

## HRG Assessment:

### OpenPower: IBM's Strategy for Best of Breed 64-bit Linux

#### *Overview*

As users migrate from RISC/UNIX® platforms to Linux®, to which 64-bit architecture will they move — AMD, Intel® or POWER™? In this *HRG Assessment*, we describe a strategy that places IBM in a strong position to gain market share with IBM eServer® OpenPower™ Linux servers. We do this by showing that there are significant benefits in moving to OpenPower, such as, price/performance advantages, investment protection, software application availability, etc.

OpenPower servers are based on IBM's new POWER5™ architecture, and they are tuned to run Linux. In the remainder of this *Assessment*, we provide a brief overview of IBM's OpenPower strategy, discuss why UNIX users are moving to Linux, analyze the benefits of moving from UNIX to OpenPower, provide a price/performance comparison among OpenPower servers and other 64-bit capable servers such as AMD Opteron™, Intel Itanium® 2 and EM64T, and present the OpenPower value proposition.

#### **UNIX Users are Considering a Move to Linux**

UNIX users are considering a move to Linux because Linux generally provides significant price/performance advantages over proprietary UNIX platforms. This is clearly evident in high performance computing (HPC), telecommunications, and financial services as well as other market segments. In many cases, Linux clusters and horizontal (scale-out) Linux servers are replacing high-end servers. Users are also moving to Linux not only to reduce their ongoing costs, but also to reap the benefits of the open source movement. Linux runs on multiple platforms and gives users a broad range of choices for hardware platforms, including the increasingly popular blade servers, where Linux is the operating system of choice.

Today, HP-UX, Tru64 UNIX, and Solaris users are re-evaluating their options. Many HP-UX and Tru64 UNIX users are faced with moving from PA-RISC- and Alpha-based architectures, respectively, to HP-UX on HP's Integrity hardware line that uses 64-bit Itanium Product Family (IPF) processors. They are doing this at a time when there is increasing uncertainty about the future of Itanium 2 — ISVs have been slow in porting applications to

For IBM to achieve its OpenPower objectives, it must be aggressive with respect to the pricing of OpenPower systems. In addition, IBM must gain a foothold for OpenPower in the volume server market with its two- and four-way OpenPower servers and expand market share as customers transition from UNIX to 64-bit Linux. IBM must also adequately position its Linux on AMD and Linux on Intel products with OpenPower. Harvard Research Group believes that IBM offers significant advantages to enterprises migrating from UNIX to 64-bit Linux.

Itanium 2 (Microsoft® may not migrate several of its 32-bit applications to Itanium 2 servers). In addition, the recent announcement of EM64T (code-named Nocona), Intel's 64-bit extension to the Xeon™ Pentium® 4 architecture, increases the uncertainty of Itanium 2. Because of the high cost of Itanium 2 servers, Itanium 2 is becoming relevant in only the largest servers (16-way to 128-way) where the high cost of Itanium 2 processors is less of an issue. Solaris has been steadily losing market share over the past two to three years, primarily to Linux and AIX 5L™. As a result, Solaris users are becoming increasingly uneasy about Sun's future along with the high cost of mid-range and high-end Solaris platforms.

### ***IBM's OpenPower Strategy***

Over a year ago IBM stated that Linux on its POWER platform (which includes eServer iSeries™, pSeries®, BladeCenter™ JS20, and OpenPower systems) would be an important part of its 64-bit Linux strategy, and that Linux on POWER would complement, not compete with, its Linux on AMD and Intel processor-based servers. Dell, HP, IBM, and Sun dominate the sales of Linux servers with offerings based on AMD and Intel architectures. HP is the market share leader, but over each of the past eight quarters, IBM has gained market share on HP.

