



The IBM eServer[®] xSeries[®] 445 Product Guide

xSeries 445 – Business Overview

The IBM eServer xSeries 445 is the next-generation scalable enterprise server based upon the second generation of Enterprise X-Architecture™ technology. As the flagship of the high-performance xSeries server brand, the x445 sets an all-new standard in the marketplace for modular scalability, industry-leading performance, mission-critical availability, and remote management. A revolution in technology and design, the x445 builds upon the phenomenal success of the x440 and extends that leadership with all-new capabilities including improved partitioning, reduced latencies, increased memory availability, and scalability up to 32-way. Pushing industry-standard servers deeper into the enterprise datacenter than ever before, the xSeries 445 is the mission-critical server that continues to revolutionize the industry-standard server market.

With support for up to 32-way SMP including the ability to share remote I/O between two servers, the x445 satisfies the needs of today's evolving datacenter with its "pay-as-you-grow" building block design, empowering lower entry price points and faster return on investment. With a flexible upgrade path that doesn't penalize you with expensive, supporting infrastructure, the x445 allows you to purchase only the performance and I/O capacity that you need, when you need it, without the upfront costs of expensive switch-based alternatives. Called XpandOnDemand™ scalability, this "pay-as-you-grow" capability is unmatched by any server in the industry-standard server market. By bridging the gap between performance and headroom, the x445 helps CIO's prepare for tomorrow by investing their IT dollars intelligently today.

Leveraging over 50 years of enterprise expertise and the world-class engineering prowess of the IBM Server Group, the x445 delivers mainframe-inspired technologies at a fraction of the cost of a true mainframe system. Built upon industry-standard processors, memory, and I/O, this next-generation Enterprise X-Architecture design makes these technologies work together better with increased performance, improved availability and extended management over the previous generation. The x445 delivers the latest OnForever™ availability features with complete N+1 redundancy and the ability to hot-swap components in every major subsystem – PCI-X adapters, main memory, hard disk drives, power supplies, and cooling fans – elevating the x445 to an unprecedented level of uptime demanded of a mission-critical enterprise server. The x445 also introduces new autonomic computing tools for improved reliability through self-healing and self-optimization. With the latest in server management – the Remote Supervisor Adapter II for Enterprise X-Architecture – built standard into every x445, IT administrators are able to more easily monitor and maintain their mission-critical servers remotely with full speed graphics console and text redirection plus virtual floppy and CD. This helps IT administrators work smarter in managing their infrastructure, not harder. And with scalability up to 32-way, IT administrators have more flexibility, more IT alternatives for partitioning and scalability than ever before.

In addition to scalability and availability, the x445 sets a new precedent for performance and introduces a new metric for comparison never before seen in the industry. As the premiere IA-32 database engine, the x445 delivers radical performance for SQL, DB2®, and Oracle, built upon the game-changing design of the x440. In designing and developing the x440, IBM walked the fine line of high-octane with fewer bottlenecks. Optimal performance is not achieved by forcing the fastest components together into a system. Rather, optimal performance is achieved by intuitive innovation. With the x445, IBM takes this innovation to the next level by reducing the communication latencies between high-performance components and doubling the amount of XceL4™ Server Accelerator Cache. Now with 64 megabytes of level-4 system cache per SMP Expansion Module (up to 256 MB per 16-way or 512 MB per 32-way), the x445 shatters previous industry-standard benchmarks. When combined with the latest Intel Xeon processors, now up to 3.0GHz with a robust 4MB L3 cache, and packaged in an incredibly rack-dense 4U chassis, what results is a high-performance system nothing short of breath-taking...the highest performing IA-32 server per U in the world!

As the world's most advanced IA-32 server, the x445 also introduces a new breed of industry-standard server optimized for server consolidation of file/print, messaging (Microsoft® Exchange, Lotus® Notes®), and custom applications through advanced system partitioning or in combination with client consolidation software such as Citrix®. And with such a suite of high availability features, the x445 is best suited for mission-critical applications such as CRM, ERP, business intelligence, and web serving found in the enterprise datacenter today.

Built upon the legacy of the x440 that allowed IBM to surpass Hewlett-Packard and claim the #1 market share position for 8-way servers worldwide – a #1 ranking that IBM retained since the third quarter of 2002 – the x445 is surely the answer to your IT demands. As the new standard bearer for Enterprise X-Architecture, the x445 once again redefines performance, scalability, and availability for industry-standard servers to deliver day-one results on demand.

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xSeries 445 – Key Differentiators

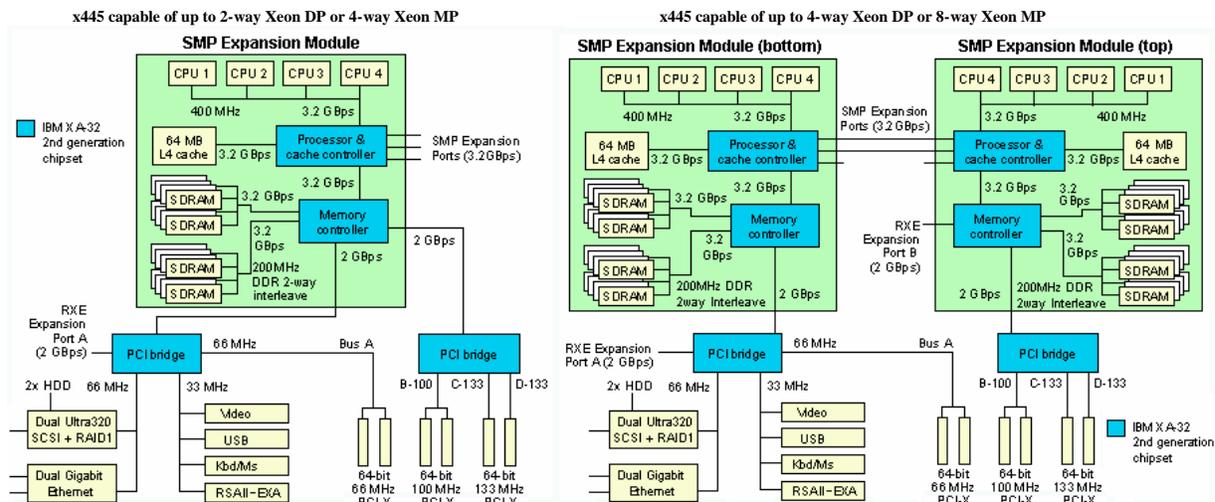
- First to market 8-way for the fourth consecutive generation of the Intel Xeon MP – a clear indicator of commitment to leadership.
- The highest performing IA-32 per U in the world – at 4U high, the x445 fits up to 80 CPUs per 42U rack – 150% more than Unisys.
- The industry’s most rack-dense 16-way at 8U height (14 inches, 35.56 cm) – 22% of the rack space of the 36U Unisys ES7000.
- Higher performance with the IBM XA-32™ 2nd generation chipset – 40% more I/O bandwidth than the previous generation.
- Modular scalability takes you from 2-way to 4-way to 8-way to 16-way and 32-way for investment protection.
- First to market and still the only server manufacturer with 4-way based upon cost-effective Intel Xeon (DP) at 3.0 GHz.
- Double the Xcel4 Server Accelerator Cache for higher performance scalability from 4-way to 8-way to 16-way and beyond.
- Industry-leading Active Memory – reduced downtime with Chipkill and Memory ProteXion including hot-swap & hot-add memory.
- Flexible Remote I/O – enhanced PCI-X expansion external to the base system for “pay-as-you-grow” I/O scalability on demand.
- Increased I/O flexibility with RIO Sharing – support for more flexible upgrades by sharing RIO Enclosures between two x445 servers.
- Light Path Diagnostics™ – reduce your repair time through quick identification of failed or failing components.
- Copper Diagnostics™ – auto-detection of multi-chassis configurations combined with autonomic cable redundancy and failover
- Active PCI-X and Dual Gigabit Ethernet – reduce network bottlenecks with up to 133 MHz PCI-X performance and Gigabit Ethernet .
- Higher throughput with Ultra320 SCSI including RAID-1 – mirror your operating system and swap-files with integrated RAID-1
- System Partitioning – consolidate servers or setup high-speed clustering configurations using logical or physical partitioning.
- Remote Supervisor Adapter II – EXA – delivers 5X greater performance of graphics and text redirect versus previous generation RSA.

xSeries 445 – Technology Overview

The IBM XA-32™ 2nd generation Chipset

The IBM XA-32 2nd generation chipset follows in the path of the hugely successfully 1st generation IA-32 chipset based upon Project “Summit.” A product of the IBM Microelectronics Division in Austin, Texas, the XA-32 2nd generation chipset is fabricated using the latest in copper technology and is composed of the following components:

1. Memory Controller: there is one high-performance memory controller per SMP Expansion Module. This memory controller delivers 7.0 GB/sec aggregate I/O bandwidth – a 40% increase over the previous generation – and 12.8 GB/sec aggregate memory bandwidth per chassis. With its multi-memory controller architecture, the x440 does not have the bottleneck of a single memory controller that handicaps the performance and scaling of other chipset designs such as Intel’s Profusion and Hewlett Packard’s F8 (used in the ProLiant DL740 and DL760 G2). While these systems are limited to 8-way scaling, XA-32 based systems are thus capable of more cost effectively scaling well beyond 8-way.
2. Processor & Cache Controller: there is one high-performance processor & cache controller per SMP Expansion Module. The second generation chipset delivers a 10% reduction in memory latency to power faster transmission of data for your high-end database.
3. PCI Bridge: there are two PCI Bridge I/O controllers per chassis located on the centerplane and the I/O board that control both the PCI-X and Remote I/O. As a demonstration of interoperability among eServer systems, this same I/O controller is also developed for and used by the eServer iSeries and pSeries.



As the “glue” that binds the processors, memory, and I/O together, the XA-32 2nd generation chipset is the “secret sauce” of the x445, allowing IBM to optimize the x445 for performance with latency reductions over the previous generation, increase the scalability up to 32-way, and build in new high availability features differentiated from other Intel-based server designs. This next-generation chipset design allows IBM to build an exceptionally rack-dense 8-way, optimize it for performance, then combine two of these systems together in a single configuration for the most

rack-dense 16-way in the world today or into four chassis for 32-way. In addition, the x445 with the XA-32 2nd generation chipset maintains the IBM industry exclusive with the Xeon DP (Dual Processor). By using this less expensive Xeon, you can combine four Xeon DP processors – limited to at two-way in servers offered by HP and Dell – into a 4-way server, resulting in exceptional price/performance compared to a Xeon MP. Though limited to 4-way with the Xeon DP, you can rest assured that you are still purchasing an x445 with the promise of XpandOnDemand™ scalability with Xeon MP up to 32-way. For a graphical lay-out of a Xeon MP 4-way or 8-way server, see the block diagrams on the previous page. To create a 2-way or 4-way Xeon DP -based server, simply ignore CPU2 and CPU3 (pre-populated with air baffles). For 16-way or 32-way SMP, simply connect two or four 8-CPU Xeon MP servers together via the SMP Expansion ports and cables (see page 9 for further details).

x440 vs. x445	
XA-32 1st Generation chipset	XA-32 2nd Generation Chipset
2-way to 16-way SMP	2-way to 32-way SMP
Xeon MP: 1.5/1M, 1.9/1M, 2.0/2M	Xeon MP: 2.0/1M, 2.2/2M, 2.7/2M, 3.0/4M
Xeon DP 2.4GHz up to 4-way	Xeon DP 3.0GHz up to 4-way
32MB Xcel4 per CEC, 128MB Max	64MB Xcel4 per CEC, 512MB Max
32GB Max Memory per chassis	64GB Max Memory per chassis
PC133 SDRAM, 4-way Interleaving	DDR SDRAM, 2-way Interleaving
Adaptec Ultra160 SCSI, RAID Opt.	LSI Ultra320 SCSI, Int. RAID-1 std.
Remote Supervisor Adapter	Remote Supervisor Adapter II for EXA
RXE-100 Remote I/O Support	RXE-100 Remote I/O + RIO Sharing
24x CD-ROM UltraBay	8x DVD-ROM UltraBay
Broadcom 5700 single port GbE	Broadcom 5704 dual port GbE
Memory Mirroring + Memory ProteXion	Active Memory + Hot-swap & Hot-add
Windows 2000, Linux, VMware ESX 1.5	Windows 2003, Linux, VMware ESX 2
35 #1 Benchmarks in 15 months	50% greater performance, 17 more #1's

The Intel Xeon: delivering ultimate price-performance with IA-32

Announced in March 2002, the x440 was the first industry-standard 8-way server with Intel's next-generation, high-performance Xeon processor – a feat that required twelve additional months for HP to match, a feat that Dell is yet to accomplish. Two years later, IBM continues to lead the marketplace by delivering the x445 with the latest iteration of the Intel Xeon processor for the fastest performance ever witnessed by an industry-standard server. The x445 continues to support both versions of the Xeon processor – the Xeon DP (a dual-processor capable CPU) up to 3.0 GHz with 512K of L2 cache and scalability up to 4-way and the Xeon MP (Multi Processor) with up to 3.0 GHz with 4MB of L3 cache and scalability up to 32-way. The x445 is the only server in the world that delivers both the Xeon DP and the Xeon MP among its product offerings.



Frequency	L2 Cache	iL3 Cache	Max CPUs	Frequency	L2 Cache	iL3 Cache	Max CPUs
1.4 GHz	256 KB	512 KB	16	2.0 GHz	512KB	1 MB	32
1.5 GHz	256 KB	512 KB	16	2.5 GHz	512KB	1 MB	32
1.6 GHz	256 KB	1 MB	16	2.8 GHz	512KB	2 MB	32
1.5 GHz	512 KB	1 MB	16	2.2 GHz	512KB	2 MB	32
1.9 GHz	512 KB	1 MB	16	2.7 GHz	512KB	2MB	32
2.0 GHz	512 KB	2 MB	16	3.0 GHz	512KB	4MB	32
2.4 GHz	512 KB	0 KB	4	3.0 GHz	512KB	0MB	4

The Xeon processor provides a substantially smaller footprint than the previous Pentium III Xeon enabling the x440 to achieve leadership rack density as the industry's first 8-way Xeon MP in a 4U chassis. Its successor, the x445, continues this 4U rack-dense form factor allowing you to fit 66% more 8-way servers in a standard 42U rack than the 7U 8-way HP ProLiant DL760 G2 (ten 4U servers versus six 7U HP servers). Although the Intel Xeon DP and Xeon MP processors are similar electrically, they differ most in terms of the processor cache that each utilizes for performance. While the Xeon DP processor takes advantage of 512KB of L2 cache, the latest Xeon MP adds an additional 2MB or 4MB of L3 cache to its 512KB L2 for a noticeable improvement in transaction performance. Although the Xeon DP does not offer the L3 cache as the Xeon MP, what makes the x445 with the Xeon DP processors so innovative is that because of the XA-32-based architecture, the Xeon DP is actually able to use the 64MB of Xcel4™ system cache (per 2-way DP) to compensate for its lack of L3, resulting in a higher performing system than would be expected. In addition to increasing the frequency of the processors, Intel continues support for its NetBurst™ micro-architecture 400MHz front-side bus. By quad-pumping data over a 100 MHz clocked system bus, the Xeon processor achieves sustainable 400 MHz front-side bus performance, suitable for server with greater than 4 processors. This delivers data in and out of the processor at 3.2 GB/s, a substantial improvement over the 1.06 GB/s of the Pentium® III Xeon processor's 133 MHz design.

In addition, the Xeon processor also continues supports for the integrated virtual processor technology called Hyper-threading. Estimated by Intel to increase processing performance by up to 30%, Intel's simultaneous multithreading design allows a single physical processor to manage data as if it were two virtual processors by handling data instructions in parallel rather than one at a time. The multi-threading design also has implications for the operating system as the OS sees the single physical processor as two logical processors. Because of Microsoft's licensing of the Windows® Server operating systems by number of processors (see chart below), the appearance of twice as many logical processors can potentially affect the install of the operating system. As a result, hyper-threading is initially turned off in BIOS to ensure proper OS installation and can be re-enabled at any time. Although the Windows 2000 and Windows Server 2003 operating systems understand and correctly report hyper-threading, Windows NT 4.0 does not. Therefore, the x445 is able to support only Windows NT 4.0 Enterprise Edition in a 4-way configuration with Xeon MP (2-way only with Xeon DP) as Windows NT sees eight logical processors instead of the four physical processors.

At this time, no patch is planned by Microsoft to address this. Furthermore, because Windows NT is not NUMA aware, a change to the NT kernel is required for Windows NT to support a 4-way with Xeon DP— a change that is not possible as Microsoft no longer supports NT.

Microsoft OS Scalability	Windows 2000 Server	Windows 2000 Advanced Server	Windows 2000 Datacenter Server	Windows Server 2003 Standard Edition	Windows Server 2003 Enterprise Edition	Windows Server 2003 Datacenter Edition
Max # supported CPUs	4	8	16	4	8	32
Max supported memory	4 GB	8 GB	64 GB	4 GB	32 GB	64 GB
Clustering Max # nodes	0	2	4	0	8	8
NUMA Support	Compatible	Compatible	Compatible	Optimized	Optimized	Optimized

At this time, interconnecting nodes of different speed processors or installing different speed processors into different SMP Expansion Modules is not supported by IBM. This is because of the differences in cache sizes between the processors and the cache coherency problems that this introduces for the operating system.

