Performance characterization of HP ProLiant BL685c G5 with Quad-Core AMD Opteron processors (2.3 GHz) in a 64-bit HP Server Based Computing environment

Executive summary

Important:
This document describes a performance characterization performed utilizing the HP 64-bit test harness, which incorporates a Microsoft® Office 2003 workload.
Test results cannot be compared directly with the results of tests performed using the 32-bit Office XP- or Office 2003-based harness.

The HP ProLiant BL685c G5 server blade delivers uncompromising performance and expandability in a dense form factor. With up to four Quad-Core AMD Opteron™ processors, 64 GB of DDR2 memory, two hot plug serial hard drives, four integrated network adapters and three I/O expansion slots, the HP ProLiant BL685c G5 server blade can support the most demanding enterprise-class applications.

A four-socket[1] HP ProLiant BL685c G5 server blade with the AMD Opteron Processor Model 8356 (2.3 GHz) can provide optimal support for up to the following numbers of users (as described in Table 2) in a 64-bit HP Server Based Computing (SBC) environment:

Heavy Users	301
Medium Users	444
Light Users	544

Since the kernel memory constraints that limit scalability in a 32-bit HP SBC environment have been removed, this performance characterization demonstrates that customers can expect to fully utilize the resources of this server in a 64-bit environment, even when running their 32-bit applications.

Testing performed in March 2008 is described.

Audience

This performance characterization is intended primarily for IT professionals planning HP SBC solution deployments. The performance and sizing information provided herein is designed to help customers estimate the number of HP ProLiant BL685c G5 server blades required for a particular environment.

Introduction

The HP ProLiant BL685c G5 server blade (shown in Figure 1) is ideal for multi-threaded, multi-tasked environments, high-performance computing, and HP SBC.

Note:
This server blade is deployed within an HP BladeSystem enclosure. For more information, refer to Appendix A – HP BladeSystem.

[1] Four-processor, also known as 4P

Figure 1. HP ProLiant BL685c G5 server blade

AMD Opteron processors

The HP ProLiant BL685c G5 server blade supports up to four Quad-Core AMD Opteron 8300 Series processors. This native quad-core processor delivers the following benefits:

- **Outstanding performance**
  The Quad-Core Opteron processor is designed for optimal multi-threaded application performance. Its native quad-core implementation features four cores on a single die for more efficient data sharing, while the enhanced cache structure and integrated memory controller can sustain application throughput. This processor provides outstanding processing power and, together with its performance-per-watt enhancements, can improve IT responsiveness while maintaining data center costs.
- **Enhanced power efficiency**
  Thanks to Enhanced AMD PowerNow!™ technology and the introduction of AMD CoolCore™ technology, Quad-Core Opteron processors are very power-efficient, helping to reduce power needs and cooling costs in the data center.
  (For more on power management enhancements, see AMD Dual Dynamic Power Management.)
- **Optimal virtualization**
  Featuring AMD Virtualization™ (AMD-V™) technology with nested paging acceleration, Quad-Core Opteron processors can accelerate the performance of virtualized applications and improve efficiency when switching between virtual machines; as a result, customers can typically host more virtual machines and users per system, maximizing the consolidation and power-saving benefits of virtualization.

- **Investment protection**
  By leveraging AMD's Common Core Strategy and Same Socket Technology, Quad-Core Opteron processors can minimize changes to the customer's software and data center infrastructure, protecting IT investments and simplifying management.

AMD Dual Dynamic Power Management

Dual Dynamic Power Management functionality allows each processor to maximize the power-saving benefits of Enhanced AMD PowerNow! without compromising performance, reducing idle power consumption and enabling per-processor power management in multi-socket systems to further reduce power consumption.

By powering core and memory controller voltage planes independently, Dual Dynamic Power Management can enhance both performance and power management.

Benefits include:

- **Increased performance**
  The memory controller is able to run at a higher frequency, helping to reduce memory latency and thus improving application performance.
- **Improved power management**
  By operating independently from the memory controller, the cores in a Quad-Core Opteron processor can exploit the power savings offered by Enhanced PowerNow! more often, resulting in reduced power and cooling bills. In addition, the processor reduces power to the northbridge[2] when memory is not in use, while continuing to provide full power to the cores.

The following sections of this paper describe the testing performed by HP to characterize the performance and scalability of an HP ProLiant BL685c G5 server blade in a 64-bit HP SBC environment.

Note:
A 64-bit HP SBC environment eliminates the kernel memory constraints that can limit server scalability in a 32-bit HP SBC environment. For more information, refer to Appendix B – Using Microsoft Windows Server 2003 x64 Editions.