IBM's strategy, in part, is to use OpenPower to take market share from HP, Sun, and other competitors while growing its AMD and Intel processor-based Linux server revenue. The company plans to do this by focusing on customers who want to migrate or are thinking about migrating from RISC/UNIX platforms to Linux platforms. IBM competes with other vendors' two- and four-way 64-bit EM64T<sup>1</sup> and Opteron servers for the UNIX to Linux migration business, and when the demand is there, compete in the 64-bit Linux on eight-way server market. We believe that IBM has an inherent advantage over the competition with its OpenPower servers — it is generally less disruptive to migrate from RISC/UNIX to Linux on a RISC processor such as POWER than it is to migrate to Linux on EM64T or Opteron. As a result, IBM has introduced its OpenPower servers. These servers are tuned for Linux and are priced to compete with AMD and Intel processor-based 32- and 64-bit Linux servers.

### ***The Benefits of moving to OpenPower***

Because IBM creates its POWER technology and has full control over the hardware features that are incorporated in it, the company has the capability to produce more highly tuned Linux servers for the enterprise than its competition does on EM64T or Opteron. This results in more increased business value for customers — better performance, better up time, etc. In addition, OpenPower servers offer users who are migrating from RISC/UNIX a high degree of investment protection such as binary compatibility with POWER4+™, POWER5, and POWER6™ processor-based servers and scalability — Linux already runs on most of IBM's POWER servers up to and including the pSeries® 690.

IBM has many years of developing its POWER technology for servers that range from entry-level, volume servers to high-end SMP servers. It has more experience than any vendor in creating features that satisfy the business needs and flexibility requirements of end users. Enterprise users who are contemplating migrating their mission-critical RISC/UNIX applications to Linux on AMD Opteron or Intel EM64T servers should know that AMD has no track record of success beyond two- and four-way servers and EM64T is targeted only at two- and four-way servers. Until recently, no major system vendor had adopted an AMD processor for a family of servers. While Intel does have a limited track record with Itanium 2 for eight-way servers and beyond, ISVs have been very slow to port applications to Itanium 2, and Intel's recent announcement of EM64T places the viability of Itanium 2 over the long term in question. Users who choose EM64T and then find that their business needs require scaling to larger servers such as those based on Itanium 2 would find that there is no binary compatibility between EM64T and Itanium 2.

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<sup>1</sup> Today there are no four-way EM64T servers available, but it is just a matter of time until they are made available at Dell, HP, and IBM.

POWER is a mature architecture with many industry leading features and a solid roadmap spanning many years. On the other hand, there is uncertainty about Opteron and EM64T (as well as Itanium 2) roadmaps for users wishing to migrate from RISC/UNIX to Linux. Users who would opt for a combination of EM64T and Opteron may have compatibility problems because Intel has hinted that some of the 64-bit extensions for EM64T may not be compatible with those of Opteron. Linux on POWER offers other benefits — running Linux in logical partitions (LPARs) and running Linux on POWER blades in IBM's BladeCenter™ product (BladeCenter has about a 40% market share).

IBM is perceived to be the industry leader in Linux. The reason for this is that no other vendor has integrated Linux into its product offerings, programs, and initiatives to the degree that IBM has. Linux is a fundamental part of IBM's grid computing, on-demand computing, infrastructure simplification, and virtualization engine initiatives. IBM is making OpenPower an attractive platform for RISC/UNIX users by working quickly to move as many ISV applications as possible to the overall Linux on POWER platform. The company currently has over 1,000 open source and over 600 certified ISV applications available for Linux on POWER. IBM Software is one of the largest, if not the largest, providers of software on Linux with over 275 products shipping on Linux, and it ships the same binary across multiple LSB (Linux Standard Base)-compliant distributions for all products.

### ***OpenPower Servers versus the Competitions' 64-bit Capable Servers***

There are two myths about OpenPower that we intend to dismiss below — OpenPower is too expensive when compared to AMD and Intel alternatives, and OpenPower does not have a value proposition. We address the first myth in this section and leave the second one for the following section.

#### **OpenPower is Fast**

The following tables show that OpenPower servers not only provide high performance, but they are less expensive than other comparably configured 64-bit capable Linux servers.