Industry Exclusive with Xeon DP

Although architected by other server manufacturers such as Dell and Hewlett-Packard to support only up to 2-way SMP, the Xeon DP when combined with the innovation of the x445 design introduces an industry-exclusive scalable solution. By virtue of the XA-32 chipset, the x445 offers the only 4-way server in the world using the Xeon DP processor. Although only 2 processors can be supported in a single SMP Expansion Module, by combining two SMP Expansion Modules into a single 4U chassis (similar to the means by which one would build an 8-way SMP), you can acquire one of the highest performing 4-way industry-standard servers in the world. Not only that, but because this is an x445 server, you can still grow that system to 16-way and beyond at any time by swapping out the Xeon DP processors for Xeon MP. Besides the higher frequency of the processor, you can also benefit from the lower price of the processor to tailor a scalability solution for your datacenter needs. The x445 with Xeon DP not only creates value scalability but once again proves that the x445 is the ultimate XpandOnDemand™ solution.

x445 SMP Expansion Module

The x445 SMP Expansion Module is the central electronics complex (CEC) that contains the processors, memory, chipset controllers, and level-4 system cache. Depending upon the model, the x445 system includes either one or two SMP Expansion Modules, each with sockets for up to four Intel Xeon MP Processors or up to two Xeon DP processors, 64 MB of XceL4™ cache (double that of the x440), and 16 DIMM slots. Although the Xeon DP and Xeon MP are similar in architecture, mixing of DP and MP in the same CEC or between two CECs is not supported. Likewise, use of the x445 SMP Expansion Module in an x440 server is not supported because of the different generations of chipsets contained therein.

The processor upgrade path differs between the Xeon MP-based and Xeon DP-based x445. While the Xeon MP-based x445 can be upgraded by adding an empty x445 SMP Expansion Module (Option Part# 02R1870) and Xeon MP processor option kits, the Xeon DP-based x445 can only be upgraded from 2-way to 4-way by adding the x445 SMP Expansion Module pre-populated with two Xeon 3.0 GHz processors (Option Part# 02R1871). There are no Xeon 3.0 GHz processor option kits available for the x445. Note: The 8870-4EX model is a 4-way Xeon DP-based x445 that already contains both CECs.

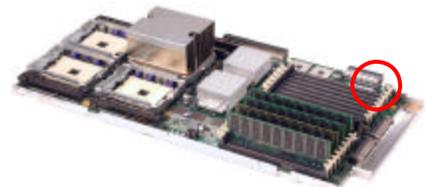
By adding that second SMP Expansion Module, you can grow the 2-way or 4-way Xeon MP to an 8-way SMP or the 2-way Xeon DP to a 4-way SMP, while still retaining the 4U rack density. When adding the second CEC, you also get an additional 64 MB of XceL4 cache (for a maximum of 128 MB) and 16 more DIMM slots to support up to a maximum of 64 GB per chassis. The SMP Expansion Module is installed from the top of the server and easily mounts to the side of the centerplane using two levers on the top of the CEC. These same levers are used to remove the top of the CEC when adding additional processors or memory. Remember: because of 2-way memory interleaving, you should always have at least 2 DIMMs in the top SMP Expansion Module.

Each SMP Expansion Module is also equipped with LEDs for Light Path Diagnostics. LEDs are available for each memory DIMM, processor, and VRM to aid in the quick identification of failed or failing components. LEDs are also located on the top of the CEC to identify when Active Memory™ mirroring is enabled for hot-swapping memory. A black button located within the CEC (see red circle in graphic above) controls the capacitor that powers the LEDs for identification of any failed components after the CEC is removed from the system for maintenance.

Because of the electrical similarities between the Xeon MP and the Xeon DP processors, if you wish to upgrade your existing x445 Xeon DP-based systems above 4-way SMP, you may exchange the Xeon DP Processors for Xeon MP Processors by purchasing only the appropriate number of option kits. For investment protection, this XpandOnDemand™ feature allows you to grow all the way up to 8-way in that same chassis, and to 16-way and beyond when combined with multiple chassis, even if you purchased the Xeon DP-based x445 server initially.



x445 SMP Expansion Module with cover

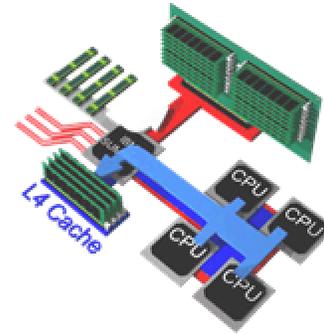


x445 SMP Expansion Module with cover off

XceL4™ Server Accelerator Cache

Integrated into the x445 SMP Expansion Module, XceL4 Server Accelerator Cache powers high-speed performance between the processors, main memory, and I/O devices. Four times faster than main memory, XceL4 becomes a necessity to alleviate the bottlenecks associated with SMP.

Each x445 SMP Expansion Module contains 64 MB of DDR-based XceL4 cache memory, twice that of the x440. Expanding from 4-way to 8-way with Xeon MP or 2-way to 4-way with Xeon DP doubles the XceL4 to 128 MB. The cache doubles again to 256 MB in a 16-way; 512MB in the 32-way. This cache becomes critical at 8-way and above in limiting the number of far memory accesses to reduce the latency associated with such transfers. Now in its second generation, the XA-32 chipset with twice the XceL4 cache powers a 10% reduction in memory latency alone.



4U Modular Rack Design Sets Standard for the Industry

The x445 leverages the award-winning mechanical design of the x440 that introduced leadership modular rack density. The x440 was the first 4U rack dense 8-way Xeon MP server available in the industry-standard server market, available 12 months ahead of HP and Unisys. A feat of cooling given the expansion capabilities and the number of electrical components integrated into the system, the x445 chassis is designed to give quick, easy, and tool-free access to the hot-swap power supplies, hot-swap fans, hot-swap I/O, SMP Expansion Module(s) and Light Path Diagnostics. Because of the layout of the mechanical and the use of ThinkPad® UltraBay™ devices for DVD-ROM and Floppy, DLT and other Tape Backup Solutions are not supported internally in the x445. Instead you should take advantage of the external SCSI port for connection of any ServerProven® external tape devices. At 27.5 inches (698 mm) deep, the x445 should only be installed in the IBM xSeries Enterprise Rack.



High-Performance Active™ PCI-X

The x445 remains the only 8-way Xeon MP-based system available from a major server vendor to support the fastest PCI-X 133MHz capability. The x445 is equipped with six full-length 64-bit Active™ PCI-X slots, capable of hot-adding, hot-swapping, and hot-deleting adapters at any time while the operating system is still running (OS support required, see page 11 for details). In addition, the second generation of the XA-32 chipset increases the aggregate I/O bandwidth by an astounding 40% over the previous generation x440, supporting simultaneous bi-directional aggregate I/O bandwidth of 7.0 GB per second per 8-way Xeon MP or 4-way Xeon DP— making x445 is one of the highest performing Intel-based servers in the world.

66 MHz → 100 MHz → 133 MHz



With four I/O buses, the x445 adapter slots will support two 133 MHz cards (each slot with its own bus), two 100 MHz cards (these slots share a bus), and two 66 MHz cards (these slots also share a bus). From the rear, the slots are oriented in order of ascending speed from left to right. Important Notes: 1) All slots support 3.3V adapters only and 2) because of the system depth, the blue handle must be removed when installing full-length PCI adapters.

Hot-Swap Redundant Power Supplies

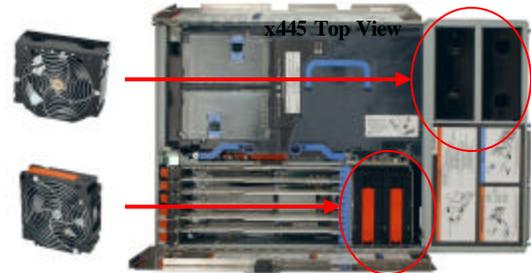
The x445 is equipped with two hot-swap, redundant power supplies (N+N) that are front accessible by removing the bezel. At 1200W each, the x445 power supply has been described as one of the most power-dense power supplies in the world. Maintaining tool-free serviceability, the x445 power supplies can be easily removed and re-installed using the lever on the front of the power supply. The x445 ships with two 1200W power supplies standard. Unlike other 8-way designs, the x445 is fully redundant at even the highest configuration with these two power supplies. Since two power supplies are the maximum, no power supply option part is available.

Because of the increased power consumption required of the new Intel Xeon processors especially when combined with a fully loaded system, the x445 can be connected to power through two means only: 1) the 220V power cord supplied with each system (two wall outlet line cords are provided) and 2) the 220V PDU adapters intended to connect the x445 to the Power Distribution Unit in the rack (two intra-rack cables are also provided). Because most companies will install the x445 in the 42U Enterprise Rack, the PDU adapters will be the most common means for connecting to power. However, the 220V cords are supplied for those companies wishing to configure the x445 in the NetBay11™ rack. Note: The x445 does not ship with 110V power cords as the system loses power redundancy at the highest configurations using this power setting. As illustrated in the photo at right, there are two power connections on the rear of the server.



Hot-Swap Redundant Cooling Fans

With four hot-swap redundant fans, the x445 has adequate cooling for each of its major component areas. There are two fans located at the front of the server that direct air through the SMP Expansion Modules. These fans are accessible from the top of the server without having to open the system panels. In the event of a fan failure, the other fan will speed up to continue to provide adequate cooling until the failed fan can be hot-swapped by the IT administrator within 24 hours. The other two fans are located just behind the power supplies and provide cooling for the I/O devices. Similar to the CEC fans, these fans will speed up in the event that one should fail to compensate for the reduction in air flow. All four fans are equipped with Light Path LEDs to enable easy identification of failed fans.



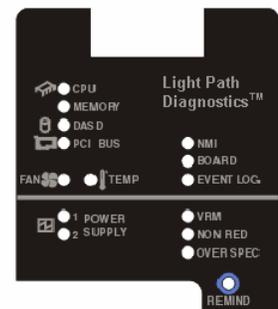
Floppy Drive & DVD-ROM Drive

In an effort to achieve the highest rack density without sacrificing essential functionality, the x445 leverages the UltraBay devices of the ThinkPad laptops. Located on the front of the server below the power supplies, the 3.5-inch floppy drive and the 8X DVD-ROM are space efficient and interchangeable with other ThinkPad UltraBay devices including CD-RW/DVD-ROM Combo drive. Check the ServerProven® web site for the officially supported options.



Light Path Diagnostics

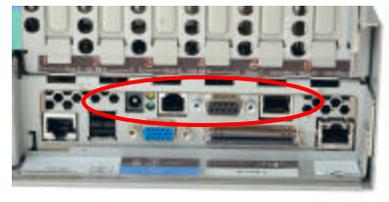
Continuing with the break-through technology of Light Path Diagnostics, the x445 brings greater ease of use and functionality to this critical Enterprise X-Architecture offering. To limit the need to slide the server out of the rack to diagnose problems, the Light Path panel is accessible from the front of the x445. This panel can be ejected from the server and folded down to view all Light Path monitored server subsystems. In the event that maintenance is then required, you can slide the server from the rack and using the LEDs, find the failed or failing component.



As illustrated in the graphic at right, Light Path Diagnostics is able to monitor and report on the health of CPUs, Main Memory, Hard disk drives, PCI-X and PCI adapters, fans, power supplies, VRMs, and the internal system temperature. Light Path in the x445 is divided into three levels: 1) front of server with Light Path panel identifies failure and sub-system, 2) LEDs on top of x445 identify to which board the failed component is attached, i.e. CEC1, CEC2, I/O, and 3) LEDs in the system help locate that component.

Remote Supervisor Adapter II for Enterprise X-Architecture

The x445 now includes the Remote Supervisor Adapter II for Enterprise X-Architecture (RSAIL-EXA) standard with every system. Positioned horizontally in a dedicated PCI slot beneath the PCI-X adapter area of the system, the RSAIL-EXA is one of the most sophisticated adapters offered by IBM, offering the following capabilities: independent power, in-band and out-band support through IBM Director; full web browser support with no other software required; enhanced security features; 5X performance of graphics/text console redirection for remote control versus previous RSA; Virtual floppy & CD (except with Windows NT); dedicated 10/100 Ethernet access port; Windows NT and Windows 2000 blue screen capture; IBM interconnect (RS485) with alerts including downstream support for previous generation RSA; serial dial in/out; email, pager and SNMP alerting; event log; Predictive Failure Analysis® on memory, power, hard drives, and L4 cache; temperature and voltage monitoring with settable threshold; Light Path Diagnostics; ASR for operating system and POST; Remote Firmware update; LAN Access; and alert forwarding.



Video Graphics, Keyboard, Mouse, USB, and Serial Ports

The x445 uses the integrated ATI Rage XL Video Accelerator chip with a 128-bit graphics engine, a PCI bus interface, and 8 MB of SDRAM. It will support up to the following video settings: 1600x1200x16.7M colors at 75 Hz, 1280x1024x16.7M colors at 100 Hz, or 1024x768x16.7M

colors at 150 Hz. The 15-pin port on the rear of the server will support any SVGA compatible monitor. The x445 offers standard PS/2 keyboard and mouse ports for use with industry-standard KVM as well as support for USB devices. There are two USB ports in the rear of the server and one USB accessible from the front for attaching a USB keyboard/mouse. The x445 also includes full serial support. This is achieved by installing the cable/bracket serial port assembly included with the server in one of the PCI slot brackets.

Broadcom Gigabit Ethernet Controller

The x445 includes one single-chip dual-port Broadcom BCM5704 10/100/1000 BASE-T network controller on a PCI 64-bit 66 MHz bus (port circled in graphic at right). The BCM5704 is a dual 10/100/1000 integrated MAC and PHY device able to share the same bus via bridge-less arbitration. The BCM5704 contains two standard IEEE 802.3 Ethernet MACs that provide full- or half-duplex performance at all speeds (10/100/1000 Mbps) as well as integrated 64K on-chip memory for buffering data transmissions and dual on-board RISC processors for advanced packet parsing and backwards compatibility with today's 10/100 networks. The Broadcom controller also includes software support for fail-over, layer-3 load balancing, and comprehensive diagnostics. For redundancy, failover, teaming, and load-balancing, refer to the NetXtreme dual-port Gigabit Ethernet Adapter, Option part# 31P6401.



Gigabit Ethernet boosts data transmission over existing Category 5 cabling, the dominant cabling infrastructure in today's corporate networks, by up to ten times compared to Fast Ethernet solutions. This leap in performance is especially critical for today's servers, workstations, and faster desktop computers that are already being bottlenecked by aging 10/100 Ethernet networks. This congestion is the result of an increased utilization of network-oriented applications such as automatic file backup, e-mail & messaging, streaming video and Network Attached Storage. Broadcom is the recognized leader in Gigabit Ethernet thanks in part to their competitive performance, advanced capabilities, and first-to-market roadmap.

Ultra320 SCSI Controller, ServeRAID™ Controllers, & Hard Disk Drives

The x445 includes an integrated dual-port LSI Logic 53C1030 Ultra320 SCSI controller with integrated RAID-1 support. This controller is capable of transmitting data at 320 MB per second. The two-channel controller connects independently to the hot-plug back plane, for mirroring the two internal drives in a RAID-1 configuration, and to the external SCSI port. This controller uses a 64-bit PCI interface at 133 MHz. A higher performance ServeRAID card can be optionally added to the x445 to provide caching of the internal drives if required. A second, longer SCSI cable ships standard in the x445 for connecting the internal drives to the ServeRAID adapter versus the embedded SCSI. The ServeRAID 6M, 4Mx and 4Lx are all supported on the x445 for higher performance RAID configurations. Note: because of the 4U height of the x445 and the lack of an indented internal connector on the ServeRAID 4H (this applies to the 4H only), the 4H controller can only be connected to external devices as there is not enough room within the system to cable the internal connector. The x445 supports the latest Ultra320 hard disk drives including the 36 GB, 73 GB, and 146 GB drives. The 36 GB and 73 GB hard drives support both 10,000 rpm and 15,000 rpm performance while the 146 GB drive is currently only available at 10,000 rpm.



The Memory Subsystem

The x445 memory subsystem includes 16 DIMM sockets per CEC spread across two banks. There are two memory ports (one for each bank) and one memory controller in each CEC. Because the x445 employs two-way memory interleaving, DIMMs must be installed in matching pairs, which makes upgrades far less expensive than the 10-bank upgrades required of competitive RAID Memory systems. Four DIMMs (all 512 MB) are shipped standard in all RX and RY models of the x445. Only the 512 MB, 1 GB, and 2 GB DIMMs are supported on the x445. The x445 is capable of supporting up to 64 GB of total main memory in a single 4U chassis leveraging the 2 GB DIMM or up to 128 GB across two chassis in a 16-way configuration for 64 GB fully mirrored. The DIMMs supported by the x445 are 3.3V 184-pin 266 MHz Registered ECC DDR SDRAM. The interface from the Memory Controller to the four System Memory Interface chips (SMI-E) is 8 bytes per port at 400 MHz (6.4 GB/sec of total memory bandwidth per SMP Expansion Module). SMI-E data is transferred to the DIMM at 32 bytes per port at 100 MHz. At 3.2 GB per second per port or 6.4GB per second per CEC, the x445 is capable of supporting up to 12.8 GB per second aggregate memory bandwidth per chassis – one of the reasons that the x445 is one of the highest performing Intel-based servers in the world.