[2] Or memory controller hub (MCH)

Test methodology

HP continues to upgrade existing HP ProLiant servers and introduce new servers to meet particular business needs. To help customers select the appropriate server for their particular HP SBC environment, HP publishes this and other performance characterizations so that you can compare individual server performance and scalability.

This section describes how HP determined the optimal number of users supported by an HP ProLiant BL685c G5 server blade with the Opteron Processor Model 8356 (2.3 GHz) – henceforth referred to as the HP ProLiant BL685c G5 server blade – in a 64-bit test harness.

Important:
As with any laboratory testing, the performance metrics quoted in this paper are idealized. In a production environment, these metrics may be impacted by a variety of factors.

HP recommends proof-of-concept testing in a non-production environment using the actual target application as a matter of best practice for all application deployments. Testing the actual target application in a test/staging environment identical to, but isolated from, the production environment is the most effective way to characterize system behavior.

This section provides more information on test tools, user profiles and test scenarios.

Test tools

To facilitate the placement and management of simulated loads on an HP SBC server, HP used Terminal Services Scalability Planning Tools (TSScaling), a suite of tools developed by Microsoft to help organizations with Microsoft Windows® Server 2003 Terminal Server capacity planning.

Table 1 describes these tools.

Table 1. Components of TSScaling

Component		Description
Automation tools	Robosrv.exe	Drives the server-side of the load simulation
	Robocli.exe	Helps drive the client-side of the load simulation
Test tools	Qidle.exe	Determines if any scripts have failed and require operator intervention
	Tbscript.exe	A script interpreter that helps drive the client-side load simulation
Help files	TBScript.doc	Terminal Server bench scripting documentation
	TSScalingSetup.doc	A scalability test environment set-up guide
	TSScalingTesting.doc	A testing guide

More information

- Roboserver (Robosrv.exe) and Roboclient (Robocli.exe): Terminal Server capacity planning
- TSScaling: Windows Server 2003 Terminal Server Capacity and Scaling

User profiles

To simulate typical workloads in this environment, HP used scripts based on the Heavy, Medium, and Light User profiles described in Table 2.

Table 2. User profiles incorporated into the test scripts

User class	Activities
Heavy User	Heavy Users (also known as Structured Task Workers) tend to open multiple applications simultaneously and remain active for long periods. Heavy Users often leave applications open when not in use.
Medium User	Medium Users (also known as Knowledge Workers) are defined as users who gather, add value to, and communicate information in a decision-support process. Cost of downtime is variable but highly visible. These resources are driven by projects and ad-hoc needs towards flexible tasks. These workers make their own decisions on what to work on and how to accomplish the task. Sample tasks include: marketing, project management, sales, desktop publishing, decision support, data mining, financial analysis, executive and supervisory management, design, and authoring.
Light User	Light Users (also known as Data Entry Workers) input data into computer systems. Activities include transcription, typing, order entry, clerical work and manufacturing.

Table 3 outlines the activities performed by each user class utilizing Office 2003 products.

Table 3. Activities incorporated into the test scripts for each user class

Activity description		Heavy User	Medium User	Light User
Access	Open a database, apply a filter, search through records, add records, and delete records.	X		
Excel	Open, print and save a large spreadsheet.	X	X	X
Excel_2	Create a new spreadsheet, enter data, and create a chart. Print and save the spreadsheet.		X	X
InfoPath	Enter data[3] into a form; save the form over an existing form.	X	X	
Outlook	First pass: Email a short message. Second pass: Email a reply with an attachment.	X		
Outlook_2	Create a long reply.	X		
PowerPoint	Create a new presentation, insert clipart, and apply animation. View the presentation after each slide is created.	X	X	
PowerPoint2	Open and view a large presentation with heavy animation and many colors and gradients.	X		
Word	Create, save, print, and email a document.	X[4]	X	X

Test scenarios

For the Heavy User type, HP initiated testing by running the appropriate script with a group of 15 simulated users. Start times were staggered to eliminate authentication overhead. After these sessions finished, HP added 15 more users, then repeated the testing. Further groups of 15 users were added until the maximum number of users was reached.

For Medium and Light User types, HP utilized groups of ten users.

Performance and scalability metrics

While the scripts were running, HP monitored a range of Windows Performance Monitor (Perfmon) counters to help characterize server performance and scalability. In particular, HP has monitored CPU utilization (**% Processor Time**) to establish the optimal number of users supported on an HP SBC server – by definition, the number of users active when processor utilization reaches 80%. At this time, a limited number of additional users or services can be supported; however, user response times may become unacceptable.

To validate scalability metrics obtained using Perfmon, HP also runs canary scripts to characterize Heavy User response times – a very practical metric – for discrete activities such as an application being invoked or a modal box appearing. By monitoring response times as more and more users log on, HP has been able to demonstrate that these times are acceptable when the optimal number of users (as determined using Perfmon counter values) is active.

