	4	16,541	8	$132,328	$0
Microsoft .NET Datacenter Server	4816-2BX	IBM	1	16,000	1	16,000	41,850
Three-Year Maintenance for Software	PROPRORS16U01	Microsoft	4	1,950	3		5,850
					Subtotal	$148,328	$47,700
Client Hardware							
IBM @server xSeries 220* One 256MB 133MHz ECC SDRAM	8646-5AX	IBM	1	1,549	6	39,294	$4,488
1.4GHz/512KB Pentium III Processor	25P2090	IBM	1	1,199	6	7,194	0
256MB 133MHz ECC SDRAM RDIMM	10K0020	IBM	1	245	12	2,940	0
18.2GB 10K Ultra160 SCSI Drive	06P5754	IBM	1	275	6	1,650	0
QLogic 2350 Fibre Channel-VI Adapter***	QLA2350-BK	QLogic	3	2,568	6	15,408	0
E54 15" (13.8" Viewable) Color Monitor*	6331147N	IBM	1	139	6	834	540
					Subtotal	$37,320	$5,028
Client Software							
Microsoft Windows 2000 Server with	C11-00821	Microsoft	4	738	6	4,428	0
Microsoft Visual C++ Professional 6.0	048-00317	Microsoft	4	549	1	549	0
					Subtotal	34,977	$0
User Connectivity							
SAN Fibre Channel 8-Port Switch*	2109S08	IBM	1	16,518	1	16,518	2,160
IBM 5M LC-LC Fibre Channel Cable	19K1248	IBM	1	129	7	903	0
					Subtotal	$17,421	$2,160
					Total	$647,616	$64,018
Large volume discount of 14% on IBM Hardware; prices will vary if purchased separately.			1			(74,831)	$0

Notes: * The standard 3-year warranties on IBM hardware have been upgraded to 7x24, 4-hour response time coverage.
** Five-year warranty. *** 10% or minimum 2 spares are added in place of on-site service (products have a 5-year return-to-vendor-warranty)
Pricing: 1 - IBM Corp.; 2 - Computer Giants; 3 - QLogic; 4 - Microsoft Corp.
Audited by Brad Aakins of InfoSizing, Inc.

Three-Year Cost of Ownership:	$711,634
tpmC Rating:	92,398.49
$ / tpmC:	$7.70

Prices used in TPC benchmarks reflect the actual prices a customer would pay for a one-time purchase of the stated components. Individually negotiated discounts are not permitted. Special prices based on assumptions about past or future purchases are not permitted. All discounts reflect standard pricing policies for the listed components. For complete details, see the pricing sections of the TPC Benchmark specification. If you find that stated prices are not available according to these terms, please inform the TPC at pricing@tpc.org. Thank you.

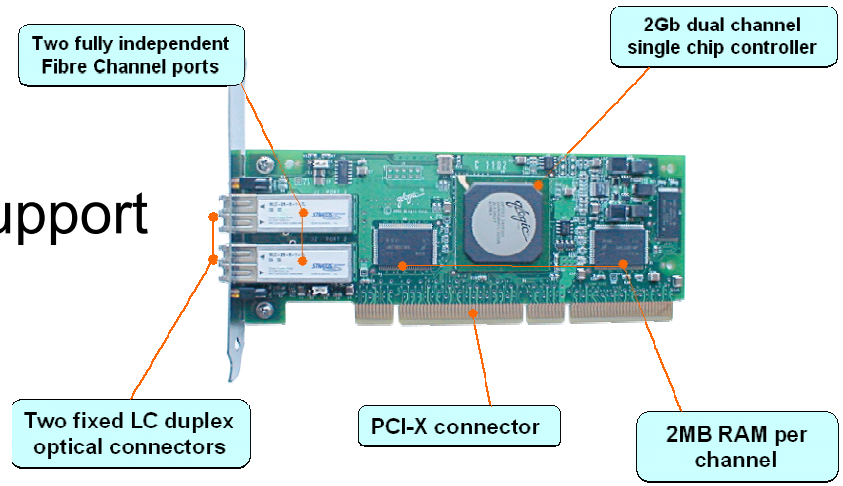
Microsoft Support

- QLogic FC-VI Supported by Microsoft Server 2000
  - IA-32 SQL Service Pack 3
  - IA-64 with initial IA-64 SQL release