Active Memory™

With support for hot-swap and hot-add memory*, the x445 takes the high availability and redundancy of Active Memory to an all-new level for mission-critical environments. With Active Memory, you can mirror the physical memory within the x445 system across the two memory ports. Shipping as default off in all x445 systems, Active Memory can be easily configured in BIOS followed by a re-boot. After re-boot, the physical memory available to the operating system will be halved, i.e. if 8GB before enabling, then 4GB after, but all data will be written to both banks of memory. You need to ensure that you install equal amounts of memory in each of the redundant banks in matching memory DIMMs to ensure that all data is mirrored properly down to the same DIMM. Unlike HP RAID Memory that involves as many as five memory controllers and is mandatory in the HP ProLiant F8-based 8-way servers for anything greater than ECC, Active Memory has no performance penalty associated with stripping data in a RAID configuration, does not carry the cost burden of multiple



*Hot-add Support requires the use of Microsoft Windows Server 2003 Enterprise or Datacenter Edition

memory controllers, and does not require extra memory expense to support Chipkill and double-bit error detection and correction, yet still provides exceptional availability at no additional cost.

The primary benefit of memory mirroring is that in the event of a DIMM failure, the system remains operational; allowing the IT administrator to schedule maintenance versus being forced to contend with unscheduled downtime. The secondary benefit of memory mirroring is that it powers the capability of hot-swapping a memory DIMM into the primary memory bank without taking the system down. Because this capability is built into the memory controller, memory mirroring and hot-swap memory are operating system independent, running on systems with Linux as easily as in systems with Microsoft Windows. Here's how it works.

1. Enable memory mirroring in BIOS and re-boot.
2. Once a bad DIMM is detected, Light Path is enabled to the bad DIMM and the memory controller reads from the other port.
3. IT Administrator receives a Service Processor alert or sees System Error and Light Path LEDs on.
4. Open system top cover and see DIMM Error LED on.
5. See Memory Hot Plug Enable LED on. Open memory access door where failed DIMM is located.
6. Opening door sends signal to turn off port. Port Power LED and Memory Hot Plug Enable LED turn off.
7. Remove failed DIMM, install new one, and close access door.
8. Closing door sends signal to turn on port. Port Power LED turns on. Basic DIMM test is run. Failed DIMM LED turns off.
9. Data is recopied to that port at the rate of 6 seconds per GB. Memory Hot Plug Enable LED blinks during testing and data recopy.
10. Memory Hot Plug Enable LED stops blinking and remains on when recopy is complete. The x445 is back in mirrored mode.

There are several important rules to remember with regard to the installing memory and setting up memory mirroring in the CECs.

1. The x445 will not operate if the bottom CEC contains no memory. Therefore, you cannot add a second SMP Expansion Module and move all the memory to the top CEC for hot-swapping memory in mirrored mode.
2. If you upgrade to an 8-way by adding the second CEC, you need to evenly divide the memory between the two CECs to realize optimal performance. For example, if you start with the base 2 GB memory (four 512 MB DIMMs) but later add a second CEC to take the x445 to an 8-way Xeon MP, you need to either remove two DIMMs from the bottom CEC and add to the top CEC or add four more 512 MB DIMMs in the top CEC (to make it 4 GB of total memory). If you already have 4 GB of memory in a 4-way Xeon MP and add a second CEC to take the x440 to an 8-way, you need to remove the four 512 MB DIMMs from slots 9, 11, 13, and 15 and re-install them in the top CEC in slots 1, 3, 5, and 7. Similarly, when upgrading from 8-way to 16-way, memory needs to be evenly divided among all four CECs in the two chassis configuration to ensure optimal performance and equal access to memory for all processors.
3. Even though you cannot access the memory in the bottom CEC while in mirrored mode for hot-swapping failed DIMMs, the advantage of having the bottom CEC mirrored is that a DIMM failure will keep the system running and allow for scheduled maintenance by the IT administrator versus unscheduled downtime. Reducing unplanned downtime is the real benefit of high availability mirroring memory, not necessarily the need to replace the DIMM while the operating system is running.
4. SMP Expansion Modules are setup for memory mirroring individually in BIOS. Thus, you could setup memory mirroring in the top CEC only or the bottom CEC only, though IBM recommends against this.
5. Memory mirroring requires that memory banks contain identical quantities of memory and identical DIMM configurations to enable mirroring at the DIMM level. When enabling memory mirroring, an example of a supported configuration would be eight 512 MB DIMMs in each bank for 4GB of memory mirrored, but not eight 512 MB DIMMs in one bank mirrored to four 1 GB DIMMs in the redundant bank.
6. Memory mirroring does not work across CECs. You cannot setup four 512 MB DIMMs in the bottom CEC to be mirrored by four 512 MB DIMMs in the top CEC. Memory mirroring only operates across banks in the same CEC. Thus, with regard to #2 above, if you add a second CEC to expand from a 4-way Xeon MP to an 8-way Xeon MP, you must balance the memory between the two CECs, i.e. four 512 MB DIMMs in each CEC, then add four 512 MB DIMMs to port 2 in each CEC to enable memory mirroring.

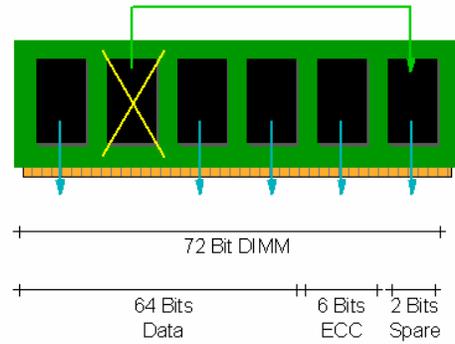
For the most dynamic server environments, support of hot-add memory ensures that you can add memory capacity to the x445 while the server is running to respond to the unpredictable and often changing conditions of your IT infrastructure on the fly. Because the operating system remains functional during this process, the ability to hot-add memory must be supported by that operating system and the server upon which that OS is functioning. Currently only the Enterprise Edition and Datacenter Edition of Microsoft Windows Server 2003 support hot-add memory on the x445. In order to hot-add memory into the x445, the following conditions must be met: 1) an empty memory bank must be accessible and 2) memory must be installed in matching pairs up to the maximum 16GB of memory supported in a single bank (using 2GB DIMMs). For these reasons, hot-add memory is not supported when memory mirroring is enabled as both banks are required for mirroring. In addition, you are only allowed a single hot-add of memory into the system as once a hot-add has taken place, that memory bank is no longer empty. In order to support future memory hot-add, the x445 would need to be taken offline, reconfigured with all memory in the single bank and re-booted.

Chipkill™ Memory

With Enterprise X-Architecture, Chipkill ascended to its third-generation (1st: 7000 M10, 2nd: 7600 & 6000) when it became integrated into the XA-32 chipset. With Chipkill now a part of the memory controller, you can use industry-standard off-the-shelf ECC DDR SDRAM and enjoy native Chipkill support. Although now a more reliable Advanced ECC algorithm, Chipkill remains unchanged in its functionality of detecting and correcting single-bit and multi-bit errors to keep a DIMM from failing. When combining Chipkill with Memory ProteXion™, the x445 is designed to provide near bullet-proof reliability in the memory subsystem. Although formerly supported in the ProLiant 8-way Profusion-based server, HP now requires RAID Memory and its associated cost of 25% extra memory cost and memory controllers to support the technical equivalent of Chipkill functionality, a feature that is supported in the x445 at no additional cost.

Memory ProteXion™

As another layer of memory reliability, Memory ProteXion, also known as “redundant bit steering” is the technology behind using redundant bits in a data packet to provide back-up in the event of a DIMM failure. Similar to Chipkill, Memory ProteXion is integrated into the XA-32 2nd generation memory controller supporting the use of off-the-shelf industry-standard ECC DDR SDRAM. Here are the specifics: because of the structure of a data stream, not all bits are used in a particular data transfer. With current 72-bit data packets, 64 bits are used for data, 6 bits are used for ECC and in all other industry-standard servers besides the x445, the remaining 2 bits go unused. IBM leverages these “extra” unused bits to provide back-up to that data transfer, similar to the Hot-spare drive of RAID. In the event of a chip failure on the DIMM detected by memory scrubbing, the memory controller can re-route data around that failed chip through the spare bits. It can do this automatically without issuing a PFA or Light Path alert to the administrator. After the second DIMM failure, a PFA and Light Path would occur on that DIMM as normal to swap it out. Available in the x445 at no additional cost, neither Memory ProteXion nor a functional equivalent is available standard from HP or Unisys. Combining Chipkill with Memory ProteXion now doubles the number of possible chipkills in the system, enabling up to 2 chipkills per memory port on the x445. A 16-way x445 with its eight memory ports could sustain up to 16 chipkills. The first chipkill on each port would not even generate a Light Path error as Memory ProteXion would provide the first-layer of defense, while DIMM replacement would be required in competitive systems. Each memory port could then sustain a second chipkill without shutting down. Providing that Active Memory with memory mirroring is enabled, the third chipkill on that port would send the alert and take down the DIMM, but keep the system running out of the redundant bank.



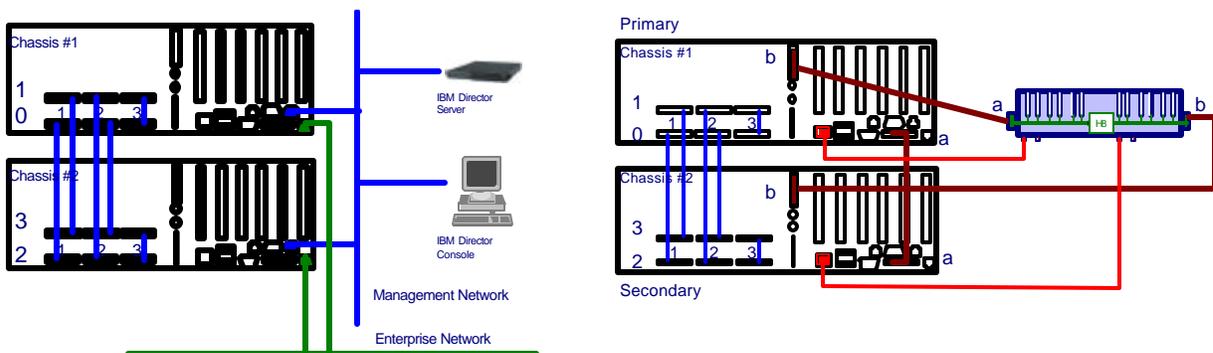
The final assessment: the x445 with the XA-32 2nd generation chipset takes high availability in the memory subsystem to an all-new level. As Active Memory expands beyond Chipkill and Memory ProteXion to include support for hot-swap and hot-add memory, the x445 introduces multiple levels of redundancy and advanced capabilities never before introduced by IBM xSeries and at no additional cost versus the competition.

XpandOnDemand™ Scalability

SMP Expansion Ports

Building upon the legacy of the x440, the x445 extends the capability of XpandOnDemand™ by powering expansion from 2-way up to 32-way using the same concept of scalable enterprise server nodes. At their most basic, these server nodes can be comprised of 2-way or 4-way SMP systems with processors, memory, and I/O devices. These nodes can then be upgraded in the future to 8-way Xeon MP or 4-way Xeon DP using the x445 SMP Expansion Module or all the way up to 16-way or 32-way with Xeon MP by connecting the systems together under a single operating system image using the SMP Expansion Ports. Also called scalability ports, the SMP Expansion Ports are InfiniBand™-type connectors (they ARE NOT InfiniBand, just similar to the connectors used by InfiniBand today) that have been developed by IBM to enable you to connect multiple x445 chassis together to achieve high-performance scalability without the requirement of an expensive switch.

Each SMP Expansion Module includes three SMP Expansion Ports, labeled 1, 2, and 3 that power high-performance bus-to-bus communication, a bi-directional high-speed connection at 3.2 GB per second. When adding a second SMP Expansion Module, these ports become the primary means of communication between the processors in the top CEC and the processors in the bottom CEC as well as for attaching to separate chassis for multi-chassis 16-way or 32-way SMP. The SMP Expansion Module Option Kit (part # 02R1870) includes two 12-inch (30.5 cm) Scalability Cables. By connecting port 1 of the top CEC to port 1 of the bottom CEC and then port 2 of the top CEC to port 2 of the bottom CEC, the x445 achieves 4-way SMP with Xeon DP or 8-way SMP with Xeon MP as well as optimal “double-barrel” performance for load balancing. The third port is not used until configuring 8-way nodes into a 16-way or 32-way configuration. Below you will see the supported cabling configuration for the 16-way and the 16-way with Remote I/O. For 32-way SMP, four chassis are connected together in similar fashion (see cable diagram below, 3.5-meter scalability cable indicated in red).



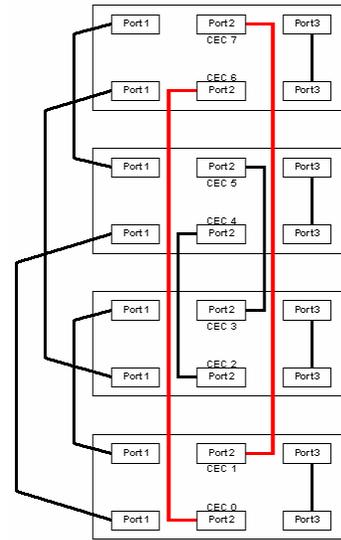
With the 2nd generation XA-32 chipset, all SMP Expansion Ports become forwarding ports versus the forwarding port/non-forwarding port combination implemented on the x440. These three ports are capable of forwarding data through that CEC when that data is requested of or being sent to another CEC in the configuration. Forwarding capability becomes important in providing cable redundancy for 16-way and 32-way

SMP. We expect that the 16-way and 32-way SMP configuration will be able to lose one cable and still stay in 16-way or 32-way mode thanks to the ability of all ports to forward data to the appropriate CEC.

Greater than 8-way Processing: XpandOnDemand in Overdrive!

With the support for 16-way and 32-way processing, the x445 ushers in a whole new way of thinking regarding scalability, price-performance, and e-business on demand. XpandOnDemand just went into overdrive! Never before has the industry-standard server market witnessed such a game-changing technology for scalable SMP, built upon today's industry standards combined with flexibility of future upgradeability of XpandOnDemand. More than ever, the x445 is prepared to take you to higher levels of performance and unlock the capabilities of your datacenter. The x445 with 16-way or 32-way SMP is designed for high-performance database applications such as Microsoft SQL Server and IBM DB2 as well as for ERP applications such as SAP. But unlike other solutions, the x445 allows you to leverage your existing administration tools and IT skills with your existing applications that already have support for higher scalability built in. And with the promise of XpandOnDemand, you are able to enjoy these benefits at any time, upgrading to that increased performance whenever it is required.

If you are interested in building a 16-way or 32-way configuration with the x445 server, contact your local IBM Authorized EXAct Business Partner or your local IBM sales representative for more information.



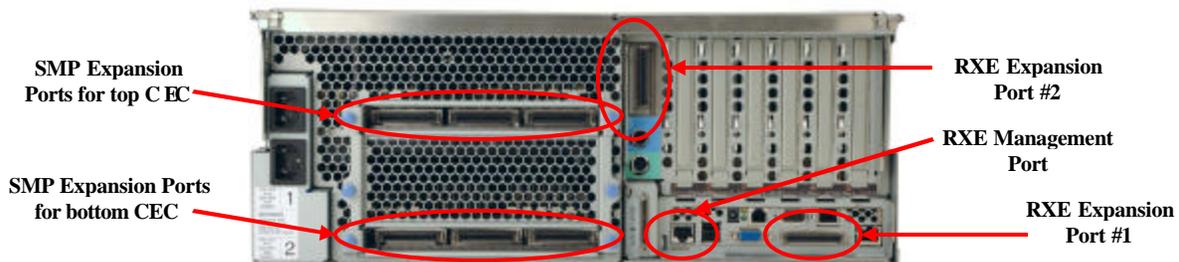
Copper Diagnostics™

Extending the autonomic computing capabilities of its flagship Enterprise X-Architecture server, IBM introduces Copper Diagnostics into the x445. Built into the BIOS firmware of the x445 to be operating system independent, Copper Diagnostics delivers two new features – cable failover and auto-detection – designed to improve redundancy, eliminate single points of failure and ease the complexity of cabling multi-chassis configurations. With the previous generation x440, any failure in the scalability cables – either as an 8-way or 16-way – would result in an automatic server re-boot with the system isolating that cable from the configuration for replacement. Now with the x445, in the event of a cable failure, the server automatically transfers all data traffic to the remaining cable(s) without a server re-boot and alerts the administrator of the failure in order to schedule replacement. Although all scalability cables are protected against a failure or accidental pull, the cables cannot be hot-connected for repair. Only a server re-boot can properly re-establish “double-barrel” throughout and load balancing for optimal performance.

With the power of XpandOnDemand scalability up to 32-way, IBM is striving to improve cabling for XpandOnDemand customers. In an effort to ensure performance for these highly scalable solutions, IBM also introduces auto-detection with Copper Diagnostics. Auto-detection enables the server to detect and report a correctly or incorrectly cabled multi-chassis configuration prior to boot as a means of ensuring optimal performance. Even before power-on, you can query the two-chassis or four-chassis cabling configuration through the IBM Director management console using the integrated Remote Supervisor Adapters. With a query to each of the Remote Supervisor Adapters in each chassis, IBM Director can give you a “thumbs-up” to ensure that proper cabling is in place to minimize the number of memory hops and improve performance through reduced response time. By doing so, you can remain confident that you are attaining the performance expected of your high-end server.