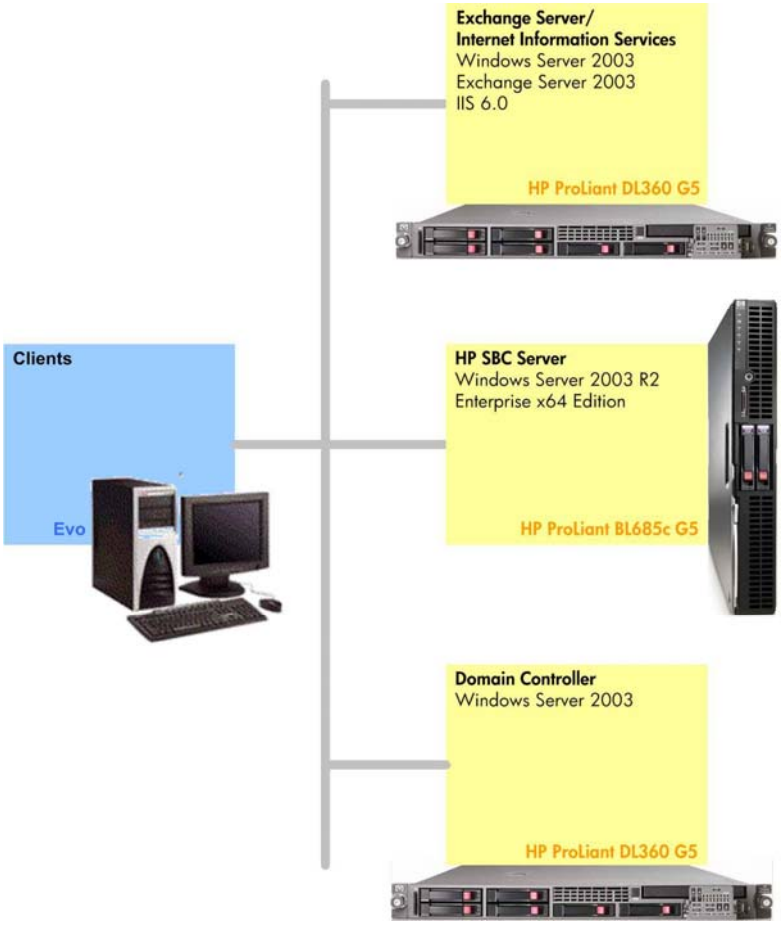
[3] Data entry for Office InfoPath 2003 requires significant processor resources
[4] Shortened version for Heavy Users

Note:
When running canary scripts, HP considers user response times to become unacceptable when they increase markedly over a baseline measurement.

Test topology

Figure 2 illustrates the HP SBC test environment.

Figure 2. The tested environment



Note:
Test environments such as that shown in Figure 2 are available to customers at HP Solution Centers to help solve a wide variety of business problems.

Configurations

Table 4 summarizes the configurations of servers and clients used in the test environment.

Table 4. System configurations

Server	Configuration
HP SBC server	4P HP ProLiant BL685c G5 server blade with: • Opteron Processor Model 8356 (2.3 GHz) – 512 KB L2 cache per core; 2 MB L3 cache • 32 GB RAM • Integrated Smart Array E200i controller with RAID 0 • Two 36 GB 15,000 rpm SAS hard drives – 48 GB page file on system partition • NC373i Multifunction Gigabit Server Adapter
	Windows Server 2003 R2 Enterprise x64 Edition with Service Pack 2; Terminal Services enabled Office 2003
Exchange Server/ Internet Information Services	2P HP ProLiant DL360 G5 server with: • Dual-Core Intel® Xeon® processor (3.2 GHz) • 2 x 2 MB L2 cache • 2 GB RAM • Four 72 GB 15,000 rpm SAS hard drives • Integrated Smart Array P400i controller with RAID 5 • NC373i Multifunction Gigabit Server Adapter
	Windows Server 2003 Enterprise Edition Microsoft Exchange Server 2003 Microsoft Internet Information Services (IIS) 6.0
Domain Controller	2P HP ProLiant DL360 G5 server with: • Dual-Core Xeon processor (3.2 GHz) • 2 x 2 MB L2 cache • 2 GB RAM • Four 72 GB 15,000 rpm SAS hard drives • Integrated Smart Array P400i controller with RAID 5 • NC373i Multifunction Gigabit Server Adapter
	Windows Server 2003 Enterprise Edition

Continued

Table 4. System configurations (continued)

Server	Configuration
Client	Variety of Intel Pentium®-based Compaq Evo workstations (600 MHz – 2.533 GHz), each with: • At least 256 MB of memory • 1024 x 768/16-bit color depth • 100 Mbps NIC
	Windows 2000 Professional or Windows XP

HP SBC server summary

Table 5 summarizes the configuration of the tested HP SBC server.

