Cost/Benefit Case for SAP HANA Deployment

Comparing Costs and Effectiveness of System x and Competitive Solutions

Note: IBM System x solution for SAP HANA was transferred to Lenovo effective October 2014.
Table of Contents

EXECUTIVE SUMMARY 1

SOLUTIONS 5
  SAP HANA 5
    Overview 5
  Platforms 6
    Overview 6
    HP ConvergedSystem 900 8
    System X6 Architecture 8
    File Systems 9
    High Availability and Disaster Recovery 10

DETAILED DATA 11
  Basis of Calculations 11
  Cost Breakdowns 11

List of Figures

1. Three-year Costs for SAP HANA Deployment – Averages for Scale-out Configurations 2
2. Largest SAP HANA Test Systems 3
3. Principal SAP HANA Applications 5
4. Scale-out Vendors and Platforms 7
5. Complex Scale-out Configuration Example – HP ConvergedSystem 500 9
6. SAN-based and GPFS Configurations 9
7. Three-year Cost Breakdowns – Averages for Scale-out Configurations 11
Executive Summary

In less than four years, SAP HANA has gone from an innovative in-memory design to a major force in the IT world. SAP investments in architecture and technology, and in creating an ecosystem of applications, skills and third-party support, have encouraged rapid adoption worldwide.

In high performance analytics, SAP HANA has been shown to deliver levels of performance that exceed – in some cases, by hundreds or thousands of times – those of conventional platforms for SAP Business Warehouse (BW). The company has also positioned SAP HANA to support its Business Suite ERP systems and other SAP and third-party applications.

At the end of second quarter 2014, according to SAP, more than 3,600 customers had licensed SAP HANA, including 1,200 that had deployed SAP Business Suite on this platform. The company has also expanded into cloud delivery of SAP HANA solutions.

The eventual objective, as stated by SAP management, is to make SAP HANA an organizational standard for deployment of enterprise applications. Some large SAP customers have already adopted SAP HANA in this role, and the company expects more will follow.

Under any scenario, realizing the potential of SAP HANA will mean addressing many business and technical challenges. One of these challenges – which is the subject of this report – will be to put infrastructures in place that are capable of handling massive, sustained growth in workloads and data volumes almost indefinitely.

In terms of underlying appliances, there are two main models for SAP deployment: scale-up servers and scale-out clusters of servers and storage. More powerful Intel processors and increasingly sophisticated symmetric multiprocessing (SMP) designs mean that scale-up servers will continue to advance. But for broad-based enterprise deployments, it can be expected that scale-out clusters will predominate.

At present, scale-out solutions from seven vendors – Cisco, Dell, Fujitsu, Hitachi, Hewlett-Packard (HP), Huawei and IBM (Lenovo) – are certified by SAP for standard configurations of up to 16 or (in the case of System x) 56 nodes. SAP certifies larger systems on a case-by-case basis.

Because they employ similar hardware components, these systems are often seen as largely undifferentiated. This is not the case, however. There are fundamental differences between the System x scale-out architecture, which is built around the IBM General Parallel File System (GPFS), and other vendor offerings. (GPFS is licensed by Lenovo for use with the System x solution for SAP HANA.)

Cisco, Dell, Fujitsu, Hitachi, HP and Huawei employ the XFS file system, a derivative of Network File System (NFS), and storage area networks (SANs), including external disk arrays.

This difference has implications in three main areas:

1. **Costs of ownership.** Three-year costs of ownership for scale-out configurations are lower for use of System x solution for SAP HANA than for competitors.

   For entry-level 4-node clusters built around 2-processor servers, costs for use of System x solution for SAP HANA average 20 percent less than for equivalent Cisco offerings with EMC VNX or NetApp FAS disk arrays.

   For 4-, 8- and 12-node clusters built around 4-processor servers with 512 gigabyte (GB) RAM, costs for use of System x solution for SAP HANA average 20 percent less than for equivalent Cisco offerings with EMC VNX disk arrays. Costs average 19 percent less for equivalent Cisco offerings with NetApp FAS disk arrays.
For the same configurations built around 4-processor servers with 1 terabyte (TB) RAM, costs for use of System x solution for SAP HANA average 26 percent less than for HP ConvergedSystem 500 with HP 3PAR StoreServ disk arrays.