RXE Expansion Ports

Every x445 includes two RXE Expansion Ports and one RXE Management Port. However, because RXE Expansion Port #2 is on the centerplane I/O board, it is not enabled until the second SMP Expansion Module is added to the base x445 system. The RXE Expansion Ports are used to connect the x445 to the RXE-100 Remote Expansion Enclosure. By leveraging the remote I/O capabilities of the XA-32 2nd generation chipset, the x445 is able to expand the total I/O capacity from the six Active PCI-X slots in a single 4U chassis up to twenty-four Active PCI-X slots by adding the RXE-100 with six Active PCI-X slots and the optional PCI-X 6-pack upgrade kit (Option part# 13N0055) in a 16-way configuration. The x445 also introduces the ability to share a single RXE-100 with a second x445 server – a first for the xSeries portfolio (see Supported Configurations for more details). By connecting the RXE Management Port on the x445 to the corresponding port on the RXE-100, the chipset ensures that the operating system sees the RXE-100 as a part of the entire configuration. The RXE Expansion Ports use the same connector type as the Scalability ports, but cannot be used as scalability ports. These ports are for connecting to remote I/O only. The RXE Expansion Ports communicate with the RXE-100 using a bi-directional 2 GB per second connection designed to provide data integrity at optimal performance.



Scalability, Remote I/O & RXE Management Cables

To support interconnecting x445 systems to remote I/O enclosures, several cables of varying lengths have been developed. The 3.5-meter Scalability & Remote I/O cable (Option part# 31P6102, shown at right) provides connectivity between the x445 chassis and the remote I/O. The 16-way SMP configuration will use a similar 2.5-meter cable that has been specially colored (copper to signify copper technology) to more easily identify these cables in the rack. These cables (four per kit) are available in the x445 Two-Chassis 16-way Configuration Kit (Option # 02R2013). Although the ports i.e. scalability and remote I/O, are not interchangeable in terms of their usage, the connectors for these ports are identical. The 3.5-meter Scalability & Remote I/O cable and the 2.5-meter Scalability cable have a similar appearance and flexibility as an external SCSI cable used to connect external SCSI devices. Both the 3.5-meter Scalability & Remote I/O cable as well as the x445 16-way Configuration Kit are available for Windows 2000 Datacenter, Windows Server 2003 Datacenter Edition, or VMware ESX Server 2.1.



Along with these cables, there is also a corresponding 3.5-meter Interconnect Management Cable used to connect the RXE Management Port on the x445 to the RXE Management Port on the RXE-100. This cable (Option part# 31P6087) is also required for connecting multiple x445 systems together to ensure that the Service Processor is able to configure the systems under a single OS image.

In addition to the 3.5-meter Scalability & Remote I/O Cable and the 3.5-meter Interconnect Management Cable, there is also an 8-meter Remote I/O cable and corresponding 8-meter Interconnect Management Cable. This cable is only for use in connecting the x445 to the RXE-100. Because of latency and data integrity, this cable cannot be used to connect multiple x445 systems together for larger SMP. Only the cables included with the x445 16-way Configuration Kit should be employed for that purpose. The 8-meter cable is identical in composition and connector type to the 3.5-meter cable, only longer for potentially connecting the x445 to an RXE-100 in an adjacent rack.

Extended Life of Key Options for XpandOnDemand

XpandOnDemand scalability is more than just an industry-leading solution for scaling processor and I/O capacity to meet your needs. It is also a commitment to you to deliver on that upgrade capability longer into the future. Because of the pace of the industry-standard server market, new technological breakthroughs in processors, memory, hard drives, and networking drive a relentless churn of new system introductions. Sometimes, this churn can be difficult for customers to manage, especially for their most mission-critical servers that are designed to be deployed and left alone. With the promise of XpandOnDemand, businesses have eagerly deployed the x440 and now the x445 with the expectation of being able to leverage the expandability when needed in the future. To mitigate the churn associated with the migration of technology and to support our commitment to XpandOnDemand, IBM has extended the period through which key options such as Xeon DP and Xeon MP Processors and SMP Expansion Modules are available selectively from IBM into 2005. In addition, IBM has partnered with I.T. Xchange, a global distributor of computer products and a key participant in IBM's Option Continuation Program, to continue to offer these options as available into 2006 – three years after the introduction of the x445. For more information, visit www.itxchange.com/ibm/xpandondemand.

xSeries 445 – Software & Solutions Overview

Operating Systems

In line with the overall eServer message of providing application flexibility to meet your varying enterprise needs, the x445 is certified for numerous operating system and application solutions. Below you will find the planned Operating System Support Matrix for the x445. Please visit the ServerProven OS Compatibility web site at www.pc.ibm.com/us/compat/nos/matrix.shtml for more information.

ServerProven® Supported Operating Systems	Windows 2000 Server Family	Windows Server 2003	Windows NT 4.0 Enterprise Edition	Red Hat Enterprise Linux AS 2.1	SUSE LINUX Enterprise Server 8.0	Novell Netware 6.0	SCO UnixWare 7.1.3	VMware ESX Server 2.0
Max # supported CPUs	16	32	4 (Xeon MP) 2 (Xeon DP)	8	8	8	8	16
Max supported memory	64GB	64GB	8 GB	16 GB	16 GB	8 GB	8GB	64 GB
Additional Information	See page 3	See page 3	No Hot-Plug PCI-X				No Hot-Plug PCI-X	Up to 80 VMs

The Xeon processor also continues supports for the integrated virtual processor technology called Hyper-threading. Estimated by Intel to increase processing performance by up to 30%, Intel's simultaneous multi-threading design allows a single physical processor to manage data as if it were two virtual processors by handling data instructions in parallel rather than one at a time. The multi-threading design also has implications for the operating system as the OS sees the single physical processor as two logical processors. Because of Microsoft's licensing of the Windows® Server operating systems by number of processors (see page 3 for details), the appearance of twice as many logical processors can potentially affect the install of the operating system. As a result, hyper-threading is initially turned off in BIOS to ensure proper OS installation and can be re-enabled at any time. Although the Windows 2000 and Windows Server 2003 operating systems understand and correctly report hyper-threading, Windows NT 4.0 does not. Therefore, the x445 is able to support only Windows NT 4.0 Enterprise Edition in a 4-way configuration with Xeon MP (2-way only with Xeon DP) as Windows NT sees eight logical processors instead of the four physical processors. At this time, no patch is planned by Microsoft to address this. Furthermore, because Windows NT does not understand NUMA, a change to the NT kernel would be required for Windows NT to support a 4-way with Xeon DP – a change that is not possible as Windows NT is no longer being developed by Microsoft.

In addition to hyper-threading, the x445 performance also benefits from NUMA code that Microsoft has included in the Windows Server 2003 Enterprise and Datacenter Editions. According to internal lab estimates, these NUMA enhancements are expected to yield a 3-5% performance boost for NUMA-based systems. Because of this performance benefit, Windows Server 2003 has been the preferred OS for our TPC 8-way benchmarks and will become the operating system of choice for future x445 deployments. In order to unlock innovation in the x445, to differentiate its features from competition, and to perform above the capabilities of the base operating system, IBM has developed a Windows HAL (Hardware Abstraction Layer) for use with the x445. Working with this HAL is only necessary at initial setup of the x445 to ensure that the system performs properly as an 8-way running on Windows. The HAL can be downloaded from the IBM.com web site. Similarly, a patch for the x445 is required for running Linux properly as an 8-way. You must install either Red Hat Linux Advanced Server 2.1 or SuSE Linux Enterprise Server 8.0 as only these releases contain the kernel required to support the Xeon processor MP up to 8-way on the x445.

For more information about operating systems, support configurations and other information pertinent to the planning and setup of your x445, visit the IBM Redbook site at www.redbooks.ibm.com for the x445 Planning & Installation Guide.

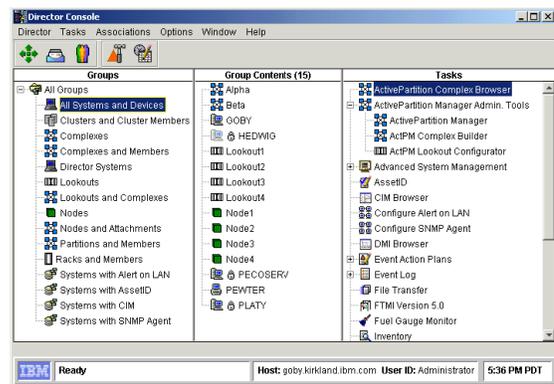


IBM Director: PC Magazine Editors' Choice for Server Management Tools



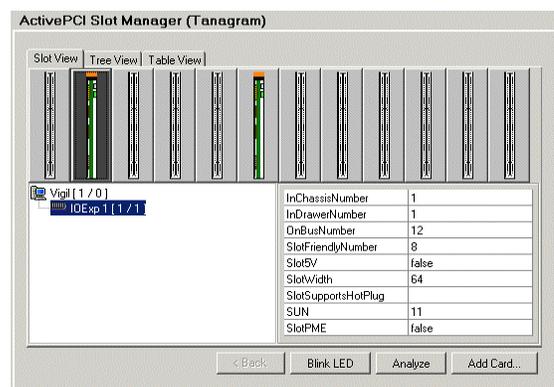
The x445 ships standard with IBM Director software. IBM Director provides systems management support in conjunction with the Remote Supervisor Adapter II - EXA. Selected by PC Magazine for its Editors' Choice award in October 2002, IBM Director is the industry's leading systems management software suite for managing enterprise systems. Commended for its ease of use and deployment, comprehensive capabilities, and compatibility with non-IBM equipment, IBM Director is the preferred

tool for lowering TCO and better maintaining the investment that you make in your IT infrastructure. As part of this key software deliverable, IBM delivers support for the Linux 2.4 kernel-based releases, headless remote control, RAID support and Service Processor support with Red Hat and SuSE, Linux Agents for Red Hat and SuSE for Software Rejuvenation, and support for Remote I/O. In addition to these and other feature additions, the x445 can take advantage of several IBM Director Extensions developed specifically for the XpandOnDemand™ servers (x365, x445) – Scalable Systems Manager and Active PCI Manager.



The Scalable Systems Manager is a new IBM Director extension. This tool allows easier management of multi-node configurations, building 16-way configurations (32-way configurations supported in SSM in the near future) using a GUI rather than BIOS. The Scalable Systems Manager (screen shot above) is a configuration browser that displays information about scalable systems (nodes and partitions) and provides the ability to activate or deactivate partitions for changing business needs. As part of the basic browser interface, the Scalable Systems Manager can be used to add and delete nodes to form a configuration and to create/delete partitions and add/delete nodes to/from a given partition.

The Active PCI Manager (screen shot at right) is part of the IBM Director Server Plus Pack. This tool enables IT administrators to optimize I/O performance by determining the best placement for their PCI and PCI-X adapters. By allowing users to analyze the current configuration of PCI and PCI-X adapters across a base system and an attached RXE-100, an administrator can see if the cards and slots are being optimally paired. For example, because the x445 includes slots that are capable of performing at different speeds, it is critical that you use 66 MHz slots for the 66 MHz cards, rather than the 133 MHz slots. This tool helps the administrator confirm that the slots are being installed for optimal performance. Similarly, because the RXE-100 includes slots that are capable of performing at different speeds based upon how the buses are shared or dedicated, the Active PCI Manager can help to ensure that these remote I/O slots are optimally paired with the adapters. This tool will also be helpful for x445 multi-chassis configurations connected together in the same OS image. Under this scenario, when a NIC or other adapter fails, this tool will aid the administrator in quickly locating the individual chassis that contains that failed adapter so that the adapter can be quickly hot-swapped.



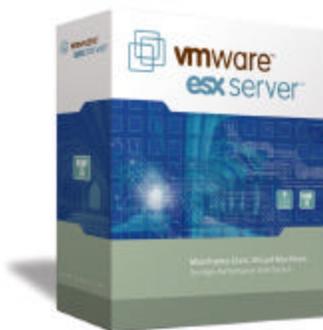
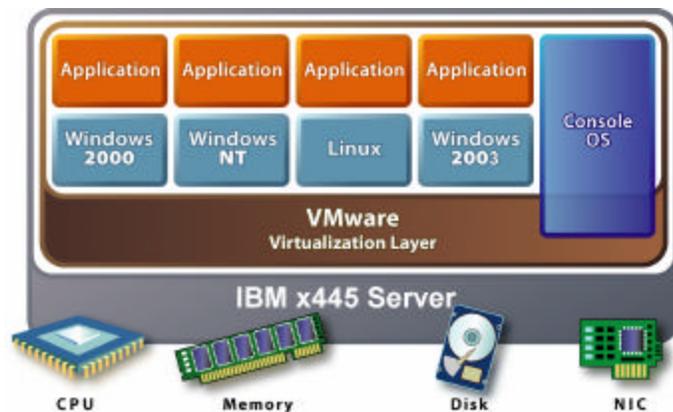
Physical Partitioning for High-Performance Clustering

Because of its flexibility of configuration and high performance suitable for database applications, the x445 is optimized for physical partitioning. By configuring into physical partitions using Microsoft Cluster Server (MSCS), SteelEye LifeKeeper, Veritas, or Oracle RAC, the x445 can be leveraged to create the ultimate high-availability, high-performance database cluster.

Although each physical partition is fixed at the chassis level, i.e. you cannot have more than one physical partition per x445 server, you are able to configure a solution suitable to your availability requirements by combining the x445, the desired operating system and database, and the Scalable Systems Manager Extension of IBM Director to create a configurable solution according to the number of desired nodes. For example, with Microsoft Windows 2000 or Windows Server 2003, you can configure a 2-node (the most prevalent cluster configuration today) or 4-node cluster with SQL Server leveraging SQL Server Failover Clustering and the integrated gigabit Ethernet adapter of the x445. With Windows Server 2003, you will be able to partition up to 8-node configurations with either Windows Server 2003 Enterprise Edition or Datacenter Edition while still leveraging industry-standard gigabit Ethernet. With Red Hat or SuSE Linux, you can configure a 2-node cluster with DB2 or Oracle leveraging SteelEye LifeKeeper. Other multi-node solutions include Oracle 9i Real Application Cluster (RAC), Veritas Cluster Server, PolyServe, and Novell Cluster Server. With the power of Scalable Systems Manager combined with the database solutions, what results is a configurable on demand solution capable of meeting your needs today and into the future.

Logical Partitioning for Server Consolidation

For the first time in the history of the industry-standard server market, servers are taking on more mainframe characteristics such as logical partitioning. Working with VMware™, the x445 offers a best-in-class solution for logical partitioning on an Intel-based server. VMware ESX Server brings mainframe-type virtualized dynamic partitioning capabilities to the industry-standard server market, enabling you to partition the physical hardware into virtual machines capable of acting as independent and secure servers. VMware is a virtualization layer that sits between the operating system-application stack and the physical hardware turning the x445 into a pool of logical computing resources that can then be dynamically allocated to any operating system or application at varying levels of granularity. This technology dramatically reduces the cost and complexity of delivering such enterprise applications as web serving, application serving, database, and email. In addition, because it can support multiple similar or dissimilar operating systems, it gives the IT administrator the opportunity and flexibility to optimize the application by operating system in secure, partitioned virtual machines. For example, while some applications run better on Windows, other applications are more suitable or are only available on Linux. In addition, not every application requires the most recent version of Windows 2000 or Windows Server 2003. Some administrators may wish to deploy on Windows NT (perhaps because the company has already purchased these licenses and wishes to continue to use them). Using VMware, ALL of these application and operating system combinations could be run from the same x445 system, allowing you to take advantage of higher system utilization, better performance, improved reliability with control from a single management console versus more numerous, single-use servers, and now the ability to support up to 2-way SMP inside the virtual server with Virtual SMP.



As part of ServerProven® support, the x445 fully supports the “off-the-shelf” VMware ESX Server 2.0 software application up to 16 CPUs, backed by IBM Service worldwide to ensure that you clearly understand our commitment to this capability in the x445 and our desire to provide you with world-class support 24x7 around the world. By working closely with VMware, the current and future versions of ESX Server now contain IBM Director Agents allowing you to use IBM Director with which you are familiar instead of the VMware interface, which might require additional training, for more integrated management of the virtual machines.

For true cost savings in the enterprise environment, VMware ESX Server becomes the critical software enabler for server consolidation, combining the workloads of many low-end uni-processor and dual-processor servers in a distributed computing network onto fewer more reliable, centralized enterprise-class servers. Ideally suited for corporate data centers where CPU utilization averages less than 10%, VMware ESX Server provides a cost-effective, high-performance virtualization platform that when combined with the performance and high-availability benefits of the x445 create the ultimate solution for server consolidation.

