HP reference configuration for x86 Citrix XenApp on XenServer: 3,500 Microsoft Office 2003 users on HP ProLiant BL460c G6

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Executive summary

HP and Citrix collaborated at an engineering level to ensure that our customers benefit from software, hardware and service solutions that are jointly tested, certified, and tuned to deliver optimal server performance. HP and Citrix have developed a range of recommended configurations and services for Citrix applications, focusing on particular business needs and technical scenarios.

Based on HP ProLiant BL460c G6 server blades and HP LeftHand P4500 iSCSI SAN storage, the reference configuration outlined in this guide is intended to help you build a virtualized x86 solution capable of supporting at least 3,500 Microsoft® Office 2003 users. This configuration is only provided for reference purposes; specific configurations will vary based on your particular needs. Processor, memory, storage, I/O, and service recommendations should be regarded as minimum levels. HP suggests working with your local HP Reseller or HP Sales Representative to help determine the best solution for your environment and strongly recommends performing a proof-of-concept.

The reference configuration was developed using the HP ProLiant sizing tool for Citrix XenApp and Microsoft Windows® Server 2003 Terminal Services[1] along with the HP BladeSystem Power Sizer[2] (BPS), which allow you to plan a specific HP BladeSystem and Microsoft Office 2003 solution, providing user density; power and cooling requirements; total cost; and a detailed Bill of Materials (BOM).

In additional to a traditional XenApp deployment, the fully redundant reference configuration defined in this document can also be used to deliver application virtualization in a Citrix XenDesktop environment.

Target audience: This document is intended for resellers and IT decision-makers interested in creating a new deployment or considering the consolidation of legacy server platforms.

Part numbers used in this white paper are current as of October 2009.

Historical scalability limitations

32-bit Microsoft 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 a XenApp 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, XenApp environments have been implemented using 2P servers. Larger, more powerful servers have typically not been deployed for two main reasons:

- Kernel memory issues have limited server performance; 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 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.

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[1] http://h71019.www7.hp.com/ActiveAnswers/cache/70245-0-0-0-121.html
[2] http://h71019.www7.hp.com/ActiveAnswers/cache/347628-0-0-0-121.html; the reference configuration presented in this guide was developed in October 2009.

The 64-bit platform shatters the earlier 4 GB limitation – for example, Windows Server 2003 R2 Datacenter x64 Edition with Service Pack 1 (SP1) supports up to 2 TB of RAM – effectively removing kernel memory limitations. By deploying a Windows Server x64 Edition operating system, customers can fully utilize the resources of their existing XenApp servers and take full advantage of new, more powerful systems – whether running 32- or 64-bit applications[3].

For any of a range of reasons, you may prefer not to migrate to x64 computing but would still be interested in exploring the benefits of consolidation. In practice, the scalability of x86 platforms has been restricted by the inherent kernel memory limitations; thus, you have typically been unable to fully utilize the computing power delivered by higher-end servers. As a result, consolidation in the x86 environment has been impractical for most scenarios. However, with the introduction of powerful HP ProLiant G5 and G6 servers, test results indicate that a virtualized x86 platform may now be able to support as many or more users compared with an x64 platform (whether virtualized or not). These results demonstrate that virtualization may be the key to unleashing the power of today's high-performance servers in an x86 environment.

Example

In testing performed in August 2006, HP found that a bare-metal x86 HP ProLiant BL460c G1 server blade was able to support 96 users running an Office 2003 workload[4]; based on this level of scalability, 16 server blades would have been required to support 1,500 users[5]. Now, however, this workload can be accommodated by four virtualized x86 HP ProLiant BL460c G6 server blades[6].

Note:
Projected numbers of users do not take into consideration factors such as third-party agents (such virus scanning, software provisioning, remote administration, and firewalls) that typically consume a modest amount of system resources. In addition, varying the user profile and workload can have a significant impact on scalability.

Additional benefits of virtualization

In addition to support for consolidation, virtualization can deliver a broad range of inherent benefits, including the following:

- Since they are isolated, virtual machines (VMs) can be configured to use specific hardware resources
- VMs are easy to copy and deploy, and may be moved between physical hosts without service disruption
- VMs and associated storage can be administered centrally using management solutions such as HP Insight Control suite and HP LeftHand SAN/iQ storage software

- Access to VMs can be provided by Thin Clients for increased data security, simplified desktop management, and lower desktop total cost of ownership

Thus, virtualization lends itself to applications such as high availability and disaster recovery (DR).

[3] For more information on the impact of 64-bit Windows Server 2003 x64 Editions in a XenApp 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."
[4] For more information, refer to http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA0-8429ENW&cc=us&lc=en.
[5] 16 x 96 = 1,536 users
[6] For more information, refer to http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA2-8000ENW&cc=us&lc=en; 4 x 401 = 1,604 users

Having described how virtualization can unleash the full power of an HP ProLiant server blade in the x86 environment, this white paper goes on to outline a reference configuration that takes advantage of this capability to provide support for at least 3,500 Office 2003 users. The following sections describe the server blade, enclosure, and SAN solution used in the reference configuration.

Server blade

The server blade selected for the Enterprise reference configuration is the HP ProLiant BL460c G6 (shown in Figure 1), which provides enterprise-class features for high performance and reliability without compromising energy efficiency or density.

Figure 1. The popular HP BL460c G6 server blade

For more information on this server blade, visit http://www.hp.com/servers/bl460c.

HP Insight Control suite

Insight Control suite provides time-smart management software that delivers deep insight, precise control, and ongoing optimization to unlock the potential of your HP ProLiant and BladeSystem infrastructure.

Based on HP Systems Insight Manager (HP SIM), Insight Control suite offers comprehensive proactive health management, remote control, patch management as well as rapid server deployment, VM management, and power management in one easy to install package.

The reference configuration provides the licenses required to take advantage of Insight Control suite. For more information on creating a well-run infrastructure, refer to http://h18013.www1.hp.com/products/servers/management/ice/index.html.

Configuration

The half-height HP ProLiant BL460c G6 server blades used in the Enterprise reference configuration are each configured as follows:

- Two Intel® Xeon® processors X5570 (2.93 GHz)
- 36 GB RAM
- Smart Array P410i controller with two 146 GB 15,000 rpm SAS hard drives and 512 MB Battery Backed Write Cache (BBWC)
- Embedded NC532i Dual Port Flex-10 10GbE Multifunction Server Adapter

Important:
You should regard the above as a minimum configuration. HP recommends continuously monitoring your resource utilization in a production environment to determine if additional resources are needed.