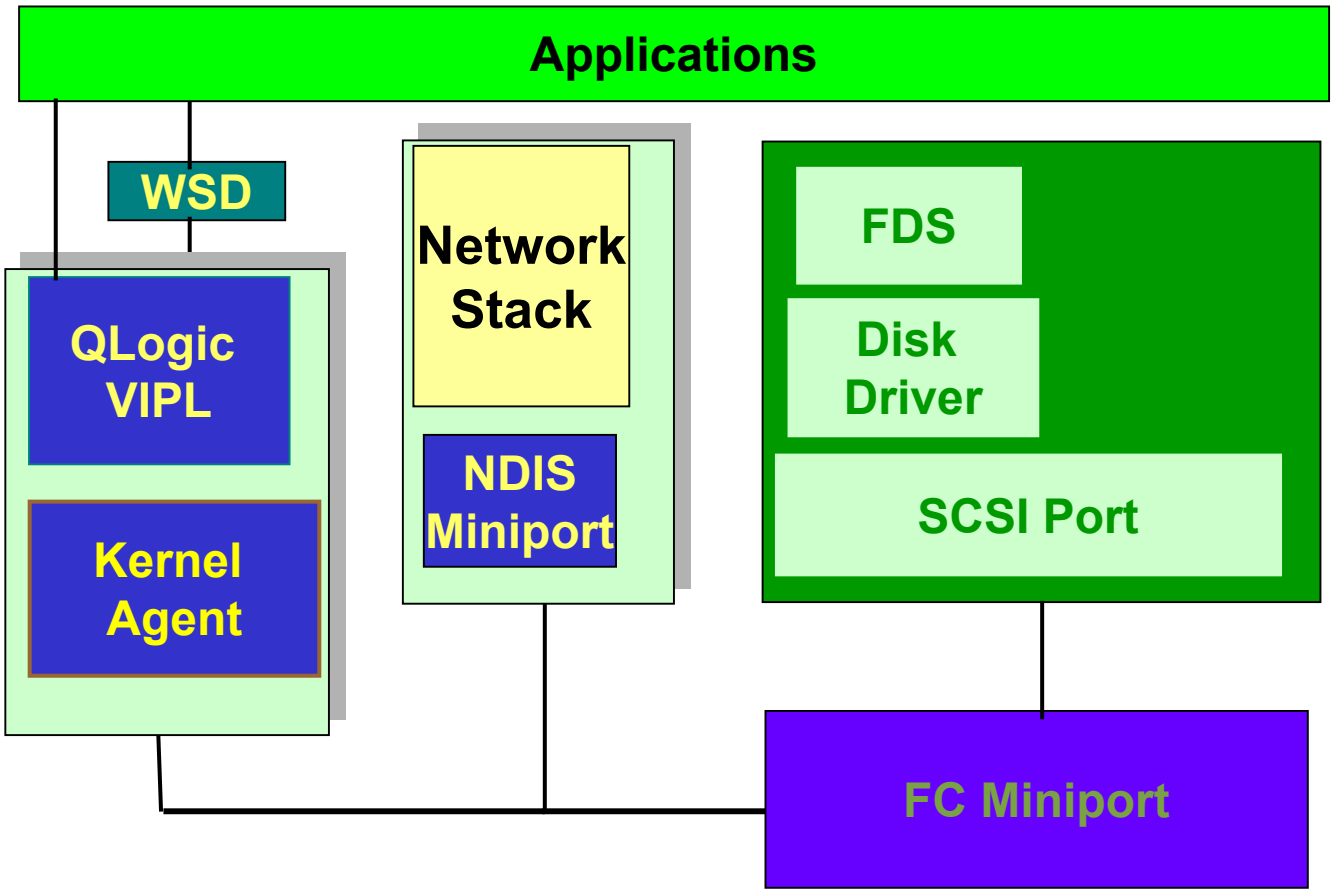
"**Microsoft SQL Server 2000 Service Pack 3 offers customers several enhancements including support for the QLogic Virtual Interface protocol**," said James Hamilton, general manager for SQL Server at Microsoft Corp. "The VI technology in the SQL Server networking layer reduces CPU consumption per transaction on the server and client systems, and improves performance."

