HP ProLiant DL360 G4 and G4p Server High-Density Deployment Solution White Paper

Introduction

This white paper is a planning guide to expedite concentrated deployments of HP ProLiant DL360 Generation 4 or 4p servers in a single rack. This information is intended for field systems engineers, IT managers, installation technicians, and any personnel tasked with the installation and maintenance of the HP ProLiant server. Use this white paper in conjunction with documents for the HP ProLiant server and HP ProLiant rack deployment products as necessary.

Symbols in Text

The following symbols are used in the text of this document.

WARNING: Text set off in this manner indicates that failure to follow directions in the warning could result in bodily harm or loss of life.

IMPORTANT: Text set off in this manner presents clarifying information or specific instructions.

Note: Text set off in this manner presents commentary, sidelights, or interesting points of information.

Executive Summary

Many business enterprises and service providers implement a distributed architecture for their infrastructure, remote client access, and Web applications. In these cases, individual applications are loaded on multiple machines, creating the need to fit a large number of density-optimized servers into existing server rooms and data centers. HP meets this need with the density-optimized line of HP ProLiant servers, such as the HP ProLiant DL360 G4 or G4p server. Because the HP ProLiant DL360 G4 or G4p server occupies 1U of rack space, up to 42 of these servers can fit in a single HP ProLiant 42U rack.

The space-saving benefits of the HP ProLiant density-optimized servers present new challenges for rapid server deployment, cable management, and environmental considerations. HP engineers have developed innovations in rapid high-volume deployment and improved cable management for large installations of these servers. HP also offers the supporting products necessary for high-volume deployment in HP ProLiant rack configurations, such as keyboard, video, and mouse (KVM) infrastructure.

The installation of a high-density system can place significant demands on utility power that, if not considered and managed appropriately, can result in downtime due to equipment failure, power main failure, or both. Power management becomes a critical element in an enterprise system handling large volumes of data and users where downtime costs can easily run into thousands of dollars per hour. HP offers sophisticated sizing and planning utilities to ensure adequate power infrastructure planning.

This white paper introduces the planning, power and thermal considerations, rack requirements, and installation configurations you need to know about to ensure a successful HP ProLiant DL360 G4 or G4p server high-density deployment.

IMPORTANT: This document discusses the HP ProLiant DL360 G4 or G4p server primarily, and the HP ProLiant 9000- and 10000-series racks and related rack options secondarily. This document does not discuss other servers, products or racks not manufactured by HP, although the ideas presented here may be applied to third-party products.

Power Distribution Solutions

HP recommends using power distribution units (PDUs) in installations where the large number of server units can place serious loading demands on the AC power bus. HP offers PDUs that provide safety and reliability to multi-server installations.

The PDUs described in this white paper offer 0U and 1U mounting options and feature circuit-breaker protection of the equipment. The equipment power can be organized in groups to minimize the impact of power interruption.

Figure 1 shows a PDU using the 0U rackmounting option. HP recommends this configuration in high-density installations that require the maximum amount of vertical space for servers and other active components. The 0U configuration offers the following advantages:

- Saves vertical rack space for equipment requiring more operator/maintenance accessibility
- Offers easy access to power connections

Figure 1. 0U Rackmounting Option

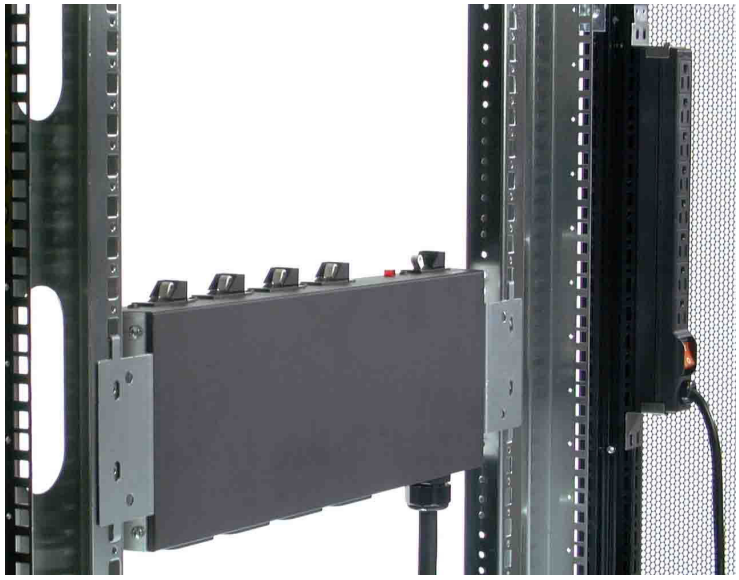


Figure 2 shows a PDU using the 1U rackmounting option. HP recommends this configuration in installations where maximum accessibility to all components is important. The 1U configuration offers the following advantages:

- Easy access to all switches and circuit beakers
- Easy viewing of circuit status LED
- Easy access for service replacement or upgrade

Figure 2. 1U Rackmounting Option

Modular PDU

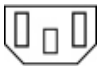
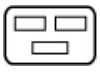
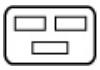
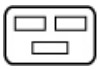
The Modular PDU consists of a control core that connects to the power bus (or to a UPS) and four extension bars that distribute power to the equipment groups. The control core includes a 15A circuit breaker for each of the four IEC C19 extension bar outputs. Available in low- and high-voltage versions, the modular PDU comes with three types of extension bars to accommodate a variety of distribution requirements. The control core may be rackmounted in a 0U or 1U configuration. The extension bars include both single-bar and double-bar mounting brackets for attachment to vertical rack supports. Several versions of Modular PDUs are available to meet a variety of electrical requirements as indicated in Table 1.

Figure 3. Modular PDU Components

Control Core

Extension Bar (2 of 4)
Shown with Double-Bar Brackets

Table 1. Modular PDU types

Name **PN**	**Voltage and Amperage**	**AC Bus Plug Type**	**Extension Bar Output Receptacle Type (Qty)**
24A NA/JPN Low, 252663-D71	100-127/ 24	NEMA L5-30P 	4 x NEMA 5-15R (8) 
24A NA/JPN High, 252663-D72	200-240/24	NEMA L6-30P 	4 x IEC 320 C13 (8) 
32A International, 252663-B31	200-240/32	IEC 309 32A 	4 x IEC 320 C13 (8) 
40A World Wide, 252663-B21	200-240/40	Terminals for hardwiring	3 x IEC 320 C13 (8)  1 x IEC 320 C19 (4) 
16A World Wide 252663-B24	200-240/16	1 x IEC 320 C20 (1) 	1 x IEC 320 C19 (2) 

Modular PDU Power/Jumper Cords

Although PDUs and servers are typically shipped with power cords, the physical and electrical requirements for a particular configuration may require different cords.

WARNING: Never cut or splice cords to accommodate a configuration. Personal injury or equipment damage could result from the use of improper power cords. The correct factory cord should always be used.

Table 2. Power and Jumper Cords

	HP Part #	Description
PDU Y- Cable kit	310782-B21	This kit includes 1 Y-cable that is 10-ft long with a 6-ft section on the single-side and 4-ft sections on the dual-side.
10A IEC-to-IEC Cables kit	142257-001 (6 ft) 142257-002 (8 ft) 142257-003 (10 ft) 142257-006 (4.5 ft) 142257-007 (4.5 ft) 15 each	The IEC-to-IEC cables can be used either as individual power cords for the server or to extend the length of the high-voltage Y-cables. The cables are available in 6-, 8-, and 10-ft lengths. The HP ProLiant server ships with one 10-ft IEC-to-IEC cable, part number 142257-003.

Fixed Cord PDUs

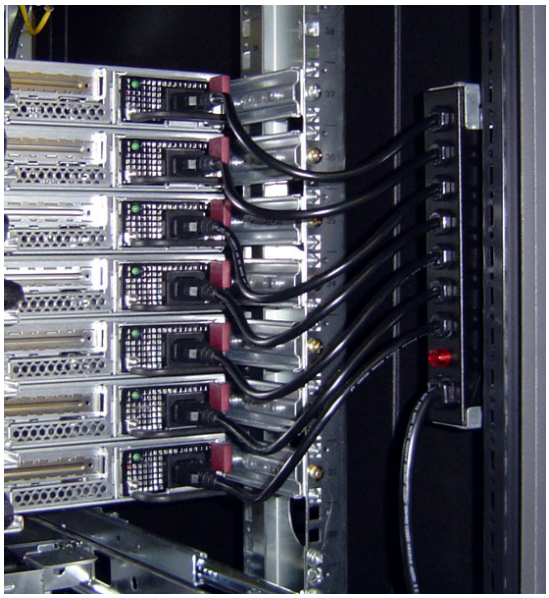
Cable management and rack airflow are increasing concerns in any rackmount environment. The HP Fixed Cord Extension Bars and Fixed Cord PDUs will significantly help you manage cable clutter in the back of the rack, which will result in improved airflow through the rack. Designed exclusively for 1U fixed rail servers (DL360, DL320, and DL140), these PDUs offer the following new features that are different from the modular PDUs:

- Output cords are attached to the PDU extension bar (stick), resulting in one less possible point of accidental disconnect.
- Each output cord is only 33 cm (13 in) long, resulting in less obstruction to rack airflow and simpler cable management.
- Seven output cords per extension bar.