Table 5. System summary for the HP ProLiant BL685c G5 server blade

Component	Description
Operating system (OS)	Microsoft Windows Server 2003, Enterprise x64 Edition
Version	5.2.3790 Service Pack 2, Build 3790
Other OS description	R2
System name	BL685G5
System model	ProLiant BL685c G5
System type	x64-based PC
Processor (each of 16 cores)	AMD64 Family 16 Model 2 Stepping 3 AuthenticAMD ~2311 MHz
BIOS version/date	HP A08, 2/26/2008
SMBIOS version	2.4
Windows directory	C:\WINDOWS
System directory	C:\WINDOWS\system32
Boot device	\Device\HarddiskVolume1
Locale	United States
Hardware abstraction layer version	5.2.3790.3959 (srv03_sp2_rtm.070216-1710)
User name	[Not available]
Time zone	New Zealand Standard Time

Continued

Table 5. System summary for the HP ProLiant BL685c G5 server blade (continued)

Component	Description
Total physical memory	32,765.62 MB
Available physical memory	30.78 GB
Total virtual memory	79.06 GB
Available virtual memory	78.78 GB
Page file space	48.00 GB
Page file	C:\pagefile.sys

Performance test results

This section outlines the test results used by HP to characterize the performance and scalability of the HP ProLiant BL685c G5 server blade.

- **Perfmon values** – Shows select Perfmon counter values for the Heavy User scenario
- **Canary times** – Shows Heavy User response times for a sample canary script

Note:
As with any laboratory benchmark, the performance metrics quoted in this performance brief are idealized. In a production environment, these metrics may be impacted by a variety of factors; for more information, refer to Appendix C – SBC solution sizing.

HP determined that there were no disk or network bottlenecks in the test environment.

Perfmon values

HP ran a series of performance tests using scripts based on the Heavy, Medium, and Light User profiles. Figure 3 shows the test results for Heavy Users.

Figure 3. **% Processor Time** values for Heavy Users – showing that 301 Heavy Users were supported when processor utilization reached 80%