FC-VI HBA Features

- 1,024 VI Connections Per Channel
- Memory Registration
  - Two memory page size support
  - 128K TPT entries for RDMA memory registration
- Configurable Memory Registration
  - send / receive
- Configurable MTU up to 256KB
- Linearly-Scalable, Multiple HBA support
- Specification Compliance
  - VIPL 1.0 – with some 1.1 features
  - FC-VI 1.82
  - Winsock 2.2



FC-VI HBA Software Architecture



Very Powerful in Blade Server Solutions

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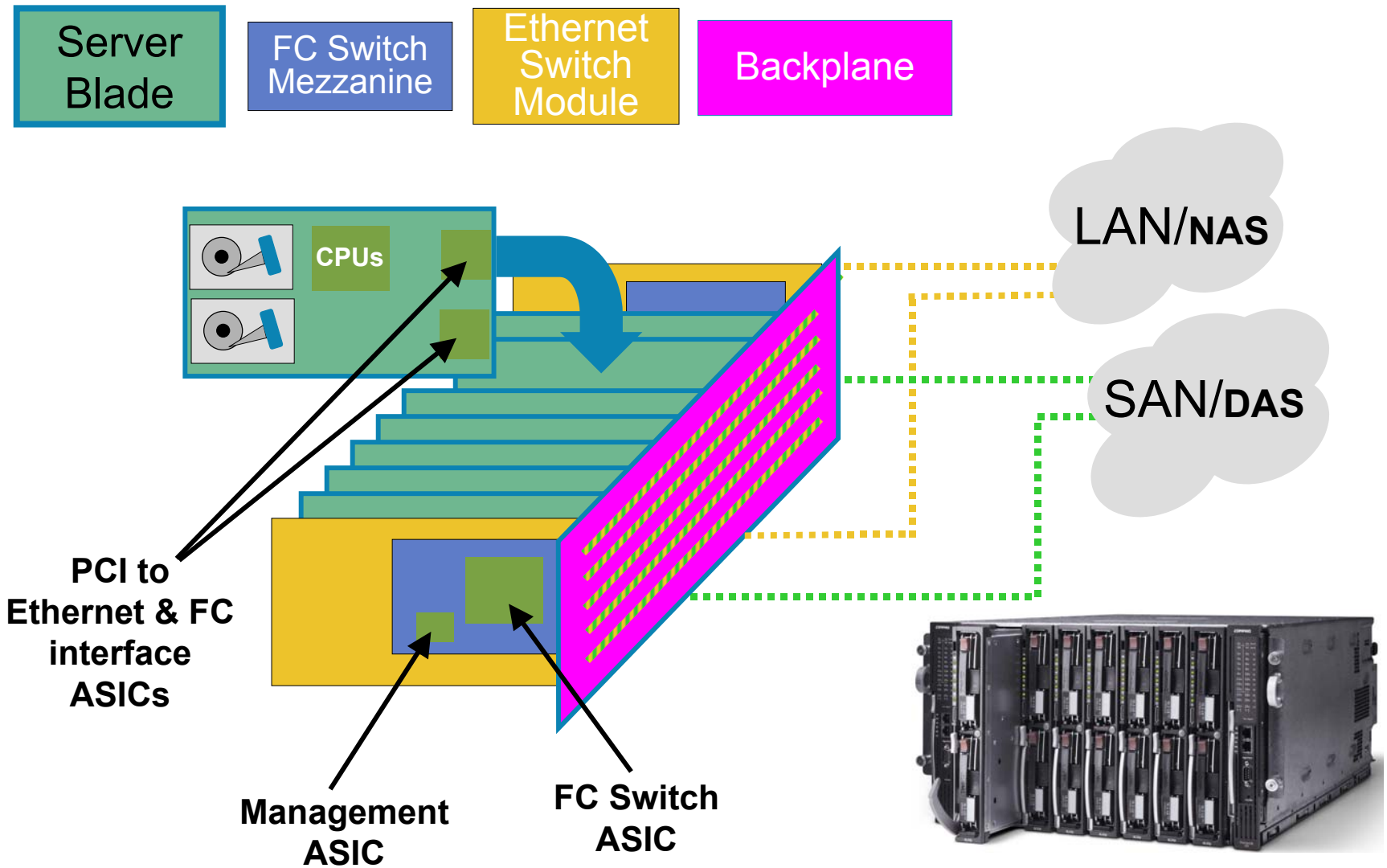
QLogic "Fibre Down™" Integrated in HP ProLiant Blade Servers for Connectivity to Storage Area Networks

