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Introduction

Organizations of every sort have benefitted from servers utilizing Intel's x86-64 Xeon processors but the tasks for which those solutions are used have changed profoundly over the years, migrating from low-end, edge of network applications to business critical workloads leveraging the latest in enhanced virtualization, database and high performance technologies. However, despite the growing importance of Intel Xeon to their clientele, the vast majority of server vendors have taken increasingly conventional paths in developing these products, especially as regards architectural-level chipset innovations.

That is not the case for IBM's System x servers which leverage the company's unique Enterprise X-Architecture whose enhanced memory, I/O and disk subsystem features are designed to address customers' critical requirements for more memory, better system utilization, easier deployment and lower datacenter costs. The enhanced memory, I/O and disk subsystem offered by IBM's Enterprise X-Architecture significantly improve the core performance of the company's Intel-based servers, benefitting a range of enterprise applications and strategies. IBM's new, fifth generation Enterprise X-Architecture (eX5) solutions, which incorporate Intel's latest Xeon microprocessors, are designed to optimize memory, scalability and flexibility, reduce expenses and simplify deployment.

In essence, IBM's new eX5 technologies should deliver notable advancements over previous generation Enterprise X-Architecture solutions and outstrip competitors' more conventional products. IBM's eX5 systems will also help customers fully leverage Intel's Xeon microprocessor technologies to address existing computing needs and to gain the advantages envisioned by IBM Smarter Planet initiative.

The Importance of x86-64

It would not be an overstatement to say that Intel's x86-64 technologies fundamentally changed the way organizations do business, providing them ready access to affordable, innovative computing solutions. Though the influence of these technologies initially occurred on the desktop, their familiarity, easy deployment and leverage of common network infrastructures proved highly attractive for developers, business customers and end users.

Over time, Intel Xeon helped to define the essence of "scale-out" computing, helping to migrate many server workloads away from traditional scale-up RISC and mainframe systems in cloistered datacenters and place them closer to the departments and individuals who worked with and depended on them every day. In addition, the evolution of Industry Standard components helped to significantly reduce server research and development (R&D) costs, opening up new opportunities for both traditional and entrepreneurial vendors.

The result? Just as Intel technologies came to dominate personal and desktop computing, so they have become the leading platform in overall server sales. But their effects extend well beyond the volume server market; x86/64 has also helped to spark remarkable bene-

fits in enterprise datacenters, and have become the platform of choice in many high performance and supercomputing applications.

This is not to say that x86-64 is not without its shortcomings but systems design and other vendor innovations have helped to overcome many of the architecture's inherent limitations. For example:

- Native system utilization in x86-64 is woefully low (5-15%,compared to 60%+ for scale-up systems). However, aggressively consolidating servers and workloads with virtualization technologies like VMware's ESX and vSphere4, and Microsoft's Hyper-V can help Intel and AMD systems achieve scale-up system utilization.
- The CAPEX costs of x86-64 servers are a fraction of scale-up RISC and mainframe solutions but their OPEX costs can easily eclipse scale-up systems, particularly in large datacenter deployments. To combat this, vendors offer a host of rack-level power, cooling and configuration innovations that vastly improve system and datacenter energy efficiency.
- The reliability, availability and security (RAS) features of x86-64 servers once significantly lagged enterprise-class scale-up systems. Today, organizations of every sort trust business-critical applications to these solutions.
- The management and maintenance requirements for large scale-out server environments can be highly complex and time consuming. However, end-to-end systems management suites can help organizations effectively overcome these challenges.

The State of Intel Xeon Innovation

Despite the enormous popularity of and continuing growth in Intel Xeon-based server sales, actual innovation has remained slow or limited, particularly at the chipset level. Why is that the case? There are a number of contributing factors. The low barriers to entry have attracted a large number of vendors to the Intel server volume market. But high competition and low profit margins have resulted in many vendors being loathe to spend excessively on R&D. As a result, most rely on Intel and third party component vendors instead of developing their own chipsets.