Table 1 outlines the software deployed on these server blades.

Table 1. Software deployed on server blades

Component	Description
XenApp/XenServer host	Windows Server 2003 Enterprise x86 Edition with SP2
	Citrix Essentials for XenServer, HP Enterprise Edition 5.5.0
	Citrix XenApp 5.0
	Office 2003
XenApp license server	Windows Server 2003 Enterprise x86 Edition with SP2
	Citrix Essentials for XenServer, HP Enterprise Edition 5.5.0
	Citrix XenApp 5.0

A performance characterization performed by HP indicates that a virtualized HP ProLiant BL460c G6 server blade configured as above can support 401 Office 2003 users in an x86 test environment[7]. However, because of the range of factors that can affect overall scalability in a production environment, HP has been conservative in specifying the number of users that can be supported by the reference configuration described in this white paper.

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[7] For more information, refer to http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA2-8000ENW&cc=us&lc=en. The tested server was configured with four virtual machines (VMs).

Factors affecting scalability

As with any laboratory benchmark, the 401-user metric is idealized. In a production environment, scalability may be impacted by a range 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 the combined overhead.

Important:
The 401-user metric does take into account virtualization overhead
(required to accommodate the hypervisor).

- **Future growth**
  To accommodate future growth, you 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:
  - Fewer users are supported when typing rates increase.
  - Opening and closing applications (rather than switching between them) or moving quickly between tasks can place a heavier load on the server.
  - Sizing for this reference configuration was based on the Heavy User profile[8]. If this profile does not match your needs, more profiles are available using the HP ProLiant sizing tool for Citrix XenApp and Microsoft Windows Server 2003 Terminal Services; alternatively, you can contact 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 white paper.

To minimize risk, HP offers automated, online tools designed to help you size a XenApp solution. For example, a sizing tool is available for enterprise and small and medium business (SMB) environments.

I/O performance

The I/O performance requirements of your workload also affect solution sizing. For more information, refer to the SAN storage section.

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[8] Heavy Users (also known as Structured Task Workers) tend to open multiple applications simultaneously and remain active for long periods. They often leave applications open when not in use.

Sizing summary

Performance characterizations indicate that the reference configuration (see

Functioning as an access device, HP Thin Clients connect over a network to a centralized HP ProLiant BL460c G6 server to access the Citrix XenApp virtual session. As all applications and data storage reside within the data center and not on employees' desk, thin clients do not require many of the components of traditional desktop PCs.

With no hard drive, fan or other moving parts, thin clients have a much longer lifespan than standard computers and use significantly less power. Lower maintenance costs are another benefit as software application updates, virus scanning and patches can be executed on the server.

Additionally, each HP thin client has been certified by Citrix as HDX Ready and includes the Citrix XenApp client for easy out of the box deployment.

Figure 3 shows the new HP t5740 Thin Client with integrated wireless and dual monitor.

Figure 3. HP Thin Clients are ideal for Citrix XenApp environments

For more information on HP thin clients, refer to http://www.hp.com/go/thinclient

HP Device Manager

Track, configure, upgrade, clone, and manage up to thousands of thin client devices with ease. Dramatically simplify device deployment, task automation, compliance management, and policy-based security management for greater business agility.

• Simplify client administration with automated management tools and administrative templates.

• Clone and group devices, enforce policies, automate tasks, and run system reports

• Update scheduling and status reporting for all thin clients in an enterprise

• Enable encrypted traffic and security issue certificates between your thin clients, gateways and servers

Each HP Thin Client ships with HP Device Manager for simplified configuration and administration. Additionally, HP Client Automation software management solutions are available for organizations with a mix of thin and traditional desktop clients, who desire one management tool for their entire desktop environment.

For more information on the HP Device Manager, refer to http://.www.hp.com/go/thinclient

For more information on the HP Client Automation, refer to http://.www.hp.com/go/clientautomation

Enterprise reference configuration
) could support as many as 5,614 users. However, HP prefers to be conservative when specifying maximum user levels for reference configurations and has provided ample headroom to accommodate the factors that typically affect server scalability in a XenApp environment.

Note that you must thoroughly understand your workload so that you can deploy a storage solution that is capable of achieving the desired I/O performance levels. For example, a single HP LeftHand P4500 storage node is sufficient to accommodate the workload supported by the reference configuration; however, HP has chosen to deploy additional nodes to help future-proof this solution, providing additional storage and redundancy, along with support for a significantly heavier I/O workload.

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 2 shows the integration of server and storage blades with HP BladeSystem scale-out infrastructure.

Figure 2. Solving infrastructure issues with the HP BladeSystem c7000 enclosure

For more information on this powerful 10U enclosure, refer to
http://h18004.www1.hp.com/products/blades/components/enclosures/c-class/c7000/.

HP Onboard Administrator

The Onboard Administrator for the HP BladeSystem c7000 enclosure is the brains of the c-Class infrastructure. Together with the enclosure's HP Insight Display, the Onboard Administrator has been designed for both local and remote administration of HP BladeSystem c-Class components and provides the following capabilities:

- Wizards for simple, fast setup and configuration
- Highly available and secure access to the HP BladeSystem infrastructure
- Security roles for server, network, and storage administrators
- Automated power and cooling of the HP BladeSystem infrastructure
- Agent-less device health and status
- Thermal Logic power and cooling information and control

Each c7000 enclosure is shipped with one Onboard Administrator module and firmware. For redundancy, you can add a second unit.

For more information on the Onboard Administrator, refer to http://h18004.www1.hp.com/products/blades/components/onboard/.

HP Virtual Connect

Before Virtual Connect, you had two basic choices for interconnects: pass-thru or switch. Pass-thrus are simple but require too many cumbersome cables and create complexity; blade switches reduce the number of cables but add to the workload of LAN and SAN administrators. With either option, multiple people are needed to perform even very simple server tasks.

Virtual Connect provides a better way to connect your HP BladeSystem c-Class enclosure to network LANs and SANs, allowing you to simplify and converge your server edge connections, and integrate into any standards-based networking infrastructure while reducing complexity and cutting your costs.

