# System x
Redefining the x86 server landscape

Enterprise X-Architecture 5th Generation
Systems for a Smarter Planet

## 15. HROUG KONFERENCIJA
Rovinj, 19-23.10.2010.

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# Agenda

- [Uvod](#)
- [eX5 tehnologija s osvrtom na Oracle](#)
- [HX5 blade – blade rješenja s osvrtom na Oracle](#)

# eX5 leadership for an evolving marketplace with increasing demands
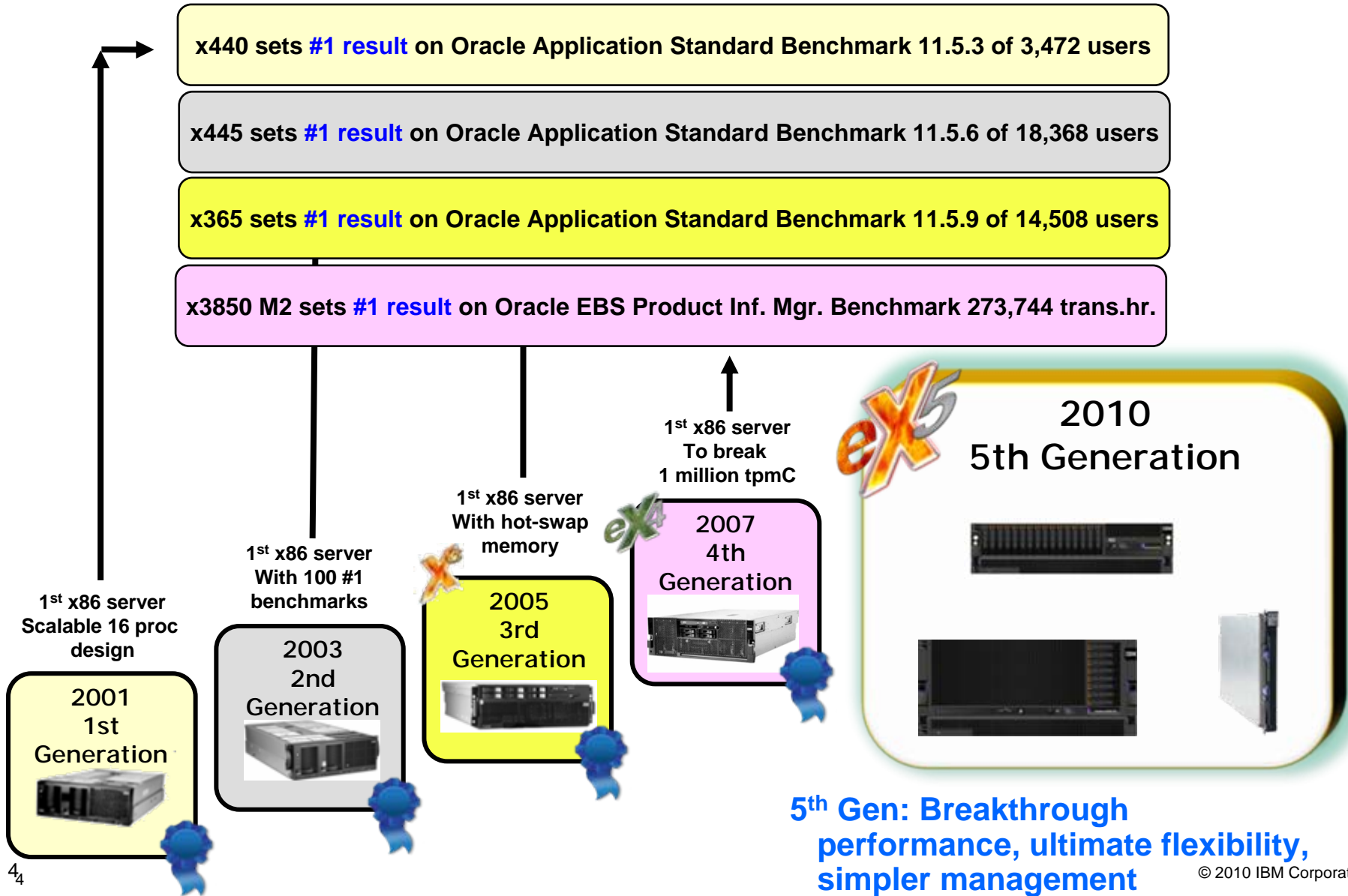
**5th Gen:** Breakthrough performance, ultimate flexibility, simpler management

**4th Gen:** First x86 server to break 1 Million tpmC

**3rd Gen:** First x86 server with Hot-swap memory

**2nd Gen:** First x86 server with 100 #1 Benchmarks

**1st Gen:** First x86 server with scalable 16 processor design

2010 5th Generation

2007 4th Generation

2005 3rd Generation

2003 2nd Generation

2001 1st Generation

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# eX5 – Built on a Proven History of Oracle Performance!

**x440 sets #1 result** on Oracle Application Standard Benchmark 11.5.3 of 3,472 users

**x445 sets #1 result** on Oracle Application Standard Benchmark 11.5.6 of 18,368 users

**x365 sets #1 result** on Oracle Application Standard Benchmark 11.5.9 of 14,508 users

**x3850 M2 sets #1 result** on Oracle EBS Product Inf. Mgr. Benchmark 273,744 trans.hr.

1st x86 server Scalable 16 proc design

**2001 1st Generation**

1st x86 server With 100 #1 benchmarks

**2003 2nd Generation**

1st x86 server With hot-swap memory

**2005 3rd Generation**

1st x86 server To break 1 million tpmC

**2007 4th Generation**

**2010 5th Generation**

**5th Gen: Breakthrough performance, ultimate flexibility, simpler management**

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# Client challenges with enterprise workloads

Database, Virtualization, Transaction processing

| Memory Capacity | Do More With Less | Simplify |
|---|---|---|
| ▪ **More virtual machines**<br><br>▪ **Larger virtual machines**<br><br>▪ **Bigger databases**<br><br>▪ **Faster database performance**<br><br>▪ **Greater server utilization** | ▪ **Buy what they need when they need it**<br><br>▪ **License Fees**<br><br>▪ **Operational Expense**<br><br>▪ **Energy and mgmt expenses**<br><br>▪ **Fit more into the datacenter they have today**<br><br>▪ **Reduce cost to qualify systems** | ▪ **Speed time from deployment to production**<br><br>▪ **Optimized performance for their workload needs**<br><br>▪ **Get more out of the people, IT, and spending they have**<br><br>▪ **Flexibility to get the IT they need, the way they need it** |

## Difficult challenges create an opportunity for innovation
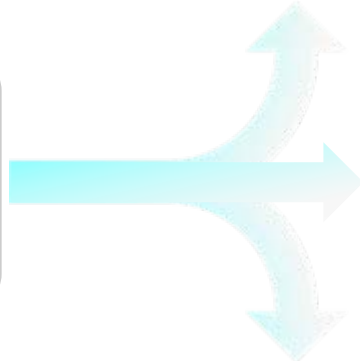
# eX5 Portfolio — Systems for a Smarter Planet

## System x3850 X5

Consolidation, virtualization, and database workloads being migrated off of proprietary hardware are demanding more addressability

**4U / 4-Way Scalable**

## BladeCenter HX5

Demand for minimum footprint as well as integrated networking infrastructure has increased the growth of the blade form factor.

Broad coverage for most enterprise applications, server consolidation, virtualized workload enablement.