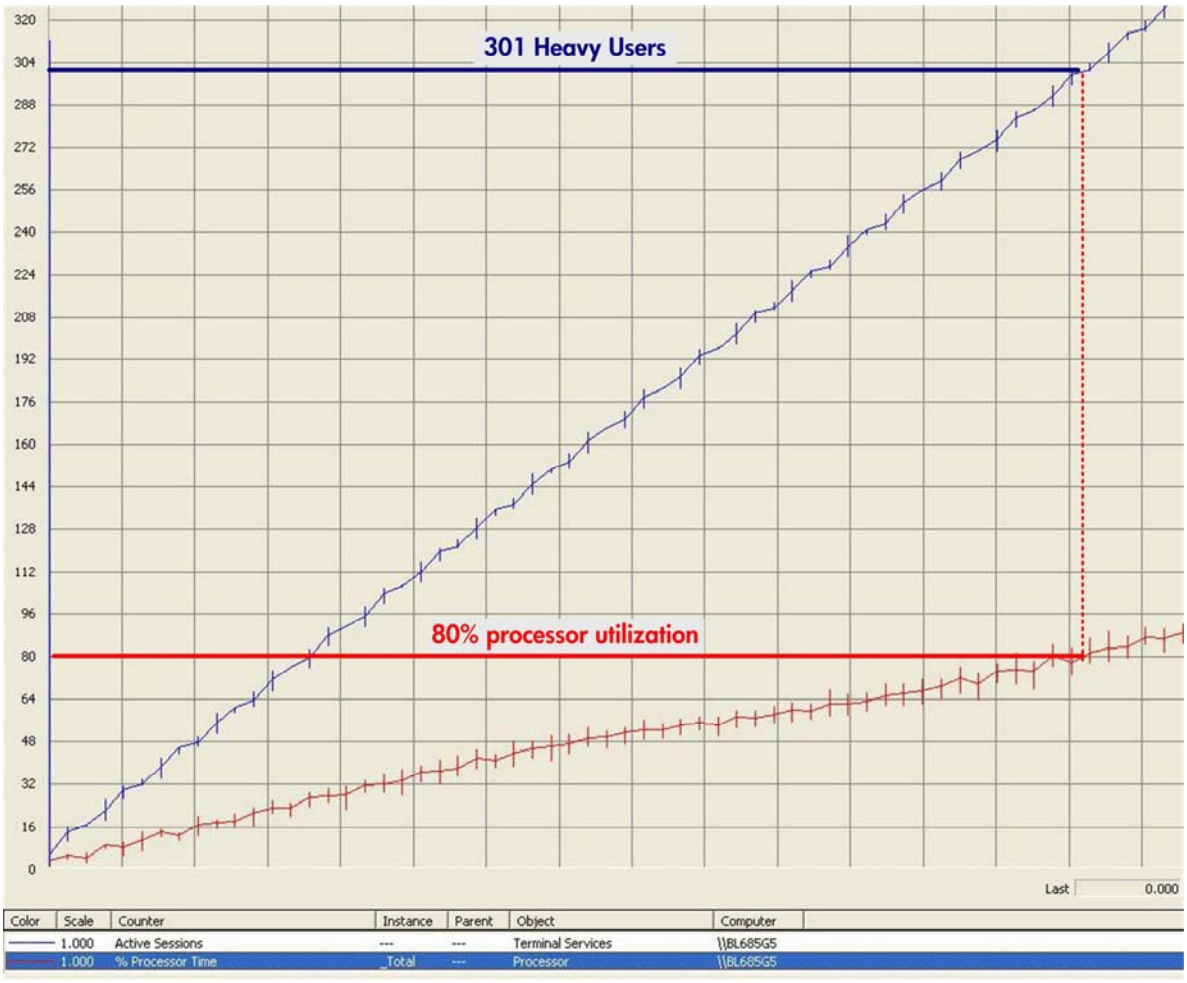


Figure 3 shows the optimal number of Heavy Users supported by the HP ProLiant BL685c G5 server blade to be 301.

Canary times

Figure 4 shows sample results for the HP ProLiant BL685c G5 server blade running a typical canary script.

Individual user response times are shown in blue, with a yellow line depicting average response times.

HP analyzed this figure to determine when response times began to increase markedly and consistently over a baseline level, indicating that user response times had become unacceptable.

Figure 4. Canary time values show that response times began to become unacceptable when 340 Heavy Users were active

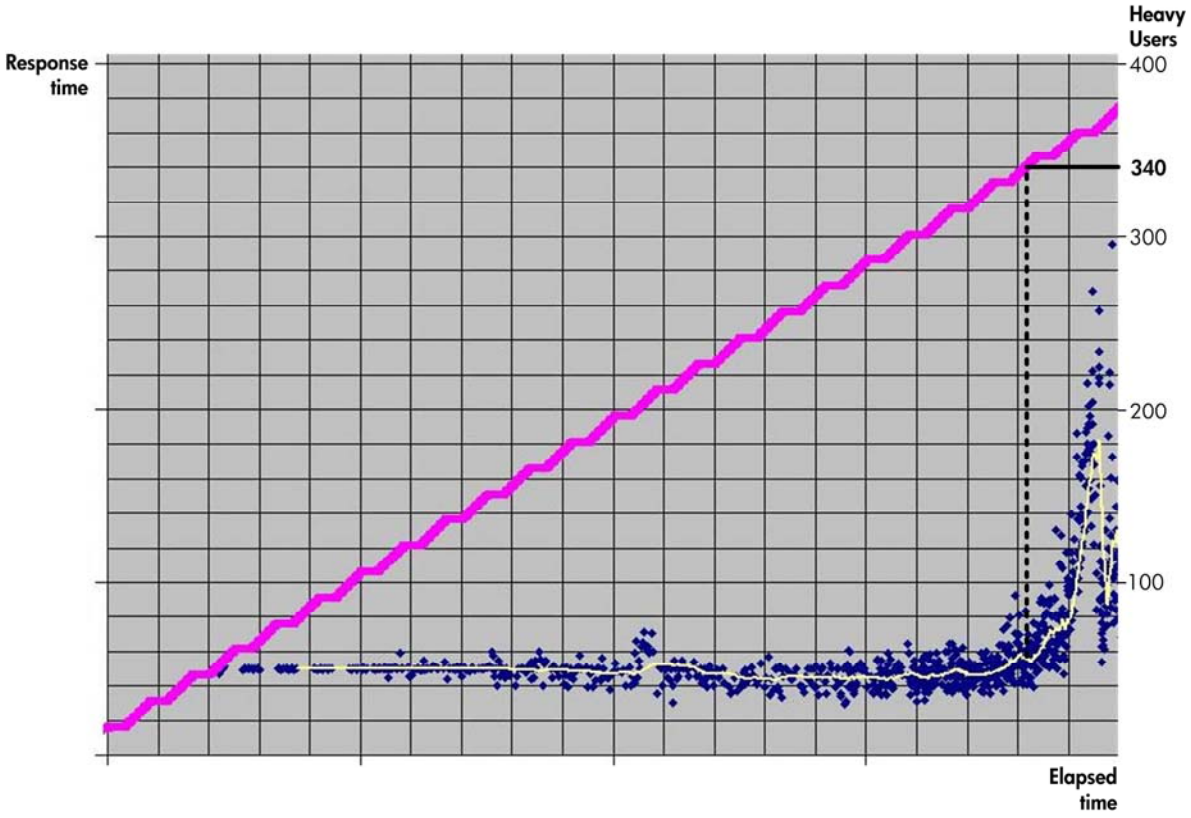
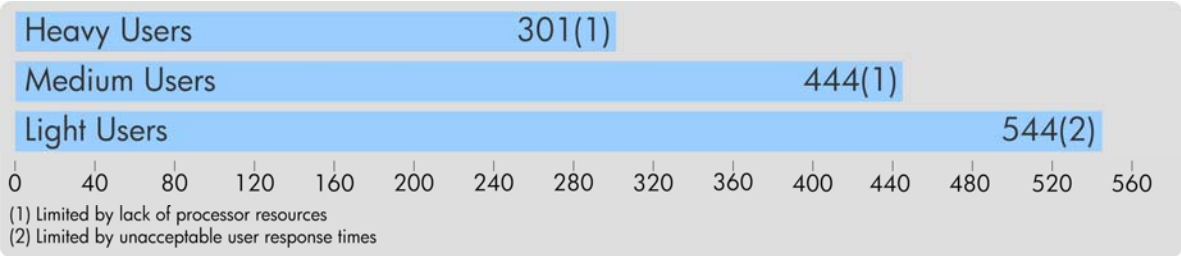