Rather than tying profiles to specific blades, you create a profile for each of the bays in an HP BladeSystem enclosure. Virtual Connect then maps physical LAN or SAN connections to these profiles, allowing you to manage connectivity between blades and networks without involving LAN or SAN administrators. In addition, if a server blade were to fail, you could move its associated profile to a bay containing a spare blade, thus restoring availability without needing to wait for assistance.

For more information, refer to Appendix B – Virtual Connect technology.

SAN storage

The reference configuration uses a cluster of three HP LeftHand P4500 iSCSI storage nodes to provide optimized shared storage with cost-effective high availability, scalable performance, and non-disruptive configuration change. This cluster includes the following components:

- HP LeftHand P4500 10.8 TB SAS Virtualization SAN Solution (AT011A), shown in Figure 3
- HP LeftHand P4500 5.4 TB Virtualization SAN Expansion Node (AT020A)

This cluster starts with a storage capacity of 16.2 TB.

Figure 3. HP LeftHand P4500 SAN

Features

All inclusive feature set enables enterprise functionality at an affordable price

- **Storage clustering** – Storage clustering allows you to consolidate multiple storage nodes into pools of storage. All capacity and performance is aggregated and available to every volume in the cluster.

- **Network RAID** – Network RAID stripes and mirrors multiple copies of data across a cluster of storage nodes, eliminating any single point of failure (SPOF) in the SAN.

- **Thin provisioning** – No storage is pre-allocated; you only allocate space as the data is being written, thus raising the overall utilization and efficiency of the SAN.

- **Snapshots** – To simplify data protection, snapshots can be used to create thinly provisioned, instant point-in-time copies of data on a per-volume basis. You can access these snapshots to recover individual files or folders from a volume, or roll back an entire volume to a prior state.

- **Remote Copy** – To reduce the cost of disaster recovery (DR), you can use the Remote Copy feature to replicate thinly provisioned snapshots between SANs at primary and remote locations. Remote Copy enables centralized backup and DR on a per-volume basis.

Superior availability and DR

- **Data remains available during a site failure** – The SAN stripes and mirrors multiple copies of data across a cluster of storage nodes, eliminating any SPOF within the SAN. Applications have continuous data availability in the event of a power, network, disk, controller, or entire storage node failure.

- **Integrated replication for DR** – Integrated replication simplifies failover and failback.

- **Update the configuration on-the-fly** – You can add capacity, increase performance, or grow and migrate volumes between storage clusters with no application downtime.

Scalable performance

- **Purchase only what you need today** – Only purchase what you need today, then grow the performance, capacity, and redundancy of your SAN online as your storage requirements evolve.
- **Scale performance and capacity simultaneously** – Each time you add a storage node to the SAN, you automatically increase the capacity, performance, and redundancy of the entire storage solution.
- **Avoid disruptive upgrades** – Add resources to the SAN non-disruptively; applications remain online during a maintenance event.

Easy-to-manage

- **Centralized Management Console** (CMC) – All SAN functionality can be managed from the CMC for simple, easy-to-manage storage. Multiple data centers and sites can be managed from a single CMC.
- **Business continuity**: The SAN includes synchronous and asynchronous replication, which simplifies the management of highly available, fault-tolerant DR storage solutions.

Scalability

When sizing a storage solution, you must understand the I/O performance requirements of your workload; without this information, you cannot select appropriate storage. For example, since it is based on Office 2003, the workload for the reference configuration consists mainly of writes.

Performance sizing

For the reference configuration, HP sized the storage solution based on throughput requirements for bare-metal HP ProLiant BL460c G6 server blades featuring internal storage. By comparing these requirements with the capacities listed in Table 2, HP was able to determine the number of HP LeftHand P4500 SANs needed to achieve the desired performance levels.

Table 2 lists performance levels supported by a two-node HP LeftHand P4500 SAN[9].

Table 2. HP LeftHand P4500 SAN maximum performance levels

Scenario	RAID 5	RAID 10
Cache only (IOPS)	120,000	120,000
Cache only (MB/s)	448	448
Sequential reads (MB/s)	306	306
Sequential writes (MB/s)	183	183

For example, a two-node HP LeftHand P4500 SAN can, at worst-case, support a throughput of 183 MB/s when processing sequential writes. The reference configuration includes a third node to enhance redundancy, storage capacity, and overall throughput.
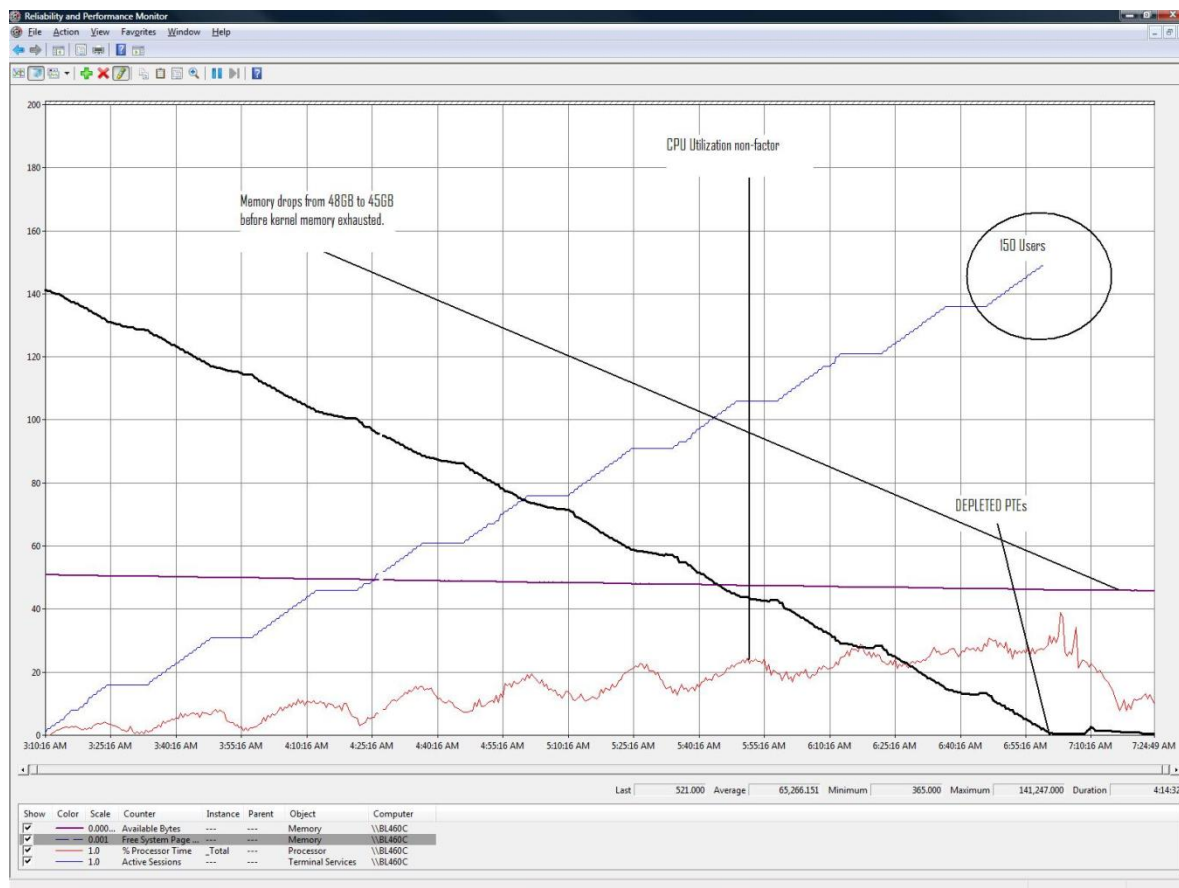
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[9] http://h18000.www1.hp.com/products/quickspecs/13254_na/13254_na.html