For 12- and 16-node clusters built around 8-processor servers, costs for use of System x solution for SAP HANA average 31 percent less than for use of HP ConvergedSystem 900, again with 3PAR StoreServ disk arrays. Comparative costs are shown in figure 1.

Figure 1: Three-year Costs for SAP HANA Deployment – Averages for Scale-out Configurations

Comparisons are for the most recent Intel Ivy Bridge v2-based server models and storage configurations from each vendor listed in SAP Certified Appliance Hardware for SAP HANA on the SAP Community Network (SCN).

Costs include hardware, maintenance, licenses and support for vendor-supplied software tools, and facilities costs including data center occupancy and power consumption. Costs of SAP software and implementation are not included.

Storage costs include internal drives and (in the case of Cisco and HP) disk arrays; and infrastructure costs are for switches, chassis, racks and other components. Calculations are based on discounted prices as reported by users. Actual vendor prices may differ in practice.

Additional configuration and cost information may be found in the Detailed Data section of this report.
2. **Performance and scalability.** The performance characteristics of SAP HANA in-memory database architecture are closer to the supercomputing world than to conventional commercial IT environments. This is particularly the case for scale-out deployments.

GPFS was designed as a parallel file system, and has been widely employed in supercomputing for more than a decade. It has shown near-linear scalability in extremely large configurations – systems with 1,000+ nodes are common, and the largest exceed 5,000 nodes. Data volumes often run to hundreds of terabytes, and petabyte-scale systems have been deployed.

NFS variants have shown more limited results. For example, academic users have reported that GPFS outperforms conventional NFS by 5 to 10 times. XFS has also been employed in some large supercomputing installations. User tests indicate that GPFS delivers from 1.35 to more than two times the performance of XFS for comparable workloads.

A further differentiator is that, in large SAN configurations, disk array and switching latencies cause performance degradation relative to GPFS.

In terms of scalability, System x solution for SAP HANA is certified by SAP for up to 56 scale-out nodes. Other vendors support up to 16. System x solution architecture is capable of scaling to 224 nodes.

In principle, other vendors also support larger configurations. (Cisco, for example, claims that up to 48 nodes may be certified on request.) It is unclear, however, whether systems of this size have been installed. In comparison, System x servers and GPFS have formed the basis of the highest-performing SAP HANA systems demonstrated to date.

In late 2012, SAP and IBM demonstrated a 100-node system – described by SAP as the world’s largest in-memory database system ever assembled – handling 1,000 TB (one petabyte) of raw data. In this test, a 25-times increase in query volume caused negligible performance degradation.

An expanded version of this cluster with 150 nodes was demonstrated at SAPPHIRE Madrid in November 2012. Figure 2 summarizes workloads and results for these tests.

<table>
<thead>
<tr>
<th>Test Date</th>
<th>October 2012</th>
<th>October 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raw data size</td>
<td>1,000 TB</td>
<td>1,000 TB</td>
</tr>
<tr>
<td>Compressed database</td>
<td>49.2 TB</td>
<td>49.2 TB</td>
</tr>
<tr>
<td>Number of records</td>
<td>1,200 billion</td>
<td>1,200 billion</td>
</tr>
<tr>
<td>Configuration</td>
<td>100 x IBM eX5</td>
<td>150 x IBM eX5</td>
</tr>
<tr>
<td></td>
<td>4 x E7-8870 10-core</td>
<td>4 x E7-8870 10-core</td>
</tr>
<tr>
<td></td>
<td>1 TB RAM/node</td>
<td>1 TB RAM/node</td>
</tr>
<tr>
<td></td>
<td>3.3 TB disk/node</td>
<td>3.3 TB disk/node</td>
</tr>
<tr>
<td>Used RAM per node</td>
<td>236 GB</td>
<td>236 GB</td>
</tr>
</tbody>
</table>

**Figure 2: Largest SAP HANA Test Systems**

Query workloads, according to SAP, were modeled on those of SAP HANA users. The 1.2 trillion records employed in the one-petabyte demonstration corresponded to ten years of data for a large corporation generating an average of 330 million transactions per day. In most cases, complex queries were processed in less than a second. The largest was processed in under 3.2 seconds.