While this is sensible from a business standpoint it hardly serves the demands of business customers, especially those that need Xeon-based systems to do more, work better and deliver on their full promise. These companies require help in further lowering the considerable OPEX costs related to Xeon servers, particularly in regards to datacenter energy and cooling requirements, and in lessening overall systems footprint.

They also want vendors' help in reducing the time needed for configuring and deploying servers for production processes, thus lowering overall qualification costs. Better quality management tools and suites can help companies get the best out of IT staff and the most from every dollar invested. Plus, few would quibble if vendors provided a means to bring down costly per-processor software licensing fees.

Most importantly, organizations require the means to use Intel Xeon systems to both support their immediate business needs and help meet future challenges as applications, workloads and processes become increasingly complex and instrumented.

The IBM/Intel Connection

Though IBM is more commonly associated with "big iron" scale-up servers and systems, the company has enjoyed long associations with Intel and used x86-64 processors and compo-

nents in a wide variety of solutions including PCs, workstations, notebooks and servers. IBM's first Intel-based servers (the PC Server, and then, Netfinity lines) arrived in the early 90s, leveraging Pentium and then Pentium Xeon processors. In 2000 the company launched its eServer brand, along with the xSeries product family (which eventually became System x).

IBM's high-end (4-way and above) systems hold a considerable lead in both market share and mindshare. The company's home grown Enterprise X-Architecture is designed to support significantly enhanced memory, I/O and disk subsystems, thus providing the means to amply improve overall system performance.

The first generation of Enterprise X-Architecture systems debuted in 2001 (along with the first non-Pentium Xeon chips), supporting the industry's first 16-socket scalable x86 servers. Second generation systems introduced snoop filter technologies and captured one hundred #1 industry benchmarks. In 2005, third generation Enterprise X-Architecture systems included hot-swappable memory for enhanced reliability, and helped lead to fourth generation (eX4), where IBM's Enterprise X-Architecture became the first x86-64 platform to break the 1 Million tpmC benchmark barrier.

Bottom line: The constant evolution and consistent enhancement of IBM's Enterprise X-Architecture have helped the company become the undisputed market leader in 4-socket and higher Intel Xeon-based systems, a point borne out in IBM's new fifth generation eX5 solutions.

Beneath the Hood – Digging into eX5 Systems

The levels of innovation offered by new eX5 systems are remarkable, even by IBM's high standards. With that in mind, it is worth digging into the entirely new or significantly upgraded features incorporated in these systems:

- **MAX5 memory** – In a recent IBM client study, 90% of the respondents said they needed more memory or more memory slots in their Intel-based servers. Technically, enhanced memory can allow businesses to run more and bigger virtual machines, larger databases and memory-intensive 64-bit business applications. Practically, enhanced memory provides clients the means to do more work with fewer servers, lower software license fees and reduce datacenter power consumption. To answer those needs, IBM developed MAX5, a new optional "side car" unit designed to significantly increase eX5 system memory capacity. Using MAX5, a client can add up to 24 extra DIMMS per each base blade and up to 32 extra DIMMS per each base rack server, and these numbers double when system pairing is employed. MAX5 supports 2GB to highest capacity DIMMs, allowing customers enormous latitude in memory-to-system configurations and in future upgrades. Given the crucial role memory plays in many business critical applications, MAX5 can be used to notably enhance system utilization, to deploy more and larger virtual machines, and to support bigger databases and better database performance. MAX5 is designed to fully optimize the memory features in current and next-generation Intel Xeon microprocessors.
- **eXFlash SSDs** – IBM's eXFlash is a dedicated SSD-based storage array for eX5 systems deployed for high performance database applications and workloads. eXFlash solutions incorporate a unique IBM controller that can support up to 1.6 TB of capacity, and leverage enhanced company I/O technologies to eliminate system bottlenecks. eXFlash is designed to replace multi-server systems utilizing so-called "short stroked" hard disk drive (HDD) so-

lutions, whose size and energy requirements tend to subtract from their overall value. In fact, the company estimates that a single System x3950 X5 server with eXFlash can deliver 480K IOPs, the equivalent performance of ten racks of spinning drives, for 97% lower cost.