Performance testing

HP carried out performance tests to characterize the I/O performance of a bare-metal HP ProLiant BL460c G6 server blade featuring internal storage. The same x86 XenApp test environment, methodology, and Office 2003 workload were utilized as for user scalability testing.

Figure 4 shows the maximum number of users supported by the tested server [10].

Figure 4. A bare-metal HP ProLiant BL460c G6 server blade with internal storage was able to support a maximum of 150 users

The maximum number of users was supported when kernel memory became constrained (as evidenced by the total depletion of system Page Table Entries (PTEs)).

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[10] http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA2-8000ENW&cc=us&lc=en

13

Figure 5 shows disk utilization and throughput during the test run.

Figure 5. Average disk utilization during testing was approximately 1.8% until system PTEs became depleted
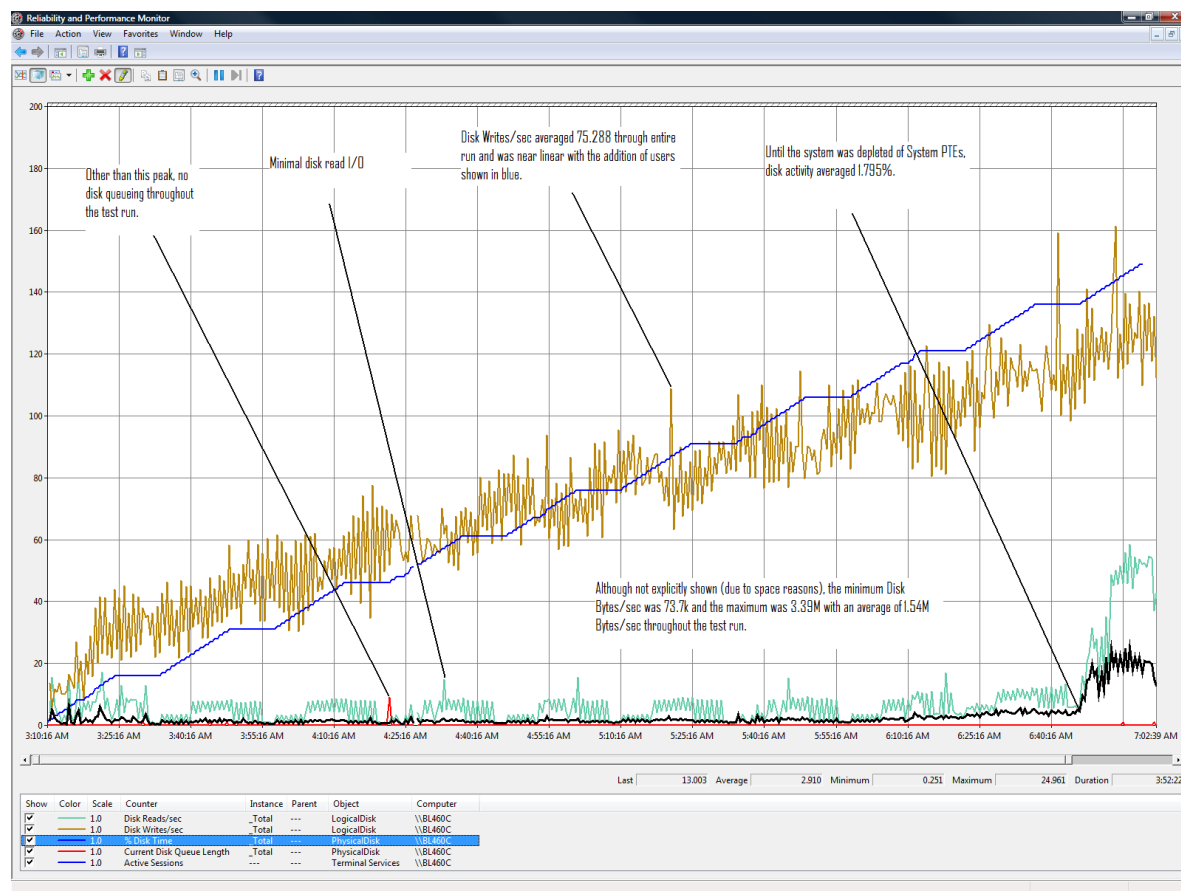

Figure 5 validates that write activity (Disk Writes/sec) with this Office 2003 workload was significantly higher than read activity (Disk Reads/sec).

Average disk utilization during the test run was approximately 1.8%; average throughput was 1.54 MB/s. Based on these metrics, HP was able to estimate the maximum throughput that would be generated by the reference configuration:

14 blades x 4 VMs/blade x 1.54 MB/s = 86.24 MB/s

Thus, this maximum level is far below the capacity of the HP LeftHand P4500 SAN deployed in the reference configuration[11].