ALISO VIEJO, Calif., February 3, 2003- QLogic Corp. (NASDAQ:QLGC), the company that powers storage networks, today announced that QLogic technology is being used in HP's highly integrated Fibre architecture, helping enable robust heterogeneous storage area network (SAN) support on HP ProLiant BL p-Class blade servers. The advanced architecture features "Fibre Down," the integration of single-chip Fibre Channel host bus adapters onto blade servers. Designed to enable the deployment of blade server farms in data centers, this innovative technology dramatically increases the storage expansion capabilities of blade servers by providing very reliable, high bandwidth, long distance connectivity to Fibre Channel SANs.

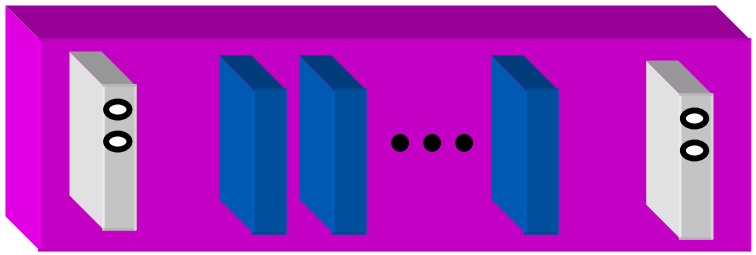
"Early blade servers supported edge-of-the-network applications such as Web serving, media streaming, load balancing, caching, and firewall protection," said Frank Berry, vice president of marketing, QLogic Corp. "Now with powerful processors and connectivity to Fibre Channel SANs, new HP ProLiant BL p-Class blade servers are equipped to support core business applications in the data center."