These results, which were run using X-Architecture Generation 5 (X5) servers equipped with 10-core Intel Westmere processors, have not been equaled since. System x solution for SAP HANA now employs X-Architecture Generation 6 (X6) servers with 15-core Intel Ivy Bridge v2 processors.
GPFS is employed for single-node as well as scale-out configurations. For single-node appliances, GPFS also offers performance advantages over XFS. The I/O strengths of X6 servers further boost throughput relative to competitive platforms.

3. **High availability and disaster recovery.** The bottom-line impact of outages affecting core ERP systems such as SAP Business Suite has been extensively documented.

Real-time analytics systems are also proving to be sensitive to downtime. Even brief interruptions of service may impair decision-making processes throughout organizations, and recovering extremely large data volumes in the event of a serious outage will be a challenging process.

As use of SAP HANA within organizations expands, vulnerability will increase. A serious outage, or a protracted delay in recovering from one, may grind the entire business to a halt.

The SAP HANA design incorporates extensive high availability and disaster recovery features, although the manner in which they are implemented varies between appliance vendors. There is, again, a striking disparity between SAN-based approaches and GPFS.

SAN-based approaches require synchronization of server- and array-based failover and recovery. Complexity is materially increased, and there are more potential points of failure. In comparison, GPFS requires only failover of servers equipped with internal disks. Failover and recovery processes are simpler and faster.

GPFS also employs a stable and widely used failover and recovery architecture built around Failure Groups. Data may be replicated to multiple standby nodes in real-time. For example, in the one-petabyte SAP HANA test discussed above, 95 active and five standby nodes were employed. In practice, ratios of active to standby nodes vary according to user requirements.

For SAP users deploying SAP HANA, the choice of an appliance platform may appear to be a secondary issue. But usage will evolve rapidly, and later changes not only in hardware, but also in file systems – which will be closely entwined with SAP software – will be disruptive. It may be necessary to interrupt service at a time when organizations are beginning to realize the full value of SAP HANA applications.

Among appliance vendors, System x solution is widely believed to be the market share leader. This is particularly the case for scale-out solutions. It would be surprising if it were otherwise. The architecture and technology underlying the company’s offerings are – by a wide margin – better equipped to deal with the challenges of large-scale SAP HANA deployment than any other platform.
Solutions

SAP HANA

Overview

Since SAP HANA first appeared in 2010, SAP has migrated most of its application portfolio to SAP HANA, in the form of customer premises and hosted solutions. Current SAP HANA core offerings include SAP BW and BusinessObjects, along with Business Suite and BusinessOne for enterprise and midsize ERP users respectively.

In addition to core offerings, the SAP HANA portfolio has expanded to include new enterprise solutions and enhanced versions of earlier SAP software. These target a wide range of emerging applications for real-time analysis and exploitation of conventional as well as text and spatial data. There is a major focus on integrating data generated through clouds, mobile devices and social media.

Currently, principal SAP HANA applications are as shown in figure 3.