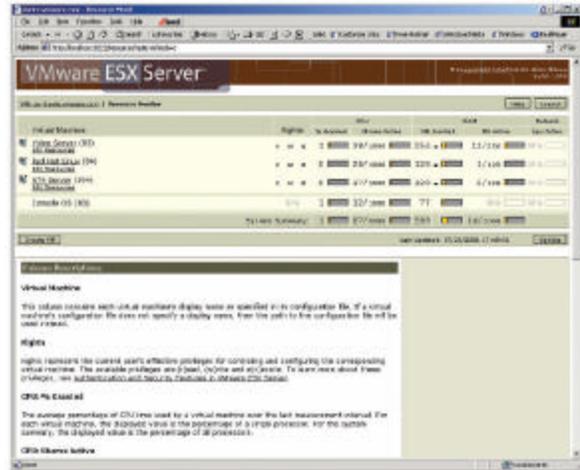
It is easier now to realize the value and flexibility of this solution for consolidating servers onto the x445 with VMware ESX. Conesco is an example of one customer that has realized this flexibility and translated it into savings. Conesco Finance reduced the number of physical servers required to support 2,000 Citrix users from 135 HP ProLiant DL360 2-way servers to five x440 8-way servers, reducing hardware and software costs by 62%. A second example is Saks Incorporated. Saks consolidated 26 physical test & development servers running Windows NT and Windows 2000 onto a single x440 8-way server connected to an IBM ESS “Shark” storage for a hardware savings of 43%. And for yet another example, there is The Lego Group, the maker of Lego toys and a customer that clearly understands the “building-block” approach! Lego consolidated 175 HP ProLiant servers onto 20 x440 4-ways for Microsoft Exchange clustering, Web applications, File/print, & SQL databases,

increasing server utilization to over 40%. These and other customers serve to illustrate that IBM, in fact, has a solution for server consolidation that is unmatched in the industry. And now with the x445, you will be able to enjoy even greater performance from those virtual machines.

The core challenges associated with server consolidation are:

- Running multiple applications on the same server, when each application requires a fine-tuned operating system and hardware
- Ensuring peak performance, scalability, availability, and security

The x445 with VMware solves these challenges by isolating operating systems and applications in virtual machines that can co-exist on the same physical server. Server resources can be dynamically allocated to each virtual machine at your preferred choice of granularity using the intuitive VMware interface (screenshot shown below). The result is better server utilization while ensuring performance and availability. When combined with new VMware tools such as VMware's VirtualCenter with support for VMotion, the result is an x445 solution that is truly a break-through in innovation and technology for the industry-standard server market.



Goals of Server Consolidation	Benefits of x445 with VMware ESX Server 2.0
Increase hardware utilization	Maximize server management efficiency to help IT staff work smarter, not harder Rapidly deploy, easily manage, and remotely control more servers while saving space, management effort, and hardware costs
Ease deployment	Speed deployment of replicated or distributed applications Reduce number of development and test servers required for new applications
Guarantee service levels	Deliver guaranteed resources at near-native performance levels and high scalability Run IT as an internal service provider, gaining control over IT performance metrics
Support legacy applications	Ensure continuous service of older, special purpose applications now on 1 way and 2way servers Reduce complexity, risk, and downtime associated with maintaining older hardware

Questions from companies regarding the benefits or downside to using VMware have included performance penalties associated with virtualization and security associated with running different operating systems and applications on the same hardware. VMware ESX Server provides fully dynamic resource allocation of CPU and memory with affinity for I/O and disk. Virtualization is available with only an estimated 10% performance overhead. Of the companies polled regarding this performance penalty, all were more focused on the cost savings associated with server consolidation and less concerned with any performance penalty that might exist from using virtualization. Again, saving money outweighed any reduction in performance, which was often masked because the workloads were being consolidated off of older, lower performing servers. Regarding security, VMware ESX introduces fully fault -isolated virtual machines that are totally secure, i.e. a user cannot get access to another virtual server while operating within an adjacent virtual server. Users see their host system as an independent system providing them with the enterprise services that they require. What they do not realize is that in reality they are sharing that physical hardware with up to dozens of other virtual machines supporting dozens of heterogeneous applications with numerous other network users.

Although the capabilities of today's VMware ESX Server are outstanding, future versions will continue to add capabilities that will more fully take advantage of the advancements built into the x445. In the chart below, you will find the specifications of the version of ESX Server 2.0 supported on the x445 up to 16 CPUs.

ESX Server	v2.0
Max Processors per System	16
Max Processors per Partition	Fractional up to 2-way
Max Part itions per System	80
Max Memory per System	64 GB
Max Memory per Partition	4 GB

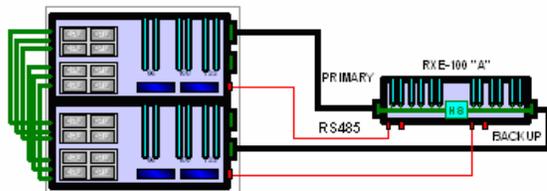
xSeries 445 – Base Models & Supported Configurations

Part#	Base Model– CPU / Cache	CPU#	Memory	Additional Detail
8870-1RX	Intel Xeon MP 2.0 GHz / 1 MB L3	2	2 GB (4x512)	One CEC, 2 Power Supplies, No DASD
8870-2RX	Intel Xeon MP 2.5 GHz / 1 MB L3	2	2 GB (4x512)	One CEC, 2 Power Supplies, No DASD
8870-4RX	Intel Xeon MP 2.8 GHz / 2 MB iL3	4	2 GB (4x512)	One CEC, 2 Power Supplies, No DASD
8870-3RY	Intel Xeon 3.0 GHz / 512 KB L2	2	2 GB (4x512)	One CEC, 2 Power Supplies, No DASD
8870-4RY	Intel Xeon 3.0 GHz / 512 KB L2	4	2 GB (4x512)	Two CECs, 2 Power Supplies, No DASD
8870-1AX	Intel Xeon MP 2.0 GHz / 1 MB L3	2	0 GB	Requires Datacenter & x445 16-way Config Kit
8870-2AX	Intel Xeon MP 2.5 GHz / 1 MB L3	2	0 GB	Requires Datacenter & x445 16-way Config Kit
8870-4AX	Intel Xeon MP 2.8 GHz / 2 MB iL3	2	0 GB	Requires Datacenter & x445 16-way Config Kit
8870-11X	Intel Xeon MP 2.0 GHz / 1 MB L3	2	2 GB (4x512)	One CEC, 2 Power Supplies, RSAII-EXA
8870-12X	Intel Xeon MP 2.2 GHz / 2 MB L3	2	2 GB (4x512)	One CEC, 2 Power Supplies, RSAII-EXA
8870-22X	Intel Xeon MP 2.7 GHz / 2 MB L3	2	2 GB (4x512)	One CEC, 2 Power Supplies, RSAII-EXA
8870-42X	Intel Xeon MP 3.0 GHz / 4 MB iL3	4	2 GB (4x512)	One CEC, 2 Power Supplies, RSAII-EXA
8870-3EX	Intel Xeon 3.0 GHz / 512 KB L2	2	2 GB (4x512)	One CEC, 2 Power Supplies, RSAII-EXA
8870-4EX	Intel Xeon 3.0 GHz / 512 KB L2	4	2 GB (4x512)	Two CECs, 2 Power Supplies, RSAII-EXA
8870-1BX	Intel Xeon MP 2.2 GHz / 2 MB L3	2	0 GB	Requires Datacenter & x445 16-way Config Kit
8870-2BX	Intel Xeon MP 2.7 GHz / 2 MB L3	2	0 GB	Requires Datacenter & x445 16-way Config Kit
8870-4BX	Intel Xeon MP 3.0 GHz / 4 MB iL3	2	0 GB	Requires Datacenter & x445 16-way Config Kit

The x445 was originally announced on June 30, 2003 with systems made generally available on July 1, 2003. With the announcement of 2-way to 16-way processing support at general availability, the x445 supports a single-chassis 2-way Xeon MP or DP, 4-way Xeon MP or DP, 8-way Xeon MP or 16-way Xeon MP.



In addition to the single-chassis 2-way to 8-way and dual-chassis 16-way capability, the x445 also supports the connection of a single RXE-100 Remote Expansion Enclosure to that single-system-image configuration, i.e. one RXE-100 per 4-way, per 8-way, or per 16-way. Within the RXE-100, you have the choice of either a 6-slot or 12-slot configuration depending upon your operating system. Limitations in Linux restrict you to the 6-slot configuration; with Windows or VMware, you can use either the 6-slot or 12-slot configuration for 8-way or 16-way, giving you up to a total of 24 PCI-X slots. In addition, the x445 is also capable of sharing a single RXE-100 with a 2nd second x445 server. This provides greater flexibility as a single server may not require all twelve slots but may only need a couple of slots to provide redundancy to SAN storage.



The x445 enables you to experience an unprecedented level of scalability offered by IBM xSeries. Leveraging the rack-optimized design of the x445, the x445 is the most rack-dense 16-way and 32-way in the world. By connecting four 8-way x445 systems together using the high-speed scalability ports together with Windows Server 2003 Datacenter Edition, you will be able to scale your applications to take advantage of up to 32-way SMP. When combined with the future support of Scalable Systems Manager Director Extension, the x445 is capable of offering a flexible on demand datacenter solution optimized for scaling databases from 8-way up to 32-way as needed. You can even have your existing x445 systems upgraded to 32-way as needed. Applications that are best suited for 16-way and 32-way include database applications such as Microsoft SQL Server as well as ERP solutions such as SAP. No other system in the industry-standard server market offers the flexibility combined with the availability punctuated with industry-leading performance and manageability that the x445 offers. Our XpandOnDemand scalability is proof that IBM is changing the game in e-business. This is why so many realize that when comparing the x445 to competition, they easily conclude...there is no competition. If you are interested in building a 32-way configuration with the x445 server, contact your local IBM Authorized EXAct Business Partner or your local IBM sales representative for more information.

xSeries 445 – Selling Features

Performance

Business

- Highest performing IA32 per U in the world* demonstrated in over 50 #1 industry-standard benchmarks relevant to enterprise e-business.
- Faster performance translates into more transactions processed on fewer systems making x445 a leader for price-performance.
- Faster access to e-business information translates into better customer service, better supply chain management, and faster decision-making, all of which contribute to improved cost savings, higher revenue, and increased customer loyalty.
- Flexibility tailored for your budget to allow scalability from 2-way Xeon DP all the way up to 32-way with Xeon MP.

Technology

- Second generation Enterprise X-Architecture chipset with latest Intel Xeon processors yields over 50% greater performance than x440.
- XceL4™ Server Accelerator Cache improves overall performance by reducing memory latency by up to 12% over the previous x440. With 64 MB of level-4 system cache available per SMP Expansion Module, you can achieve up to 512 MB in a 32-way SMP configuration.
- Industry-exclusive scalability from 2-way to 4-way with Xeon DP for affordable high performance computing with investment protection.
- High-performance memory controller powers 7.0 GB/sec aggregate I/O bandwidth and 12.8GB/sec aggregate memory bandwidth per 8-way.
- Active PCI-X delivers 2X (up to 1 GB/s) data throughput versus the fastest PCI using 64-bit 133 MHz I/O slots.

Scalability

Business

- The x445 delivers 8-way SMP power in a 4U rack-dense package – 42% more rack dense than the 7U HP DL760 G2 8-way – with the flexibility to grow without penalty up to 32-way.
- The x445 is the most rack dense 8-way ever offered by IBM xSeries and can be configured into the most rack dense 16-way and 32-way in the world, helping save money in the datacenter by being able to concentrate more performance in a smaller area.
- The only 4-way SMP Xeon DP server available in the world.
- Triple your I/O capacity at any time without the expense of a full system upgrade with the optional RXE-100 Remote Expansion Enclosure
- XpandOnDemand™ Scalability powers the “pay-as-you-grow” upgrade path for value scalability with Xeon DP or extreme scalability with Xeon MP for adding processing power and I/O capacity as you need it, without having to purchase expensive up-front infrastructure.

Technology

- Able to easily grow base system from 2-way Xeon DP or Xeon MP to 4-way, then from 4-way to 8-way Xeon MP by easily adding an additional SMP Expansion Module and processors.
- Systems are available with Xeon MP Processors up to 3.0 GHz and 4 MB iL3 cache or Xeon DP processors up to 3.0 GHz and 512 L2 cache.
- Base models are available with a robust and more cost-effective 2 GB base memory minimum, expandable up to 64 GB of memory per chassis, up to 128 GB maximum with a 16-way for 64GB address memory fully mirrored.
- The x445 is optimized for external storage, capable of managing terabytes of data using the FASTT Family of Storage Servers and Enclosures across fiber or SCSI. The x445 contains two hard disk drive bays capable of 292 GB of maximum internal storage.

Availability

Business

- Designed to create a near-bulletproof memory subsystem, Active Memory combines the capabilities of ECC, Chipkill, Memory Mirroring and Memory ProteXion with the new features of Hot-swap and Hot-add memory support to introduce a system most suitable for your mission-critical data. With native Chipkill support now built into the XA-32 chipset, memory reliability is dramatically improved while using more cost-effective industry-standard DIMMs.
- Marrying advanced hardware with the break-through autonomic computing technology, the x445 high availability features, such as redundant, hot-swap power supplies, fans, memory and hard drives combined with advanced systems management to drive increased productivity, reduced downtime with the ultimate goal of saving 30% of IT maintenance dollars.
- Award-winning IBM Director offers the industry’s leading suite of system management tools to make managing a burgeoning IT infrastructure easier with various alerts and diagnostic tools to improve uptime by identifying problems before they result in downtime.

Technology

- Active Memory with Memory Mirroring and Memory ProteXion provide multiple levels of memory fault tolerance to ensure that mission-critical data is always available and that in-memory databases was constantly accessible.
- MEDIC™ Diagnostics allows the system to return to operation in the event of a catastrophic failure to return users to productivity while IT administrators diagnose using Real-Time Diagnostics the cause of the failure.
- Copper Diagnostics eliminates single points of failure in the cabling of multi-chassis configurations through redundancy and failover.
- Software Rejuvenation, Capacity Manager, and Predictive Failure Analysis® collaborate to monitor system health without user intervention.
- N+N power eases the transition of the x445 into the data center ensuring quick setup, environmental efficiency, and optimal failover.

*As measured by TPC (www.tpc.org) as of March 2, 2004. 1U = 1.75in/44mm.

Manageability

Business

- The x445 offers world-class systems management designed for the lowest total cost of ownership of any industry-standard server in its class.
- As an industry-leading systems management application, IBM Director requires little re-training for IT administrators, yet extends the remote capabilities beyond those offered by competitive applications.
- From Predictive Failure Analysis to Light Path Diagnostics, every xSeries server is designed with reliability and uptime in mind. When combined with IBM Director, these system management capabilities help to proactively manage your servers to prevent costly downtime.
- With the standard Remote Supervisor Adapter II for Enterprise X-Architecture (RSAAI-EXA), you can entirely manage the x445 remotely and link other systems together to manage collectively.
- With 5X the performance of the previous RSA, the RSAAI-EXA delivers high-speed graphics console and text redirection as well as support for virtual floppy and virtual CD for ease of remote maintenance.
- The x445 includes an enterprise-class high-availability warranty offering three-year 9x5 Same Business Day response time for any required servicing including all parts & labor. This warranty can be easily upgraded to include a three-year 24x7 same business day warranty.

Technology

- Light Path Diagnostics is the premier quick-find trouble-shooter for diagnosing and resolving alerts and failures in your xSeries systems.
- The integrated RSAAI-EXA is the most sophisticated solution for remote management offered by xSeries. Integrated into every x445 server, the RSAAI-EXA is installed in a dedicated slot and does not require an Active PCI-X slot from the system.

Customer & ISV Endorsements, Analyst & Press Reviews

Dr. Ng Yan Hong, Senior Lecturer, School of Inform-Communications Technology, Singapore Polytechnic "We are extremely excited about the introduction of the IBM eServer x445. With its superior price-performance and promise of XpandOnDemand scalability, we realized early that no other system but the x445 could satisfy our high-performance research needs today and into the future. With the Enterprise X-Architecture and the x445, IBM is truly extending its technology leadership in industry-standard servers by offering pay-as-you-grow scalability, industry-leading price-performance, and extended memory availability, which caters to both SMP and cluster environments for our research in Bioinformatics. The versatility of x445 provides us with a SMP platform on the one hand, to support the E-Cell research project, and on the other hand, giving us a master-slave cluster configuration to speed-up our research effort in Virtual High Throughput Screening (VHTS). With the x445, we will be able to advance our bioinformatics research works confidently on one of the most advanced and versatile industry-standard servers in the world."

Jean-Yves Blanc, Ph.D., High Performance Computing Expert, Compagnie Générale de Géophysique (CGG) "We are very excited by the introduction of the x445 and its promise of XpandOnDemand scalability. With the x445 IBM eServer xSeries is extending the technology by offering scalability up to 32-way SMP, increased L4 cache for faster performance, and extended memory availability to include hot-swap and hot-add memory. We are confident that our data processing applications will run extremely well on what appears to be one of the most advanced servers in the industry."

Diane Greene, President & CEO, VMware, Inc. "A precedent was set with VMware ESX Server and the IBM x440 that fundamentally changed the industry. With this innovative solution, customers were able to more easily and effectively consolidate servers to realize lower costs and improve utilization. Now with the introduction of the x445, IBM takes it to the next level, extending its leadership in the industry-standard server market with a product that offers even greater XpandOnDemand scalability, higher performance, and increased availability. Combined with the advanced VMware Virtual SMP capabilities of VMware ESX Server, the x445 will empower customers to more efficiently manage their IT infrastructure, consolidate a greater variety of underutilized servers to further reduce cost, and create a truly dynamic, on demand business."

Dave Perkowski, Vice President of Systems Development, ARGO Data Resource Corporation "ARGO Data was an early advocate of the IBM x440 because of its vertical scalability, performance and high availability necessary to meet the demands of our financial services customers. With the introduction of the xSeries 445, IBM extends the capabilities of its flagship Enterprise X-Architecture platform with increased modular scalability and greater performance. The xSeries remains an exceptional fit with our middle office architecture, helping minimize transaction response times and optimize processor utilization, which is a huge benefit in the customer-focused banking industry. From our customers' point of view, by delivering 16-way today and 32-way in the future, the new x445 is a low-risk investment in their enterprise architecture, offering an affordable investment, vertical scalability, and enterprise-level performance from day one."