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[11] Based on the capacity of a two-node HP LeftHand P4500 SAN (183 MB/s for sequential writes) and the estimated throughput of the reference configuration (86.24 MB/s for a workload consisting mostly of writes); HP added a third node to the reference configuration to enhance redundancy, storage capacity, and overall throughput

HP Thin Client

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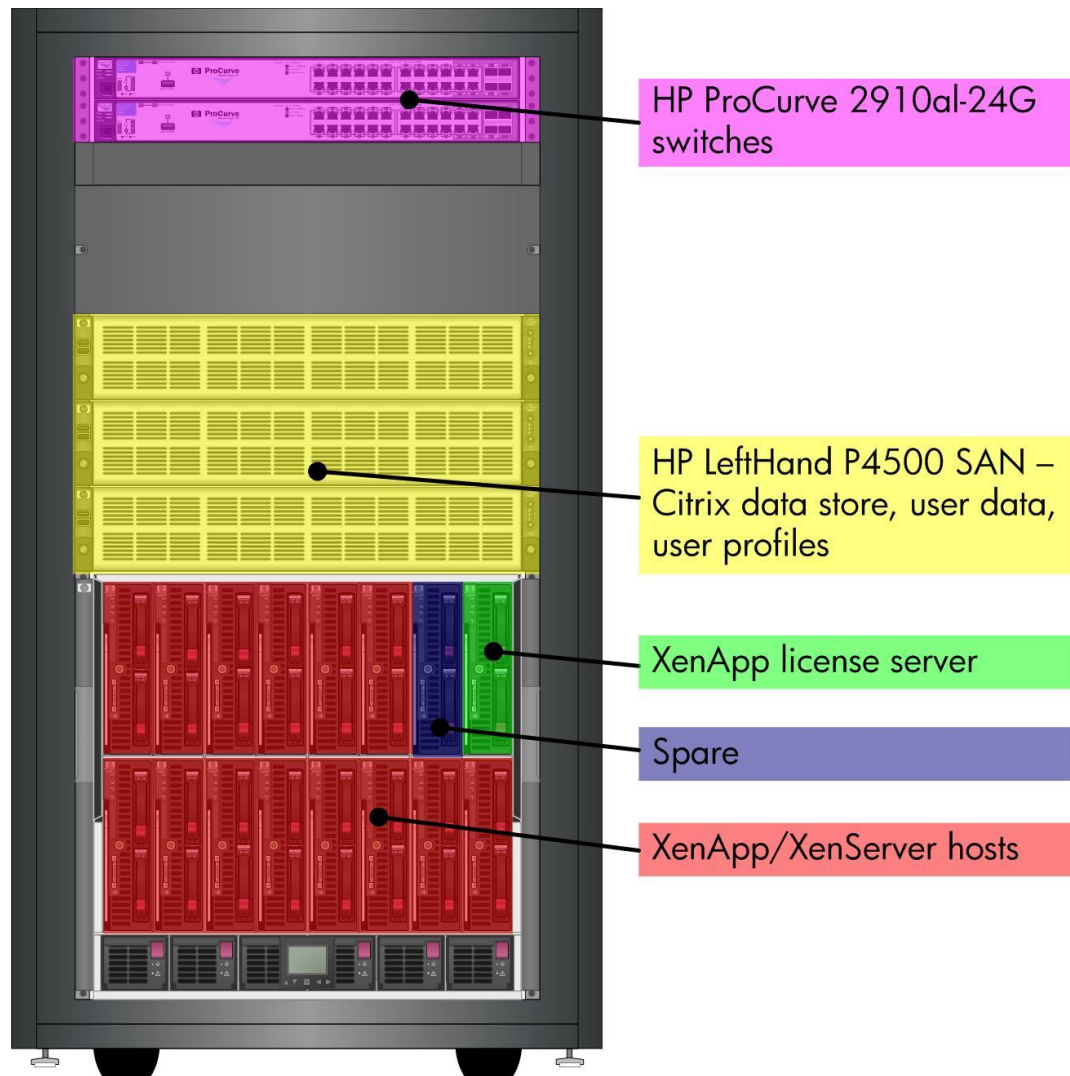

Enterprise reference configuration

Designed for the enterprise, this scalable solution is based on an HP BladeSystem c-Class enclosure. Features include:

• XenServer virtualization (Essentials for XenServer, HP Enterprise Edition 5.5)
• Scalable, highly-available, network-based SAN
• Tested for at least 3,500 Office 2003 users in less than 22U of space

Figures 6 and 7 show this virtualized adaptive infrastructure, which includes an HP LeftHand P4500 SAN. Table 3 provides more information.

Figure 6. Overview of the Enterprise reference configuration

HP ProCurve 2910al-24G switches

HP LeftHand P4500 SAN – Citrix data store, user data, user profiles

XenApp license server

Spare

XenApp/XenServer hosts

The reference configuration uses the following devices to achieve SAN connectivity, as shown in Figure 7:

- HP ProCurve 2910al-24G switches[12] with HP ProCurve 2-Port 10-GbE CX4 al Modules

Note:
The second HP ProCurve switch has been installed to provide full, multi-path redundancy and eliminate single-points-of-failure from the network.

- HP Virtual Connect Flex-10 10Gb Ethernet Modules for BladeSystem c-Class (installed in HP BladeSystem c7000 enclosure)
- HP LeftHand P4500 storage nodes – 1 GbE ports

Note:
While LeftHand P4000 SANs can support 10 GbE connectivity, HP considers 1 GbE to be sufficient for the reference configuration.

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[12] For more information, refer to Appendix C – HP ProCurve 2910al switches