<table>
<thead>
<tr>
<th>CORE OFFERINGS</th>
<th>HANA Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP Business Suite</td>
<td>Business Intelligence On Demand</td>
</tr>
<tr>
<td>▪ Business Suite on HANA</td>
<td>Sales &amp; Operations Planning</td>
</tr>
<tr>
<td>▪ Sales Analysis for Retail</td>
<td>Supplier InfoNet</td>
</tr>
<tr>
<td>▪ ERP Operational reporting</td>
<td>Developer Access via AWS</td>
</tr>
<tr>
<td>▪ Sentiment Analysis</td>
<td></td>
</tr>
<tr>
<td>▪ Sales Pipeline Analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>SAP BW on HANA</td>
<td></td>
</tr>
<tr>
<td>▪ BW powered by HANA</td>
<td></td>
</tr>
<tr>
<td>▪ Business Planning &amp; Consolidation</td>
<td></td>
</tr>
<tr>
<td>Business One on HANA</td>
<td></td>
</tr>
<tr>
<td>▪ Business One on HANA</td>
<td></td>
</tr>
<tr>
<td>▪ SAP Business One Analytics</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>HANA Accelerators</td>
<td></td>
</tr>
<tr>
<td>▪ CRM customer segmentation</td>
<td></td>
</tr>
<tr>
<td>▪ Profitability Analysis (CO-PA)</td>
<td></td>
</tr>
<tr>
<td>▪ Finance &amp; Controlling</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>ENTERPRISE APPLICATIONS</td>
<td></td>
</tr>
<tr>
<td>Intelligent Customer Engagement</td>
<td>Dynamic Business Planning</td>
</tr>
<tr>
<td>▪ Account Intelligence</td>
<td>DSO (days sales outstanding) Scope</td>
</tr>
<tr>
<td>▪ Audience Discovery &amp; Targeting</td>
<td>Sales and Operations Planning</td>
</tr>
<tr>
<td>▪ Customer Engagement Intelligence</td>
<td>Working Capital Analytics</td>
</tr>
<tr>
<td>▪ Customer Value Intelligence</td>
<td></td>
</tr>
<tr>
<td>▪ Precision Marketing</td>
<td></td>
</tr>
<tr>
<td>Real-Time Sensing and Responding</td>
<td>Consumer Applications</td>
</tr>
<tr>
<td>▪ Demand Signal Management</td>
<td>Care Circles (healthcare providers)</td>
</tr>
<tr>
<td>▪ Energy &amp; Environmental Resource Management</td>
<td>Precision Gaming (gaming industry publishers)</td>
</tr>
<tr>
<td>▪ Overall Equipment Effectiveness Management</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Custom-Built Applications</td>
</tr>
<tr>
<td></td>
<td>Predictive analytics &amp; machine learning</td>
</tr>
<tr>
<td></td>
<td>Text analysis &amp; natural language processing</td>
</tr>
<tr>
<td></td>
<td>Spatial processing</td>
</tr>
<tr>
<td>Proactive Risk Management</td>
<td>Identity Analytics</td>
</tr>
<tr>
<td>▪ Accelerated Trade Promotion Planning</td>
<td>Liquidity Risk Management</td>
</tr>
<tr>
<td>▪ Fraud Management</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3: Principal SAP HANA Applications

The company has also moved aggressively to encourage both independent software vendors (ISVs) and customers to develop SAP HANA applications that may later be commercialized. In 2012, for example, the company formed a SAP HANA Real-Time Fund to invest in early-stage companies developing SAP HANA applications. An initial investment of $155 million was expanded to $405 million in 2013.
The first applications developed under this program, as well as through cooperative development with customers, are starting to appear. The portfolio will clearly expand in the future.

Although some new transaction processing solutions have been introduced, most activity in vendor- as well as customer-developed applications has been in high-value analytics.

The implications for SAP HANA platform choices are important. Experience has shown that large organizations routinely employ hundreds or even thousands of analytics applications, and numbers of these continue to increase. As SAP users transition to SAP HANA, workloads will expand far beyond present levels. Data growth, as well as real-time operations, will magnify stresses on underlying platforms.

User populations are also growing. Large organization data warehouses with 50,000+ internal users are increasingly common as access is extended to mid-level managers, professionals and, in many cases, front-line staff. SAP users are, moreover, extending access to business partners and customers via conventional e-commerce as well as mobile and social media channels.

These trends will apply to analytics applications on customer premises systems, as well as those delivered through clouds. The challenges of cloud-based delivery may be even larger when service providers support user populations across multiple organizations.

How will these challenges be met? That will depend upon which platform is employed.

**Platforms**

**Overview**

In enabling hardware support for SAP HANA, the company defines specifications for and certifies hardware platforms, while vendors implement, install and support these.

There are currently two categories of certified hardware:

1. **Single-node** solutions range from 2-processor servers with 128 GB of database memory to 4-processor servers with 2 TB of RAM. Internal flash drives and/or HDDs form storage pools holding SAP HANA logs and data.

   A separate category of *SAP Business Suite powered by SAP HANA (SoH)* solutions is single servers optimized to support the company’s mainstream ERP stack. Current solutions include 2-, 4- and 8-processor servers with between 768 GB and 6 TB RAM. SoH solutions employ SAP storage pools.

   The 8-processor System x3950 X6 server can support 12 TB of memory, but to date has been certified by SAP only for 6 TB configurations for production environments. The 12 TB configuration can be used in non-production environments, according to SAP’s relaxed configuration guidelines.

