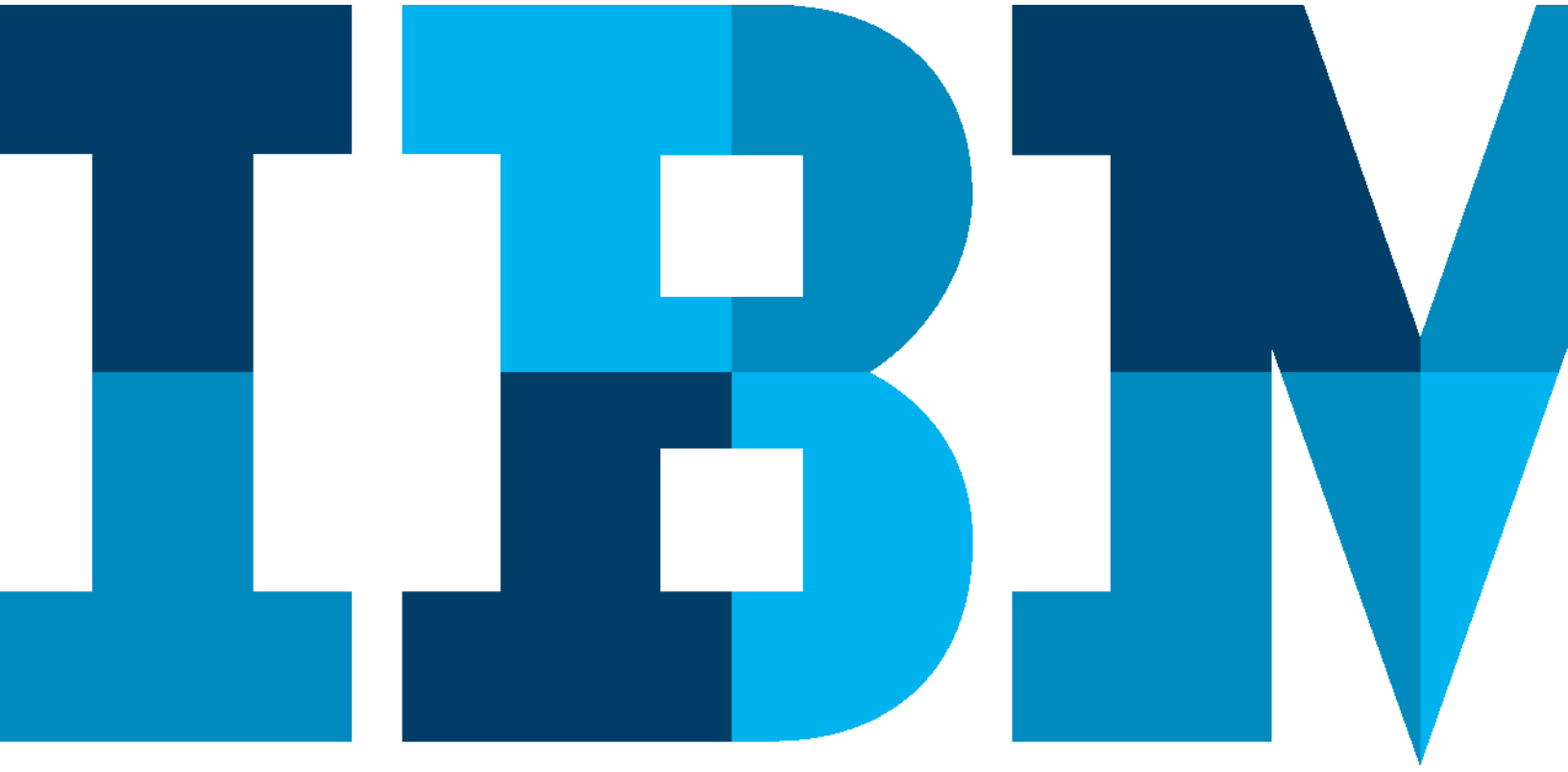
SAP HANA on IBM Power Systems

IBM Power Systems delivers the flexibility, resilience and performance needed to support demanding SAP HANA workloads



IBM

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Introduction

As SAP clients seek to gain maximum business value from their most strategic IT systems, they are faced with both opportunities and challenges.