Today, Dell, HP, IBM, and Sun have product families for Linux built around the following 64-bit architectures:

- Dell — EM64T and Itanium 2
- HP — EM64T, Itanium 2, and Opteron
- IBM — EM64T, Itanium 2, Opteron, POWER4+, and POWER5
- Sun — Opteron

When compared with other vendors' four-way, 4U, 64-bit capable servers, Table 1 shows that the IBM OpenPower 720 server is competitive with respect to the SPECInt\_rate benchmark. It is approximately 14% faster than the Sun V40z (Opteron-based) and more than 20% faster than the HP Integrity rx4640 (Itanium-2-based) per the important SPECfp\_rate benchmark. These results combined with OpenPower's significantly lower cost structure (see Table 2) easily give it the best price/performance ratio among four-way 64-bit capable Linux servers.

**Table 1. Performance of Various Four-way Linux Systems<sup>2</sup>**

Systems	SPECint_rate		SPECfp_rate	
	Base	Peak	Base	Peak
Dell 6650 4 x 3.0GHz Xeon (32-bit)	55.9	57.2	32.3	32.4
Sun Fire V40z 4 x 2.4GHz (850 Opteron)	63.5	N/A	N/A	70
IBM OpenPower 720 4 x 1.65GHz	N/A	59.3	N/A	80.5
EM64T-based systems	N/A	N/A	N/A	N/A
HP Integrity rx4640 4 x 1.5GHz (Itanium 2)	63.4	64.2	65.6	65.6
HP DL585 4 x 2.4GHz (850 Opteron)	63.7	68.6	N/A	70

Source: HRG, IBM, and SPEC2000, August 2004

**OpenPower is Less Expensive than the Competition — and by a Lot**

Table 2 contains pricing for 4U, four-way 64-bit capable servers based on AMD Opteron, Intel Itanium 2, and IBM POWER5 processors. Servers based on Intel’s EM64T are not included because there are currently no four-way EM64T servers available. It is HRG’s perspective that four-way EM64T servers will be priced comparable to AMD Opteron servers. We also expect the prices in Table 2 to dip, and dip significantly in some cases, over the next 10 – 12 months because this is a buyer’s market with vendors offering the same operating system(s), Linux (and Windows) on very similar hardware platforms. Dell’s PowerEdge 6650, a 32-bit Xeon processor-based server, is included to show the relative pricing of 32-bit and 64-bit servers.

The pricing in Table 2 is for one-, two- and four-way configurations of up to four-way, 4U Linux servers. The Sun Fire V40z has a 3U chassis. One very interesting thing that we see in Table 2 is that with the exception of Itanium 2-based Linux servers, the four-way, 4U, AMD Opteron and IBM OpenPower Linux servers are less expensive than the comparably configured 32-bit Xeon, four-way Dell PowerEdge 6650. In fact, the OpenPower servers are less expensive than all other servers in Table 2, even when \$1,100 is added to their prices for an additional GB of memory.

Two-way, 2U servers are generally priced much lower than a two-way configuration of an up-to-four-way 3U or 4U server. For example, a Sun Fire V20z server (2U) with two Opteron 2.2GHz processors is priced at about \$4,845 and a Sun Fire V40z (3U) with two Opteron 2.2GHz processors is priced at \$10,395 (see Table 2). A HP

<sup>2</sup> N/A means not available at this time.

DL145 (1U) with two Opteron 2.4GHz processors is priced at \$5,116 and the 4U DL585 with the same configuration as the DL145 is priced at \$12,988. There is a delta of about \$6,000 -\$7,000 difference in pricing. The same delta holds true for a Dell PowerEdge 3250 with two 1.5GHz Itanium 2 processors and a PowerEdge 7250 with the same configuration. Based on this analysis, we would expect a two-way, 2U OpenPower server, when it becomes available, to be priced well below other 64-bit two-way, 2U platforms given the relatively low prices for two- and four-way 4U OpenPower servers. *But, IBM is going further than the competition — its two-way, 2U OpenPower servers will be priced at or below the price points of two-way, 2U Intel processor-based 32-bit servers.*

Itanium 2 servers with configurations comparable to those of Opteron and OpenPower are priced out of the competition, often two or more times as expensive. For example, the HP DL585 (Opteron-based) is less than one half the price of a comparably configured HP rx4640 (Itanium 2-based) and the same DL585 is about one half the price of the PowerEdge 7250 (less than one half for the four-way configuration). As a result, Itanium 2 servers are not considered in the competition for users migrating from UNIX to Linux.