## System x3690 X5

Powerful and scalable system allows some workloads to migrate onto 2-socket design that delivers enterprise computing in a dense package

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# IBM System x3850 X5
## Flagship System x platform for leadership scalable performance and capacity

*Versatile 4-socket, 4U rack-optimized scalable enterprise server provides a flexible platform for maximum utilization, reliability and performance of compute- and memory-intensive workloads.*

## Maximize Memory
– 64 threads and 1TB capacity for 3.3x database and 3.6x the virtualization performance over industry 2-socket x86 (Intel Xeon 5500 Series) systems
– MAX5 memory expansion for 50% more virtual machines and leadership database performance

## Minimize Cost
– Lower cost, high performance configurations reaching desired memory capacity using less expensive DIMMs
– eXFlash 480k internal IOPs for 40x local database performance and $1.3M savings in equal IOPs storage

## Simplify Deployment
– FlexNode Partitioning and Automatic Node failover for maximum flexibility and application uptime
– Pre-defined database and virtualization workload engines for faster deployment and faster time to value

### System Specifications

✓ 4x next-generation Intel Xeon Nehalem EX CPUs
✓ 64 to 96 DDR3 DIMMs
✓ 6 open PCIe slots (+ 2 additional)
✓ Up to 8x 2.5" HDDs or 16x 1.8" SSDs
✓ RAID 0/1 Std, Optional RAID 5/6
✓ 2x 1GB Ethernet LOM
✓ 2x 10GB Ethernet SFP+ Virtual Fabric / FCoEE
✓ Scalable to 8S, 192 DIMM
✓ Internal USB for embedded hypervisor
✓ IMM, uEFI & IBM Systems Director

# x3850 X5:  4-socket 4U x86 (Nehalem EX) platform

**(2x) 1975W Rear Access  Hot Swap, Redundant P/S**

**2x 10Gb Ethernet Adapter**

**(8x) Memory Cards for 64 DIMMs – 8 1066MHz DDR3 DIMMs per card**

**6x - PCIe Gen2 Slots (+2 additional)**

**(4x) Intel Xeon CPU's**

**RAID (0/1) standard, RAID 5/6 Optional**

**(2x) 120mm Hot Swap Fans**

**2x 60mm Hot Swap Fans**

**DVD Drive**

**(8x) Gen2 2.5" Drives or 2 eXFlash packs**

**Dual USB**

**Light Path Diagnostics**
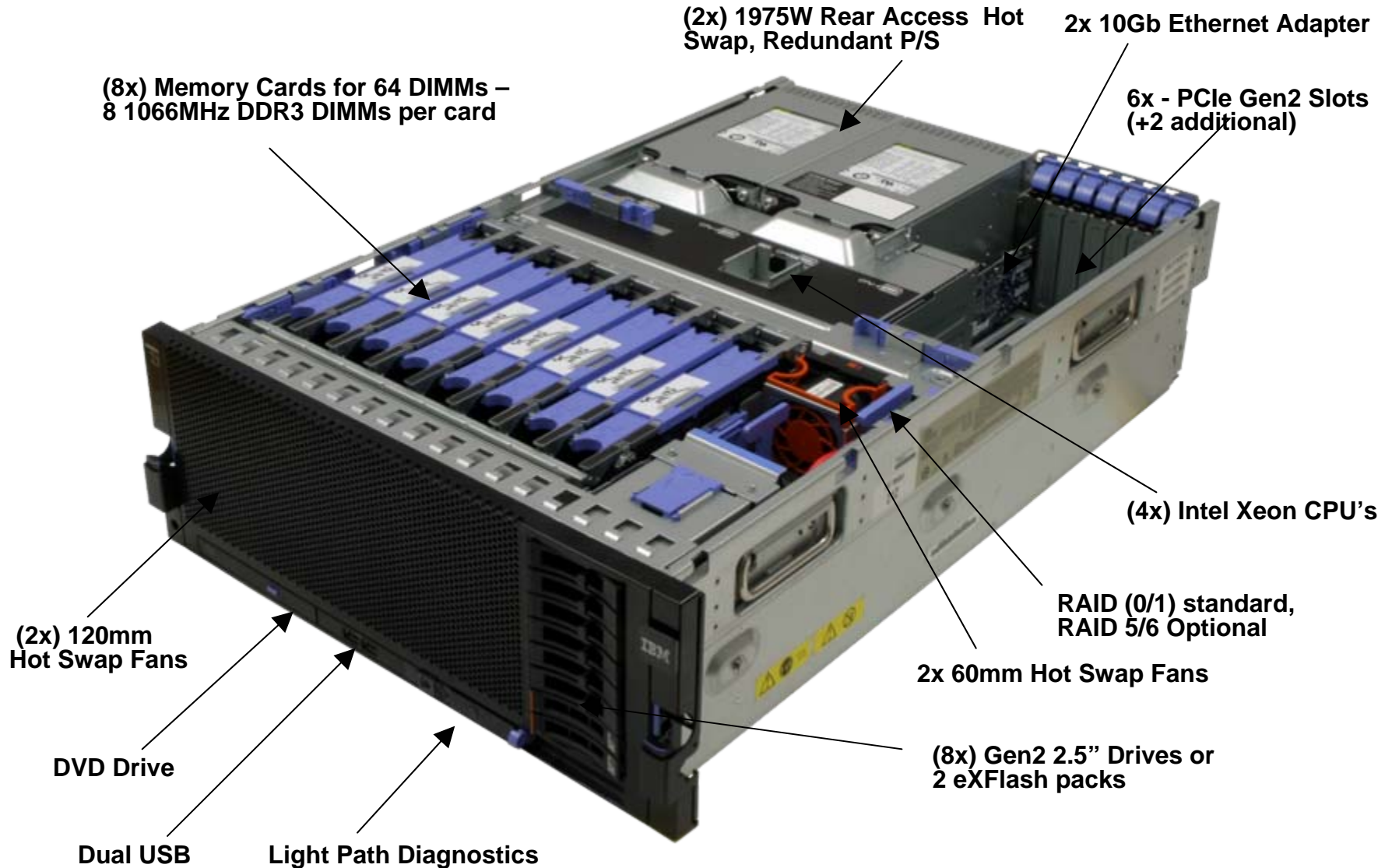
# MAX5: Memory Access for eX5

## Greater productivity and utilization through memory expansion and flexibility

Take your system to the MAX with *MAX5*

### *MAX* memory capacity

- An additional 32 DIMM slots for x3850 X5 and x3690 X5
- An additional 24 DIMM slots for HX5

### *MAX* virtual density

- Increase the size and number of VMs
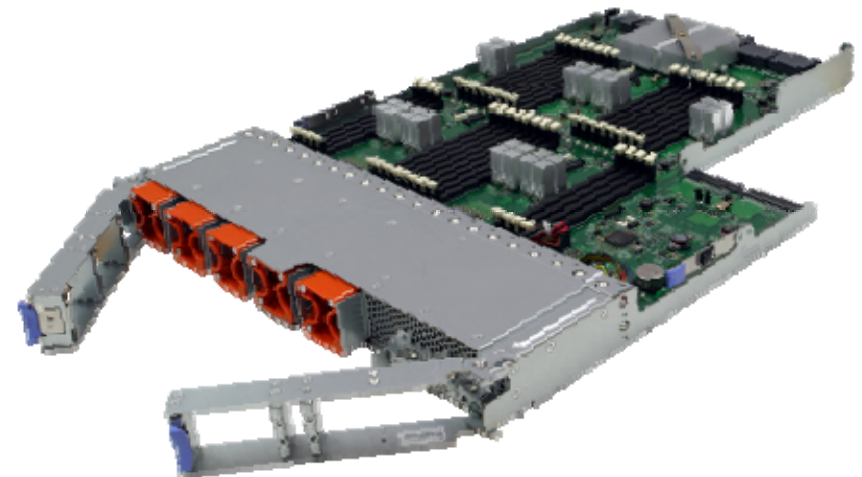
### *MAX* flexibility