   HP claims that a 16-processor SoH version of its ConvergedSystem 900 can *theoretically* support 12 TB RAM, and SGI has also discussed plans for larger models. SAP has not, however, certified such configurations.

   SAP supports use of 8-processor servers with 12 TB RAM for non-production systems.
2. **Scale-out** solutions employ 2-, 4- or 8-processor servers with 256 GB to 1 TB or (in the case of the HP ConvergedSystem 900 and System x3950 X6) 2 TB of RAM each. Servers are configured in standard clusters of up to 16 or (for System x solution for SAP HANA) 56 nodes. SAP may also certify larger clusters for individual customers.

With the exception of System x solution for SAP HANA, vendor offerings employ external disk arrays. Current configurations listed on SAP SCN are summarized in figure 4.

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Servers &amp; RAM</th>
<th>Maximum Nodes</th>
<th>File System</th>
<th>Disk Arrays</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco</td>
<td>B260 M4 (2-socket) + 512 GB B460 M4 &amp; C460 M4 (4-socket) + 1 TB</td>
<td>4 16</td>
<td>XFS or NFS</td>
<td>EMC VNX 5400 or NetApp FAS 8040</td>
</tr>
<tr>
<td>Dell</td>
<td>R920 (4-socket) + 1 TB</td>
<td>16</td>
<td>XFS</td>
<td>Compellent Storage Array</td>
</tr>
<tr>
<td>Fujitsu*</td>
<td>RX600 (2-socket) + 256 GB RX600 (4-socket) + 512 GB RX600 (8-socket) + 1 TB</td>
<td>16</td>
<td>NFS</td>
<td>Eternus NR1000 3240/3250 or NetApp FAS 3240/3250</td>
</tr>
<tr>
<td>HP</td>
<td>ConvergedSystem 500 (4-socket) ConvergedSystem 900 (8-socket)</td>
<td>16</td>
<td>XFS</td>
<td>3PAR StoreServ 7400</td>
</tr>
<tr>
<td>Hitachi</td>
<td>CB520X B1 (4-socket) + 1 TB</td>
<td>16</td>
<td>XFS</td>
<td>Hitachi Unified Storage (HUS) VM</td>
</tr>
<tr>
<td>Huawei</td>
<td>FusionCube E9000 or RH5885H V3 (4-socket): 512 GB or 1 TB</td>
<td>16</td>
<td>XFS</td>
<td>FusionStorage or OceanStor S5500T</td>
</tr>
<tr>
<td>System x</td>
<td>x3850 X6 (2-socket) + 256 GB x3850 X6 (4-socket) + 512 GB x3950 X6 (4- &amp; 8-socket): 512 GB-2 TB</td>
<td>4 56 56</td>
<td>GPFS</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Westmere-based

**Figure 4: Scale-out Vendors and Platforms**

With the exception of Fujitsu, servers employ Intel Ivy Bridge v2 processors. Scale-out certifications for Fujitsu servers with Ivy Bridge v2 processors had not been published when this report was written. The Fujitsu configurations shown are for Westmere-based models.

This list should not be considered exhaustive. In practice, vendors often offer other configurations on a case-by-case basis. System x solution for SAP HANA options, for example, also include x3850 X6 models with 128 GB and 768 GB RAM, and x3950 X6 models with 1.5 TB RAM. Others offer comparable variants.

These solutions may be deployed on SUSE as well as Red Hat Enterprise Linux (RHEL) variants of Linux. System x was the first platform to offer a full suite of certified SAP HANA configurations for RHEL.

Although initial SAP HANA servers were based on the Intel Westmere generation of technology, vendors of all three types of solution have largely transitioned to Intel Ivy Bridge v2 processors and, for scale-out solutions, upgraded disk array platforms. Although IBM has continued to employ GPFS, other vendors have typically moved from earlier Linux-based file systems to XFS.

SAP also offers the Tailored Data Center Integration (TDI) program, which allows use of a broad range of Tier 1 and midrange disk arrays in SAP HANA deployments. The objective is to allow users to employ existing arrays rather than installing new ones. TDI implementations must be certified by SAP.