The opportunity comes from the promise of combining transactional and analytics systems into a single solution, something SAP calls “real-time business.” This approach combines mission-critical day-to-day online transaction processing (OLTP) with online analytics processing (OLAP). Historically, these were separate activities, requiring organizations to move data between systems, which caused a delay between activity and analytics. By removing the barrier between the two systems, businesses will be better positioned to garner deep business insights that support better decision making and deliver real competitive advantage. The release of S/4HANA establishes a new generation of SAP HANA based applications.. Simplification of applications and data models results in more efficient and faster business transactions.

The challenges come from the high demands these real-time applications place on IT infrastructure. As an in-memory database, SAP HANA is designed to work best on hardware that delivers high levels of memory bandwidth, multithreading, processor data caching, and automated error checking and correcting. Since SAP HANA often forms the basis for the most critical applications a business uses, high levels of resilience are also required. Finally, a newly implemented SAP HANA database must also integrate well into an organization’s established system landscape. This means that the platform it runs on needs to be flexible enough to integrate new workloads into existing resources and operations.

Against this background, it’s clear that deciding to implement SAP HANA is merely the first step toward capitalizing on everything it has to offer. To really make the most of SAP HANA as well as the applications leveraging its capabilities, you need to deploy it on a platform that can provide the unmatched flexibility, rock-solid resilience and industry-leading performance that SAP HANA workloads demand.

This paper will demonstrate how IBM® Power Systems™ is the optimal platform to meet the unique requirements of SAP HANA, now and into the future. By deploying SAP HANA on IBM Power Systems, organizations can simplify their IT infrastructure, decrease total cost of ownership, and maximize the benefits of SAP HANA.

About SAP HANA on IBM Power Systems

SAP HANA customers are moving their workloads to IBM Power Systems to take advantage of a hardware platform that was designed specifically to support big data and analytics workloads, while also providing enterprise-level mission-critical 24x7 reliability.

One key benefit of running SAP HANA on IBM Power Systems is its unmatched flexibility. Today, many of our competitors' SAP HANA configurations are deployed as appliances. This means the user has to accept preconfigured and preinstalled hardware and software. This limited customers' choices in how they could deploy their SAP HANA configurations.

SAP HANA on IBM Power Systems is not offered as an appliance, meaning that customers have the flexibility to deploy on a wide range of IBM POWER8®-based servers, combined with various storage options. In many cases, current IBM customers will be able to integrate their SAP HANA workloads into their existing IBM Power Systems infrastructure; this is in stark contrast to traditional appliance-based SAP HANA deployments from other vendors, which require organizations to deploy single-purpose dedicated hardware appliances.

IBM Power Systems also provides market-leading capabilities for reliability, availability, and serviceability (RAS), including self-monitoring and predictive failure alerts, making it the perfect choice to support mission-critical workloads running on SAP HANA. The built-in virtualization capabilities of IBM POWER8 reduce the need to maintain dedicated redundant hardware systems for failover. Instead, organizations can use virtual hardware systems as failover targets, which can also be used for test and development workloads when they are in standby mode. This represents a more efficient way to maintain the high availability that organizations need for their SAP HANA workloads.

Finally, organizations that run SAP HANA on IBM Power Systems can take advantage of the well-established performance advantages of the IBM POWER8 CPU. With its support for leading technologies like eight-core simultaneous multithreading (SMT-8), and memory bandwidth up to four times higher than that of current x86-based systems, the outstanding speed and throughput of IBM POWER8 make it optimally suited for SAP HANA workloads. In addition, the performance benefits of IBM POWER8 often translate into more efficient operations for organizations running SAP HANA, due to the ability to better virtualize workloads. By reducing the size of their system footprint, organizations are able to cut costs in a variety of key areas, including staffing, ongoing maintenance, and infrastructure costs.

Flexibility

When you are running an SAP HANA configuration, having the flexibility to support specific organizational needs is of the utmost importance. Platforms that force a one-size-fits-all approach on their users limit what those organizations can accomplish with SAP HANA.

IBM Power Systems offers a number of features to create greater flexibility, including support for virtualization out of the box, and the ability to deploy as a tailored data center integration, rather than an application.

With support of SAP HANA Version 2, the IBM POWER platform has introduced full data compatibility with x86 platforms. This increases flexibility on business data level. It allows easy data migration from x86 to IBM POWER (and vice versa) by using simple copy or backup/restore tasks. Even mixed SAP HANA replication clusters can be built for database resiliency.