- Expand memory capacity, scale servers, or both

### *MAX* productivity

- Increase server utilization and performance

### *MAX* license optimization

- Get more done with fewer systems

# MAX5 for x3690 X5 and x3850 X5

**Lightpath Diagnostics**

**Hot swap fans**

**System removes from chassis for easy access**

**32 Memory DIMMs**

**QPI Ports**

**Firehawk Chipset**

**EXA Ports**
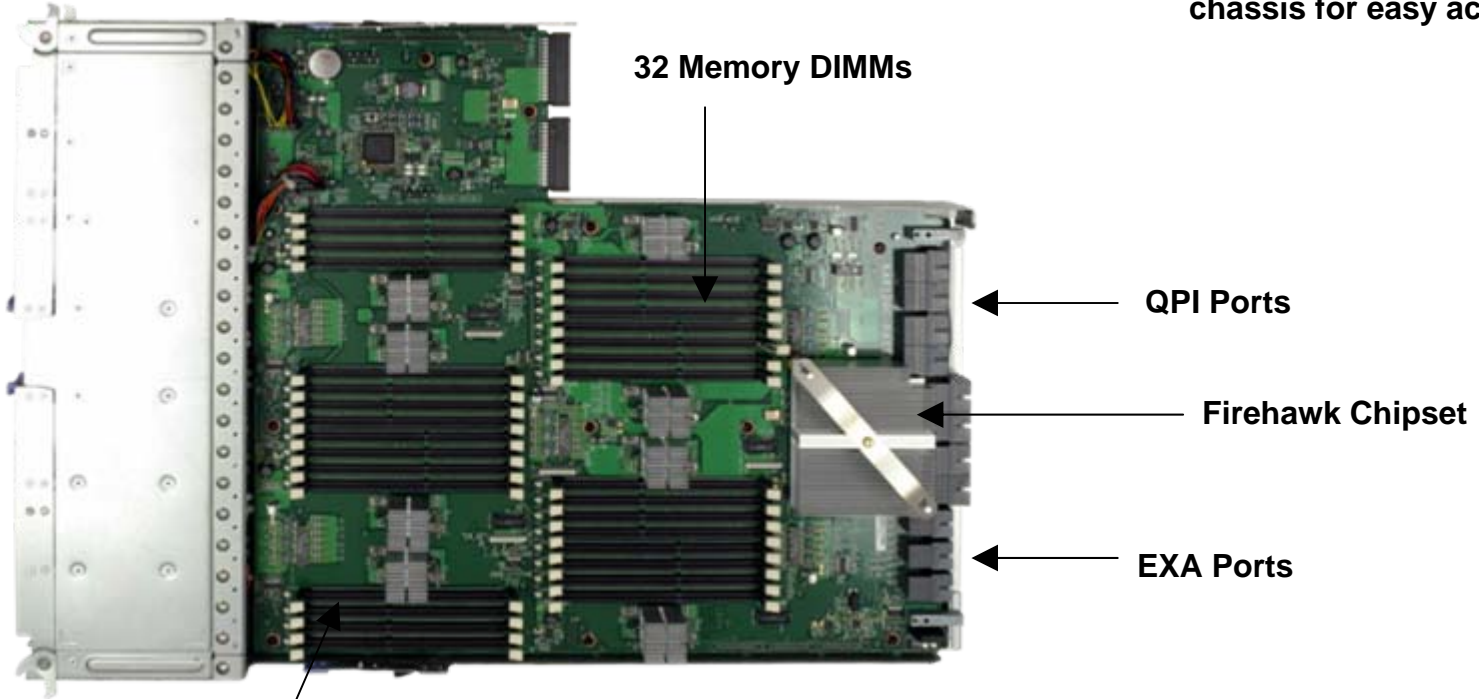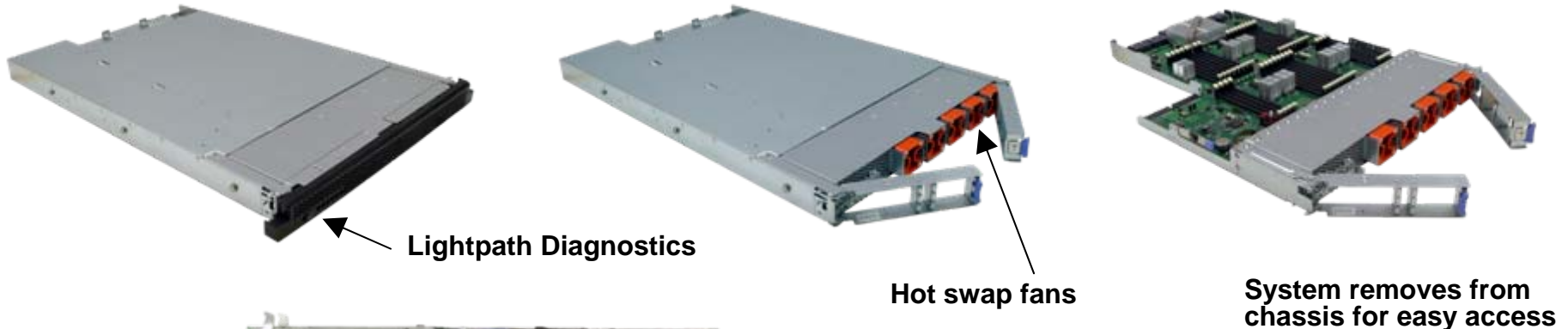
**Memory Buffers**

- QPI attaches to systems
- EXA Scalability to other memory drawers

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# eX5 Rack System Configurations

*Leadership high end x86 performance and flexibility*

**Memory Enhanced**

**Memory Enhanced**
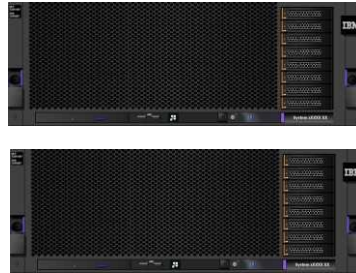
**x3850 X5**
(8S 128 DIMM)

**x3850 X5 w/ MAX5**
(8S 192 DIMM)

**Memory Enhanced**

**x3850 X5 w/ MAX5**
(4S 96 DIMM)

**Base Systems**

**x3850 X5**
(4S 64 DIMM )

# eXFlash — Maximum internal storage performance

*Combination of solid-state disk technology and high-speed controller architecture deliver extreme performance to replace limited IOPs of traditional HDDs*

## Maximize performance

- Up to 200x performance increase for local databases
- 99% better performance per watt for database-type workloads

## Maximize cost savings

- 100 to 1 replacement ratio of traditional drives, replacing thousands of drives and cables
- $670,000 hardware savings per eXFlash pack over equal IOPs HDDs
- Up to 40x greater solution density over traditional HDD solution

## Maximize reliability

- RAID 5/6 controller for redundant data storage reliability at 37.5% greater capacity
- Greater reliability over traditional HDDs

### eXFlash Features

- ✓ Up to 2 eXFlash packs in x3850 X5
- ✓ Up to 240,000 IOPs read-only per eXFlash pack
- ✓ Up to 87,000 IOPs RAID 5/6 read/write mix per eXFlash pack
- ✓ Up to 1.6TB per eXFlash pack
- ✓ Hot swappable, front accessible, modules

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# FlexNode Automatic Node Failover
Automatic node failover maximizes systems uptime

## What is it…
- If one node in a multi-node system experiences a fatal error and a shutdown, the system will reboot as a single-node
- After reboot the remaining system continues to operate without the failed node

## Customer value…
- **Greater uptime:** Automatic reboot brings the eX5 system back online faster than manual intervention. Monolithic multi-socket systems down until the fatal error resolved.
- **Simpler management:** Easier identification of the failure

**Back up and running!**

**Single 8-socket systems**

**Down until help arrives!**

**Automatic reboot**

**Total system failure**

# Scale Up Oracle Database – x3850/x3950 X5

## *Unparalleled Performance & Scalability Surpassing Traditional UNIX Solutions*

| Key Features | Benefits |
|---|---|
| **QPI Links** | • **Investment Protection to grow as needs dictate** |
| | • **Immediate scaling to 2nd chassis via Intel QPI links – works for all Oracle DB versions (9i to 11g)** |
| | • **Proven near-linear scalability** |
| **Memory Capacity** | • **Load larger transactions into memory for enhance performance** |
| | • **Page in memory to meet transaction need automatically** |
| | • **Add optional memory drawer for additional memory beyond what is resident within the chassis** |
| **Intel Processors** | • **Proven performance for Oracle EBS and Database** |
| | • **Outperform UNIX processor at an aggressive price** |
| | • **QPI Links provide easy scale up implementation** |
| | • **OS Flexibility - Windows, Linux** |
| **IBM Director** | • **Broad array of management tools to manage your IT shop** |
| | • **Power monitoring capabilities – stay within power envelope** |
| | • **Capacity planning to manage your IT growth** |
| | • **Runs across all IBM servers and many 3rd party servers** |
| **Availability** | • **Malfunction to one chassis does not effect others** |
| | • **Ability to add Cluster RAC capability in future** |
| | • **No single points of failure** |

# IBM System x3690 X5
## Industry's first high end scalable 2-socket for maximum memory and performance

*High-end 2-socket, 2U scalable server offers up to four times the memory capacity of today's 2-socket servers with double the processing cores for unmatched performance and memory capacity.*

## Maximize Memory

– 33% more cores and 5x more memory capacity for 1.7x more transactions per minute and 2x more virtual machines than 2-socket Intel Xeon 5500 Series systems

– MAX5 memory expansion for additional 46% more virtual machines and leadership database performance

