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Intel's Nehalem Resets the x86 Performance Scale

Gary Burgess, SVP Research and Operations

Many of us have learned to take product announcements with a grain of salt. Rarely do the generational shifts in product performance justify the buzz generated from corporate marketing and communications departments. However, every now and then, something comes along that does live up to the hype.

Performance indications reveal that Intel's next-generation "Nehalem" processor architecture, released for servers in March of this year with the Intel Xeon Processor 5500 Series, offers performance gains over the previous generation that are more revolutionary than the usual evolutionary. In fact, the processor has the potential to reset expectations for x86-technology server performance and elevate x86 servers to a new level of competition.

Recently, Intel CEO Paul Ottelini stated that Nehalem would be 50% of shipments for servers supporting two or more processors by August of this year, indicating that some market momentum is indeed occurring. So, what is different about this processor release?

In terms of performance, does the hype live up to the reality? What does the data show? How does Nehalem stack up against the previous generations of Intel server processor technologies? And what sort of threat does the Intel Xeon 5500 pose to IBM's POWER processor, which has long claimed processor performance superiority over the competition?

Intel's New Generation Performance vs. Old

The TPC-E Benchmark is a good starting place because it is a relatively new benchmark, and there have been quite a few Intel-based systems tested with various processor types. Hence, we can get a feel for the performance differential between old and new Xeon-processor-based systems.

Chart 1 below shows average total performance by processor type. (In cases where more than one TPC-E result exists for a particular processor configuration, the average of the results has been plotted for simplicity). These averages are further categorized according to the number of cores tested. So a processor bar may appear more than once in the chart, representing the average performance for all configurations using that number of processor cores. For example, the X7350 has been tested at 16, 32, and 64 processor cores.

On the TPC-E benchmark, the four tested Nehalem (X5570) configurations all featured eight processor cores. The spread was from 766 to 817 tpsE, for an average total performance of 795 tpsE (represented by the yellow bar in Chart 1). Chart 1 shows that the X5570 performance averages are well above other eight-core results for previous-generation Intel processors and on par with configurations featuring significantly more processors. To get a better feel for how different the X5570 results are, Chart 2 (next page) normalizes the results and plots the average performance per processor core.

Chart 2 reveals that Nehalem's average tpsE per core is between two and five times higher than that of the other processors. This striking outcome is the first indication that Nehalem may be more than just yet another run-of-the-mill performance upgrade.