Virtualization

In 2015, IBM and SAP took steps to enable flexibility in SAP HANA environments through virtualization. This occurred when SAP announced that it would make generally available support for the use of virtualization based on IBM PowerVM® technology, consolidating multiple SAP HANA virtual machines on a single system. This completely redefines what organizations accomplish with their SAP HANA workloads, while also allowing them to deploy their SAP HANA environments in a manner that avoids the complexity found on bare metal infrastructures.

Organizations that deploy IBM POWER8 can take advantage of both dedicated and shared processor resources via PowerVM virtualization. SAP allows users to virtualize up to eight production SAP HANA LPARs with a fine granularity not linked to physical CPU boundaries on a single IBM Power Systems environment. In addition, customers can run non-production workloads and traditional production workloads in a shared processor pool, all on a single server. By supporting all LPARs, including high-priority production LPARs, IBM Power Systems allows organizations to maximize the flexibility and efficiency they can achieve using virtualization. This helps consolidate workloads onto fewer servers, while also keeping overall usage rates for processors high, even in the face of fluctuating demand. In turn, this leads to greater efficiency and lower total cost of ownership.

Another important virtualization feature offered by IBM Power Systems is the ability to better manage peaks and troughs in demand through dynamic capacity sizing. Processors from other vendors rely on inexact “T-shirt” sizing, where organizations that need to add more memory will have to jump up in large increments—like moving from a medium T-shirt size to a large. Each move up in size requires the organization to add more CPUs, and to take the performance hit that comes from having to reboot. With agile capacity sizing based on virtualization, IBM Power Systems allows organizations to scale the amount of capacity in their environment quickly and granularly, without the need to purchase new systems.

IBM Power Systems also offers Live Partition Mobility, a virtualization feature that supports flexibility and application availability. Live Partition Mobility allows an LPAR containing a running SAP HANA database to be moved from one server to another, without disrupting the database. This supports both non-disruptive cross-server workload balancing and planned hardware maintenance with no downtime.

SAP Tailored Data Center (TDI) integration

IBM POWER8 processors are designed to be deployed as part of SAP's Tailored Data Center integration (TDI) model. TDI is meant to reuse existing customer IT environments, including storage and networking. This is in contrast to other vendors, which may require SAP HANA to be deployed as an appliance, separate from other IT infrastructure. As the figure below illustrates, deploying SAP HANA as an appliance requires an organization to use preconfigured and preinstalled hardware and software, leaving the organization with no choice in the technology they use to support their SAP HANA environment.

A TDI approach is more efficient and cost-effective than deploying SAP HANA as an appliance. This is because organizations running SAP HANA as an appliance on bare metal will need to purchase new hardware specifically to support their new SAP HANA application, rather than using the strategic storage and network systems they may have already deployed.

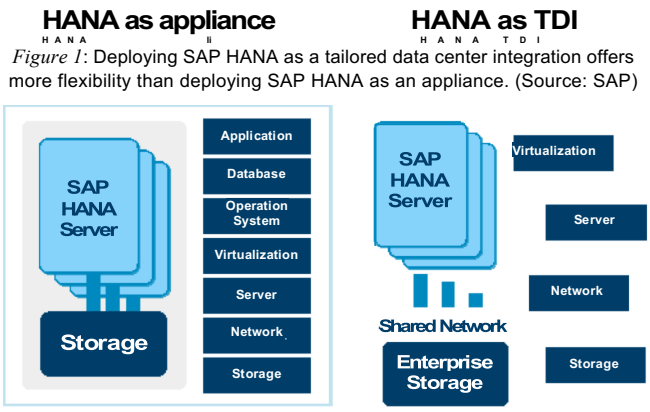

Figure 1: Deploying SAP HANA as a tailored data center integration offers more flexibility than deploying SAP HANA as an appliance. (Source: SAP)

Support for scale-up and scale-out architecture

Different types of workloads imply certain qualities of database updates and node synchronization – some requiring a single-node, i.e. scale-up deployment, others in addition allowing a scale-out topology across multiple database nodes. IBM supports both SAP HANA scale-up nodes for transactional SAP Business Suite workloads and scale-out topologies for SAP Business Warehouse type workloads (16 nodes max.) and high-end S/4HANA (4 nodes max.). IBM PowerVM provides highly efficient virtualization on any Power System. Thus, any supported server with SAP HANA can be used for both deployment types. This means S-class servers can host smaller scale-up SAP HANA databases plus their surrounding SAP eco-system. On the high-end side, E-class models can exploit their physical scalability by collocating multiple SAP HANA scale-out nodes in LPARs onto one server, and in addition consolidate various associated workloads into a shared resource pool. Both choices help customers to significantly reduce IT and operational complexity and cost compared to identical SAP landscapes residing on numerous dedicated servers and appliances.