**Table 2. Pricing for 4U, Four-way Servers with One, Two, and Four processors**

System Configuration	One-way	Two-way	Four-way
HP rx4640 — 1.5Gz (Itanium 2), 4U, 2GB memory, 36GB disk, 3 year warranty	N/A	\$35,900 (with 1.3GHz ---\$19,855)	\$52,400 (with 1.3GHz--- \$26,255)
Sun Fire V40z — 2.2GHz (Opteron), 3U, 73GB disk, three year warranty	N/A	\$10,395	\$17,445 \$22,445 (with 4 x 2.4GHz)
Dell PowerEdge 6650 —3.0GHz (32-bit Xeon), 2U, 2GB memory, 36GB disk, three year warranty	\$8,785	\$13,784	\$23,784
HP DL585 —2.4GHz (Opteron), 4U, 2GB memory, 36GB disk, three year warranty	N/A	\$12,988	\$22,096
IBM OpenPower 720 —1.5GHz (POWER5), 4U, 36GB disk, three year warranty <sup>3</sup>	\$5,000 (.5GB memory)	\$8,000 (1GB memory)	\$13,500 (1GB memory)
IBM OpenPower 720 — 1.65GHz (POWER5), 4U, 36GB disk, three year warranty	N/A	\$9,250 (1 GB memory)	\$16,000 (1GB memory)
Dell PowerEdge 7250 —1.5GHz (Itanium 2), 4U, 2GB, 36GB disk, three year warranty	\$16,499	\$24,749	\$37,249

Source: HRG, Dell, HP, IBM, and Sun, August 2004

Based on the competitive pricing and good performance of the new 64-bit Linux servers, we expect users to start purchasing the new 64-bit servers at a faster pace than earlier thought. Because Dell is less enthusiastic about

<sup>3</sup> 1GB IBM memory is approximately \$1,100.

Linux than IBM, Dell's EM64T servers are likely to be just an alternate for its 32-bit servers until the 64-bit versions of Windows® XP and Windows Server are available in the first half of 2005. Because, IBM's strength is Linux and is very enthusiastic about moving ISV applications to 64-bit Linux servers, we would expect IBM to be more proactive than the competition with all of its 64-bit Linux platforms.

**No Contest: IBM OpenPower is Easily the Price/Performance Leader**

Applications utilize a mix of integer and floating-point instructions. To make price/performance observations using the performance results in Table 1 and the pricing information in Table 2 more meaningful, we use an average of the SPECint\_rate and SPECfp\_rate numbers (69.9 for the IBM OpenPower 720) for all servers. Table 3 illustrates how much more expensive comparably configured servers from Dell, HP, and Sun are than the IBM OpenPower 720.

The performance benchmark test results and the pricing information indicate the following:

- Based on the SPECint\_rate and SPECfp\_rate benchmarks in Table 1, the IBM OpenPower 720 is more than 4% faster than the Sun Fire V40z and more than 7% faster than the HP Integrity rx4640. There are no published SPECfp\_rate benchmark numbers for the HP DL585 and no SPECint\_rate or SPECfp\_rate benchmark numbers for the Dell PowerEdge 7250.
- Based on Tables 1, 2, and 3, the IBM OpenPower 720 has clear pricing advantages and performance advantages over comparably configured four-way servers from Dell, HP, and Sun giving it unquestioned price/performance leadership.