The Fixed Cord Extension Bars and Fixed Cord PDU are available in two configurations—either with a modular PDU core and extension bar, or the extension bars only.

Figure 4. Fixed cord extension bars

Single Extension Bar



Dual Extension Bars

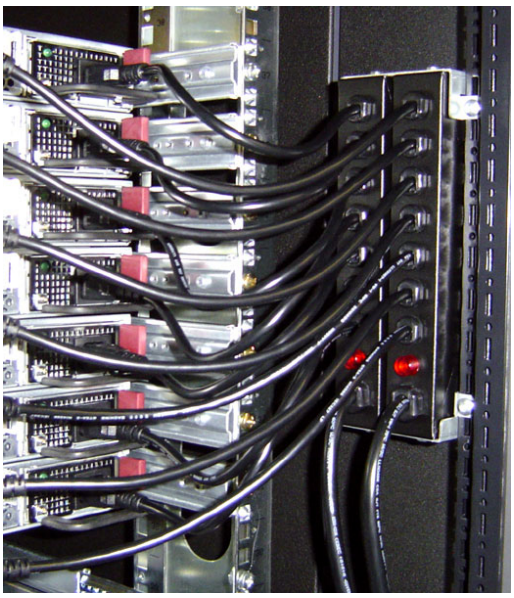


Table 3 Fixed Cord PDUs

Description	PDU Core	Voltage	Input.	Extension Bars	Outputs	Part Number
Fixed Cord Extension Bars (Worldwide)	No, but compatible with all cores	Either	Attached input cord per stick: IEC-320, C20 plugs into core	2	(14) IEC 320 C-13	351655-B21
Fixed Cord PDU (NA/Japan)	Yes, 24A HV	HV	Attached modular core input cord: NEMA L6-30P	4	(28) IEC 320 C-13	351655-D72
Fixed Cord PDU (International)	Yes, 32A HV	HV	Attached modular core input cord: IEC 309-32A	4	(28) IEC 320 C-13	351655-B31

The extension bars can be operated over the entire low-voltage (LV) to high-voltage (HV) range, enabling the flexibility to apply to only the extension bar in either scenario. Since most installations are either HV or LV, and do not typically change, it is the specific application that drives either the LV or HV selection. The cores are specifically LV or HV by design and cannot be changed.

To determine actual power requirement per server instead of using the server nameplate rating, refer to the ActiveAnswers Power Calculator.

Console Management Systems

A KVM console management system enables a single keyboard and video console to control multiple servers. A console management system mounted in the rack may be used to manage a single rack of servers or groups of racks. The HP IP console switch products have 16 ports that can access up to 128 servers. The HP IP Consoling Solution combines analog and digital technology to provide flexible, centralized KVM control of data center servers. This solution provides enterprise customers with a significant reduction in cable volume, secure remote access, and high-performance server KVM access. Using the IP console viewer, users can access local KVM functions from any Microsoft® Windows® or Linux workstation by means of a 10/100 network connection. Alternatively, an off-rack console management system may also be used to manage the servers locally.

Table 4. Local/IP Console Management Options

Product Name	HP Part No.	Description
1x1x16 IP Console Switch	262585-B21	16-port KVM switch — provides access for 2 simultaneous user sessions (1 network session and 1 local session at a rackmounted console)
3x1x16 IP Console Switch	262586-B21	16-port KVM switch — provides access for up to 4 simultaneous user sessions (3 network sessions and 1 local session at a rackmounted console)
4 Interface Adapters (8 per Pack)	262587-B21	Transitions traditional KVM cabling to CAT5 — one needed for each server (convenient 8-pack)
Interface Adapters (Single Pack)	262588-B21	Transitions traditional KVM cabling to CAT5 — one for each server
Expansion Module	262589-B21	Enables up to 8 servers per port on the IP console switch to be tiered
CAT5 Cables 3 FT (1 M) (4 per Pack)	263474-B21	4-pack of 3-ft UTP CAT5 cables with RJ-45 connectors
CAT5 Cables 6 FT (1.8 M) (8 per Pack)	263474-B22	8-pack of 6-ft UTP CAT5 cables with RJ-45 connectors
CAT5 Cables 12 FT (3.6 M) (8 per Pack)	263474-B23	8-pack of 12-ft UTP CAT5 cables with RJ-45 connectors
CAT5 Cables 20 FT (6.5 M) (4 per Pack)	263474-B24	4-pack of 20-ft UTP CAT5 cables with RJ-45 connectors
CAT5 Cables 40FT (13 M) (1 per Pack)	263474-B25	Single 40-ft UTP CAT5 cable with RJ-45 connectors
TFT5600 Rackmount Keyboard and Monitor	221546-001	1U integrated keyboard and monitor
TFT5110R Flat Panel Monitor	281683-B21	1U rack-optimized monitor (keyboard not included)
Integrated Keyboard and Drawer	257054-001	1U Keyboard with Hot keys