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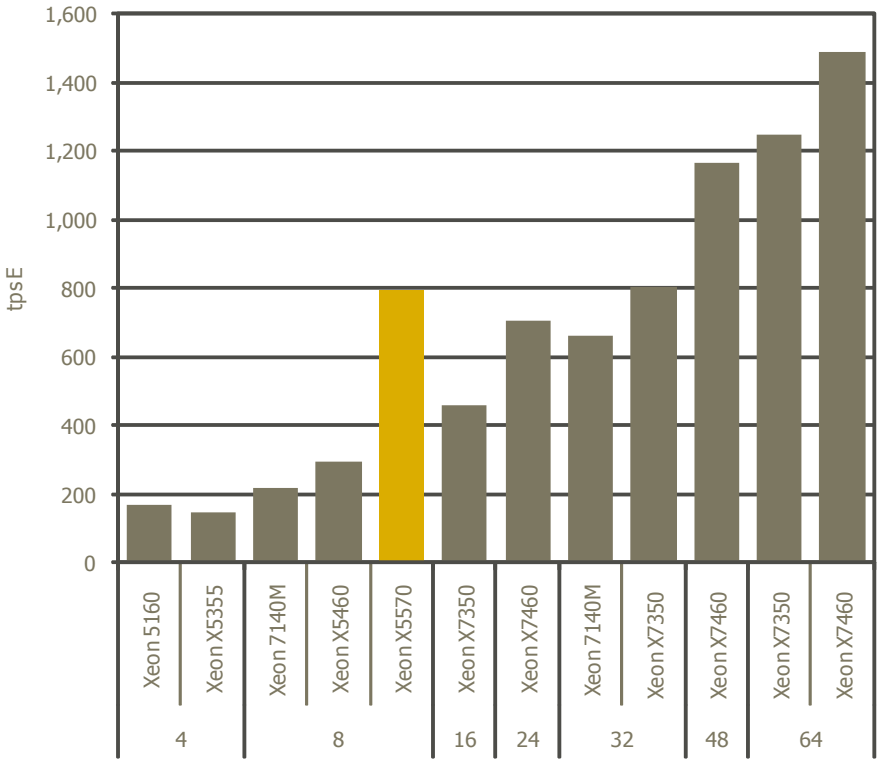
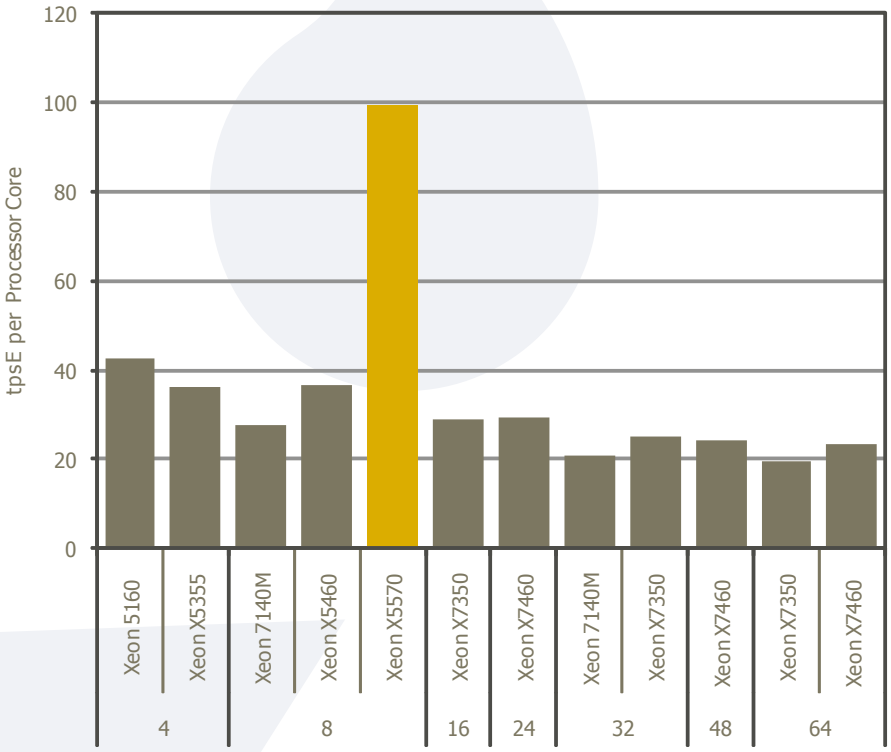
Chart 1 – TPC-C tpsE: Overall Performance



Source: www.tpc.org

Chart 2 – TPC-E tpsE: Average Performance/Core



Source: Raw results from www.tpc.org with additional analysis by IDEAS

Clearly, the current iteration of Nehalem – the Xeon X5500 Series – surpasses prior Xeon generations by a wide margin, but how does it stack up in a broader sense on other workloads? In particular, how does the Xeon X5500 Series fare against the IBM POWER processor series, which many see as the benchmark of per-core performance?

Intel Nehalem vs. IBM POWER

Clearly, the current iteration of Nehalem – the Xeon X5500 Series – surpasses prior Xeon generations by a wide margin, but how does it stack up in a broader sense on other workloads? In particular, how does the Xeon X5500 Series fare against the IBM POWER processor series, which many see as the benchmark of per-core performance? To find out, IDEAS first turned to the TPC-C Benchmark, which is a favorite of IBM and where many believe the POWER architecture performs best relative to the competition.

Chart 3 (next page) is similar to the previous charts in that it compares the average performance for a given processor type at a given configuration core count. It looks at current TPC-C results since the beginning of 2007 for configurations featuring the Intel Xeon and IBM POWER processors.

Two things are immediately apparent. First, the TPC-C per-core performance differential – between Intel's Nehalem (yellow) and previous-generation Intel server processors (gray) – is similar to that of the TPC-E Benchmark. Second, the average per-core performance of the Intel processor is approaching the level of the POWER processors (blue).