- **FlexNode partitioning** – Since the 2001 launch of its Autonomic Computing initiative, IBM has made a regular practice of migrating valuable technologies and features across its server portfolio. The new FlexNode partitioning featured in eX5 servers was taken directly from the company's scale-up Power Systems. FlexNode is designed to maximize system flexibility, and to provide clients the means to configure or reconfigure systems according to specific business or workload needs. Using IBM System Director, 2- and 4-socket eX5 servers can be seamlessly coupled with like systems to double their size and easily divided into dedicated 2-socket partitions. Along with increasing deployment flexibility, FlexNode offers automatic failover to maximize uptime, supports multiple operating environments and can help clients achieve faster system qualification and lower software licensing costs.
- **Virtual Fabric** – Previously available only on IBM's BladeCenter systems, Virtual Fabric offerings can now be used with eX5 systems, as well. Virtual Fabric can become 1GBE, 10 GBE, iSCSI or Fibre Channel networks, and allows clients the freedom to address critical network requirements, including the need for multiple Ethernet ports in highly virtualized environments. IBM Virtual Fabric can also help "future proof" systems by allowing them to be easily adapted to changing network demands and new technologies. In time, we expect IBM will extend its Open Fabric Manager across all eX5 solutions, allowing organizations to better and more easily manage I/O and network connections across hundreds of eX5 servers.

Though IBM's new eX5 systems provide significantly higher levels of performance than previous generation Enterprise X-architecture systems, their robust memory, throughput and storage subsystem features deliver other benefits that accrue directly to a customer's bottom line. For example, enabling more memory per socket can reduce software fees when license price is based on socket number. IBM estimates that eX5 systems can support up to 82% more Virtual Machines (VMs) per socket than comparable current systems, or the same number of VMs for 50% of the cost of a hypervisor license.

Along with lower software licensing costs, investing in IBM eX5 systems can also help simplify server deployment & ownership, and speed time to value. Deploying a single architecture across blades and 2-way and 4-way racks can significantly reduce server qualification time. The ability to expand memory, CPUs and I/O independently allows clients to configure and reconfigure systems when and as they please. Finally, IBM's Systems Director management suite and ToolsCenter offerings work seamlessly across all standard and optional eX5 features, as well as a host of IBM and other vendors' server platforms.

IBM eX5 Family Snapshots

How does IBM leverage these innovative features and technologies in its new Enterprise X-Architecture systems? Below are snapshots of the first four members of the IBM's eX5 product family:

1. **System x3690 X5** – The x3690 X5 is a new entry point to enterprise workloads, such as CRM, ERP and SCM applications. IBM's first 2-socket Enterprise X-Architecture offering, the x3690 X5 offers all standard eX5 features and more memory than comparable systems. The x3690 X5 supports up to 32 DIMMS in its base configuration, and optional MAX5 enables up to 32 additional DIMMs (or 64 total DIMMS) on a 2-socket system. In addition, two

systems can be paired to create a 4-way system with double the number of total base and MAX5 DIMMs. Its generous memory capacity makes the x3690 X5 a solid migration platform for some 2-socket+ workloads, and can also help reduce software license expenses where socket count determines license cost. Overall, the System x3690 X5 offers clients enterprise-class capabilities in a small, dense package.

2. **System x3850 X5** – The x3850 X5 is a 4-socket base configuration that supports all standard and optional eX5 features. The x3850 X5 offers up to 64 DIMMS in base configuration, and optional MAX5 enables up to 32 additional DIMMs (or 96 total) on a 4-socket system. In addition, the x3850 X5 can be doubled to 8-sockets by pairing with another system, doubling the number of total base and MAX5 DIMMs, and the new systems also support FlexNode system partitioning. As a result, the x3850 X5 offers the offers best density for Xeon-based enterprise applications, and can be used for demanding virtualization, database and consolidation workloads

3. **BladeCenter HX5** – The first Enterprise X-Architecture BladeCenter system, the HX5 is a 2-socket base system that can be doubled to 4-sockets by pairing with another HX5 blade. Each HX5 system supports up to 16 DIMMS and optional MAX5 enables up to 24 additional DIMMs (or 40 in total) on a single 2-socket system. Like other IBM BladeCenter solutions, the HX5 blade provides organizations highly powerful and flexible computing resources in a very small footprint. In addition, IBM BladeCenter's integrated networking features make the HX5 a good choice for I/O-intensive business applications and processes.