Figure 4 indicates that the HP ProLiant BL685c G5 server blade could support 340 Heavy Users before response times started to increase markedly, validating the optimal value of 301 Heavy Users derived using **% Processor Time** values.

Test analysis summary

Figure 5 summarizes the optimal numbers of users supported by the HP ProLiant BL685c G5 server blade.

Figure 5. Optimal numbers of users supported in the 64-bit test harness



For Heavy and Medium Users, HP characterized the scalability of the HP ProLiant BL685c G5 server blade through the numbers of users supported when CPU utilization reached 80%. For Light Users, response times became unacceptable before CPU utilization reached 80%.

Appendix A – HP BladeSystem

Out of the box, HP BladeSystem removes constraints imposed by conventional IT infrastructures, unifying server, storage, networking, power, and management capabilities in a change-ready, energy-thrifty, and cost-effective system. HP BladeSystem helps customers of all sizes – from large enterprises to small and medium businesses (SMBs) – make an easy transition to an Adaptive Infrastructure by enabling tighter and more dynamic connections between IT and the business process. With its simplified, flexible infrastructure, HP BladeSystem is prepared for change.

Two HP BladeSystem enclosures are offered, the c7000 and c3000.

HP BladeSystem c7000 enclosure

The HP BladeSystem c7000 enclosure has been designed to tackle the toughest problems facing today's IT infrastructures: cost, time, energy, and change. The c7000 enclosure consolidates the essential elements of a data center – power, cooling, management, connectivity, redundancy, and security – into a modular, self-tuning unit with built-in intelligence. In addition, this enclosure provides flexibility, scalability and support for future technologies.

Figure A-1 shows the integration of server blades with HP BladeSystem scale-out infrastructure.

Figure A-1. Solving infrastructure issues with the HP BladeSystem c7000 enclosure

This powerful 10U enclosure delivers the following features:

Performance

- Up to 16 c-Class server blades
- Up to four redundant I/O fabrics
- Multi-terabit mid-plane to support current and future I/O connections
- N+N or N+1 power redundancy for maximum configuration flexibility

Management

- HP Onboard Administrator provides complete control of the infrastructure
- Interactive HP Insight Display allows easy setup and configuration from the front of the rack
- HP Insight Control Environment for HP BladeSystem automates deployment, provisioning, server and performance management, and patch and vulnerability management, providing a single, easy-to-use solution for heterogeneous environments

Options

- HP Active Cool fan technology provides superior airflow, power and acoustic performance and is hot pluggable for easy upgrades (up to a maximum of 10 fans)
- Redundant HP Onboard Administrator module support ensures that enclosure management is always available
- Additional power supplies (up to a maximum of six) can be added to the enclosure to meet changing needs

HP BladeSystem c3000 enclosure

The HP BladeSystem c3000 enclosure brings additional capabilities to HP BladeSystem. This enclosure is ideal for remote sites needing two to eight server blades, mid-sized companies with between three and 100 servers, and enterprises with special data center requirements, such as DC power or very limited rack power and cooling capacities.

A rack enclosure is shown in Figure A-2; a tower enclosure, designed with casters, is available for sites without racks.