This article focuses on performance and performance per core in particular. However, it is worth noting that TPC Benchmarks include a pricing metric in addition to the performance measurement, and thus provide some insight into server price/performance. Chart 3 consolidates several tests into one average outcome. The full details of all tests making up the POWER and Intel Nehalem outcomes appear in Table 1 below the chart.

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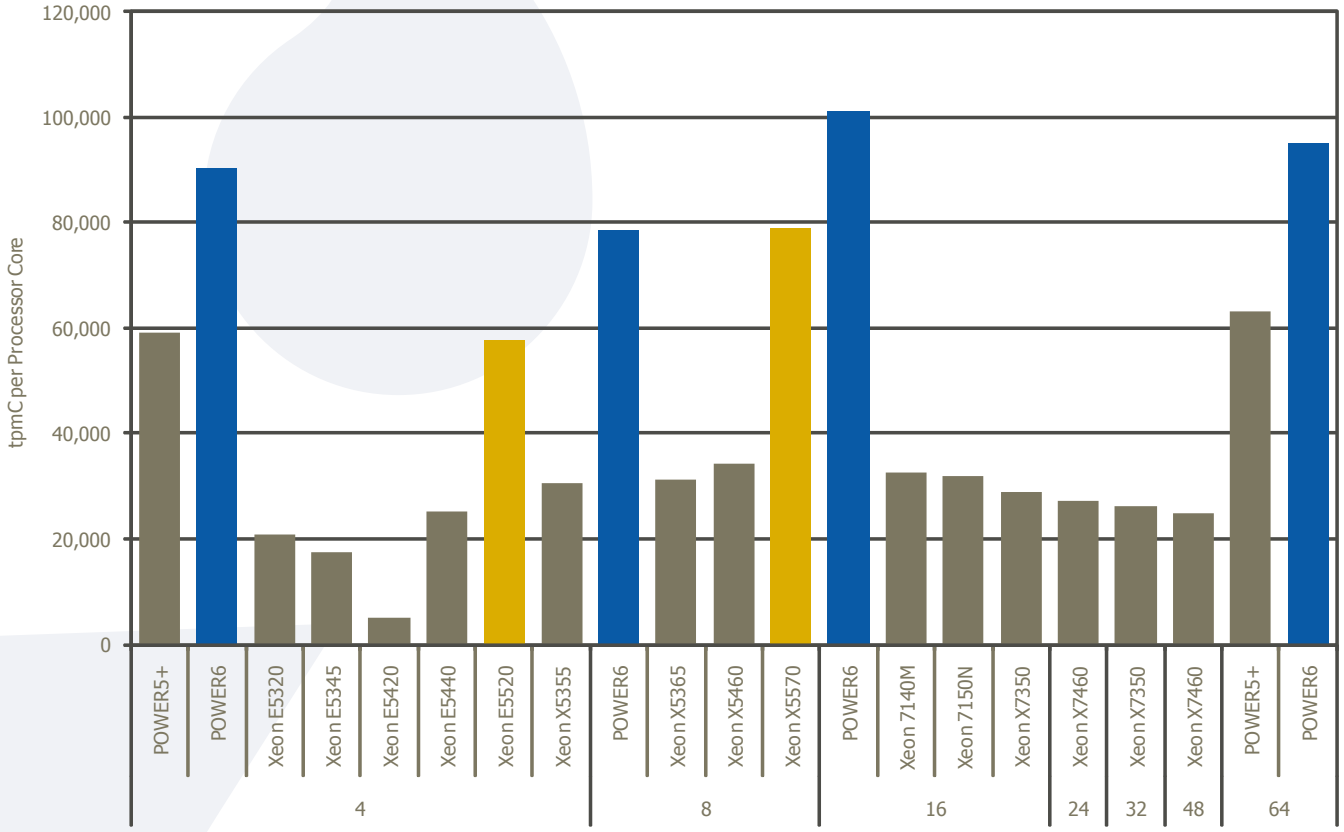
Chart 3 – TPC-C: Per-Core Performance