In-Rack Local Consoles

With an in-rack local console, all equipment, servers, switchboxes, keyboards, keyboard drawers, and video displays are installed in the same rack. The HP switchboxes mount behind the keyboard drawer and do not consume extra panel space in the rack. Using the TFT5600 RKM and an IP console switch will consume a total of 1U to accommodate up to 128 servers. One console switchbox can support up to 16 directly attached servers with no user blocking. Up to eight servers may be tiered or cascaded on each switch port using either a legacy Compaq KVM switch or an Expansion Module. Only one user can access tiered switches or servers connected by Expansion Modules at any one time, however. Critical devices requiring frequent access should be attached directly to a switch port. Server accessibility should be assessed by the IT manager before deployment to determine the appropriate server density per console switch.

Table 5 outlines the number of devices that fully populate a 47U, 42U, or 36U rack with an in-rack local console.

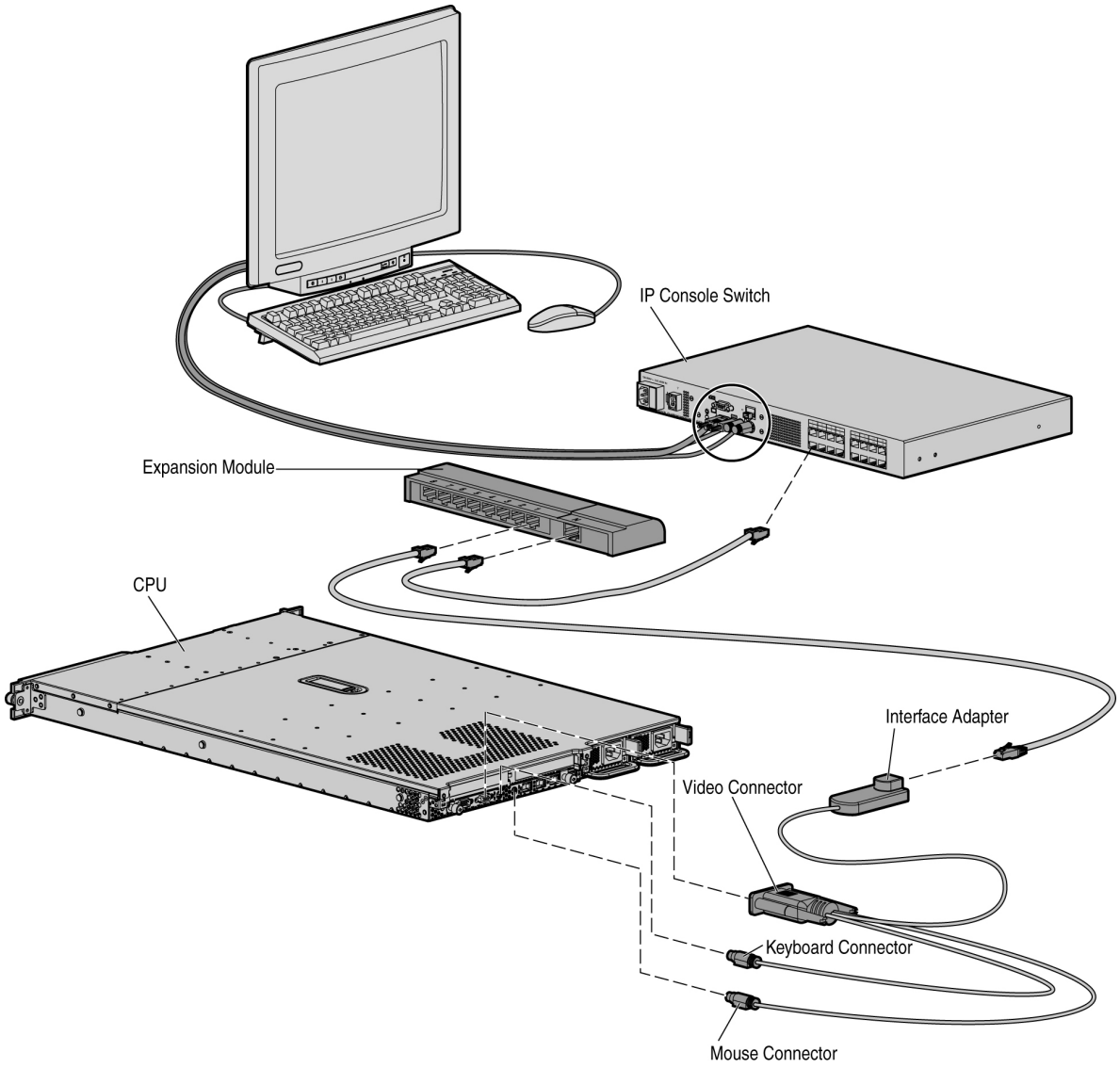
Table 5. Device Configuration for an In-Rack Local IP Console