Figure A-2. The HP BladeSystem c3000 rack enclosure

Performance

- Up to eight c-Class server blades
- Up to three I/O fabrics
- Multi-terabit mid-plane to support current and future I/O connections
- N+N and N+1 power redundancy for maximum configuration flexibility
- Choice of AC (with support for low-line or high-line power) or DC power supplies

Management

- HP Onboard Administrator provides complete control of the infrastructure
- Interactive HP Insight Display allows easy setup and configuration from the front of the rack
- HP Insight Control Environment for HP BladeSystem automates deployment, provisioning, server and performance management, and patch and vulnerability management, providing a single, easy-to-use solution for heterogeneous environments

Options

- HP Active Cool fan technology provides superior airflow with enhanced power and acoustic performance and is hot pluggable for easy upgrades (up to a maximum of six fans)
- Additional power supplies (up to a maximum of six) can be added to your enclosure to meet changing needs

Appendix B – Using Microsoft Windows Server 2003 x64 Editions

Microsoft offers a new generation of high-performance platforms for 64-bit applications with continued support for 32-bit applications and existing deployment and management tools – all on the same platform. These new operating systems provide an evolutionary path to 64-bit technology, allowing 64-bit and 32-bit applications to run side-by-side during the gradual migration to 64-bit computing.

64-bit editions of Windows Server 2003 running on Quad-Core AMD Opteron processors can improve the performance of HP SBC servers by processing more data per clock cycle, addressing more memory, and running some numerical calculations faster. Large data sets can be loaded entirely into memory, reducing the need for slower disk access; complex calculations that take hours to complete on a 32-bit system can be performed in minutes; and workloads that once required a large server farm can be performed by a single server.

In addition, this new 64-bit platform also removes many of the limitations that have previously inhibited scalability in an HP SBC environment.

Historical scalability limitations

32-bit Windows operating systems can directly address 4 GB of memory, 2 GB of which is reserved for the operating system kernel and 2 GB for applications. Since kernel memory is shared by all applications, the relatively small size of this space can be particularly problematic in an HP SBC environment where a server may be responsible for hundreds of users and thousands of processes. In this scenario, kernel memory can become constrained, making user response times unacceptably long and effectively limiting the ability of the server to scale up.

Historically, HP SBC environments have been implemented using 1P or 2P servers. Larger, more powerful servers have typically not been deployed for two main reasons:

- Kernel memory issues have limited the performance of more powerful servers; either a disk I/O bottleneck occurs or kernel memory is consumed before processor resources can be fully utilized
- Scalability in a 32-bit symmetric multi-processing (SMP) system is inherently non-linear above 2P

With these 1P and 2P server farms, opportunities to scale up are limited. As a result, customers are forced to scale out, which can create new problems such as deployment and management complexity, high power and cooling requirements, under-utilized resources, and minimal opportunities for server consolidation.

The 64-bit platform shatters the earlier 4 GB limitation – for example, Windows Server 2003 R2 Datacenter x64 Edition with Service Pack (SP) 1 supports up to 2 TB of RAM – effectively removing kernel memory limitations and eliminating disk I/O bottlenecks. By deploying a Windows Server x64 Edition operating system, customers can fully utilize the resources of their existing HP SBC servers and take full advantage of new, more powerful systems – whether they are running 32- or 64-bit applications.

More information

For more information on the impact of 64-bit Windows Server 2003 x64 Editions in an HP SBC environment, refer to the HP white paper, "Scalability and performance of HP ProLiant servers on 64-bit Microsoft Windows Server 2003 in an HP SBC environment."

To learn about 64-bit computing in an HP SBC environment, refer to the HP white paper, "Fundamentals of 64-bit computing in an HP SBC environment."

Appendix C – SBC solution sizing

As with any laboratory benchmark, the performance metrics quoted in this performance brief are idealized. In a production environment, these metrics may be impacted by a variety of factors, including the following:

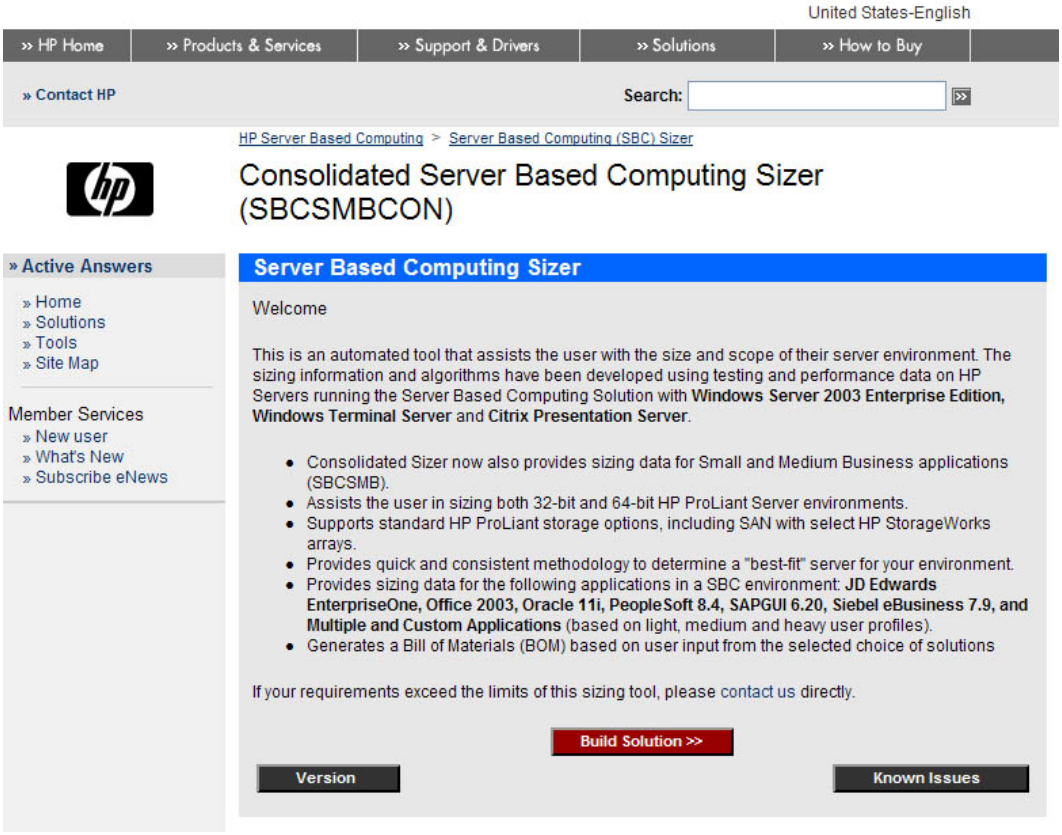
- **Overhead**
  Agents and services (virus scanning, backup and restore, provisioning, security, management and more) automatically consume overhead. Rogue applications can consume additional overhead. The system architect may wish to provide a 25% – 30% buffer to accommodate this overhead.
- **Future growth**
  To accommodate future growth, the system architect may wish to provide an additional buffer. Alternatively, servers can be added as needed, taking advantage of the server farm's inherent ability to scale out.
- **User profiles**
  The particular application in use directly impacts the number of users supported by a particular server. Further, user behavior can also impact scalability:
  - Increased typing rates correspond to fewer users.
  - Opening and closing applications (rather than switching between them) or moving quickly between tasks can place a heavier load on the server.
  - For accurate sizing, system architects should closely match their user profiles with the Heavy, Medium, and Light User profiles specified by HP in Table 2. If the profiles do not match, more are available using the online sizer tool (described below); alternatively, the system architect can consult HP Services for more information.
- **Background grammar checking**
  Background grammar checking can significantly impact scalability, reducing the number of users supported by as much as 50%. HP disabled background grammar checking for the testing described in this performance brief.

Online sizer tool

To minimize risk, HP offers automated, online tools that can help the customer size an HP SBC solution. The algorithms and methodology used by the sizer are based on the results of customer surveys and thorough testing.

A consolidated sizer is available for enterprise and small and medium business (SMB) environments. Figure C-1 shows a typical HP SBC sizer screen.

Figure C-1. The HP SBC sizer's welcome screen



Based on information provided by the customer, the sizer can provide a quick, consistent mechanism for identifying the "best-fit" server for a particular HP SBC environment and generate a Bill of Materials (BOM) for that server.

For more information

HP ProLiant BL685c G5 server blade	http://www.hp.com/servers/bl685c
HP BladeSystem c-Class server blades	http://www.hp.com/servers/cclass
HP ActiveAnswers for Server Based Computing	http://www.hp.com/solutions/activeanswers/hpsbc
HP ProLiant Essentials Rapid Deployment Pack (RDP)	http://www.hp.com/go/rdp
Consolidated HP SBC online sizer tool	http://h71019.www7.hp.com/activeanswers/Secure/70245-0-0-0-121.aspx
HP Services	http://www.hp.com/hps/
HP Solution Centers	http://www.hp.com/go/solutioncenters
Microsoft Windows Server 2003	http://www.microsoft.com/windowsserver2003/evaluation/overview/family.mspx
Terminal Server enhancements in Windows Server 2003	http://www.microsoft.com/windowsserver2003/techinfo/overview/termserv.mspx
Citrix XenApp (formerly Presentation Server)	http://www.citrix.com/site/PS/products/feature.asp?familyID=19&productID=186&featureID=4110
Quad-Core AMD Opteron processors	http://multicore.amd.com/us-en/AMD-Multi-Core.aspx

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