Source: Raw results from www.tpc.org with additional analysis by IDEAS

Table 1 – TPC-C: Outcomes Used in Chart 3

Company	Model	Processor	tpmC	$/tpmC	No. of Cores
IBM	Power 550 Express	POWER6	276,383	2.22	4
Bull	Escala PL1660R	POWER6	404,463	3.51	4
IBM	Power 570	POWER6	404,463	3.50	4
HP	ProLiant ML350 G6	Xeon E5520	232,002	0.54	4
Bull	Escala PL860R	POWER6	629,159	2.49	8
IBM	Power 550 Express	POWER6	629,159	2.49	8
HP	ProLiant DL370 G6	Xeon X5570	631,766	1.08	8
Bull	Escala PL1660R	POWER6	1,616,162	3.54	16
IBM	Power 570	POWER6	1,616,162	3.54	16
Bull	Escala PL6460R	POWER6	6,085,166	2.81	64
IBM	Power 595	POWER6	6,085,166	2.81	64

Source: www.tpc.org

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In general terms, the Intel technology configurations have better price/performance outcomes than the POWER tests, with price/performance ratios that are at least half those of similar POWER configurations.

At this point it is worth noting that IBM's results are relatively old; the most recent test was over a year ago and the current-generation POWER6+ processor is not featured. Also, there are some critics in the industry that feel the TPC-C benchmark itself is old and that other benchmarks are more relevant. Therefore, IDEAS turned to the SAP 2-tier benchmark to see what that reveals.

Chart 4, which compares average SAP Tier 2 per-core performance, includes a POWER6+ configuration (dark blue) as well as more direct comparisons at the eight-processor-core range. As evidenced by the chart, Nehalem (yellow) not only eclipses the performance levels of previous-generation Intel processors (gray), but it also encroaches into POWER (blue) territory.

It is important to note that the X5500 Series is designed for up to two-socket servers. Hence, on all the benchmarks featured in this article, Nehalem has only been tested to a scaling level of eight cores. New tests will likely emerge once the "Nehalem EX" processors for servers with four or more sockets are introduced.

For the time being, IBM has an edge with results featuring 16, 32, and 64 processor-core configurations.

While Chart 4 provides an average performance viewpoint of SAP Tier 2, Chart 5 (next page) focuses on the competitive hot spot for the two processor types. It looks at just the POWER versus Xeon X5570 results at the eight-processor-core level, broken out by individual test. This breakdown reveals the number of results for each architecture involved, as well as the spread of results that make up the averages.

It is worth noting that Chart 5 and Chart 4 group results into two different revisions of the benchmark: ERP 6.0 2005 and ERP 6.0U 2009. The change in specification had a significant effect on reported performance with outcomes generally lower under the new 2009 specification. This effect is highlighted in Chart 5 by the dark gray bars, which represent HP ProLiant DL380 G6 results under the two specifications. This specification change also probably helps to explain why IBM's POWER6+ results, which were tested under the 2009 specification, are not substantially different than the POWER6 results tested under the older 2005 rules.