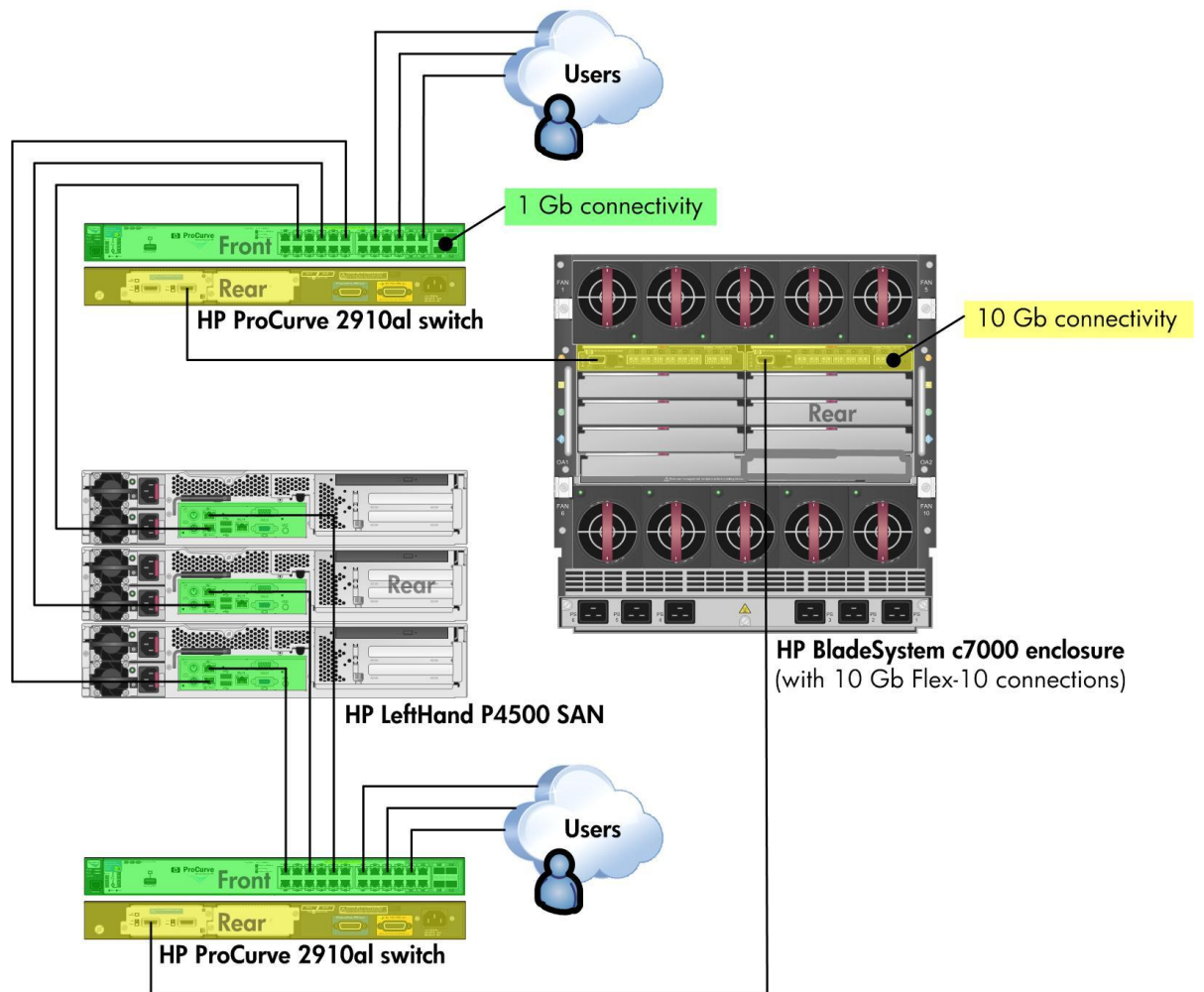**Figure 7.** Network topography for the reference configuration

Users

1 Gb connectivity

HP ProCurve 2910al switch

10 Gb connectivity

Rear

Front

Rear

HP LeftHand P4500 SAN

HP BladeSystem c7000 enclosure
(with 10 Gb Flex-10 connections)

Users

Front

Rear

HP ProCurve 2910al switch

Table 3. Key components of the Enterprise reference configuration

Component	Description
XenApp/XenServer host	14 x HP ProLiant BL460c G6 server blade
XenApp license server	1 x HP ProLiant BL460c G6 server blade
Spare	1 x HP ProLiant BL460c G6 server blade
Citrix data store/user data/user profiles	Three-node HP LeftHand P4500 iSCSI SAN featuring HP LeftHand SAN/iQ storage software[13]
Infrastructure	22U rack
	HP BladeSystem c7000 enclosure with Virtual Connect Flex-10 technology
	2 x HP ProCurve 2910al-24G switch with 2-Port 10-GbE CX4 al module

Integration with Citrix XenDesktop

XenDesktop is a desktop virtualization solution that delivers the complete Windows desktop experience as an on-demand service to any user, anywhere. Whether you are a task worker, a knowledge worker, or a mobile worker, XenDesktop can quickly and securely deliver individual applications or complete desktops while providing an outstanding user experience.

With application virtualization, you can control data access, manage fewer desktop images, eliminate system conflicts, and reduce application regression testing. Adding, updating, or removing an application is simple and self-service for users.

Since XenApp can be fully integrated with XenDesktop, the reference configuration described in this document can be used to deliver applications in an overall XenDesktop environment.

For more information on XenDesktop, refer to http://www.citrix.com/English/ps2/products/product.asp?contentID=163057 .

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[13] For more information, refer to Appendix A – HP LeftHand P4500 SAN.

Bill of material

Table 4 provides a BOM for the hardware required for the Enterprise reference configuration.

Note:

HP LeftHand SAN/iQ storage software and HP Insight Control suite are included. Windows, XenApp, XenServer, Office 2003, and additional management software are not provided.

Table 4. BOM for the reference configuration

Quantity	Part Number	Description
1	507015-B21	HP BladeSystem c7000 Enclosure, Single-Phase with 6 Power Supplies, 10 Fans with 16 HP Insight Control suite Licenses
16	507864-B21	HP BL460cG6 CTO Chassis
32	504062-B21	HP 146GB 3G SAS 15K SAS 2.5 DP ENT HDD
96	500656-B21	HP 2 GB 2Rx8 PC3-10600R-9 Kit
96	500658-B21	HP 4 GB 2Rx4 PC3-10600R-9 Kit
16	507791-B21	HP ProLiant BL460cG6 X5570
16	507791-L21	HP ProLiant BL460cG6 X5570 FIO Kit
1	AF021A	10622 G2 (22U) Rack Cabinet - Pallet
16	462967-B21	512 MB BBWC Cache Module
1	AT011A	HP LeftHand P4500 10.8TB SAS Virtualization SAN Solution
1	AT020A	HP LeftHand P4500 5.4TB Virtualization SAN Expansion Node
2	J9145A	HP ProCurve 2910al-24G Switch
2	J9149A	HP ProCurve 2-Port 10-GbE CX4 al Module
2	455880-B21	HP Virtual Connect Flex-10 10Gb Ethernet Module for the c-Class BladeSystem
3,500	VU899AA	HP t5740 Thin Client (2GB/1GB)

Additional services

To make it easier for you to deploy this solution, HP offers a range of Thin Client Management Services. More information is available from the following sources:

- http://h10134.www1.hp.com/services/thinclientmgmt/
- http://h20195.www2.hp.com/V2/GetDocument.aspx?docname=4AA2-7923ENW&cc=us&lc=en

Appendix A – HP LeftHand P4500 SAN

Appendix A outlines what you receive with an HP LeftHand P4500 10.8 TB SAS Virtualization SAN Solution (AT011A). For more information, refer to http://h18000.www1.hp.com/products/quickspecs/13254_na/13254_na.html.