## Minimize Cost

– Achieve 4-socket memory capacity with 2-socket software license costs and cheaper "2-socket only" processors

– eXFlash 720k internal IOPs for 40x local database performance and $2M savings in equal IOPs storage
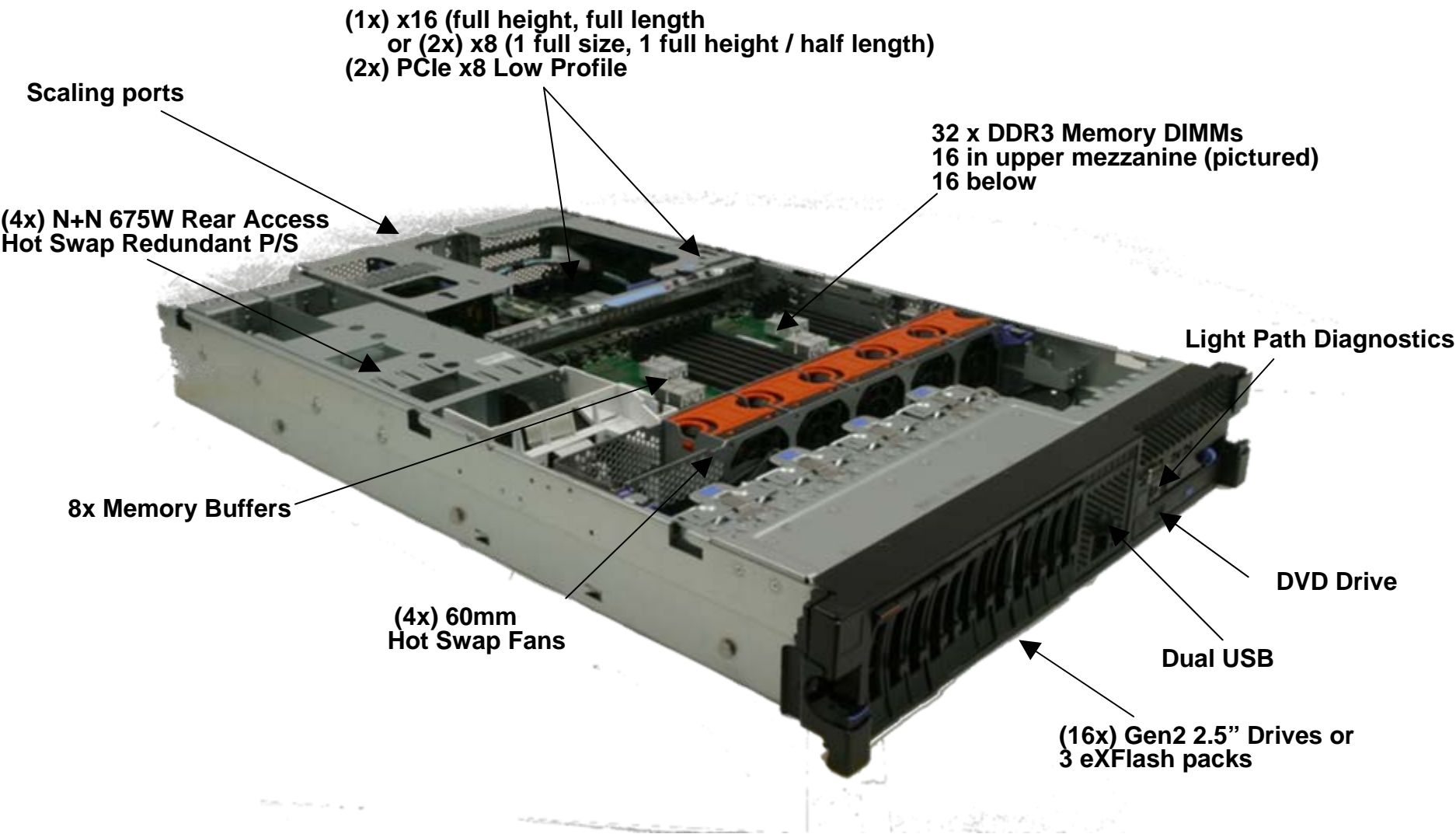
## Simplify Deployment

– FlexNode Partitioning and Automatic Node failover for maximum flexibility and application uptime

– Pre-defined database and virtualization workload engines for faster deployment and faster time to value

### System Specifications

✓ 2x next-generation Intel Xeon Nehalem EX CPUs
✓ 32 to 64 DDR3 DIMMs
✓ 2 x8 PCIe slots, 2 x8 Low Profile slots
✓ Up to 16x 2.5" HDDs or 32x 1.8" SSDs
✓ RAID 0/1 Std, Opt RAID 5
✓ 2x 1GB Ethernet
✓ Optional 2x 10GB SFP+ Virtual Fabric / FCoEE
✓ Scalable to 4S, 64 DIMM or 128 DIMM
✓ Internal USB for embedded hypervisor
✓ IMM, uEFI, and IBM Systems Director

# x3690 X5:  2-socket 2U (Nehalem EX) platform



**(1x) x16 (full height, full length**
**or (2x) x8 (1 full size, 1 full height / half length)**
**(2x) PCIe x8 Low Profile**

**Scaling ports**

**32 x DDR3 Memory DIMMs**
**16 in upper mezzanine (pictured)**
**16 below**

**(4x) N+N 675W Rear Access**
**Hot Swap Redundant P/S**

**Light Path Diagnostics**

**8x Memory Buffers**

**DVD Drive**

**(4x) 60mm**
**Hot Swap Fans**

**Dual USB**

**(16x) Gen2 2.5" Drives or**
**3 eXFlash packs**

# x3690 X5 configuration flexibility

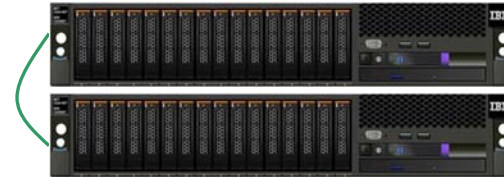Choose a system that fits your needs today and in the future

**Memory Expansion and Scaling with MAX5**
4 socket
128 DIMM
9.6T storage

**Native (QPI) Scaling**
4 socket
64 DIMM
9.6T storage

**Memory Expansion with MAX5**
2 socket
64 DIMM
4.8T storage

**Base System**
2 socket
32 DIMM
4.8T storage

# Oracle Cluster RAC Database – x3690 X5

## *Unparalleled Scale-Out Performance, Designed for growth at a low price point*

| Key Features | Benefits |
|---|---|
| **Intel Xeon 6500/6500 Series Processors** | • **Proven performance for Oracle** |
| | • **Outperform UNIX processor at an aggressive price** |
| | • **OS Flexibility - Windows, Linux** |
| **Memory Capacity** | • **Load larger transactions into memory for enhance performance** |
| | • **Add optional memory drawer for additional memory** |
| **QPI Links** | • **Easily scale up nodes as needs dectate to 2X capacity** |
| **IBM Director** | • **Broad array of management tools to manage your IT shop** |
| | • **Power monitoring capabilities – stay within power envelope** |
| **Availability** | • **Malfunction to one chassis does not effect others** |
| | • **Increase performance while reducing downtime for critical DB** |
| | • **QPI Fail Down** |
| **Cost Savings** | • **Improved performance while lowering energy cost** |
| | • **2U height requires less space in RACK** |
| | • **Management tools improve utilization** |
| | • **Downtime for patch updates and maintenance decreased** |
| **Networking Options** | • **10GB Cluster Interconnect ensures wide pipe to move data** |
| | • **Infiniband attractive for large file scans and reports** |

# x3690 X5 database optimized systems

## **Capabilities**

- High speed access for hot data at up to a million IO per sec

- Up to 4.8TB of high speed capacity per server

- Custom high speed direct connect adapter, and custom high speed RAID 5/6 adapter choices for targeted use-cases

## **Benefits**

- Up to 200x faster local database performance

- Minimize costs replacing 80 storage enclosures for a $670,000 USD cost savings and a 97% reduction in energy

- Maximum reliability with custom high speed RAID 5/6 flash adapter and individual front access, hot-swap components