Disk array platforms supported under the TDI program, however, remain subject to the limitations of SAN-based approaches described in this report.
SAP also supports VMware for non-production and (since May 2014) production SAP HANA environments on 2- and 4-processor single-node servers.

Two recent innovations in server hardware supporting SAP HANA deployments – the HP ConvergedSystem 900, and X6 architecture on System x platforms – deserve closer attention.

**HP ConvergedSystem 900**

The appearance of this platform in June 2014 generated considerable interest. According to HP, the design employs crossbar-switching technology originally developed for the HP Integrity UNIX platform.

Although HP has advertised that the ConvergedSystem 900 can in principle support 16-processor configurations and larger main memories for SAP HANA SoH deployments, this platform is currently certified for only eight processors and 6 TB of memory, the same as for the x3950 X6.

According to HP, future versions of the ConvergedSystem 900 will include multisystem configurations supporting more than 80 TB in physical memory. It is unclear when this solution will be available, or whether it would be supported in scale-out environments.

Although the ConvergedSystem 900 employs new scaling technology, it is still fundamentally an SMP system. In meeting future SAP demands, a choice emerges between progressively larger SMP platforms and clusters in general, and GPFS clusters in particular.

A number of questions should be posed about use of large single servers. One is that it is unclear whether these could realistically support the kind of workloads that would be generated by SAP HANA in large organizations in, say, five years.

Another concerns high availability and disaster recovery. Experience has shown that use of a few large systems to support business-critical applications increases vulnerability to severe data center disruptions – *more eggs are in fewer baskets*. While exposure can be mitigated, this typically requires major investments in duplicate systems, data center hardening and high-end software.

In comparison, scale-out clusters offer redundancy built around smaller, less expensive servers. In four-node environments, for example, vendors typically offer 3+1 configurations (three active servers and one standby). GPFS provides greater flexibility.

**System X6 Architecture**

System x servers built around X6 architecture also feature significant hardware innovation.

X6 refers to the sixth generation of Enterprise X-Architecture, which is designed to deliver *balanced system performance*; i.e., the potential of all performance-related variables – including processors, memory, I/O, storage and network fabrics – is maximized. X-Architecture designs have proved highly synergistic with SAP HANA workloads.

X6 servers support CacheCade, which accelerates read and write I/O performance by allowing specially configured solid state drives (SSDs) to act as an extension of server cache. This technology, originally developed by LSI Logic, has been implemented in a manner optimized for SAP HANA. Up to four 400 GB SSDs are supported in RAID 0 or RAID 1 configurations.

Although no data on SAP HANA-specific performance impacts has been released, CacheCade users have typically experienced improvements of three to five times in I/O throughput for other workloads.

To facilitate cluster upgrades and migration, System x solution for SAP HANA allows coexistence of servers based on X6 as well as previous generation X5 architecture.
File Systems

In SAP HANA scale-out configurations, the XFS file system is coupled with external disk arrays and SANs. These add to complexity. Figure 5, for example, shows components for the HP ConvergedSystem 500.

<table>
<thead>
<tr>
<th>Component</th>
<th>Base</th>
<th>4 nodes x 4-processors (4 TB/node)</th>
<th>8 nodes x 8 processors (8 TB/node)</th>
<th>12 nodes x 8 processors (12 TB/node)</th>
<th>16 nodes x 8-processors (16 TB/node)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Compute node</td>
<td>DL580 G8</td>
<td>4x</td>
<td>8x</td>
<td>12x</td>
<td>16x</td>
</tr>
<tr>
<td>NFS Block</td>
<td>DL380p G8</td>
<td>2x</td>
<td>2x</td>
<td>2x</td>
<td>2x</td>
</tr>
<tr>
<td>Central Management Console (CMC) Block</td>
<td>DL380p G8</td>
<td>1x</td>
<td>1x</td>
<td>1x</td>
<td>1x</td>
</tr>
<tr>
<td>Storage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3PAR Base Block</td>
<td>StoreServ 7400</td>
<td>1x</td>
<td>2x</td>
<td>3x</td>
<td>4x</td>
</tr>
<tr>
<td>3PAR SP Block</td>
<td>Service Processor</td>
<td>1x</td>
<td>2x</td>
<td>3x</td>
<td>4x</td>
</tr>
<tr>
<td>3PAR Drive Enclosures</td>
<td></td>
<td>2x</td>
<td>4x</td>
<td>6x</td>
<td>8x</td>
</tr>
<tr>
<td>Switches</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAN Block</td>
<td>SN6000B 16Gb 48-port/24-port Active Fibre Channel Switch</td>
<td>2x</td>
<td>4x</td>
<td>6x</td>
<td>8x</td>
</tr>
<tr>
<td>LAN Block</td>
<td>5900 AF-48XG-4QSFP+ Switch</td>
<td>2x</td>
<td>4x</td>
<td>6x</td>
<td>8x</td>
</tr>
<tr>
<td>Management Switch Block</td>
<td>5900AF-48G-4XG-2QSFP+ Switch</td>
<td>1x</td>
<td>1x</td>
<td>1x</td>
<td>1x</td>
</tr>
</tbody>
</table>