Software

- SAN/iQ Storage Clustering
- SAN/iQ Network RAID
- SAN/iQ Thin Provisioning
- SAN/iQ Snapshots
- SAN/iQ Remote Copy (asynchronous replication)
- SAN/iQ Multi-Site/DR Solution (synchronous replication)
- SAN/iQ Solution Pack for Microsoft Windows
- P4000 Replication for Remote Offices (DR for 10 remote sites)

Hardware

- Dual redundant, active-active storage controllers
- 24 x 450 GB 15,000 rpm SAS disk drive
- 4 GB RAM
- Redundant hot swap power supplies
- 1,024 MB battery backed cache
- Support for RAID 5, 10, 6
- 4 x 1 Gb NIC
- Integrated DVD/CD-ROM drive

Services

- Three years hardware maintenance on-site, next business day
- HP LeftHand P4000 SAN Basic or Advanced Training (one seat, expires after 90 days)
- Customer Self Installable

Appendix B – Virtual Connect technology

Optional Virtual Connect Ethernet and Fibre Channel modules are interconnects that can be deployed in HP BladeSystem c7000 or c3000 enclosures in place of conventional pass-thru or managed-switch modules.
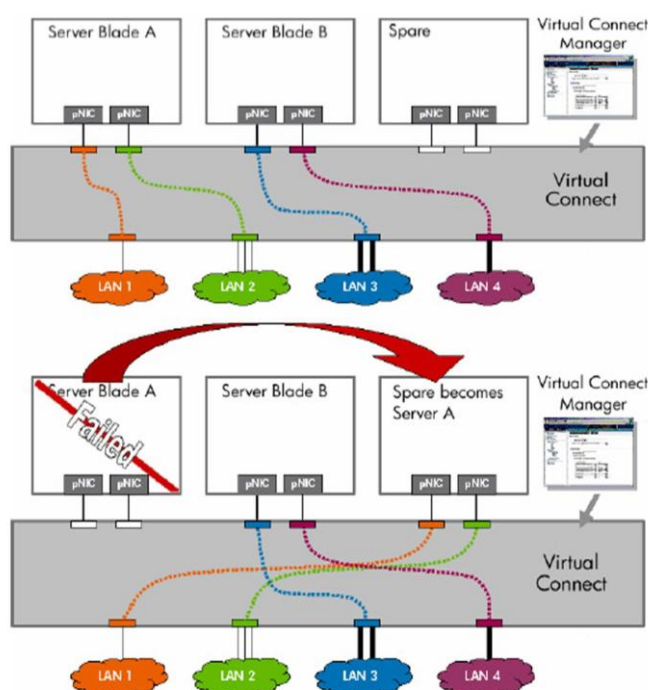
Virtual Connect provides server-edge I/O virtualization, creating an abstraction layer between blades and external networks. Now, rather than individual server blades, the local area network (LAN) or storage area network (SAN) sees a pool of blades.

On the server-side of the abstraction layer, connectivity is achieved via profiles created by the server administrator rather than using default hardware identifiers – that is, Media Access Control (MAC) addresses[14] or World Wide Names (WWNs)[15].

You create profiles for the bays in each HP BladeSystem enclosure rather than tying the profiles to specific blades. Virtual Connect maps physical LAN or SAN connections to these profiles, allowing you to manage connectivity between blades and networks without involving LAN or SAN administrators.

Consider the example shown in Figure B-1 where Server Blades A and B are connected to four LANs. When Server Blade A fails, you can move its profile to a bay containing a spare blade to restore availability without waiting for assistance from the LAN administrator.

Figure B-1. After Server Blade A fails, the system administrator moves the desired profile to a bay containing a spare blade

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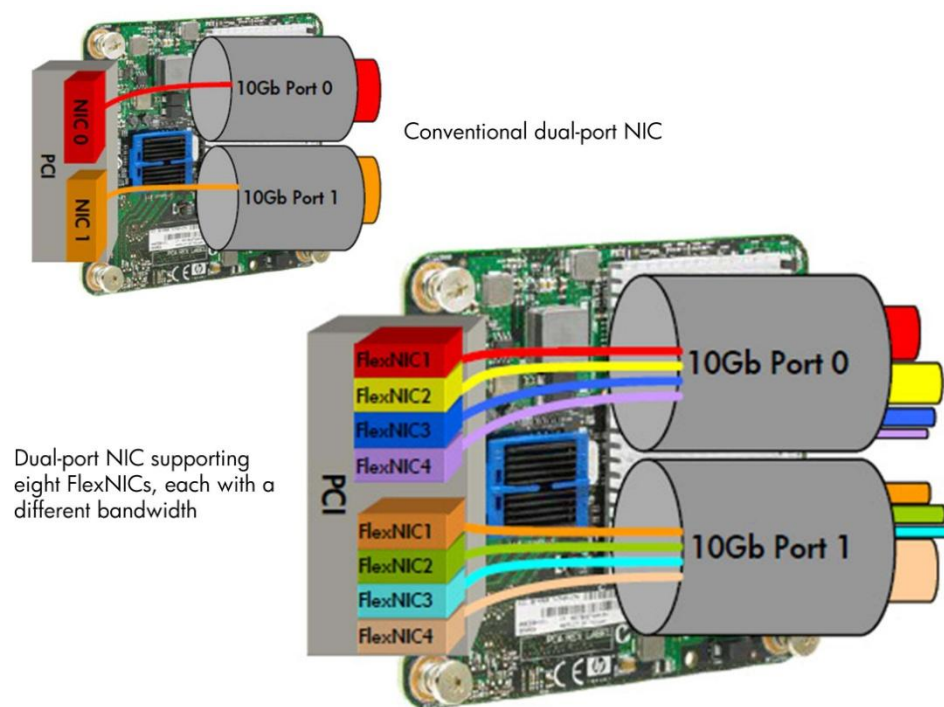[14] Conventionally used to identify Network Interface Cards (NICs) for the LAN
[15] Conventionally used to identify Host Bus Adapters (HBAs) for the LAN

Virtual Connect Flex-10

Virtual Connect Flex-10 technology extends the capabilities of Virtual Connect by allowing a server blade's 10 Gb network ports to be partitioned. A single port now represents four physical NICs (known as FlexNICs) with a combined bandwidth of 10 Gb; to the operating system, each FlexNIC appears to be a discrete NIC with its own driver.