4. **System x3950 X5 Workload-Optimized** – A subset of the eX5 portfolio are the workload -optimized systems, which are pre-integrated to support specific workload-intensive business processes and applications, including VMware virtualization and databases. Factory pre-integration/optimization also allows x3950 X5 customers to significantly speed system deployment and qualification time for critical business applications. Along with being the highest performance, highest capability System x server, the x3950 X5 will allow Intel-based server customers to seamlessly capture the benefits of new IBM workload-optimized solutions, such as the Smart Analytics System and Smart Analytics Optimizer.

IBM's X Factor – How New eX5 Solutions Differ from the Competition

IBM's System x eX5 solutions provide organizations a range of significant benefits that other vendors do not or cannot offer. All of IBM's new modular eX5 solutions feature notable scalability—from 2- to 4-socket blades and 2- to 8-socket rack-optimized servers. In addition, IBM's optional MAX5 allows companies to scale memory when and as they like to meet a broad variety of application and process requirements, business objectives and budget limits.

IBM's FlexNode options bring the system configuration flexibility common in scale-up servers to scale-out Intel Xeon environments. IBM's eXFlash allows eX5 owners to enjoy bigger, faster, better database performance without system bottlenecks and at a fraction of the cost of comparable HDD-based solutions. Finally, IBM's x3950 X5 systems fully extend the company's broader workload optimization strategy to System x and allow owners of Xeon-based systems to quickly benefit from optimal application performance.

In addition, IBM intends System x eX5 to play a critical role in enabling and realizing the company's vision of a Smarter Planet. IBM's Smarter Planet foresees a future in which businesses and processes are increasingly instrumented and connected. Though challenging, these developments will provide notable benefits in how organizations work internally, as well as in the way they interact with clients and partners. However, achieving these results

will place notable pressure on and require significant innovation from IT vendors and solutions of every sort. IBM's unique approach to systems development, as is apparent in its new eX5 system offerings, will help ensure that the company's customers will have the solutions they need to work and thrive on the Smarter Planet.

IBM's new generation eX5 technologies allow organizations to combine the full advantages of current and next generation Intel Xeon technologies with IBM's latest and best System x innovations. In essence, IBM's anything but standard approach to Industry Standard computing makes the company's new System x eX5 solutions significantly different than and should make them superior to competitors' Intel Xeon server products.

Summary Conclusions

For years, organizations have benefitted from Industry Standard servers utilizing Intel's Xeon processors. But as the tasks for which those solutions are used evolved profoundly, the vast majority of server vendors have taken a conventional path in product development, depending largely on Intel and third parties to provide architectural-level chipset innovations.

But that is not the case for IBM's Enterprise X-Architecture systems, including the company's new eX5-based systems. Like previous Enterprise X-Architecture offerings, IBM eX5 systems are designed to deliver enhanced memory, I/O and disk subsystem performance. But new IBM innovations such as the MAX5 memory "side car," eXFlash SSD arrays and Flex-Node partitioning, along with Virtual Fabric features previously available only on the company's BladeCenter systems, take the new eX5 solutions a long step beyond both past IBM System x servers and other vendors' current offerings.

As a result, IBM System x eX5 customers should be able to do more work with fewer servers, enjoying notably better system utilization and energy efficiency, along with significantly improved OPEX costs. In addition, the substantially higher performance and greater flexibility of IBM's eX5 solutions can help organizations lower their software licensing costs, and capture significant benefits from simplified system deployment and management and improved time to value. Perhaps most importantly, IBM's eX5 efforts will also help ensure that the company's customers have the solutions they need to work and thrive on the Smarter Planet.

In essence, IBM's new eX5 systems allow organizations to combine the full advantages of Intel's Xeon processors with the latest and most advanced System x features and performance. IBM's innovative approach to Industry Standard computing makes the company's new advanced System x eX5 solutions significantly different than and should make them superior to other vendors' Intel-based servers.

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