Device or Cable	**47U Rack**	**42U Rack**	**36U Rack**
HP ProLiant DL360/320 G4 or G4p servers	46	41	35
KVM IP Console Switches	1	1	1
Interface adapters	46	41	35
UTP CAT5 cables for KVM access	46	41	35
Expansion modules	4-16	3-16	3-16
TFT5600 RKM (integrated monitor/keyboard)	1	1	1

As illustrated in Figure 5, each server deployed in a fully populated rack with an in-rack IP console management system requires the following accessories for successful deployment and operation:

- Interface adapter
- UTP CAT5 cable 6-ft (1.8-m) cables for sliding rail solutions
- Universal Sliding Rack Rail
- Velcro ties to secure the cabling
- Optional cable management arm
- Optional fixed cord PDU

Figure 5. Remote Console Management System



Planning Rack Configurations

You must consider several important factors when planning a rack configuration:

- The number of servers deployed in the rack
- The number of other devices such as keyboard drawers, video displays, and console switchboxes that support the servers
- The number of PDUs and their orientation
- The type of rack
- The rack management system
- The console management system
- The remote management system
- Network Interface scheme

All these factors influence floor support requirements, future service and upgrade requirements, and installation requirements.

Weight Considerations

Due to the higher densities possible with HP ProLiant servers and HP ProLiant Infrastructure products, it is possible to configure a rack that can present floor loading issues. Floor loading is an even more important factor when several enclosures are positioned in one row. The Rack/Site Installation Preparation Utility provides you with the total rack weight information necessary to verify that floor loading remains within design specifications.

Special Considerations for Compaq Racks

HP recommends that you consider the following when installing HP ProLiant servers in Compaq racks:

- To effectively cool the HP ProLiant server in a Compaq 7000-series rack, replace the front door of the rack with the High Air Flow Rack-Door. Install the door before deploying the servers in the rack.
- Use the Rack Extension kit (P/N 154392-B21) to alleviate any space problems for cable bundles at the rear of Compaq 7000-series racks.

WARNING: Follow these guidelines to reduce the risk of personal injury or damage to the equipment:

- **Do not install an HP ProLiant server into a rack until the rack has been placed in its final location.**
- **Preinstall slide rails, PDUs, power cords, and cables into the rack in a build room or other location before moving the rack to its final location.**
- **Extend the leveling jacks to the floor and rest the full weight of the rack on the jacks before installing any servers. The casters are not designed to support the full weight of a populated rack.**
- **Do not move a rack populated with servers. A fully populated rack can weigh up to 771 kg (1,700 lb). Moving a populated rack can cause the rack to become unstable, resulting in serious personal injury or equipment damage.**

Rack Management Systems

To determine the best rack management solution, consider the service and upgrade demands of the servers deployed in the rack.

Universal Sliding Rack Rails

The Universal Sliding Rack Rails and optional cable management solution enable in-rack servicing and provide convenient access to the server cables and connectors. With this solution, a server can be powered down and serviced without disconnecting the server cables or removing the server from the rack. The low-friction sliding rack rails are designed for either square- or round-hole racks. The sliding rack rails compress and snap securely in place in the rack without screws or nuts. This solution fits either HP ProLiant or third-party racks. Velcro ties, provided with each server, secure the cables away from the rear of the server.