To date there have been seven X5570 results under the 2009 specification. As

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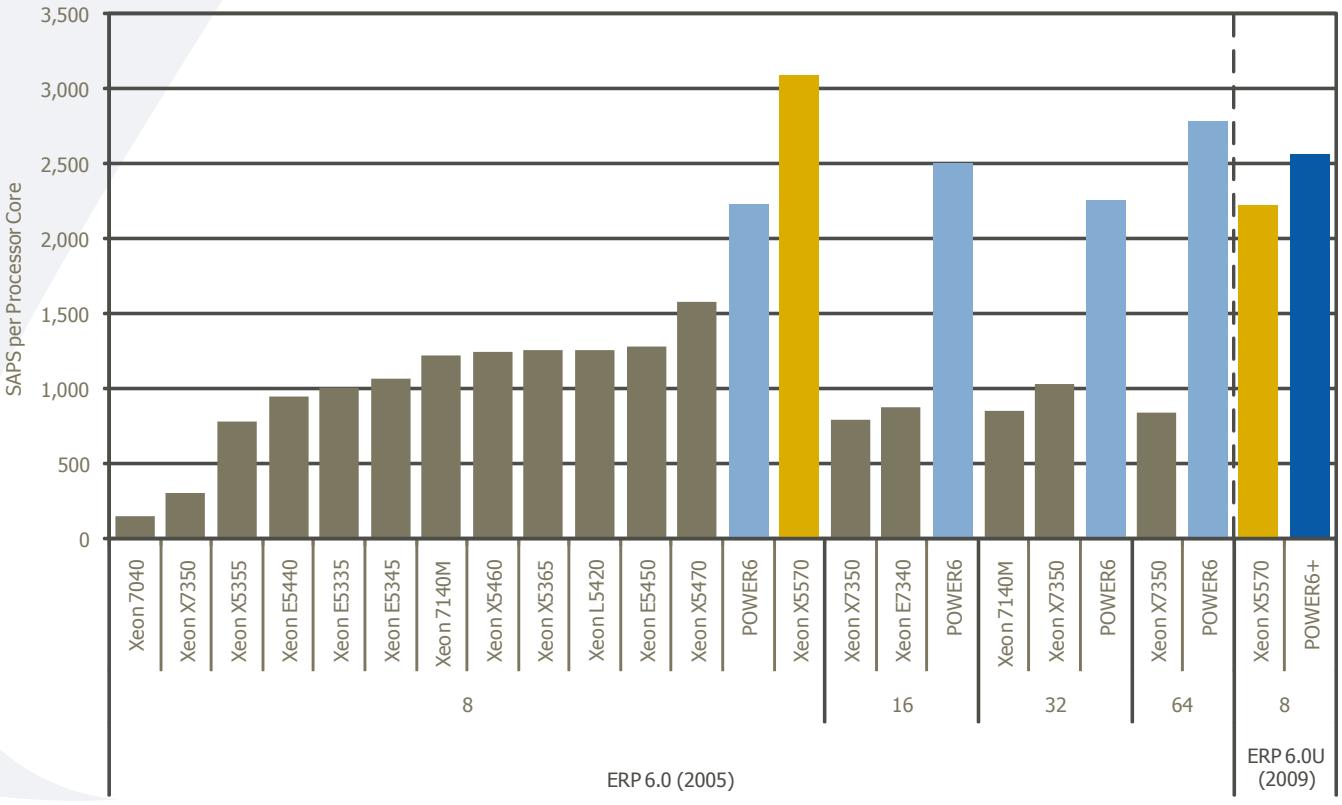
Chart 4 – SAP Tier 2: Intel Xeon vs. IBM POWER Per-Core Performance



Source: Raw results from SAP with additional analysis by IDEAS

shown in Chart 5, the outcomes range from 80% of per-core POWER6+ performance to near parity per-core performance with POWER6+ (Sun Fire X4270).

Two Xeon X5470 results (in gray) are also included to provide a comparison of how the Intel performance expectations have changed between the two generations.

The IDEAS Bottom Line: What Does All of This Mean?