*IOPS of 2,932 HDDs in one server*
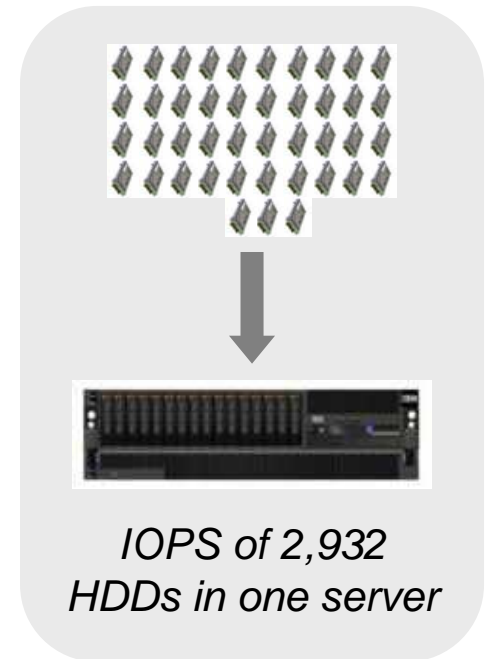
# x3690 X5 virtualization optimized systems

## Capabilities

- MAX5 expansion for up to a 512GB of added memory
- Large quantity of smaller, cheaper DIMMs per system
- Choice of hypervisor options for maximum customer environment flexibility

## Benefits

- Up to 5.3x the number of virtual machines of single VMware license industry standard 2U Intel Xeon 5500 Series system
- Integrated hypervisor for simpler deployment and management

*5x the VMs of industry standard 2-socket 2U systems*
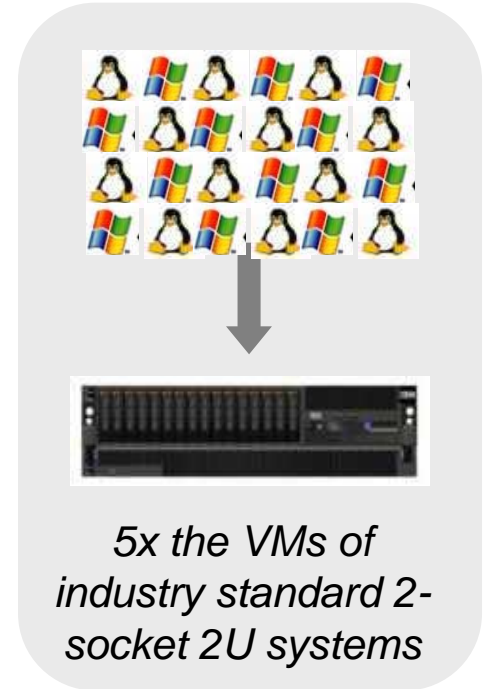
# Oracle / IBM Virtualization : Oracle VM on IBM System x
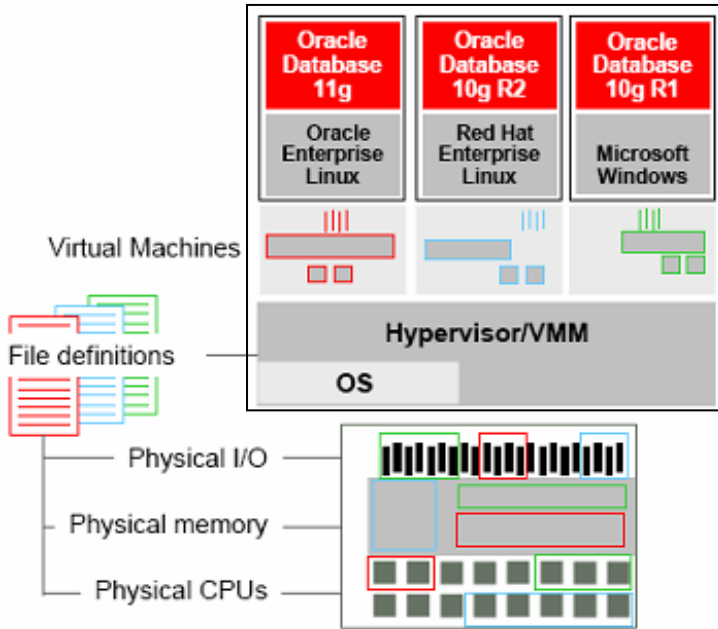


➡ Strong Isolation between Virtual Machines

➡ Dynamic resizing & Migration

➡ Rapid VM Instantiation & Cloning

➡ Workload Management

➡ Limitless Partitions, Sub processor core partitions (micropartitions)

### *Benefits :*

• Simplified solutions
• Reduced down-time
• A highly available and serviceable architecture.
• Decrease
  • the power and cooling cost
  • saves datacenter space
  • the networking and SAN interconnectivity
  • the cost of physical server maintenance

**Note:** All product support for Oracle VM and the Oracle Enterprise Linux OS comes directly from Oracle. IBM's support is limited to server warrantee break/fix support.  This is Oracle's preferred support model and is very popular with customers.

# Proof Points with Oracle VM on System x

**IBM-Oracle International Competency Center**
- First non-Oracle Technical Solution Organization to test Oracle VM
- ***Oracle VM on IBM System x***, 1st Install & Configuration Guide
- Testing with various Oracle workloads & operating systems

**IBM-Oracle Joint Solution Center**
- Developed hand-on expertise with Oracle VM across System x
- Developed a set of demonstrations
- Conducting a series of education sessions to partners & customers

**University of Pretoria, South Africa**
- Installed Oracle VM on x3850 M2 & x3650 servers
- PeopleSoft ECM, BI and Fusion SOA running is separate partitions
- Red Hat Enterprise Linux 4.3 & Windows 2003 R2

**K.K. Ashisuto – IBM Business Partner based in Japan**
- IBM & Oracle announced 1st WW Collaboration effort
- Completed a series of technical proof points on System x
- Developed service offerings to assist customers with Oracle VM

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# EIGHT YEARS OF DURABLE INFRASTRUCTURE

2002 — **BladeCenter with Gb Ethernet support**

2003 — **2Gb Fibre Channel support**

2004 — **1x InfiniBand$^{TM}$ support**

2005 — **4Gb Fibre Channel support**

2006 — **Cell BE Engine$^{TM}$ processor support[1]**

2006 — **10Gb Ethernet uplink enablement**

2006 — **Advanced Management Module**

2007 — **Intel® quad-core processors**

2007 — **HS21 extended memory blade**

2008 — **HS12 blade**

2009 — **HS22 blade, FcOE**

2010 — **HS22v blade, HX5 blade**

## IBM BladeCenter

*Compatibility is the foundation for smarter IT*



✓ Add new IT as it comes out

✓ Keep your infrastructure in place— rack, power[2], cabling, switching…

✓ Stay current without the churn

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# Extend blade benefits to entire business

*Chassis tailored to specific needs*

**IBM BladeCenter E**
*Enterprise, best efficiency, best density*

**IBM BladeCenter S**
*Distributed, small office, easy to configure*

**IBM BladeCenter H**
*Enterprise high performance*

**IBM BladeCenter T**
*Ruggedized, short-depth*

**IBM BladeCenter HT**
*Ruggedized, high performance*

- **A common set of blades**

- **A common set of industry-standard switches and I/O fabrics**

- **A common management infrastructure**

# IBM BladeCenter HX5

## Scalable high end blade for high density compute and memory capacity

Scalable blade server enables standardization on same platform for two- and four-socket server needs for faster time to value, while delivering peak performance and productivity in high-density environments.