Resilience

While availability is important in any database environment, it is particularly important for in-memory databases such as SAP HANA. This is mainly because in-memory data is not maintained across reboots, meaning that data must be reloaded from persistent memory every time the system has to start up again.

As a result, it's important that organizations using SAP HANA maximize availability and minimize reboots. Deploying SAP HANA on a highly resilient architecture like IBM Power Systems can help accomplish that goal. In fact, while some vendors consider mission-critical reliability to be optional, this reliability is built into IBM Power Systems by default.

IBM POWER8 offers a variety of features and technologies to support reliability, availability, and serviceability (RAS). Many of these features are considered industry leaders, while others are completely unique.

System reliability

IBM POWER8 is intended to support 24/7 mission-critical enterprise customer operations, and this fact shows in how it keeps both planned and unplanned downtime to a minimum. In a recent report from ITIC[1] , IBM hardware was named the most reliable on the market for the sixth consecutive year. The report indicated that IBM Power Systems offerings averaged only 13 minutes of unplanned downtime per server, per year.

One example of how IBM Power Systems accomplishes this is by using IBM FlashSystem™ storage to minimize start-up time, helping organizations meet their recovery time objectives. FlashSystem can also deliver enterprise-grade reliability, extreme performance based on IBM FlashCore™ technology, and a wide range of operational and cost efficiencies. By using an all-hardware data path, FlashSystem arrays can maximize I/O bandwidth, significantly reducing SAP HANA table load times. Using IBM MicroLatency® technology, IBM FlashSystem V9000 can perform up to 2.5 million I/O operations per second, with data transfer rates of up to 20 GB/s. As a result, organizations can load even very large SAP HANA databases into memory in a matter of minutes.

Scale-up architecture and virtualization for graceful failover

The fact that IBM POWER8 can operate as a best-of-breed scale-up architecture creates several built-in resilience benefits. A traditional scale-out architecture requires a minimum of n+1 redundant hardware nodes. The spare node remains passive until it's activated to respond to the failure of an active host.

However, on an IBM POWER8 scale-up architecture, with its out-of-the-box support for virtualization, organizations can perform quicker, more effective failover techniques by creating separate virtual footprints within the same server, or on different servers running other workloads. One of these footprints could serve as the failover target, providing the same level of protection offered by passive physical hardware nodes within scale-out environments. However, since this failover target is virtualized, it does not have to remain passive until a failure occurs. Instead, the failover target can be used to perform active workloads such as testing and development, contributing to better overall utilization of hardware assets.

Predictive failure alerts

By the time you've received an indication that there is something wrong with the platform you're using to run your SAP HANA configuration, it may be too late for you to do anything about it. Ideally, your database administrators would find out about all possible failures before they occur, giving them the opportunity to take action in order to prevent unplanned downtime or data loss.

IBM POWER8 offers this capability through its support for predictive failure alerts. Instead of waiting until a failure has already been detected, IBM POWER8 uses heuristics, running in the background of ongoing SAP HANA workloads, to pre-emptively warn DBAs when a failure is likely to occur. This allows the DBAs to take action immediately and migrate at-risk workloads before a failure occurs. By tracking key characteristics of different elements throughout the database environment, IBM POWER8 helps organizations address any issues that may endanger the continued uptime of their SAP HANA configurations.

Chipkill memory

Another example of a feature IBM POWER8 offers to support the very high level of reliability required by SAP HANA is

chipkill memory. Chipkill memory is an advanced error checking and correcting (ECC) technology that allows organizations to protect data stores from single memory chip failure. By isolating and neutralizing the failing chip, IBM POWER8 removes the potential for memory loss. This helps organizations keep their throughput levels high, while still providing the level of memory protection than SAP HANA demands.

Many Intel systems offer a similar type of technology called lockstep memory or RAS mode. However, this technology is not included by default, and it can significantly harm performance when enabled. In addition, customers may not realize that all performance benchmarks for Intel systems are run with RAS mode disabled. This means that customers would have to choose between accepting a less reliable system, or a system that can't provide the level of performance quoted in published benchmarks. Since IBM Power Systems offers RAS capabilities that are enabled by default, reliability is factored into the benchmark results. As a result, IBM customers don't have to choose between reliability and maximum performance.