Telco Rack Solution

The telco rack solution is available as part number 1UKIT-009 from http://racksolutions.com. This kit provides the components necessary to mount two servers.

Cable Management Solution

The optional cable management solution is designed for use with the adjustable-depth rack rail mechanism for either square- or round-hole racks. This solution fits either HP ProLiant or third-party racks.

The optional cable management arm attaches directly onto the rear of the rack rail. The arm can be mounted on either side of the rack. It secures and routes the power, network, and KVM cables along the rear of the rack.

When a server is extended from the front of the rack for servicing, the cable arm extends as well. This not only prevents the cables from sagging and tangling with the server in the rack, it also enables proper air ventilation through the rack while enabling full extension of the servers from the rack without disconnecting any of the server cables.

Refer to the *HP ProLiant DL360 Generation 4 Server Setup and Installation Guide or the HP ProLiant DL360 Generation 4p User Guide* for complete installation instructions.

Online Calculators

HP provides online calculator utilities that simplify the process of determining power requirements and offer convenient "what if" calculations. These utilities, available online at no charge, offer several advantages over "scratch pad" methods using nameplate figures:

- Calculations are based on formulas using actual measurements of equipment running various exercise utilities.
- Calculations are based on active components exercised at 100% duty cycle, generally allowing additional extra capacity for typical installations.
- Air volume calculations are based on measurements taken in equipment operating in an airflow chamber.

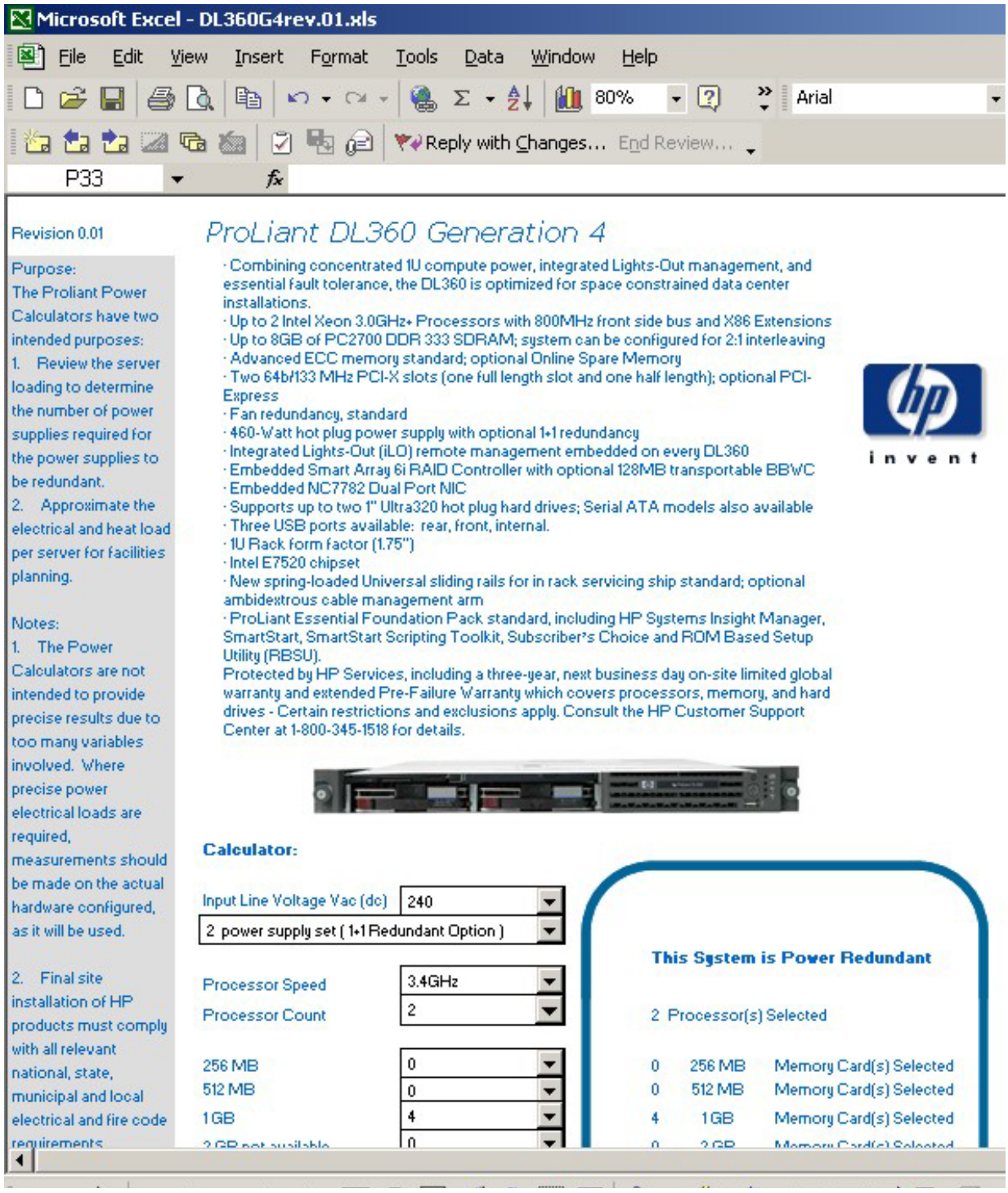
The "ActiveAnswers" section of the HP web page provides two types of online calculators:

- Power Calculator – Calculates the power requirements for a single server
- Rack/Site Installation Preparation Utility – Calculates the power, vertical space, airflow, and cooling requirements for a complete rack of servers.

Power Calculator Utility

The Power Calculator utility, as illustrated in Figure 6, computes the power requirements for a single server. Using drop-down menus, you select the number of CPUs, amount of memory, hard drive type and size, and PCI card compliment of the server. Each configuration change is re-calculated instantly. The calculator displays a yellow warning message if a particular parameter will not work or will seriously degrade performance.

Figure 6. Power Calculator Utility Opening Screen. This screen is similar for HP ProLiant DL360 G4 and G4p servers.



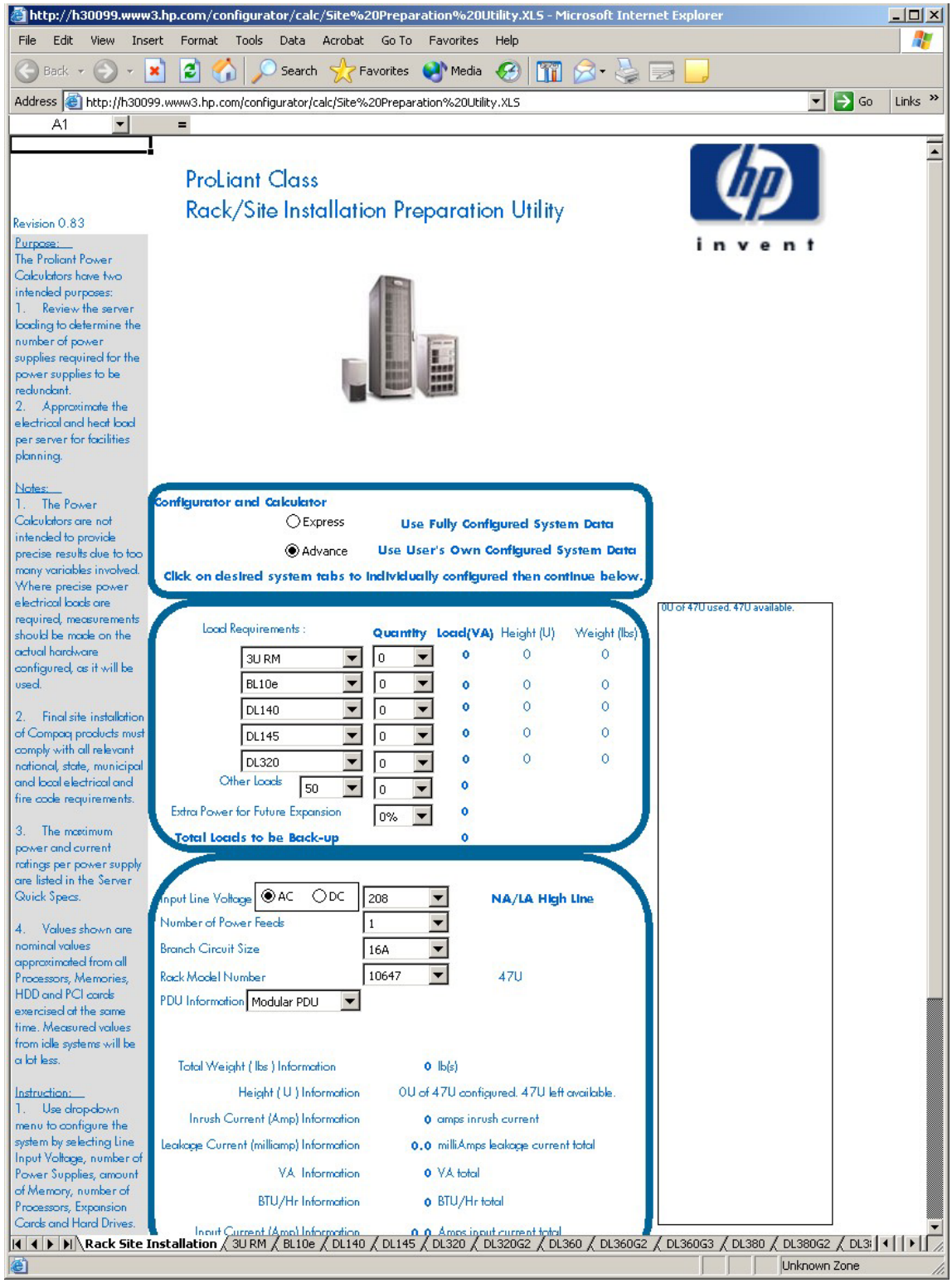
The power calculator is convenient for small server system planning or for making minor additions to existing installations. For a more thorough analysis of a complete installation, HP recommends that you use the Rack/Site Installation Preparation Utility.