Mark Wright, President & CEO, Aurema, Inc. "The scalability, high performance and flexibility of the IBM eServer xSeries 445, together with the robust system resource management and reporting capabilities of ARMTech and Application Workload Manager, provide the essential building blocks for today's on demand enterprise. The combination delivers our customers a cost-effective platform optimized for mission-critical availability and maximum server utilization without compromising application performance. Together, IBM's x445 and Aurema's resource management and reporting solutions bring new levels of productivity, efficiency and accountability to the on demand enterprise."

Russell Shelton, Vice President of Marketing, SteelEye Technology, Inc. "The combination of SteelEye LifeKeeper running on IBM eServer x445 provides customers with a tremendous solution for establishing the highest levels of business continuity and disaster recovery capabilities required to support business critical Microsoft Windows and Linux applications. The new XpandOnDemand "pay-as-you-grow" scalability powered by Enterprise X-Architecture, coupled with the flexibility and ease-of-implementation of SteelEye LifeKeeper, enables customers to establish high availability cluster solutions that are capable of evolving to meet a broad spectrum of business, technical and performance requirements."

Bob Sutor, Director of Marketing, IBM WebSphere "The x445 is another statement of technology leadership for IBM eServer xSeries. This server platform will offer WebSphere customers with new levels of performance and scalability for business-critical e-business infrastructure solutions. We are confident that the x445 will emerge as a server platform of choice for our WebSphere customers."

Joel Heinke, Director of PeopleTools Strategy, PeopleSoft, Inc. "PeopleSoft customers are looking for a computing solution that delivers the outstanding availability and scalability for their current and future needs. The PeopleSoft Pure Internet Architecture was designed with this in mind, and the x445 with its "pay-as-you-grow" building block design is a natural fit for customers requiring a cost-effective, high-performance solution on which to deploy their PeopleSoft applications."

David Jones, Senior Vice President of Corporate Development, Citrix Systems, Inc. "Citrix and IBM have enjoyed a close relationship since the late 1980s; in fact Citrix was founded by ex-IBM executives. The launch of the new xSeries 445 server provides a new and improved platform on which our mutual customers can deploy Citrix MetaFrame Access Suite solutions. When combined with the VMware product, Citrix and IBM solutions allow customers to use logical partitions for deploying multiple instances of the Citrix MetaFrame Presentation Server enabling superior performance and significant reductions in cost. The launch of the x445 extends this capability with new functionality and results in a superior platform for server consolidation."

Charlie Latch, Vice President of Corporate Alliances, i2 Technologies, Inc. "i2 supports the prospect of using Intel-based servers like the latest xSeries for enterprise scale application deployment. Because the x445 extends autonomic computing through advances in memory fault tolerance and systems management tools, we expect that our customers could benefit from improved scalability and performance to run their i2 solutions with utmost confidence."

Sandy Carter, Vice President, Tivoli Marketing, IBM "Customers turn to IBM Tivoli intelligent management software to help them integrate, automate, and optimize the management of their critical IT infrastructures. These customers are constantly looking for ways to improve the performance and reliability of the key business services that they deliver to become more competitive. The new x445 and its focus on providing leading scalability and performance will create a powerful foundation for centralizing IT management and deploying the business applications essential for business success."

Janet Perna, General Manager, IBM DB2 Data Management "DB2 Universal Database will continue to push the performance envelope for databases within the industry-standard space when coupled with the IBM xSeries x445, the next generation scalable enterprise server powered by Enterprise X-Architecture. The flexible, single chassis 4-to 8-way node design for the x445 delivers XpandOnDemand scalability up to 32-way SMP, allowing customers to take full advantage of DB2 UDB's ability to scale. Now they can grow their DB2 UDB databases quickly without unnecessary up-front infrastructure investments. Together, xSeries and DB2 are laying the foundation for delivering e-business on demand."

Dave Dargo, Vice President, System Platforms Division, Oracle Corporation "The new IBM eServer x445 combined with Oracle9i Real Application Clusters provides our joint customers with flexibility, high availability, and scalability for their database infrastructure. Several key performance enhancements and future support for InfiniBand will appeal to Oracle customers, particularly those running mission-critical environments."

Gordon Haff, Senior Analyst & IT Advisor, Illuminata, Inc. *IBM Builds Windows Scale One Block at a Time*

"IBM is making its presence felt on the playing field that Unisys enjoyed in virtual isolation until recently. ... Processor for processor, IBM appears to have reached parity with - or perhaps even exceeded - Unisys' 16-way system-level performance running Windows Server 2003 with its NUMA extensions.

IBM's building block design is also a more cost-effective way to start small and grow big with a single system than is Unisys' more traditional Big Box design. ... Given this common scenario, the ability of a system like the x445 to perform well at competitive price points all the way from 4-way up to 16-way is an appealing alternative to starting big or not at all.

Whether for buyers looking for a 32-bit x86 system as fast as any out there or for those looking to grow one system building block at a time, IBM has clearly arrived."

Jane Wright, Research Director, Gartner Research *Review: IBM eServer xSeries 445 Server*

"The design and implementation of the eServer x445 demonstrate that IBM has adapted some key mainframe technologies on an IA-32-based system. As one of only two available servers in the market today that support 16 or more Intel 32-bit processors, the eServer x445 provides customers with a rare opportunity to consolidate a large number of Windows or Linux applications onto an enterprise class Intel-based server."

**Alan Zeichick, Principal Technology Analyst, InfoWorld*
*IBM Reaches Sweet 16***

"In the realm of x86-based servers, I haven't yet found an Intel-based machine that's as powerful, resilient, and scalable as the eight-processor 2.8GHz Xeon MP-based x445.

IBM differentiates itself with robustness and reliability. Also tops is IBM's maintainability.

Applications from the likes of Oracle, SAP, and PeopleSoft need power, headroom, and servers that don't break. As Big Blue's high-end IBM x86 server, the xSeries 445 is a machine worthy of deployment anywhere you need an eight-way box -- with room to grow."

*To read this review, please visit the x445 website at www.ibm.com/eserver/x445.



xSeries 445: 8-way+ Competitive Comparison (As of 10 May 2004)



8-Way+	IBM	HP	HP	Dell	Sun	Unisys	Unisys
Model	xSeries 445	ProLiant DL740	ProLiant DL760 G2	PowerEdge 8450	Fire V880	ES7000 Aries 510	ES7000 Orion 540
Chassis	4U	4U	7U	7U – RETIRED	16U	4U + 1U Serv Proc	36U
Processor	Xeon MP 3.0 GHz	Xeon MP 3.0 GHz	Xeon MP 3.0 GHz	PIII Xeon 900 MHz	UltraSPARCIII 1GHz	Xeon MP 3.0GHz	Xeon MP 3.0GHz
8-way SMP	YES	YES	YES	YES	YES	YES	YES
16-way SMP	YES	NO	NO	NO	NO	NO	YES
32-way SMP	YES	NO	NO	NO	NO	NO	YES
Chipset	IBM XA-32 2nd Gen	HP F8	HP F8	Intel Profusion	Superscalar SPARC 9	Unisys CMP	Unisys CMP
DIMM slots	32	32 + 8 optional	32 + 8 optional	32	32	16	64
Memory, Std.	2 GB DDR (4x512)	2GB (1.5), 4GB (2.0)	2GB (1.5), 4GB (2.0)	256 MB	4 GB	4 GB	4 GB per cell
Memory, Max	128GB	32 GB	32 GB	32 GB	64 GB	16 GB	64 GB
Chipkill	YES	NO	NO	YES	NO	NO	NO
Memory ProteXion	YES	NO	NO	NO	NO	NO	NO
Hot-Swap Memory	YES	YES	YES	NO	NO	NO	NO
Hot-Add Memory	YES	YES	YES	NO	NO	NO	NO
L4 Cache (Max)	64MB/4-way (512)	NO	NO	NO	NO	16 MB/4-way (32)	16MB 4-way (128)
Hard drive bays	2	4	4	2	12	1	1 per cell
Max Int. Storage	292 GB	587 GB	587 GB	146 GB	876 GB	30 GB	30 GB per cell
SCSI	Dual Ultra320	Ultra160	Ultra160	Ultra2	NO (FC)	NO (IDE)	NO (IDE)
Hot-Swap HDDs	YES	YES	YES	YES	NO	NO	NO
Redundant HDDs	YES	YES	YES	YES	YES	NO	NO
RAID	Integrated RAID-1	Int. Smart Array 5i	Int. Smart Array 5i	Optional	Optional	NO	NO
NIC	Dual Gigabit Ethernet	Dual Gigabit Ethernet	Gigabit Ethernet	10/100	Gigabit Ethernet	10/100	10/100
Hot-Swap PCI	YES	YES	YES	YES	YES	NO	NO
PCI/PCI-X (Open)	0/6 (6)	0/6 (6)	1/10 (11)	10/0 (10), No PCI-X	9/0 (9), No PCI-X	8/0 (8), No PCI-X	32/0 (32), No PCI-X
64-bit/133 MHz	2 PCI-X	0	0	0	0	0	0
64-bit/100 MHz	2 PCI-X	6 PCI-X	10 PCI-X	0	0	0	0
64-bit/66 MHz	2 PCI-X	0	0	4 PCI	2 PCI	8 PCI	32 PCI
64-bit/33 MHz	0	0	1 PCI	6 PCI	7 PCI	0	0
Systems Mgmt Software	IBM Director	Insight Manager	Insight Manager	Dell OpenManage	Solaris/Solstice Mgr	Unisys Server Sentinel	Unisys Server Sentinel
Service Processor	RSAL-EXA standard	Integrated Lights Out	Optional	Optional	Sun Remote System Control	Optional 1U Server	Optional 1U Server
Power Supplies	2 x 1200W standard	2 x 1100 W standard	2 x 1100 W standard	3 x 750 W standard	3 x 1500 W (N+1)	1 x 1200W standard	1 per cell standard
Redundant Power	YES	YES	YES	YES	YES	Optional	Optional
Hot-Swap Power	YES	YES	YES	YES	YES	NO	NO
Hot-Swap Fans	YES	YES	YES	YES	YES	NO	NO
Remote I/O	YES + RIO Sharing	NO	NO	NO	NO	NO	NO
Light Path Diagnostics	YES	YES	YES	NO	NO	NO	NO
Predictive Failure Analysis	HDD, Memory, CPU, Fans, Power Supplies	HDD, Memory, CPU	HDD, Memory, CPU	Fans, Power Supplies	NO	CPU	CPU
Operating Systems	WinNT, W2K, Win2003, Red Hat, SuSE, NetWare, SCO UnixWare, VMware	W2K, Win2003, Red Hat, SuSE	W2K, Win2003, Red Hat, SuSE	WinNT/2K, Linux, NetWare	Solaris only	W2K, Win2003, SCO UnixWare (No Linux)	W2K, Win2003, SCO UnixWare (No Linux)

On July 21, 2003, Neil Hand, director of product marketing at Dell, announced that Dell no longer intends to “bring an eight-way Xeon system to market.” As stated in the CNet News article announcing the cancellation (http://news.com.com/2100-1010_3-1027556.html), “the end of the eight-processor system illustrates the difficulties Dell faces when that effort carries the company beyond its areas of expertise.” According to Nathan Brookwood, an analyst with Insight64, who was interviewed in the article, Dell “failed miserably with the Profusion product a few years ago [the product detailed in the list above]...I don’t think people want to buy systems in that price class from Dell.”

xSeries 445: 4-way Competitive Comparison (As of 10 May 2004)

						
4-way	IBM	HP	HP	Dell	Dell	Sun
Model	xSeries 445	ProLiant DL580 G2	ProLiant DL585	PowerEdge 6650	PowerEdge 6600	Fire V480
Chassis	4U	4U	4U	4U	7U	5U
Processor	Xeon MP 3.0 GHz or Xeon DP 3.0GHz	Xeon MP 3.0 GHz	AMD Opteron 848 2.2GHz	Xeon MP 3.0GHz	Xeon MP 3.0GHz	UltraSPARC III 900 MHz
8-32-way Capable	YES	NO	NO	NO	NO	NO
Chipset	IBM XA-32 2nd Gen	ServerWorks GC-HE	ServerWorks GC-HE	ServerWorks GC-HE	ServerWorks GC-HE	Superscalar SPARC 9
DIMM slots	32	16	16	16	16	16
Memory, Std.	2 GB DDR (4x512)	2 GB DDR	2 GB DDR	512 MB DDR	512 MB DDR	4 GB
Memory, Max	64 GB	32 GB	64 GB	16GB	16 GB	32 GB
Chipkill	YES	YES	NO	YES	YES	NO
Memory ProteXion	YES	NO	NO	NO	NO	NO
Hot-Swap Memory	YES	NO	NO	NO	NO	NO
Hot-Add Memory	YES	NO	NO	NO	NO	NO
L4 Cache (Max)	64 MB (128)	NO	NO	NO	NO	NO
Hard drive bays	2	4	4	5	12	2
Max Int. Storage	292 GB	291 GB	584 GB	365 GB	876 GB	146 GB
SCSI	Dual Ultra320	Dual Ultra160	Dual Ultra320	Single Ultra160	Single Ultra160	NO (FC)
Hot-swap HDDs	YES	YES	YES	YES	YES	YES
Redundant HDDs	YES	YES	YES	YES	YES	YES
RAID	Integrated RAID-1	Int. Smart Array	Int. Smart Array	Optional	Optional	Optional
NIC	Dual Gigabit Ethernet	Gb Ethernet in slot	Int. Dual Gb Ethernet	Dual Gigabit Ethernet	Dual Gigabit Ethernet	Dual Gigabit Ethernet
Hot-swap PCI	YES	YES	NO	YES	YES	YES
PCI/PCI-X (Open)	0/6 (6)	0/6 (5), 4 HS	0/8 (8)	1/7 (7)	0/11 (11)	6/0 (6), No PCI-X
64-bit/133 MHz	2 PCI-X	0	2 PCI-X	0	0	0
64-bit/100 MHz	2 PCI-X	6 PCI-X	6 PCI-X	7 PCI-X	11 PCI-X	0
64-bit/66 MHz	2 PCI-X	0	0	0	0	2 PCI
64-bit/33 MHz	0	0	0	0	0	4 PCI
Systems Mgmt Software	IBM Director	Insight Manager	Insight Manager	Dell OpenManage	Dell OpenManage	Solaris/Solstice Mgr
Service Processor	RSAL-EXA standard	Integrated Light Out	Integrated Light Out	Optional	Optional	Sun Remote System Control
Power Supplies	2 x 1200W	2 x 800W	2 x 800W	2 x 900 W	3 x 600 W	2 x 1440 W (N+1)
Redundant Power	YES	YES	YES	YES	YES	YES
Hot-swap Power	YES	YES	YES	YES	YES	YES
Hot-swap Fans	YES	YES	YES	YES	YES	YES
Remote I/O	YES + RIO Sharing	NO	NO	NO	NO	NO
Light Path Diagnostics	YES	YES	YES	NO	NO	NO
Predictive Failure Analysis	HDD, Memory, CPU, Fans, Power Supplies	HDD, Memory, CPU	HDD, Memory, CPU	Fans, Power Supplies	Fans, Power Supplies	NO
Operating Systems	Win2003, Red Hat, SuSE, NetWare, SCO UnixWare, VMware	W2K, Win2003, Red Hat, SuSE	W2K, Win2003, Red Hat, SuSE	WinNT/2K, Linux, NetWare	WinNT/2K, Linux, NetWare	Solaris only

IBM versus the Unisys ES7000 Aries and Orion 500 Series

CNet News: "Unisys, Microsoft to launch anti-Unix ads" (<http://news.com.com/2100-1001-870805.html>)

"The Unisys ES7000 server can accommodate as many as 32 Intel processors and can be divided into independent 'partitions,' each with its own operating system. The Datacenter version of Windows 2000 can run on machines with as many as 32 processors. These top-end configurations are rare, Unisys has said, with eight-, 12-, or 16-processor partitions more common."

IBM Response: By their own admission, Unisys sells few 32-way SMP systems. Unisys is basically selling multiple 8-way and 16-way servers as partitions in an extremely expensive rack...but not even doing that very well. While Unisys can get as many as four 8-way partitions in its 36U Orion 540, IBM can get up to TEN 8-way partitions in a 42U industry-standard rack, all manageable from the same IBM Director console and each running its own operating system.

"Unisys faces competition not only from Unix servers, which have accommodated dozens of processors for years, but also from IBM's new Summit servers, which top out at 16 processors but cost considerably less than the ES7000."

IBM Response: "Considerably less" was an understatement. As a result of competition from the x440, Unisys reduced the price of the Orion server by over \$150,000 for its 16-way but is still more expensive than either the x440 or the x445. Not only is the x445 16-way 3/4th the price of the Orion 540 but it only takes up 1/4th of the rack space (8U rack space for two x445 chassis connected together as a 16-way SMP versus 36U for the Unisys ES7000 Orion 540).