Though FlexNICs share the same physical port, traffic between a particular FlexNIC and the Virtual Connect Flex-10 interconnect module is isolated using individual MAC addresses and virtual LAN (vLAN) tags. You can control the bandwidth available to each FlexNIC[16] through the Virtual Connect Manager interface, as shown in Figure B-2.

Figure B-2. Configuring a dual-port NIC with eight FlexNICs

For more information, refer to
http://h18004.www1.hp.com/products/blades/virtualconnect/index.html.

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[16] In increments of 100 Mb

Appendix C – HP ProCurve 2910al switches

The HP ProCurve Switch 2910al Series includes the following switches:

- 2910al-24G and -24G-PoE+[17] with 24 10/100/1000 ports
- 2910al-48G and -48G-PoE+ with 48 10/100/1000 ports

Both switches have four dual-personality ports for 10/100/1000 or mini-GBIC connectivity. Together with static routing, robust security and management features, free lifetime warranty, and free software updates, the 2910al Series delivers a cost-effective, future-proof solution for high-performance networks.

Features include:

- Access layer switch
- Enterprise-class features
- Layer 2 and Layer 3 lite feature sets
- Scalable 10/100/1000 connectivity
- Integrated 10 GbE uplinks

Expansion modules

HP ProCurve 2910al switches support a range of expansion modules, including the HP ProCurve 2-Port 10-GbE CX4 al Module (shown in Figure C-1), a dual-port 10 GbE expansion module featuring two fixed CX4 ports.

Figure C-1. Installing the 10 GbE expansion module

HP ProCurve 2910al switches are ideal for deployments such as the following:

- Enterprise edge
- Remote branch offices
- Converged networks
- Data center top-of-rack

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[17] Where PoE refers to Power over Internet

For more information, refer to

Appendix D – HP Thin Clients

Selecting the appropriate thin client will help optimize both user experience and IT budgets. Many IT departments deploy a mix of HP thin client models; matching targeted end-user needs with the thin client capabilities. And while each HP thin client provides increased security, longer life-cycles, and lower administration cost, product families have been designed with varying feature sets to fit the needs of your particular IT environment.

Figure D-1 summarizes the recommended models for a Citrix XenApp environment, ideal end-user groups, and key features available for your deployment.

Essential Series	Simple and affordable	Models
Ideal for basic, task-oriented applications and terminal services	• Marvell Smart ARM-based architecture with HP Thin Pro • Basic multimedia support (lower resolution, smaller window size) • Essential peripheral support	HP t5325 (HP Thin Pro)

Mainstream Series	Enhanced Features, Mainstream Use	
Ideal for most business productivity applications	• Choice of Microsoft Embedded CE6.0 or HP Thin Pro • Media Player • Terminal Emulation • Wide peripheral support • Secure USB compartment	HPt5540 (CE 6.0) HP t5545 (HP Thin Pro)

Flexible Series	Powerful, flexible, Innovative	
Rich performance for most any server-based or remote computing environment	• Choice of Microsoft Windows Embedded Standard (WES) or HP Thin Pro • Next-gen Intel Atom N280 processor (select models) • Integrated Wireless 802.11 a/b/g/n (select models) • Highly configurable OS & support for local apps • Secure USB compartment & PCIe/PCI Expansion option • Write Filter & Firewall • Broad peripheral support • Supports Dual monitor	HP t5740 (WES) HP t5745 (HP Thin Pro) HPt5630w(WES)

Specialty Series	Mobile Thin Clients	
Mobile , more secure with 14" display	• 14" WXGA LCD • Integrated Wireless • Support for local applications	HP 4410t

Upgrade path

HP ProCurve introduces the 6600 switch series to extend the [Adaptive Infrastructure](#) to server-edge connectivity. With an expansive portfolio of adaptive networking solutions, HP ProCurve enables consistent core-to-edge connectivity that can reduce complexity and streamline your data center infrastructure.

For more information, refer to
http://h40060.www4.hp.com/procurve/solutions/ent/datacenter/networking.php?cc=tr&lc=tr.

For more information

Contact HP	http://welcome.hp.com/country/us/en/contact_us.html
HP ProLiant BL460c G6 server blade	http://www.hp.com/servers/bl460c
HP LeftHand P4000 SAN	www.hp.com/go/p4000
HP ProCurve networking	http://www.procurve.com/
HP Server Based Computing and Citrix XenApp (formerly Citrix Presentation Server)	http://www.hp.com/solutions/activeanswers/hpsbc
HP BladeSystem Power Sizer	http://h71019.www7.hp.com/ActiveAnswers/cache/347628-0-0-0-121.html
HP ProLiant Sizer for Citrix XenApp and Microsoft Windows Server 2003 Terminal Services	http://h71019.www7.hp.com/ActiveAnswers/cache/70245-0-0-0-121.html
HP Services	http://www.hp.com/hps/
HP Solution Centers	http://www.hp.com/go/solutioncenters
Citrix XenApp	http://www.citrix.com/site/PS/products/feature.asp?familyID=19&productID=186&featureID=4110
Citrix XenServer	http://h71019.www7.hp.com/ActiveAnswers/cache/457122-0-0-225-121.html
	http://www.citrix.com/English/ps2/products/product.asp?contentID=683148
Citrix Essentials for XenServer, HP Enterprise Edition	https://h20392.www2.hp.com/portal/swdepot/displayProductInfo.do?productNumber=HPE4XSE

To help us improve our documents, please provide feedback at
http://h20219.www2.hp.com/ActiveAnswers/us/en/solutions/technical_tools_feedback.html.

Technology for better business outcomes

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