## Maximize Memory

– 1.7x greater performance over 2-socket x86 (Intel Xeon 5500 Series) systems while using same two processor SW license
– MAX5 memory expansion to 320GB in 60mm for over 25% more VMs per processor compared to competition

## Minimize Cost

– Upgrade to 80 DIMM for max memory performance or to save up to $6K by using smaller, less expensive DIMMs
– Memory bound VMWare customers can save over $7K in licensing with memory rich two socket configurations

## Simplify Deployment

– Get up and running up to 2X faster by qualifying a single platform for 2 and 4 socket server needs
– Partitioning of 4 socket to two 2 sockets without any physical system reconfiguration, and automatically fail over for maximum uptime
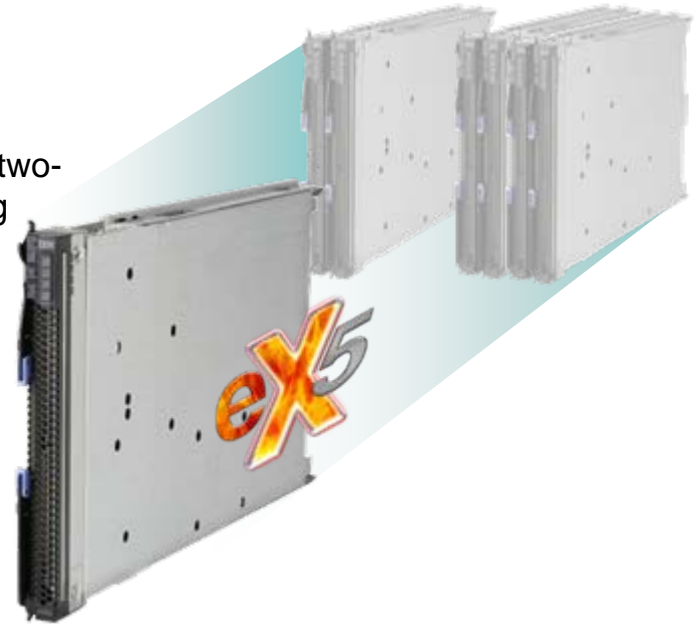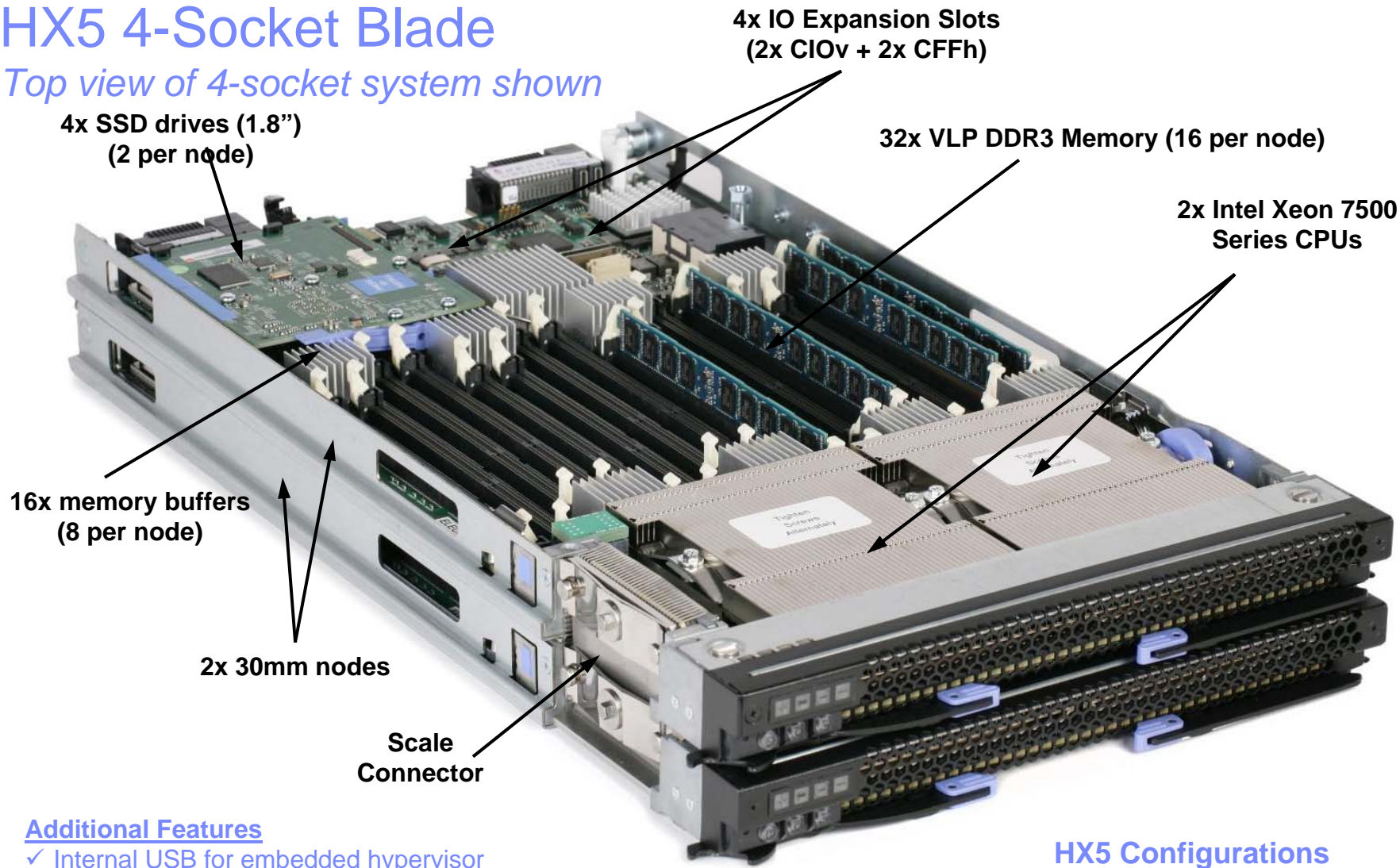
### System Specifications

✓ 2x next-generation Intel Xeon Nehalem EX CPUs
✓ 16x DDR3 VLP DIMMs
✓ MAX5 memory expansion to 2 socket 40 DIMM
✓ Scalable to 4S, 32 DIMM or 4S, 80 DIMM
✓ Up to 8 I/O ports per node
✓ Up to 2x SSDs per node
✓ Optional 10GB Virtual Fabric Adapter / FCoEE
✓ Internal USB for embedded hypervisor
✓ IMM, uEFI, and IBM Systems Director