Figure 5: Complex Scale-out Configuration Example – HP ConvergedSystem 500

Latencies are significantly higher than for System x. In System x SAP HANA configurations, there are no disk arrays – internal storage is tightly integrated with servers – and only two multifunction switches are required. Higher latencies translate into greater performance degradation. In Cisco and Huawei solutions, blade fabrics compound these effects.

In comparison, GPFS stripes data across all disks on all nodes, and reads and writes to these in parallel. External disk arrays and SANs are not required. Figure 6 illustrates this distinction.

GPFS also incorporates a distributed metadata structure, policy-driven automated storage tiering, managed high-speed replication, information lifecycle management (ILM) tooling and other features.

Figure 6: SAN-based and GPFS Configurations
High Availability and Disaster Recovery

High availability and disaster recovery features form part of the SAP HANA design. *Auto-host failover* supports use of cold, warm and hot standby servers. (*Cold*, in this context, means that a standby server receives periodic scheduled backups, but is not activated until the primary server fails; *warm* means that data is copied periodically between active servers; and *hot* means that data is replicated continuously, in real time.)

Synchronous *system replication* for disaster recovery is supported for local or regional replication, typically up to 50 kilometers (c. 30 miles), while asynchronous replication may be employed at distances of over 500 kilometers (or 300 miles). Although SAP offers deployment consulting and support services, vendors typically play the central role in implementing solutions.

There are, again, significant differences between SAN-based approaches and GPFS. The former result in more complex configurations requiring synchronization of server- and array-level failover and recovery processes.

In comparison, GPFS employs technologies that are integrated into the core file system structure rather than implemented through hardware add-ons and software overlays. GPFS automatically replicates data to one or multiple standby servers in real time, implements locking and enables clusters to continue operation using replicated data. No interruptions of service occur.

The core structure for this approach is a GPFS Failure Group, which consists of a set of administrator-defined servers sharing a potential point of failure. Data is replicated to and may be reactivated on one or two servers outside this group.

The GPFS-based disaster recovery solution for SAP HANA was certified by SAP as of December 2012. It is currently supported in synchronous mode only. There are no restrictions on configuration size.

HP has also announced support for its ServiceGuard high availability and disaster recovery solution for SAP HANA for ConvergedSystem 500 and 900. This implementation is, however, restricted to scale-up configurations.
Detailed Data

Basis of Calculations
Cost comparisons presented in this report were calculated for scale-out solutions offered by Cisco Systems with NetApp FAS 8040 and, separately, EMC VNX 5400 disk arrays; HP (ConvergedSystem 500 and 900, which include 3PAR StoreServ 7400 disk arrays); and System x3850 and x3950 with internal drives and GPFS.

Calculations were for hardware and, where appropriate, systems software as described in SAP and/or vendor documentation, and based on discounted list prices as reported by users.

Costs are divided between servers, storage, infrastructure (including switches, racks and other components supporting servers and storage) and facilities. Each category includes hardware acquisition as well as three-year maintenance costs. Software costs for GPFS are included in server costs, and include licenses as well as three years of software maintenance (SWMA) coverage.

All maintenance and software costs were for 24/365 coverage with a minimum four-hour response time. Calculations do not include costs for SAP software and Linux operating systems.