Extra chip per memory rank

IBM Power Systems offerings also come with an extra chip per memory rank, enabling built-in memory rank sparing. When a chip begins to fail, the contents of the failing chip can be copied to the extra chip, ensuring ongoing availability. Since Intel systems do not provide an extra chip per memory rank, they can only replicate this level of availability using memory mirroring, which reduces the maximum available memory in a system by half.

Performance

IBM POWER8 was designed specifically for big data and analytics workloads like SAP HANA. This section of the paper will explore the performance benefits of IBM POWER8 over competing platforms in more detail. Using these performance benefits, organizations can put themselves in a better position to manage transactions and queries with consistent load times, even at very high load conditions.

Simultaneous multithreading

Perhaps the clearest indication of the performance benefits offered by IBM POWER8 can be found in its support for simultaneous multithreading with eight threads per core (SMT-8). SMT refers to a system's ability to concurrently execute multiple sets of instructions during the same CPU clock cycle. Simply put, SMT helps a platform respond to a greater number of CPU requests within the same period of time, cutting down on the amount of time one must spend waiting for workloads to finish executing.

While previous IBM Power Systems processors have provided support for simultaneous multithreading with four threads per core (SMT-4), IBM POWER8 takes its SMT capabilities to the next level, doubling the amount of threads per core an organization can support. In addition, SMT on IBM POWER8 offers up to four times as many threads per core as any Intel-based platform, as these platforms top out at only two threads per core. SMT modes can be switched to best accommodate optimal working environment for changing workloads.

As one would clearly expect, the ability to run four times as many threads per core contributes to significantly higher levels of per-core performance. This, in turn, allows organizations to do more with less. Higher throughput per core allows an organization to meet all of their SAP HANA performance requirements while running a smaller number of cores.

By running fewer cores, organizations have the potential to reduce their server footprints over time, which in turn would allow them to operate with a smaller staff, fewer maintenance and troubleshooting requirements, and lower overall operating expenses. It also provides greater flexibility to run in scale-up mode, which allows SAP HANA to operate in a single memory space for customers who choose not to cluster across multiple servers.

The performance advantages SMT-8 offers over platforms that can only run two threads per core are illustrated in ***Figure 2***. CPU performance test results published by the Standard Performance Evaluation Corporation (SPEC)2 showed that an IBM POWER8 platform with SMT-8 can offer significantly higher levels of performance than an Intel platform that only supports two threads per core, even when both systems are running an identical number of cores. This held true for both integer and floating point benchmarks.

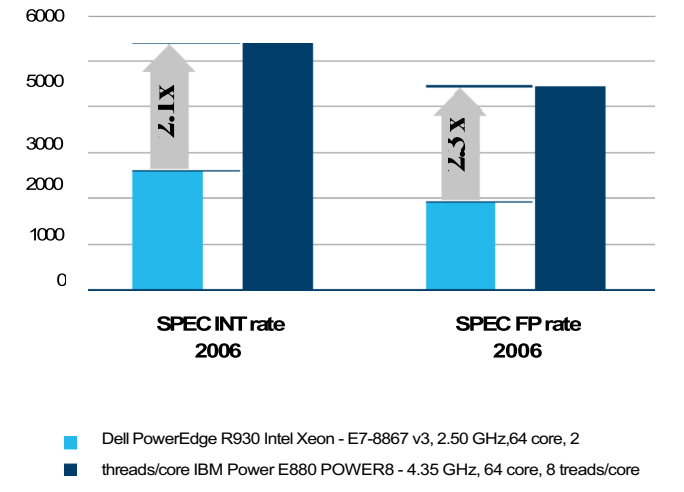

Figure 2: SPEC CPU2006 INT rate and FP rate comparison between IBM POWER8 and Intel Haswell E7 v3

Memory capacity

The performance of SAP HANA workloads can be directly affected by the level of memory capacity provided by the platform that the database is operating on. This is because the performance benefits of in-memory databases such as SAP HANA can all be traced back to the fact that data is stored in memory. By removing the need to store data on external disk systems, an organization can also do away with the latency that arises when the database has to access data stored on those disk systems.