# HX5 4-Socket Blade
## *Top view of 4-socket system shown*

**4x IO Expansion Slots**
**(2x CIOv + 2x CFFh)**

**4x SSD drives (1.8")**
**(2 per node)**

**32x VLP DDR3 Memory (16 per node)**

**2x Intel Xeon 7500 Series CPUs**

**16x memory buffers**
**(8 per node)**

**2x 30mm nodes**
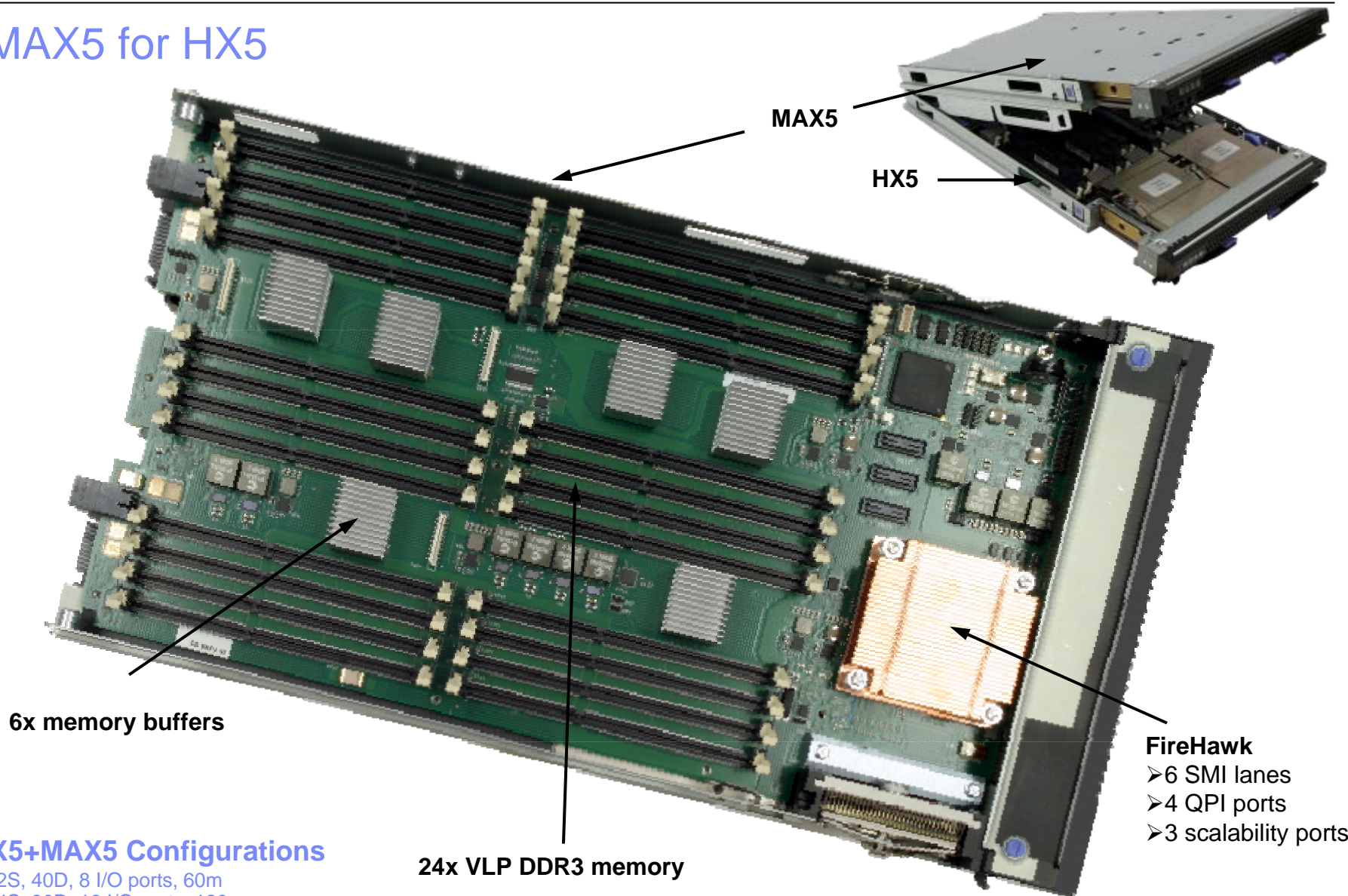
**Scale Connector**

**Additional Features**
✓ Internal USB for embedded hypervisor
✓ Dual & redundant I/O and Power
✓ IMM & UEFI

**HX5 Configurations**
– 2S, 16D, 8 I/O ports, 30m
– 4S, 32D, 16 I/O ports, 60mm

# MAX5 for HX5

**MAX5**

**HX5**

**6x memory buffers**

**FireHawk**
➢6 SMI lanes
➢4 QPI ports
➢3 scalability ports

**HX5+MAX5 Configurations**
– 2S, 40D, 8 I/O ports, 60m
– 4S, 80D, 16 I/O ports, 120mm

**24x VLP DDR3 memory**

# IBM BladeCenter Scalable Blades

*Maximum performance and flexibility for database and virtualization in a a blade*

## HX5 Blade

*Never before seen levels of scaling…*
- 2-socket, 30mm building block
- 2-socket → 4-socket w/ logical partitioning

Common Building Block

2P, 30mm

*2-socket,
16DIMM
8 I/O ports
30mm*

*4-socket,
32DIMM
16 I/O
60mm*

*Max compute density!*
- Up to 32 cores in a 1¼ U equivalent space
- Modular scalability in 2-socket increments to get to 4-socket
- *Targeted for database*, and compute intensive simulations
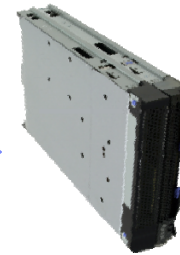
## HX5 Blade with MAX5

*Bringing the goodness of eX5 to blades…*
- Snaps onto base blade (sold as a bundle w/ base HX5)
- Enables more memory than any other blades

*2-socket,
40DIMM
8 I/O
60mm*

*4-socket,
80DIMM
16 I/O
120mm*

*Blade leadership!*
- Up to 30% more VMs than max competition blade
- Flexible configurations & unmatched memory capacity, scaling from 1-socket, 32D → 4-socket, 80D
- Uses processors that cost up to 30% less than the competition for scaling
- *Targeted for Virtualization* & DB for customers that need a blade form factor

# FlexNode feature allows a single System to dynamically become two distinct systems or back again

**FlexNode benefits include:**

**Scheduled Provisioning:** Run scale-out apps by day on a 2P system and scale-up jobs by night on 4P system

**Optimize SW licensing costs:** Execute partitions to optimize SW licensing costs when priced per socket

**Faster Qualification:** Qualify a single platform for 2- and 4-socket server needs
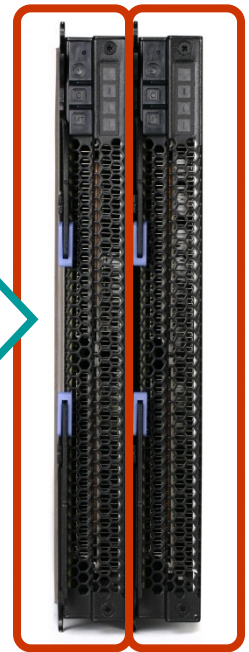
**Built-in virtualization:** Run multiple OSs on the same box without hypervisor overhead

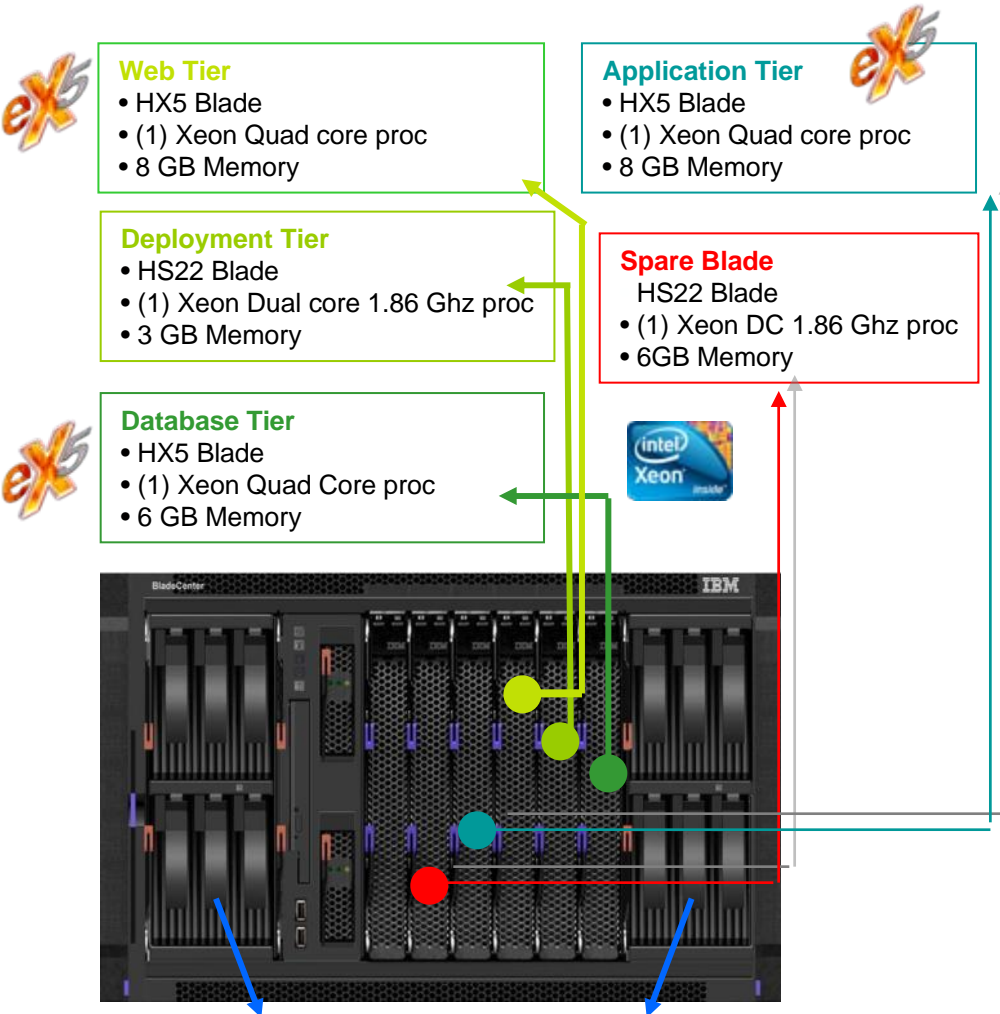**Greater security:** Workload isolation to assure quality of service

One 4P System                                    Two 2P Systems



IBM® Systems Director
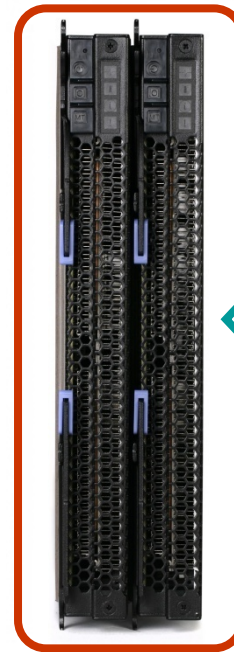
# BladeCenter S with HX5 – JD Edwards Suite 500 Users