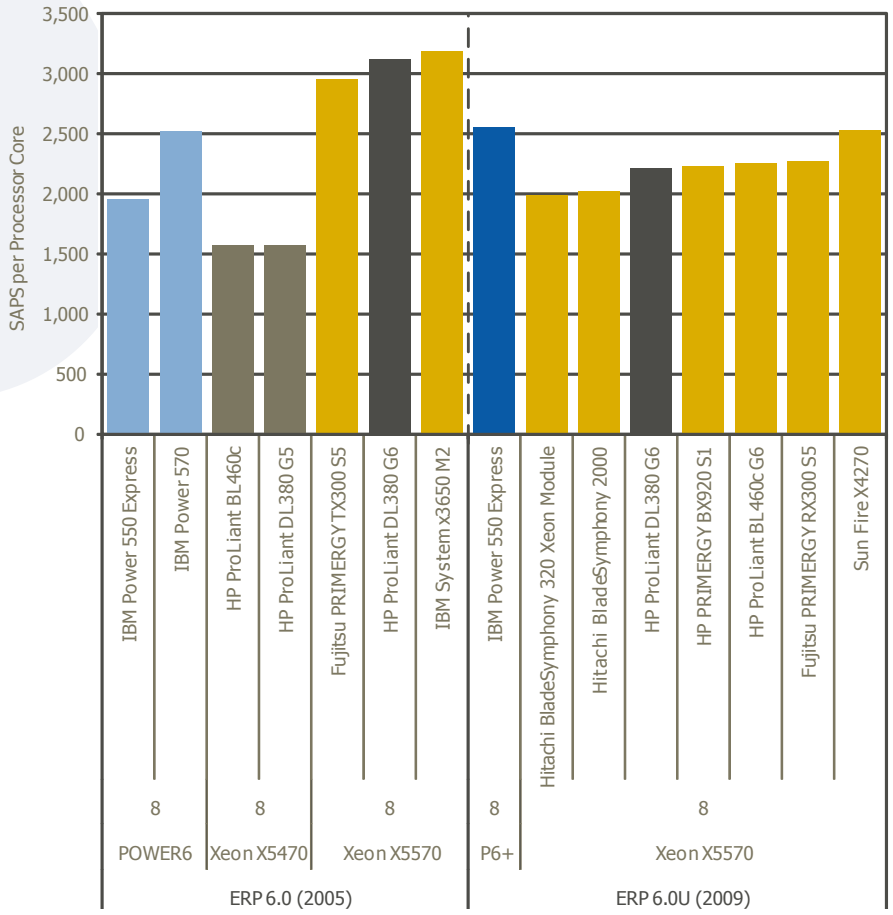
IDEAS must acknowledge the limited scope of this article; it concentrates on application performance per core, focusing specifically on Intel Xeon versus IBM POWER. (However, an analysis of the SPECrate Benchmark processor performance, under both the integer and floating point workloads, shows similar outcomes to what we have seen with the application workloads.) It's important to note that other companies compete with other processor types and not all compete on raw performance per core. At the end of the day, overall system performance is what matters. If one company uses more processors than another, but provides better or cheaper overall performance, then it offers a valid solution worth considering. Moreover this story concentrates solely on performance; it does not explore in depth any of the price or price/performance angles that may come into play.

That being said, the following insights can be gleaned from the analysis:

» From this analysis it definitely appears that the new Intel Xeon Processor 5500 Series processors represent a significant generational shift in x86 performance – one that is more revolutionary than the usual evolutionary.

» IBM has claimed the processor performance mantel for some time off the back of POWER's superior per-core performance. With the new performance potential of the Intel Xeon Processor 5500 Series, it appears that Intel has elevated itself into a new competitive position and will take the challenge up to IBM.

Chart 5 – SAP Tier 2: Benchmark Performance



Source: Raw results from SAP with additional analysis by IDEAS

» It is also fair to say that IBM has probably been relatively conservative of late with its POWER6 architecture. The POWER6+ snuck out into the market quietly; its industry-standard benchmark results are at least six-months old and there is probably room for improved outcomes with the latest software and technology. One can speculate that IBM is waiting for others to catch up and that it will look to make the next significant leap with POWER7, thus raising the bar in this extended game of leapfrog. (See the IDEAS blog, "IBM Reveals a Few POWER7 Details" at www.ideasint.blogs.com.)

» IBM currently claims the better scalability, with demonstrated high performance per core all the way up to 64 processor cores. Hence, IDEAS expects that for the time being, IBM will continue to dominate Intel in terms of highly scalable performance.

» However, with its new level of performance, probable future support for higher levels of scalability with the "Nehalem EX" processor, and the potential to drive higher volumes, Intel may start to reset expectations for x86 server technology performance, especially in the in two-socket and four-socket processor server space, not only against IBM, but also against other processor offerings.

The stage is certainly set for an interesting second half of 2009.■

Upcoming Competitive Profiles Enhancements Highlight Software as a Key Storage Differentiator

The storage marketplace continues to undergo significant structural change at an increasingly rapid pace. Once upon a time, storage consisted of two major product groupings: disk arrays and tape. Now, with the shift from direct-attached storage to network-based storage, many new product categories have emerged, such as Storage Area Networks (SAN), Network Attached Storage (NAS), and more recently, Unified and Clustered storage. The appearance of new protocols, such as iSCSI and Fiber Channel over Ethernet (FCoE), are starting to change the face of the storage communications layer, which will most likely undergo a degree of convergence with more traditional non-storage-based networking equipment. New drive types are becoming part of the mainstream, with SAS and SATA already deeply entrenched in the market, and vendors (both Tier 1 and niche) looking to support Solid State Disk (SSD) options on their products.