The more memory capacity a platform can offer, the more data SAP HANA can actually keep in memory. In spite of its built-in data compression algorithms, SAP HANA can still benefit greatly from running on a platform that provides it with ample memory capacity.

By providing up to 32TB of memory on a single scale-up server, IBM POWER8 offers significantly more memory capacity per system than typical Intel platforms.[3] This additional memory capacity helps make IBM Power Systems the superior platform for unlocking the full potential of in-memory databases like SAP HANA and their associated ecosystems.

IBM POWER8 is able to provide this level of memory capacity for consolidation of SAP HANA and further collocated workloads, so that organizations can benefit from high memory capacity while still using a single server. This is in contrast to a scale-out architecture where additional capacity is added to the platform by implementing multiple servers. For those organizations that are willing to invest in premium hardware systems in order to pursue performance optimization, the scale-up capabilities offered by IBM Power Systems are unmatched.

In addition to the reliability benefits of scale-up environments described above, maintaining a single server also has performance benefits. Adding additional servers creates the need for a network connection to facilitate synchronization operations between the servers. Keeping everything on a single server allows organizations to avoid the latency created by these inter-server connections.

Memory bandwidth

When it comes to supporting SAP HANA databases, being able to store large amounts of data in memory is really only half the story: SAP HANA performance is also highly dependent on how quickly the CPU can access that data. This is a concept known as memory bandwidth. IBM POWER8 CPUs offer over twice the memory bandwidth per socket of Intel Haswell E7 v3, another clear indication that IBM Power Systems is better suited to helping organizations capitalize on all the benefits that an in-memory database like SAP HANA can offer.[4]

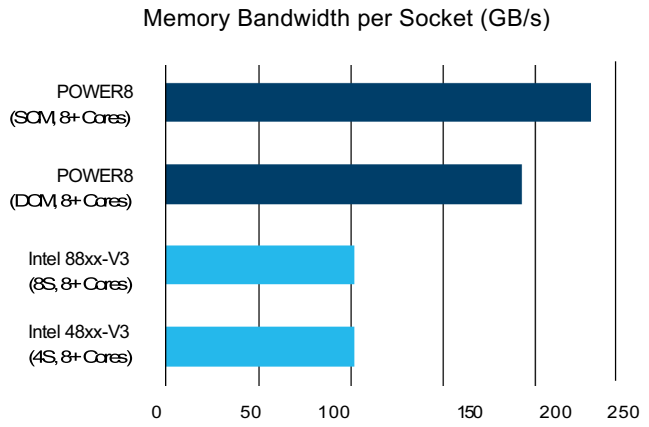

Figure 3: Memory bandwidth per socket of IBM POWER8 and Intel E7 v3 systems

Memory latency

Taking advantage of local caches for data storage represents another important opportunity to maximize the performance of SAP HANA. Data on local caches can be accessed much quicker than data stored in the main memory. This means that the more cache capacity a system offers, the lower its latency for accessing data in memory would be.

Once again, the IBM POWER8 architecture is suited to providing the best possible results for SAP HANA. IBM POWER8 offers significantly larger L2 and L3 caches than Intel Haswell E7 v3, and offers an additional L4 cache off chip, something that the Intel architecture does not offer. When totaled, the cache size per socket of the IBM POWER8 processor is more than four times greater than that of the Intel Haswell processor. This indicates that IBM Power Systems can offer significantly lower memory latency, another sign that it is the optimal architecture for running SAP HANA workloads.

Single instruction multiple data vector processing

Single instruction multiple data (SIMD) vector processing refers to an in-memory database's ability to process multiple elements of data as a single instruction. It represents another important performance benefit for in-memory databases such as SAP HANA; however, both the hardware and software must support SIMD if the database is to take advantage of the benefits it can offer. This provides yet another example of how getting the most out of SAP HANA depends on choosing the right platform to run it on.

IBM POWER8 offers an integrated dual-pipeline vector scaling floating point unit that supports SIMD instructions, as opposed to the single-pipeline unit found in Intel systems. It can support up to eight single-precision or four double-precision floating point operations per clock cycle.
The SAP HANA code has been optimized to fully exploit IBM POWER8 vector instructions. Organizations that choose IBM POWER8 to run their SAP HANA configuration would have the vector instructions needed to support SIMD processing.