**Web Tier**
• HX5 Blade
• (1) Xeon Quad core proc
• 8 GB Memory

**Application Tier**
• HX5 Blade
• (1) Xeon Quad core proc
• 8 GB Memory

**Deployment Tier**
• HS22 Blade
• (1) Xeon Dual core 1.86 Ghz proc
• 3 GB Memory

**Spare Blade**
  HS22 Blade
• (1) Xeon DC 1.86 Ghz proc
• 6GB Memory

**Database Tier**
• HX5 Blade
• (1) Xeon Quad Core proc
• 6 GB Memory

intel Xeon inside

## *Why IBM BladeCenter S?*
• Collapsed all tiers to run single chassis
• Saves footprint & rack space
• Saves power vs. rack optimized servers
   • Chassis only requires 110V power
• Space for additional blades to run:
      • Back up or Development
      • Non-Oracle applications
• Save cable complexity
• 1.46 TB internal storage within chassis
• No need for external storage

**Chassis has 1.46 TB of storage space.**

Sample Configurations for BladeCenter S & JD Edwards – IBM.com

# Full-featured SAN enables VMware & Vmotion For Oracle
## Virtualize servers, storage, and even networking with BladeCenter S

With an all-in-one approach, an entire VMware stack (servers, networking, storage), can all be built within a BladeCenter S chassis, all that without having to cable up anything but the power!



**VMware Infrastructure**

DRS | HA | Consolidated Backup

**VirtualCenter Management Server**

**Virtual Machines**

App OS (x10)

**Virtual SMP** | **ESX Server** | **VMFS**

Enterprise Servers

Enterprise Network

Enterprise Storage
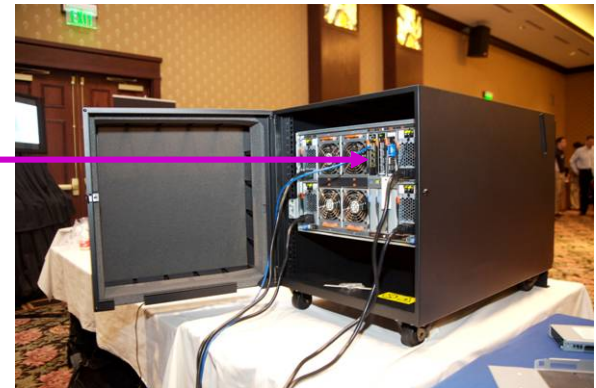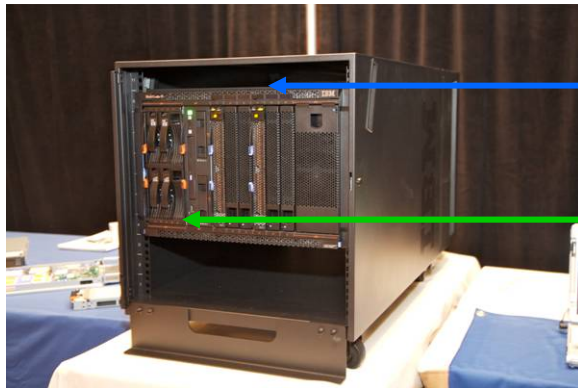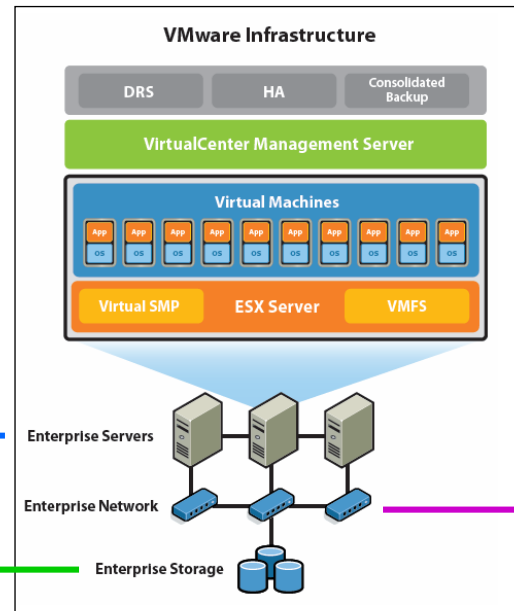
# Extend blade benefits to connect entire business

*I/O tailored to specific needs*
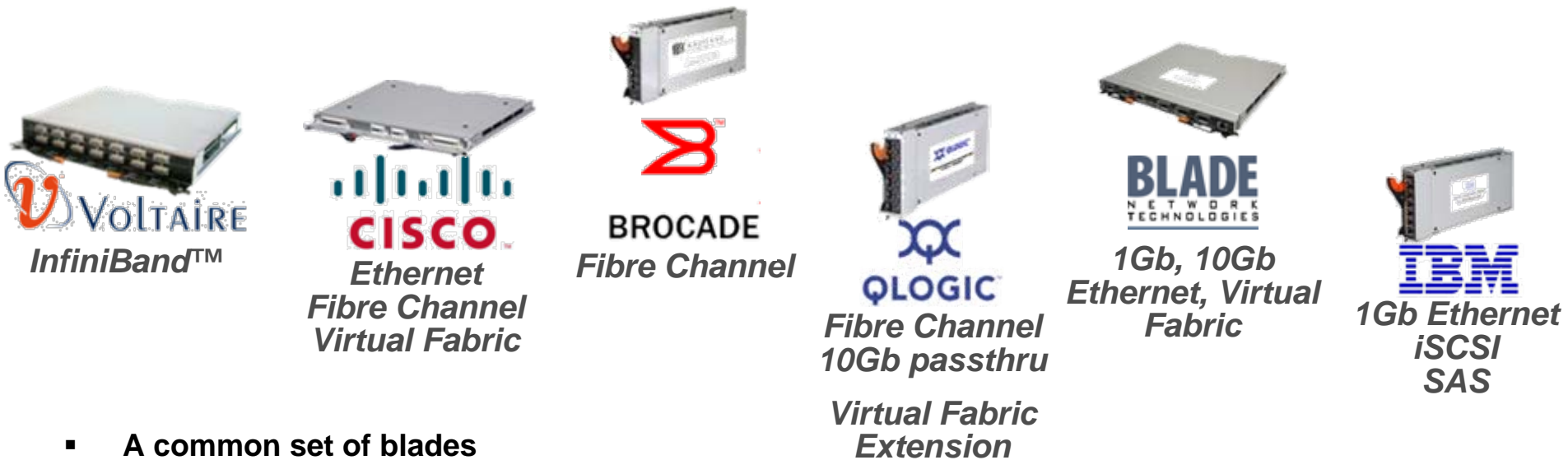
**InfiniBand™**

**Ethernet
Fibre Channel
Virtual Fabric**

**Fibre Channel**

**Fibre Channel
10Gb passthru**

**Virtual Fabric
Extension**

**1Gb, 10Gb
Ethernet, Virtual
Fabric**

**1Gb Ethernet
iSCSI
SAS**

- **A common set of blades**

- **A common set of industry-standard switches and I/O fabrics**

- **A common management infrastructure**

# Extend blade benefits to all applications

*Blades tailored to specific needs*

**HX5**
*Enterprise
performance*

**HS22v**
*Virtualization*

**HS22**
*Performance*

**HS12**
*Entry & SMB*

**LS42**
*Scalable*

**LS22**
*High Performance
Computing*

**JS23 Express**
*Great Value
for
AIX and IBM i*

**JS43**
*High-performance
with native
virtualization*

**A common set of blades**

- **A common set of industry-standard switches and I/O fabrics**

- **A common management infrastructure**

# eX5 Offers Choice To Meet Equal DB Requirements

Avoid the cost of Oracle RAC licenses, and FlexNode provides ability to mask node failures.  Simplier then complex cluster to manage.

**IBM x3950 X5**

Two-way nodes provide low cost option to grow RAC cluster, let meet performance level of most SMP servers.

Good choice to decrease solution footprint and hose non-Oracle workloads.  Run Linux, and AIX in chassis!

**IBM x3850 X5**

**IBM x3690 X5**

**BladeCenter – HX5**

Low entry point of 2 procs and avg. 4GB DIMMS makes for low entry price point.

+8-Way

4-Way

2-Way

Uni

1 Node          4 Node          8 Node          +8 Node

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