**Table 3. Pricing Comparison for System Configurations in Table 2**

System Name	Two-way	Four-way
HP rx4640	246% more expensive	206% more expensive
Sun Fire V40z	N/A for 2.4GHz Opteron	31% more expensive
HP DL585	25% more expensive	29% more expensive
Dell PowerEdge 7250	139% more expensive	117% more expensive

Source: HRG, August 2004

### ***Value Proposition: Determining the Value of OpenPower***

There are two sets of value propositions that pertain to OpenPower — the overall Linux on POWER value proposition and the OpenPower Linux server value proposition. The Linux on POWER value proposition pertains to BladeCenter, i5/iSeries™, p5/pSeries, and OpenPower. The OpenPower value proposition is specific to OpenPower.

Linux for POWER delivers value in several ways:

1. POWER provides high performance 64-bit architectures to enable mission critical workloads to run on Linux.
2. POWER provides enterprise reliability, availability, and scalability (RAS) features that help insure applications are running around the clock.
3. IBM provides a stable POWER roadmap with a commitment to Linux on POWER.
4. IBM Virtualization Engine™ technologies improve resource utilization, reduce downtime, improve systems management, and lower costs. The POWER Virtualization Option includes Micro-Partitioning™, dynamic LPARs, virtual SMP, and virtual LAN.
5. BladeCenter JS20 blades, i5/iSeries servers, p5/pSeries servers, and OpenPower servers provide binary compatibility for Linux applications.
6. Over 600 certified ISV applications and over 1,000 open source applications run on Linux on POWER servers.

While the value proposition given above applies to OpenPower, there is also a value proposition specific to OpenPower:

1. OpenPower is designed and tuned to run only Linux.
2. OpenPower servers are the lowest cost 4U, four-way 64-bit Linux servers on the market.
3. OpenPower servers easily provide the best price/performance ratio among comparably configured 64-bit Linux servers.
4. When compared to comparably configured 32-bit Intel servers, OpenPower servers are less expensive (in some cases by several thousand dollars) and provide higher performance.
5. OpenPower is RISC-based thereby facilitating the migration of RISC/UNIX applications to OpenPower.
6. The POWER Virtualization Option is available for OpenPower giving users more flexibility than any competitor provides and at a much lower cost than the competition.
7. Users who need to scale to meet their business needs can move their Linux binaries from OpenPower servers to larger, more robust pSeries servers that are already running Linux with no work or cost involved. Vendors who provide AMD Opteron and Intel EM64T Linux servers cannot make this claim —

applications would have to be ported to another architecture because there are no Opteron servers beyond four-way and no EM64T servers beyond two-way.

## ***Conclusions***

IBM's Linux strategy is focused — use OpenPower to take market share from HP, Sun, and others while growing its AMD and Intel processor-based Linux server revenue. It is doing this by focusing on customers who want to migrate from RISC/UNIX platforms to Linux platforms. Today, there is no dominant 64-bit capable Linux hardware platform in terms of market share, but the competition is heating up between EM64T, OpenPower, and Opteron.

It is HRG's perspective that customers who are considering a move from RISC/UNIX to Linux on a 64-bit capable platform should take a serious look at OpenPower. OpenPower servers are less expensive and provide better price/performance ratios than their 64-bit capable counterparts from Dell, HP, and Sun — dispelling the myth that OpenPower servers are too expensive. In addition, they are certified to run over 600 ISV applications and over 1,000 open source applications — dispelling the myth that there is no value proposition for OpenPower. And when compared with comparably configured 32-bit Intel servers, OpenPower servers are competitively priced and provide much higher performance.

IBM creates its POWER technology and has full control over the hardware features that are incorporated into it. This gives IBM the capability to produce highly tuned 64-bit Linux servers. In addition, a solid roadmap for POWER technology is already in place giving customers investment protection. Users who migrate their RISC/UNIX platforms to Linux on EM64T or Opteron and then need to scale to larger servers to meet business needs will almost certainly have to move to a new processor architecture because EM64T and Opteron have no track record beyond four-way servers. As result, they will encounter a binary compatibility problem. On the other hand, OpenPower servers are binary compatible with POWER4+ and POWER5 processor-based servers (and will be binary compatible with POWER6) that scale to 32-way and beyond, all of which run Linux today.



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