World-record performance

The SAP Business Warehouse Enhanced Mixed Load (BW-EML) Standard Application Benchmark for SAP HANA 1.0 is the only publically available benchmark that shows performance results for different platforms running an in-memory database. Based on the two-billion record SAP BW-EML benchmark, IBM POWER8 E870 set a new world record for performance.[5]

When the different processors were ranked according to the number of ad hoc navigation steps per hour they can perform, IBM POWER8 was in the highest position overall, in spite of the fact that it runs fewer cores. On a per-core basis, the results were even more impressive, with IBM POWER8 delivering performance levels 1.8 times higher than the highest-performing Intel Haswell system.

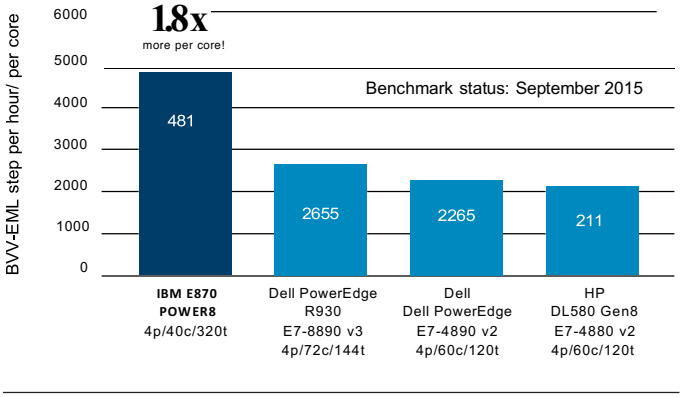

Figure 4: SAP BW-EML results for Intel Haswell and IBM POWER8 processors, all running SAP HANA 1.0

New developments for SAP HANA on IBM Power Systems

At IBM, we're always looking for new opportunities to better meet the needs of SAP HANA users. While IBM Power Systems already provides the best mix of flexibility, resilience and performance for running SAP HANA workloads available today, there are a number of recent developments that will make IBM Power Systems even better suited to support SAP HANA.

About the IBM-SAP alliance

The SAP HANA capabilities outlined in this document are the product of a long and close working relationship between SAP and IBM. This partnership stretches back several decades, and is still shaping the direction of SAP HANA on IBM Power Systems environments today.

IBM is a multifaceted SAP partner, with over 30,000 employees specifically supporting SAP work. There are currently over 6000 successful SAP implementations running on IBM Power Systems worldwide. In addition, IBM has received 31 Pinnacle Awards as an outstanding SAP partner over the last 13 years, and was named the 2015 SAP HANA Adoption Partner of the Year.

Organizations that choose to work with IBM to support their SAP HANA implementation will get the benefit of our many years of SAP experience, as well as a single point of contact and end-to-end support for all SAP implementations. In addition to hardware and software offerings, IBM also has an SAP Consulting Practice that offers customers a variety of technical services, such as discovery, assessment, benchmarking, proofs of concept, and express deployment.

Final thoughts

Whether you're looking to move your SAP HANA workloads to a better platform, or make the move to SAP HANA for the first time, IBM Power Systems is the right choice for you. With its flexibility to deploy the way you want to deploy, resilience to keep your SAP HANA workloads up and running, and proven unmatched performance, no other hardware platform is as well suited for SAP HANA workloads as IBM Power Systems.

For more information

To learn more about IBM Power Systems for SAP HANA, contact your IBM representative or IBM Business Partner, or visit the following website: **ibm.com/power/saphana**

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Produced in the United States of America
August 2016

1 ITIC 2014 Reliability Survey. (http://itic-corp.com/blog/2014/04/ itic-2014-reliability-survey-ibm-servers-most-reliable-for-sixth-straight-yearcisco-ucs-comes-on-strong-hp-reliability-rebounds/)

2 SPEC CPU2006 test results. August 2015. (http://www.specbench.org/cpu2006/results)

3 Accelerate Big Data Insights With the Intel Xeon Processor E7-8800/4800 v3 Product Families, (http://www.intel.com/newsroom/kits/xeon/e7v3/pdfs/Xeon_E7v3_ProductBrief.pdf)

4 Intel product specifications, (http://ark.intel.com/compare/84679,84678,84677,84676,84688,84686,84685,84684,84683,84682,84681,84680)

5 Complete benchmark results and configurations are available at "SAP BW Enhanced Mixed Load (BW EML) Standard Application Benchmark Results" at (http://global.sap.com/solutions/benchmark/bweml-results.htm)

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