On top of all of these hardware components of course is a key layer in any storage solution: the software. As such, storage software is one focus of an upcoming update to Competitive Profiles.

Software's Role in Differentiating Storage Solutions

In many ways, the key building blocks of any storage solution are becoming commodities. For example, most vendors do not manufacturer their own drives; instead, they procure the drives from a handful of manufacturers. The same holds true for memory and other hardware components. Hence, storage solution differentiation now depends largely on the implementation of the solution and the role of the solution's software and firmware.

The differentiation lies not only in the software features, but also in the software costs. IDEAS' analysis of its library of sample storage configurations reveals that separate software license fees can be 25% of the cost of the hardware, or more. This value of course, varies depending on the product, capacity, and price point of the hardware involved, and more typically falls in the range of 15 to 17%. However, as virtualization and network-based solutions (including "cloud" solutions) become ever-more pervasive, the significance of the software – in terms of both competitive feature differentiation and percentage of overall solution cost – will grow, as more and more value moves into this aspect of a solution.

Figure 1 below plots average software cost as a percentage of hardware cost across the various storage solutions available within Competitive Profiles CPStorage. The chart categorizes the solutions into price and capacity bands. Each grouping of bars represents a price band. For instance, the "$10,000" block represents the group of solutions valued at up to $10,000; the $100,000 group represents those products valued between $10,000 and $100,000; and so on. The individual bars in each group represent the raw capacity of the solutions in terabytes. For instance, the 10 TB category represents configurations with a raw capacity up to 10 TB; the 100 TB category represents those solutions with a capacity between 10 TB and 100 TB; and so on.

It comes as no surprise that lower-capacity solutions (under 10 TB) have a higher relative cost of software, at between 20% and 25%. The sweet spot belongs to solutions in the $100,000 to $1M and 100 TB to 1,000 TB ranges, where the average is down around

(Continued on page 8)

Fig 1 – Average Storage Software Cost as a Percentage of Hardware

Source: Competitive Profiles, an Ideas International Service

the 15% mark. At the very high end – greater than 1,000 TB and over $1,000,000 in hardware cost – the cost of software as a percentage of the hardware spikes back up to around 25%.

An analysis of the underlying data reveals that there is great variation among offerings at the high end. For example, in one solution, software represents a separate added cost that almost matches the cost of the hardware itself. In others solutions, additional software charges are marginal (less than 2%), because the required functionality is bundled with the base hardware and firmware.

Competitive Profiles to Feature Expanded Storage Software Coverage

Competitive Profiles has long recognized the importance of software in differentiating storage solutions. Currently, one third of all the profiles in CPStorage are for storage software products. An imminent Competitive Profiles update in early September 2009 will further extend this storage software coverage by:

- Adding over 50 new storage software profiles
- Including Competitive Landscapes for storage software
- Enhancing the linkages between hardware and software profiles for improved analysis of a particular solution

These additions, combined with the storage software licensing rules and pricing information that are already provided in CPStorage, will give users greatly enhanced insight into this key area of competitive differentiation in storage solutions.

CPStorage contains a library of sample "working" configurations so that users can see how a typical storage solution is put together with its combination of hardware and software. With the complexity of storage solutions increasing, such sample configurations can prove more insightful than part lists alone. Readers may not be aware that over the past 12 months, the number of prebuilt sample configurations in CPStorage has risen dramatically to include over 1,400 unique priced configurations for the US and international markets. Furthermore, these are not isolated samples. IDEAS has put forth a lot of effort to ensure that all the sample configurations have been constructed to similar targets in order to provide the best "apples-to-apples" comparisons possible of sometimes differing, but competitive, architectures.

The enhanced storage coverage also extends into CPService, with comprehensive coverage of storage services for hardware and increased coverage of services for storage software. In addition, IDEAS is currently working on a project to make storage cost of ownership perspectives available sometime in the fourth quarter of this year. Storage Cost of Ownership, with its ability to directly compare and contrast storage solutions from hardware, software, and service perspectives, will round off what IDEAS believes is the most comprehensive competitive storage resource in the industry. ■