Unisys ES7000 Orion 540 16-way (36U)

Qty	Description	Price (USD)*
1	ES7000 16-way Xeon 2.0GHz, 64GB RAM, 30GB HDD, 32 PCI slots	\$251,750
4	Fiber Channel Host Bus Adapters	\$11,400
4	cLAN Controllers	\$3,020
1	36U Cabinet	\$2,537
1	1U Service Processor Server	\$4,576
1	3-year Maintenance	\$13,692
		Total: formerly \$436,850, now \$286,975

IBM x445 16-way (8U)

Qty	Description	Price (USD)*
2	Two x445 servers, each with 8 Xeon MP 3.0GHz CPUs	\$145,083
64	1 GB DIMM (Match at 64 GB total)	\$39,616
1	36 GB 10K U320 Hard disk drive	\$299
4	TotalStorage Fiber Channel Host Bus Adapters	\$5,940
1	3-year Maintenance	\$6,442
		Total: \$197,380

*Source: TPC-C benchmark, disclosure posted to www.tpc.org

"Another obstacle for Unisys: Only a few hundred ES7000 servers have been sold so far, and sales partnerships with Dell, Compaq and Hewlett-Packard have all fallen apart."

CNet News: "Dell drops plan to sell Unisys server" (<http://news.com.com/2100-1001-857174.html>)

"The ES7000 servers have commonly been selling for \$480,000 with an average of 22 processors, Weber said. About 600 CMP systems have been sold so far, Krempasky said." Since this article was published in March 2002, CNet published a new article in April 2003 in which Unisys updated its sales for the ES7000 to 1000 servers...an average of 30 systems per month. (<http://news.com.com/2100-1001-995660.html>)

IBM Response: By contrast, IBM will sell over 1000 x445 every 30 days! This is what happens when you are the overall #1 server vendor in the world including the #1 market share position worldwide in the 8-way segment (3Q2002 through 3Q2003 latest data released by IDC).

CNet News: "IBM to release high-end Intel server" (<http://news.com.com/2100-1001-858833.html>)

"Unisys counters that it's got a track record with its ES7000, which has been on the market with other Intel processors since 2000. And an ES7000 can continue running even when a processor fails, a feature IBM can't match, Unisys said."

IBM Response #1: some track record. 1000 servers in 4 years, 3 failed OEM partnerships, and 10 benchmarks. By contrast, the x440 has ranked first in 35 industry-standard benchmarks from SAP to TPC. The x445 continues that trend adding 16 new #1 benchmarks for over 50 total #1's!

IBM Response #2: The feature claim above against IBM is false. This is called MEDIC Diagnostics and was first introduced on the x440.

Processor Failure on Unisys: In the statement above, Unisys is referring to its partitions not the whole system. No Windows operating system can survive a processor failure. However, an ES7000 4-way partition can crash following a processor failure without taking the other three partitions down in the Unisys rack, the same as an x440 in an industry-standard rack with up to ten other partitions.

IBM's Response: MEDIC™ Diagnostics (MEDIC = Module Error Detection, Isolation & Correction): Advancing autonomic computing

- MEDIC enables an 8-way to lose the top SMP Expansion Module as a result of a CEC failure and re-boot using Automatic Server Re-boot (ASR) back up into a 4-way while holding that the top SMP Expansion Module in isolation for diagnosis of the failure. Using Real Time Diagnostics while the system remains operational, the IT administrator can diagnosis the failure. This applies only to the top CEC because the bottom CEC controls the I/O and has to be functional for the server to boot. MEDIC enables a 16-way to lose a SMP Expansion Module or entire node as a result of a processor failure and re-boot using ASR back up into an operational configuration for Real Time Diagnostics according to the following rules:
 - 16-way as 2x8-way: lose top SMP Exp Module -- re-boot back as 12-way
 - 16-way as 2x8-way: lose bottom SMP Exp Module -- re-boot back as 8-way
 - As implemented in a physical partitioning scenario: this would be identical to the Unisys claim. The physical partition would crash with a CPU failure but the other partitions would remain operational.
 - As implemented in the 4-way up to 16-way, in the event of a processor failure only (not CEC failure), MEDIC will detect the CPU failure and re-boot that physical partition holding just that processor in isolation.

Bottom Line: The Unisys claim is exaggerated. The x445 has the same physical partitioning capability available in the Unisys system with additional logical partitioning capabilities available through VMware including support for Linux that Unisys does not offer.

Following the lead of the IBM autonomic computing initiative, Unisys is developing self-optimizing features into the ES7000. But Unisys forgets that it is making claims against the company that invented autonomic computing.

Their Autonomic Computing capabilities

Configuration Management & partitioning setup
 Application Resource Management
 System Health Monitoring
 System Health Advisor
 Automatic fault handling, alerts and diagnosis.
 Automating manual tasks
 Managing the CPU workload within partitions.
 Anytime/Anywhere Remote Management
 Call Home

True autonomic computing delivered from IBM today

Configuration Management and Partitioning Setup: Got it. Scalable Systems Manager.
 Application Resource Management: Got it. Called Application Workload Manager.
 System Health Monitoring: Got it. Standard with IBM Director.
 System Health Advisor: Got it. Standard IBM Director.
 Automatic fault handling, alerts and diagnosis: Got it. Standard with IBM Director.
 Automating manual tasks: Got it. Standard with IBM Director.
 Managing the CPU workload within partitions: Got it. Called Capacity Manager.
 Anytime/Anywhere Remote Management: Got it. Called Remote Supervisor Adapter.
 Call Home: Got it. Standard with IBM Director and the integrated RSAPI-EXA

What they left out that we deliver

Real-Time Diagnostics for diagnostics while the system is running
 Software Rejuvenation for improved software performance
 Chipkill memory for higher reliability
 Active Memory with Memory Mirroring
 Memory ProteXion for more reliable memory subsystem
 Predictive Failure Analysis on all major subsystems

Light Path Diagnostics for easy identification of failing parts
 Active PCI-X for hot-swapping failed PCI/PCI-X adapters
 Active PCI Manager for optimizing slot-adaptor performance
 Remote Deployment Manager for easier remote deployment
 UpdateXpress for easier remote management of software updates
 Virtual Server Manager for managing virtualized servers remotely

In addition to omitting numerous systems management features, the Unisys ES7000 lacks most of the high -availability features that customers have come to expect from a mission-critical server.

	Unisys ES7000	IBM x445
Service Processor	<input checked="" type="checkbox"/> Optional 1U (\$5K)	<input checked="" type="checkbox"/> Standard
ECC Memory	<input checked="" type="checkbox"/> Standard	<input checked="" type="checkbox"/> Standard
Chipkill Memory	<input checked="" type="checkbox"/> Not Offered	<input checked="" type="checkbox"/> Standard
Memory ProteXion	<input checked="" type="checkbox"/> Not Offered	<input checked="" type="checkbox"/> Standard
Memory Mirroring	<input checked="" type="checkbox"/> Memory Not Accessible	<input checked="" type="checkbox"/> Optional
Hot-swap / Hot-add Memory	<input checked="" type="checkbox"/> Not Offered	<input checked="" type="checkbox"/> Optional
Hot-swap Hard disk drives	<input checked="" type="checkbox"/> Not Offered	<input checked="" type="checkbox"/> Standard
Mirrored Hard disk drives	<input checked="" type="checkbox"/> Not Offered	<input checked="" type="checkbox"/> Standard: 2 SCSI HDDs
Hot-swap Power Supplies	<input checked="" type="checkbox"/> Not Offered	<input checked="" type="checkbox"/> Standard
PCI-X I/O Signal integrity	<input checked="" type="checkbox"/> Not Offered	<input checked="" type="checkbox"/> Standard
Hot-swap PCI	<input checked="" type="checkbox"/> Not Offered	<input checked="" type="checkbox"/> PCI-X Standard
Hot-swap Fans	<input checked="" type="checkbox"/> Not Offered	<input checked="" type="checkbox"/> Standard
Predictive Failure Analysis	<input checked="" type="checkbox"/> Not Offered	<input checked="" type="checkbox"/> HDDs, Power, Fans, L4 cache, Memory
Light Path Diagnostics	<input checked="" type="checkbox"/> Not Offered	<input checked="" type="checkbox"/> Standard

In summary, Unisys needs business and is striving to gain attention with a product indicative of its lack of leadership.

- As stated in CNet News, after four years, Unisys has only sold 1000 ES7000 servers, suffered through three failed OEM relationships (Dell, Compaq, HP) and have had to drop prices on their high-end system by as much as 35% just to compete!
- Unisys is a distant #6 in worldwide market share according to Gartner for 3Q 2003, relegated to "Other" category. (<http://news.com.com/2100-1001-995660.html>)
- Because of poor I/O performance, Unisys only publishes benchmarks that are CPU dependent, i.e. TPC-C and SAP. This is the reason that Unisys could only use the 36U Orion 540 for the TPC-C, because it needed the aggregate bandwidth and memory scalability of four cells just to compete against the two-chassis 8U x445.
- Unisys lacks most of the high availability features that are indicative of a mission-critical server. By contrast, IBM with the eServer xSeries 440 and the next-generation x445 has seen and will continue to enjoy great success including:
 - Catapulting from #3 to #1 in 8-way worldwide market share in only 2 quarters, a lead maintained through since 3Q 2002.
 - Over 50 combined #1 benchmarks in 2 years including TPC-C/H/W, SAP, Siebel, Baan, Citrix, and Oracle.
 - Over three dozen customer and ISV endorsements.
 - Four major industry awards for the x440 including PC Expo Overall Best of Show, PC Expo Enterprise Hardware Best of Show, PC Magazine Technical Excellence for Enterprise Servers, and Network World Best Enterprise Server of 2002.

And what about Hewlett-Packard and their late-to-market F8-based 8-way Server?

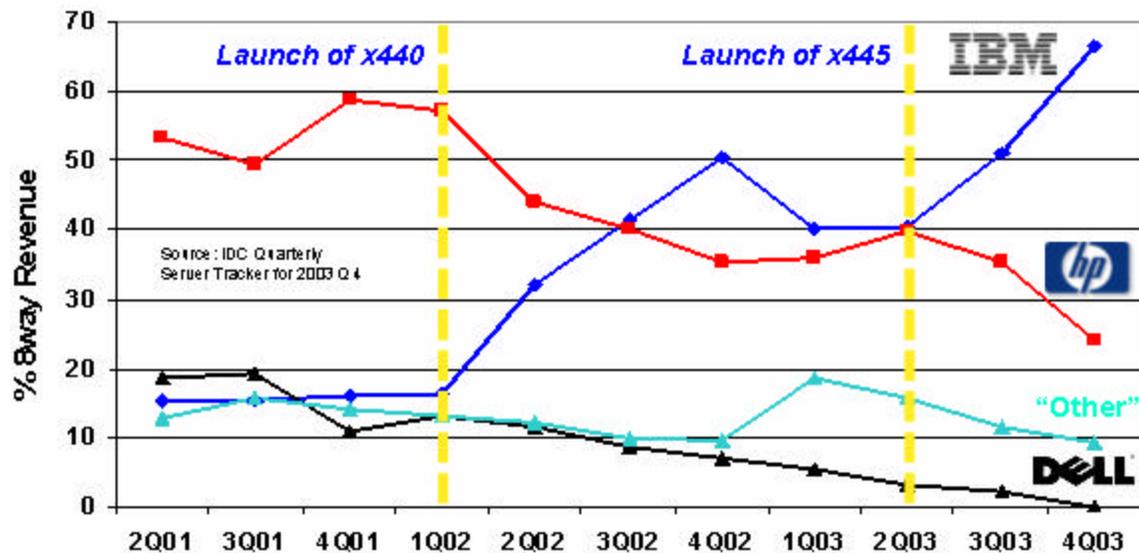
Back in March 2002 when the x440 was first announced, Hewlett-Packard stated publicly that they were waiting on the introduction of Intel's follow-on Xeon MP "Gallatin" processor to launch their 8-way Xeon MP-based server because of the increased processor cache needed for performance. FACT: the claim by HP that the first-generation Xeon MP "Foster" processor didn't provide adequate performance was an excuse

for not having a product to compete against the x440. FACT : the F8 chipset did not work. While HP was trying to get their first product out the door, IBM was developing its next-generation product, the x445, which will widen the performance gap and enable IBM to maintain its #1 worldwide market share leadership in the 8-way segment.

If you were losing market share at the rate of 12% per quarter in the most profitable segment in the industry-standard market, wouldn't you introduce a new system even if it only MATCHED the performance of your previous generation just to be able to say you have the latest technology? Why would HP suddenly skip a processor introduction unless F8 flat out didn't work? Why also did they introduce a 4-way Xeon MP in a 4U when they were offering a 4-way in a 4U with Pentium III Xeon? What value did they offer the customer then besides latest technology if in fact the Xeon MP CPU didn't out-perform the previous generation? The difference? The 4-way was powered by the readily - available ServerWorks Grand Champion HE chipset...F8 didn't work. The result: 12 months late to market and surrender of the #1 worldwide market share position in 8-way servers, a segment invented by Compaq with the first Profusion 8-way in 1998 and this is what you get:

	IBM eServer x445	HP ProLiant DL740	HP ProLiant DL760 G2
Processors	Intel Xeon MP 2.2/2M, 2.7/2M, 3.0GHz/4M	Intel Xeon MP 2.2/2M, 2.7/2M, 3.0GHz/4M	Intel Xeon MP 2.2/2M, 2.7/2M, 3.0GHz/4M
Supported Configs	2-way up to 32-way	4-way and 8-way only	4-way and 8-way only
Chipset	XA-32 2nd Generation	HP F8	HP F8
Level-4 System Cache	128MB XceL4 per 8-way	None	None
4-way SMP with Xeon	Yes, 4-way with 3.0GHz Xeon DP	Never	Never
8-way SMP	Yes	Yes	Yes
16-way SMP	Yes	Never	Never
32-way SMP	Yes	Never	Never
Max Memory	64GB, Max for 32-bit (populated in banks of 2)	80GB needed for RAID (populated in banks of 10)	80GB needed for RAID (populated in banks of 10)
Memory Availability	ECC, Chipkill, Memory ProteXion, Mirroring	Basic ECC, Optional RAID Memory	Basic ECC, Optional RAID Memory
Hot-Swap Memory	Yes	Yes	Yes
I/O	6 Hot-swap Active PCI-X Slots	6 Hot-swap PCI-X Slots	11 Hot-swap PCI-X Slots
Remote I/O	Yes, 12 additional PCI-X slots in 3U + RIO Sharing	Never	Never
Base I/O Configuration	2@133MHz, 2@100MHz, 2@66MHz	6@100MHz (No 133MHz)	10@100MHz, 1@33MHz (No 133MHz)
RIO Configuration	Up to 12@100MHz	None	None
NC	Int, Broadcom Dual 10/100/1000 Ethernet	Int, Dual 10/100/1000 Ethernet	Int, 10/100/1000 Ethernet
Internal Storage	2 HDDs x 146GB = 292GB Ultra320	4 HDDs x 146GB = 584GB Ultra320	4 HDDs x 146GB = 584GB Ultra320
RAID	Integrated RAID1	Integrated RAID5	Integrated RAID5
Supported OS	W2K, Win2003, NT4, RHAS, SuSE, Netware, SCO Unix	W2K, Win2003, RHAS, SLES8	W2K, Win2003, RHAS, SLES8, SCO Unix
TPC-C 8-way	156,105 tpmC, \$4.31/tpmC	No Available Benchmark	115025 tpmC, \$7.69/tpmC
Chassis	4U	4U	7U

In spite of having 12 months of additional development time to get it right, the DL740 and DL760 G2 was barely competitive with the x440. Little did they know that the x445 was just around the corner. But what HP lacked in leadership, they tried unsuccessfully to make up for with innovation. Unfortunately, this innovation too lacks compelling value when compared with the more cost-effective x445. Touted by HP for its high availability, the DL740 and DL760 G2 introduced the new RAID Memory capability of the F8 chipset. Unfortunately, RAID Memory is an expensive way of addressing the need for high availability in the memory subsystem, but at a substantial premium when compared to the x445. Is it any wonder that IBM and HP's fortunes have reversed so substantially in 8-way market share?



Thanks to the integration of ECC, Chipkill and Memory ProteXion into the XA-32 2nd generation chipset, the x445 is able to offer single-bit and double-bit error detection and correction at no additional cost using off-the-shelf industry-standard DIMMs. By contrast, the HP 8-way servers require the investment of 25% additional memory expense to create the RAID portion of the memory array plus the added cost of five memory controllers to enable anything greater than ECC in the DL740 and DL760 G2. When powering a 64GB high-performance database engine, this adds over \$20,000 in additional memory to the price of the HP server just to power RAID Memory, dollars saved if invested in the x445.

Memory Error	HP DL740	HP DL760 G2	IBM x445
Single-bit Error	Basic ECC Standard, No Added Cost	Basic ECC Standard, No Added Cost	Basic ECC Standard, No Added Cost
Chipkill	No Protection Requires optional RAID	No Protection Requires optional RAID	Chipkill Standard, No Added Cost
Double-bit Error	No Protection Detect only, Requires RAID	No Protection Detect only, Requires RAID	Memory ProteXion Standard, No Added Cost

The memory subsystem is not the only place where IBM is able to save you money. Overall, the x445 is less expensive to purchase and maintain than either of its F8-based competitors as either a scalable 4-way or an 8-way server. HP has recently completed several price reductions in an attempt to stem the loss of sales to the x445 (latest pricing reflected below as of May 10th, 2004). In spite of these price actions, the x445 remains a less expensive 8-way server that still provides scalability up to 16-way and beyond by combining multiple x445 chassis, expandability that cannot be matched by the DL740 and DL760 G2, in spite of their higher price tags.