Blade Server Design

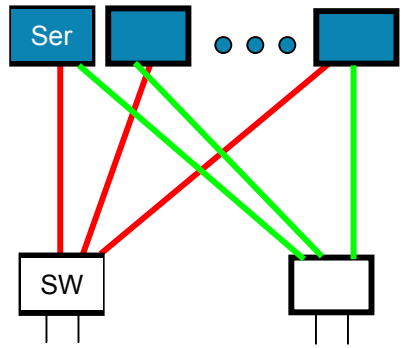


System Architecture

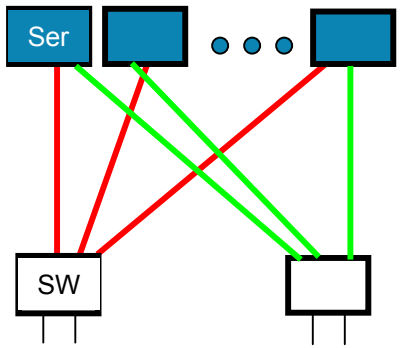
Chassis View

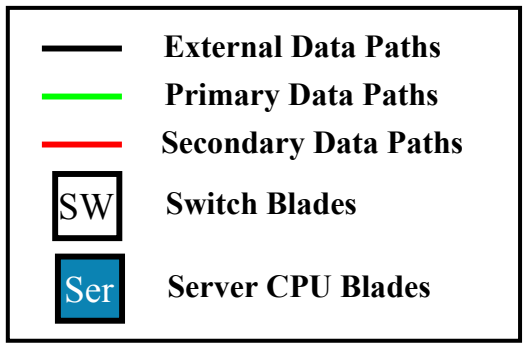


Ethernet Topology View



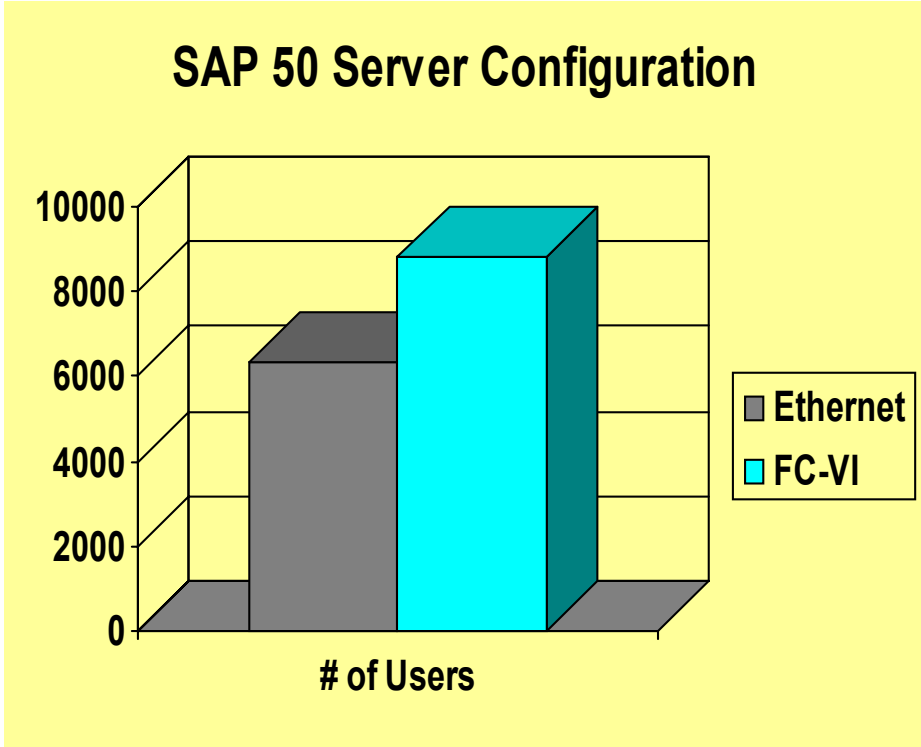
Fibre Channel Topology View





Performance

- FC – VI performance Network within Data Center
  - Demonstrated very high performance and scalability
    - SAP - 3 Tier Data Center - 40% gain at 2% higher cost
    - 50 Server stable SAN using FC-VI
- Memory Registration Speed – Using 2K buffer size based on P-III, 800 Mhz
  - Registration time: 6.5 µs
  - De-registration time: 36 µs
- Coming Improvements to FC-VI Latency Performance
  - Sub 20 µs with next-gen HBAs
  - Sub 10 µs with 4 and 10 Gb FC



IPC Solutions comparison

	FC VI	IB	RDMA TOE
Availability	5th Generation FC Ready for Prime Time Viable Long Term	1st Generation Industry Support Waning Long Term Viability questionable	Emerging Not Proven Yet
Speeds	2Gb, 4Gb, 10Gb	2Gb, 10Gb, 30Gb	1Gb, 10Gb
Distance	Within Data Center	Within RACK	Within Data Center
Standard	Complete for FC Complete for VI	Complete	IETF Process Starting RDMA Consortium
Infrastructure	Use of Existing FC Switches, Cables, HBAs, Management Software	Brand New Switches, HBAs, Cables and Management Software	Use of Existing Ethernet Switches, Next-generation HBAs
Cost of Ownership	Low	Very High	Should be Low

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