Facilities costs for data center occupancy are for space occupied by racks, including allowance for service clearances and inactive areas, and are based on a conservative assumption of average cost per square foot for existing Tier I facilities (i.e., costs do not include new construction). Costs also include energy consumption by IT equipment and by cooling, power distribution and related equipment. Costs were calculated based on 24-hour, 365 days per year utilization over a three-year period.

All cost values are for the United States.

Cost Breakdowns
Detailed breakdowns of costs are presented in figure 7.

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Servers ($)</th>
<th>Storage ($)</th>
<th>Infrastructure ($)</th>
<th>Facilities ($)</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-processor servers (256 GB/node) x 4 nodes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cisco + EMC VNX 5400</td>
<td>24,100</td>
<td>240,380</td>
<td>86,991</td>
<td>72,053</td>
<td>423,524</td>
</tr>
<tr>
<td>Cisco + NetApp FAS 8040</td>
<td>24,100</td>
<td>247,880</td>
<td>86,991</td>
<td>60,706</td>
<td>419,677</td>
</tr>
<tr>
<td>System x3850</td>
<td>251,464</td>
<td>27,474</td>
<td>20,119</td>
<td>38,204</td>
<td>337,261</td>
</tr>
<tr>
<td>4-processor servers (512 GB/node) x 4-12 nodes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cisco + EMC VNX 5400</td>
<td>430,779</td>
<td>427,852</td>
<td>136,553</td>
<td>139,677</td>
<td>1,134,861</td>
</tr>
<tr>
<td>Cisco + NetApp FAS 8040</td>
<td>430,779</td>
<td>433,790</td>
<td>136,553</td>
<td>119,791</td>
<td>1,120,913</td>
</tr>
<tr>
<td>System x3850</td>
<td>748,666</td>
<td>48,079</td>
<td>35,208</td>
<td>76,679</td>
<td>908,632</td>
</tr>
<tr>
<td>4-processor servers (1 TB/node) x 4-12 nodes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP ConvergedSystem 500</td>
<td>684,263</td>
<td>390,595</td>
<td>185,388</td>
<td>182,018</td>
<td>1,442,264</td>
</tr>
<tr>
<td>System x3850</td>
<td>880,190</td>
<td>54,947</td>
<td>40,238</td>
<td>87,953</td>
<td>1,063,327</td>
</tr>
<tr>
<td>8-processor servers (1 TB/node) x 12 nodes + 8-processor servers (2 TB/node) x 16 nodes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HP ConvergedSystem 900</td>
<td>2,619,865</td>
<td>576,349</td>
<td>262,311</td>
<td>446,888</td>
<td>3,905,412</td>
</tr>
<tr>
<td>System x3950</td>
<td>2,283,241</td>
<td>160,907</td>
<td>57,614</td>
<td>210,977</td>
<td>2,712,739</td>
</tr>
</tbody>
</table>

Figure 7: Three-year Cost Breakdowns – Averages for Scale-out Configurations
International Technology Group

*ITG sharpens your awareness of what’s happening and your competitive edge . . . this could affect your future growth and profit prospects*

International Technology Group (ITG), established in 1983, is an independent research and management consulting firm specializing in information technology (IT) investment strategy, cost/benefit metrics, infrastructure studies, deployment tactics, business alignment and financial analysis.

ITG was an early innovator and pioneer in developing total cost of ownership (TCO) and return on investment (ROI) processes and methodologies. In 2004, the firm received a Decade of Education Award from the Information Technology Financial Management Association (ITFMA), the leading professional association dedicated to education and advancement of financial management practices in end-user IT organizations.

Client services are designed to provide factual data and reliable documentation to assist in the decision-making process. Information provided establishes the basis for developing tactical and strategic plans. Important developments are analyzed and practical guidance is offered on the most effective ways to respond to changes that may impact complex IT deployment agendas. A broad range of services is offered, furnishing clients with the information necessary to complement their internal capabilities and resources.

Clients include a cross section of IT end users in the private and public sectors representing multinational corporations, industrial companies, financial institutions, service organizations, educational institutions, federal and state government agencies as well as IT system suppliers, software vendors and service firms. Federal government clients have included agencies within the Department of Defense (e.g., DISA), Department of Transportation (e.g., FAA) and Department of Treasury (e.g., US Mint).