IBM xSeries 445 8-way			HP DL740 8-way			HP DL760 G2 8-way		
Qty	Description	Price	Qty	Description	Price	Qty	Description	Price
1	x445 4x3.0GHz, 2GB RAM	\$40,799	1	DL740 4x3.0 GHz, 4GB RAM	\$40,999	1	DL760G2 4x3.0GHz, 4GB RAM	\$43,999
1	SMP Expansion Module	\$4,849	1	4-CPU Option Kit	\$29,699	1	4-CPU Option Kit	\$29,699
32	1GB DIMMs: 32GB Total	\$19,808	32	1GB DIMMs: 32GB+8GB RAID	\$23,470	32	1GB DIMMs: 32GB+8GB RAID	\$23,470
4	Xeon MP 3.0GHz/4MB L3	\$26,396	2	36 GB 10K SCSI HDD	\$598	2	36 GB 10K SCSI HDD	\$598
2	36 GB 10K U320 SCSI HDD	\$550	1	Remote Insight Board – LOE II	\$634	1	Remote Insight Board – LOE II	\$634
1	3-year SBD 24x7 Upgrade	\$3,200	1	3-year SBD 24x7 Upgrade	\$3,390	1	3-year SBD 24x7 Upgrade	\$3,390
TOTAL		\$95,602	TOTAL (3% higher than x445)		\$98,790	TOTAL (6% higher than x445)		\$101,790

IBM xSeries 445 4-way			HP DL740 4-way			HP DL760 G2 4-way		
Qty	Description	Price	Qty	Description	Price	Qty	Description	Price
1	x445 DP 4x3.0GHz 2GB RAM	\$25,049	1	DL740 4x3.0GHz, 4GB RAM	\$40,999	1	DL760G2 4x3.0GHz, 4GB RAM	\$43,999
12	512 MB DIMMs (8GB Total)	\$2,988	10	512MB DIMMs (8GB+2GB RAID)	\$2,890	10	512MB DIMMs (8GB+2GB RAID)	\$2,890
2	36 GB 10K SCSI HDD	\$550	2	36 GB 10K SCSI HDD	\$598	2	36 GB 10K SCSI HDD	\$598
1	3-year SBD 24x7 Upgrade	\$3,200	1	Remote Insight Board – LOE II	\$634	1	Remote Insight Board – LOE II	\$634
TOTAL		\$31,787	TOTAL (52% higher than x445)		\$48,511	TOTAL (62% higher than x445)		\$51,511

Why should you buy the x445 versus Unisys or Hewlett-Packard?

- x440: 10 times the sales of the Unisys ES7000 in 1/4th the time...proof that customers invest in IBM. The x445 continues this trend.
 - Over 10,000 x440 and x445 units in one year versus 1000 ES7000 units in 4 years
 - While IBM is #1 on the 8-way market share chart, Unisys is relegated to the "Other" category.
- Twelve months time-to-market lead over the F8-based HP DL740 and DL760 G2 with the x440...proof that IBM is a market leader.
 - IBM catapulted from #3 to #1 in 8-way worldwide market share after only 2 quarters, taking that #1 position from HP.
- The vision and commitment to leadership with Enterprise X-Architecture.
 - IBM delivers the 2nd generation of XA-32 15 months after the x440 and has commenced work on the 3rd generation for 2005.
 - Unisys may not be committed to ES7000 long term because it appears to be a money-losing business. According to Wall Street rumors, they are actively shopping for a buyer. Why should you invest in ES7000 when even Unisys does not appear to be?
 - After a 3-year development effort, HP just introduced their first-generation F8 chipset-based systems. It should be at least a year before they are able to introduce the second generation of F8 products to compete against the second generation x445.
- EXA: 5 times more #1 benchmarks than Unisys ES7000, over three dozen customer and ISV endorsements and four major industry awards.
 - 35 #1 benchmarks for x440 plus 16 #1's for x445 in 2 years versus 10 for the ES7000 in the same time period.
 - See <http://www.pc.ibm.com/us/eserver/xseries/x440.html> for endorsements of the x440.
 - See <http://www.pc.ibm.com/us/eserver/xseries/x445.html> for endorsements of the x445.
 - x440: Winner of the PC Expo Overall Best of Show, PC Expo Enterprise Hardware Best of Show, PC Magazine Technical Excellence for Enterprise Servers, and Network World Best Enterprise Server of 2002.
- Over 15 TIMES more #1 benchmarks than both the HP DL740 and DL760 G2 combined with lower pricing and better availability.
 - Only 4 known benchmarks for both the DL760 G2 and DL740 in 12 months
 - x445 enjoys over 25% better raw performance and 35% better price-performance advantage over the HP DL760 G2 (tpmC).
 - The x445 industry-exclusive 4-way with Intel Xeon DP is over 40% less expensive than the HP F8-based servers.
- x445 16-way: 1/4th the rack space and 3/4th the price and 2 1/2 times the partitions in the same amount of rack space versus the Unisys ES7000 Orion 540 16-way.
 - x445 16-way: 1/5th the rack space, 1/10th the price of the HP Superdome 16-way.
 - As HP offers no IA-32 16-way solution, if you want 16-way from HP, you have to buy expensive Itanium2
 - In the same amount of rack space as the Superdome 64-way, the IBM x445 16-way can deliver ten x445 16-ways versus one HP Superdome 64-way, both requiring two racks, at 20% of the price.

8. x445 8-way: 4 times the I/O bandwidth, 5 times the memory bandwidth, 20% more rack dense and 4/5th the price including integrated Remote Management vs. the Unisys ES7000 Aries 510 8-way which requires an additional 1U service processor.
 - The Aries 510 offers very few high availability features and no integrated service processor. Customers must add a \$4500 1U server to manage the system remotely, a capability that is standard in the more highly available x440.
9. x445: hot-swap redundancy for all high availability components versus Unisys ES7000 which has hot-swap redundant nothing, which when combined with the need to connect systems via the Unisys Cell Interconnect Module creates a potential service nightmare.
10. x445: Active Memory delivers support for ECC, Chipkill, and Memory ProteXion at no additional cost. For memory fault tolerance beyond ECC, HP requires that customers enable RAID Memory with its 20% extra memory expense and five memory controllers to match what IBM can provide at no additional cost. Other than ECC, Unisys has no such solution for high availability memory.

The Competitive Bottom line

- Buy for Scalability: no other Tier-1 system vendor offers scalability up to 16-way or 32-way SMP. In addition, no other vendor offers the most affordable, yet highest performing 4-way with Xeon DP.
- Buy for Remote I/O: no other industry-standard server vendor will offer Remote I/O capability. Period.
- Buy for Enterprise X-Architecture: this is our strategy for leadership. Learn about the vision of Enterprise X-Architecture and all that is included within the XpandOnDemand servers.
- Buy for Performance: the x445 is a leadership performance server. Our benchmarks provide proof-points that illustrate that we are ahead of our competitors. Remember that our XpandOnDemand servers were the platform used by Intel to validate the Xeon processor MP.
- Buy for High Availability: with Active Memory, Active PCI-X, Memory ProteXion, Light Path Diagnostics, and the whole suite of autonomic computing technologies, such as Predictive Failure Analysis, Software Rejuvenation, Capacity Manager, no other server manufacturer even comes close to the promise that IBM makes for OnForever availability.
- Buy from IBM: The investment that we have made in Enterprise X-Architecture is paying off. No other company can provide the technology leadership that IBM can. And customers are voting with their wallets because they, like us, realize that technology does matter and that the future of IT is NOT commodity driven. You know what's best for your business. So does IBM.

xSeries 445 – Performance Benchmarks

The IBM eServer x440 and the x445 have demonstrated #1 performance in over 50 combined #1 benchmarks since March 2002!

Benchmark	Result	Configuration	Notes
SAP 2-Tier 4-way ¹	525 SD Users	Xeon MP 2.8GHz/2M, Windows Server 2003 EE, IBM DB2, SAP v4.7	Leadership Benchmark for 4-way IA-32 server
SAP 2-Tier 4-way ¹	456 SD Users	Xeon DP 3.0GHz/512K, Windows Server 2003 EE, IBM DB2, SAP v4.7	Leadership Benchmark for 4-way Xeon DP IA-32 server
SAP 2-Tier 8-way ¹	950 SD Users	Xeon MP 2.8GHz/2M, Windows Server 2003 EE, IBM DB2, SAP v4.7	Leadership Benchmark for 8-way IA-32 server
SAP 2-Tier 16-way ¹	1520 SD Users	Xeon MP 2.8GHz/2M, Windows Server 2003 EE, IBM DB2, SAP v4.7	Leadership Benchmark for 16-way IA-32 server
SAP 2-Tier 8-way ¹	1165 SD Users	Xeon MP 3.0GHz/4M, Windows Server 2003 EE, IBM DB2, SAP v4.7	New Leadership Benchmark for 8-way IA-32 server
SAP 2-Tier 16-way ¹	2050 SD Users	Xeon MP 3.0GHz/4M, Windows Server 2003 EE, IBM DB2, SAP v4.7	New Leadership Benchmark for 16-way IA-32 server
TPC-C 4-way ²	90,271 tpmC, \$3.97/tpmC	Xeon MP 2.8GHz/2M, Windows Server 2003 Datacenter, SQL Server	#1 TPC-C Benchmark for 4-way IA-32 server (Avail: 12/31/03)
TPC-C 8-way ²	139,153 tpmC, \$5.07/tpmC	Xeon MP 2.8GHz/2M, Windows Server 2003 Datacenter, SQL Server	#1 TPC-C Benchmark for 8-way IA-32 server
TPC-C 16-way ²	190,510 tpmC, \$8.39/tpmC	Xeon MP 2.8GHz/2M, Windows Server 2003 Datacenter, SQL Server	#1 TPC-C Benchmark for 16-way IA-32 server
TPC-C 8-way ²	156,105 tpmC, \$4.31/tpmC	Xeon MP 3.0GHz/4M, Windows Server 2003 Datacenter, SQL Server	New #1 TPC-C Benchmark for 8-way IA-32 server (Avail: 8/31/04)
TPC-C 16-way ²	215,485 tpmC, \$8.72/tpmC	Xeon MP 3.0GHz/4M, Windows Server 2003 Datacenter, SQL Server	New #1 TPC-C Benchmark for 16-way IA-32 server (Avail: 8/31/04)
TPC-H 8-way ³	5602 QphH@ 100 GB, \$73/ QphH	Xeon MP 2.8GHz/2M, Windows Server 2003 EE, IBM DB2	A New World Record for this benchmark! (Avail: 12/31/04)
TPC-H 8-way ³	6354 QphH@ 300 GB, \$69/ QphH	Xeon MP 2.8GHz/2M, Windows Server 2003 EE, IBM DB2	#1 TPC-H Benchmark for 8-way IA-32 server (Avail: 12/31/03)
TPC-H 8-way ³	6551 QphH@ 300 GB, \$66/ QphH	Xeon MP 3.0GHz/4M, Windows Server 2003 EE, IBM DB2	New #1 TPC-H Benchmark for 8-way IA-32 server (Avail: 8/31/04)
Oracle 4-node ⁴	18368 OASB users @ .55 sec resp	Xeon MP 2.8GHz/2M, SUSE LINUX Enterprise Server 8, Oracle 9i	The highest result ever recorded for Intel-based server & Linux server
PeopleSoft	5000 Concurrent Users @ 2 sec resp	Xeon MP 2.8GHz/2M, Windows Server 2003 EE, SQL Server	#1 PeopleSoft Benchmark for 8-way IA-32 server
SPECjbb2000 ⁵	128,556 Ops/second	Xeon MP 2.8GHz/2M, SUSE LINUX Enterprise 8.0	#1 Benchmark for Java server-side computing

xSeries 445 – Easy Configurator

Base models with minimum configurations for customization

8870 – 1RX	2 x 2.0 GHz/1MB Xeon MP, 2 GB, RSA
8870 – 2RX	2 x 2.5 GHz/1MB Xeon MP, 2 GB, RSA
8870 – 4RX	4 x 2.8 GHz/2 MB Xeon MP, 2 GB, RSA
8870 – 3RY	2 x 3.0 GHz/512K Xeon DP, 2 GB, RSA
8870 – 4RY	4 x 3.0 GHz/512K Xeon DP, 2 GB, RSA
8870 – 11X	2 x 2.0 GHz/1MB Xeon MP, 2 GB, RSAII-EXA
8870 – 12X	2 x 2.2 GHz/2MB Xeon MP, 2 GB, RSAII-EXA
8870 – 22X	2 x 2.7 GHz/2MB Xeon MP, 2 GB, RSAII-EXA
8870 – 42X	4 x 3.0 GHz/4MB Xeon MP, 2 GB, RSAII-EXA
8870 – 3EX	2 x 3.0 GHz/512K Xeon DP, 2 GB, RSAII-EXA
8870 – 4EX	4 x 3.0 GHz/512K Xeon DP, 2 GB, RSAII-EXA



Base models for configuring 8-way and 16-way MS Datacenter

Purchase in matched pairs with Datacenter 16-CPU License

8870 – 1AX	2 x 2.0 GHz/1MB Xeon MP, 0 GB, RSA
8870 – 2AX	2 x 2.5 GHz/1MB Xeon MP, 0 GB, RSA
8870 – 4AX	2 x 2.8 GHz/2MB Xeon MP, 0 GB, RSA
8870 – 1BX	2 x 2.2 GHz/2MB Xeon MP, 0 GB, RSAII-EXA
8870 – 2BX	2 x 2.7 GHz/2MB Xeon MP, 0 GB, RSAII-EXA
8870 – 4BX	2 x 3.0 GHz/4MB Xeon MP, 0 GB, RSAII-EXA

RXE-100 Remote Expansion Enclosure & Options

8684 – 2RX	6 Active PCI-X Slots, 2 Power Supplies
13N0055	xSeries Remote I/O PCI-X 6-pack Upgrade Kit
31P6087	3.5m Interconnect Management Cable Kit
31P6088	8m Interconnect Management Cable Kit
31P6102	3.5m Remote I/O Cable Kit
31P6103	8m Remote I/O Cable Kit



Processor Upgrades

Xeon MP Option 2.0GHz / 1MB L3 02R2062	Xeon MP Option 2.5GHz / 1MB L3 02R2063	Xeon MP Option 2.8GHz / 2MB L3 02R2064	Xeon DP w/ CEC 3.0GHz / 512KB L2 02R1871
Xeon MP Option 2.2GHz / 2MB L3 13N0723	Xeon MP Option 2.7GHz / 2MB L3 13N0722	Xeon MP Option 3.0GHz / 4MB L3 13N0721	

Memory Upgrades: Must be added in matching pairs

512 MB DDR ECC SDRAM DIMM 33L5038	1 GB DDR ECC SDRAM DIMM 33L5039	2 GB DDR ECC SDRAM DIMM 33L5040

Hot-Swap Hard Disk Drives

36 GB Ultra320 10K: 32P0726 15K: 32P0734	73 GB Ultra320 10K: 32P0727 15K: 32P0735	146 GB Ultra320 10K: 32P0728

CEC Options

x445 SMP Expansion Module (For x445 Xeon MP only) 02R1870	x445 SMP Expansion Module with Dual Xeon 3.0 GHz 02R1871

ServeRAID Adapter Options

IBM ServeRAID- 6M Ultra320 SCSI 256MB 02R0988	IBM ServeRAID- 6M Ultra320 SCSI 128 MB 32P0033	IBM ServeRAID- 4Lx Ultra160 SCSI 06P5740

Networking & Storage Options

IBM Dual Gigabit Ethernet Adapter 31P6401	Intel Pro/1000 Gigabit Ethernet Adapter 31P9601	2Gb Fiber Channel PCI-X Adapter 24P0960

Other Options

x445 Two-Chassis 16-way Configuration Kit 02R2013	USB to Serial Adapter for UPS Mgmt 10K3661	CD-RW / DVD-ROM UltraBay Combo 22P6991

Need more information?

World Wide Web

IBM eServer xSeries 445

IBM Enterprise X-Architecture

IBM Benchmarks

x445 ServerProven

VMware ESX Server

Microsoft Datacenter

Systems Management

PC Magazine PC Expo Best of Show

PC Magazine Technical Excellence Award

Network World Fusion World Class Award

Network World Best of the Tests Award

InfoWorld Review of x445

PC Magazine Editors' Choice

XpandOnDemand @ I.T. Xchange

www.pc.ibm.com/us/eserver/xseries/x445.html

www.ibm.com/enterprisearchitecture

www.pc.ibm.com/ww/eserver/xseries/benchmarks/

www.pc.ibm.com/us/compat/machines/x445.html

www.pc.ibm.com/ww/eserver/xseries/vmware.html

www.pc.ibm.com/ww/eserver/xseries/windows/datacenter.html

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www.pcmag.com/article2/0,4149,273123,00.asp

www.pcmag.com/article2/0,4149,728675,00.asp

www.nwfusion.com/reviews/2002/1007rev1.html

www.nwfusion.com/best/2002/tests.html

www.infoworld.com/6

www.pcmag.com/article2/0,4149,530298,00.asp

www.itxchange.com/ibm/xpandondemand

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Benchmark Sources (page 25):

1) SAP: <http://www.sap.com/solutions/technology/benchmark/sd2tier.asp>

2) TPC-C: http://www.tpc.org/tpcc/results/tpcc_results.asp

3) TPC-H: <http://www.tpc.org/tpch/results/h-results.idc>

4) Oracle: http://www.oracle.com/apps_benchmark/html/index.html?results.html

5) SPEC: <http://www.spec.org>

For more information about the IBM eServer xSeries 445, please visit www.ibm.com/eserver/x445.