Rack/Site Installation Preparation Utility

The Rack/Site Installation Preparation Utility will calculate all power, vertical rack space, and airflow requirements for a complete server installation. In addition, the Rack/Site Installation Preparation Utility includes sub-calculators for determining the power requirements of individual components.

The Rack/Site Preparation Utility is accessed through the HP ActiveAnswers web site. You are presented with the main screen (Figure 7), which includes four control/result areas, individual calculator tabs, and a rack space indicator.

Figure 7. Rack/Site Installation Preparation Utility Opening Screen



Using the Rack/Site Installation Preparation Utility

Select either the **Express** or **Advanced** mode of calculation. Express calculation uses pre-set values for components and can be used for producing a quick estimate of system requirements. Advanced calculation requires user to configure individual components. HP recommends using advance calculation for final installation planning. If **Express** mode is selected, proceed to step 5 on the screen.

1. Select the **DL360G4** or **DL360G4p** tab at the bottom of the screen. The individual component configuration page is displayed. Starting with the line voltage, select the configuration parameters desired, scrolling down to ensure all appropriate parameters are chosen. Be aware of error messages indicating possible problems.

2. When component configuration is complete, click on the **Rack Site Installation** tab to return to the main calculator page (Figure 7).

3. Complete the **Load Requirements** and **Input Line Voltage** configuration areas. Each configuration change is calculated instantly. The rack space indicator indicates the amount of vertical space used and the amount that is still available.

ProLiant Server Power Requirements

In the standard single-processor configuration, the HP ProLiant DL360 G4 or G4p server includes a single power supply that can operate from high- or low-voltage AC power. Single power supply units can be upgraded to a dual-power supply configuration with a redundant power supply option kit. The power supplies are hot-pluggable, allowing removal and replacement without interrupting server operation.

AC power is provided to the HP ProLiant server through an IEC C14 connector mounted on the chassis. HP offers a variety of power cord kits with matching IEC C13 connectors and that are compatible with the physical and electrical requirements of the HP ProLiant server.

To review typical system power ratings use the Power Calculator utility, which is available on the HP website:
http://h30099.www3.hp.com/configurator/powercalcs.asp.

Power Configuration Examples

The high- or low-voltage AC power and dual-power supply capabilities of the HP ProLiant server makes it adaptable to a variety of power configurations. Each of the following examples suggests a method of power distribution for a group of servers mounted in a rack. These examples illustrate server power configurations and do not take into account such accessories as KVM switches and display monitors that are typically included in an installation. These examples also suggest ways to accomplish server management using Integrated Lights-Out (iLO) and KVM switching products.

Suggested Configurations

Table 6 is a quick-reference table with suggested rack configurations for deploying HP ProLiant servers. Examples of these configurations are described in Configurations A, B, and C.

These examples assume a server configured with two processors, six DIMMs, two hard drives, and a single PCI card. Consult the power calculator for other configurations.

Table 6. Suggested Rack Configurations Quick Reference

Configuration	**A**	**B**	**C**
Priority	Maximum Performance Density	Maximum Flexibility with Redundant Power	Conventional
Rack Size	42U	42U	42U
Server Count	42	35	24
Power Source	High Voltage	High Voltage	Low Voltage
PDU	4 x 40 Amp Modular PDU	4 x 40 Amp PDU	4 x 24 Amp PDU
KVM Switching	No local KVM Switching (iLO only)	IP Console Switch	IP Console Switch
Local Console	No Local Console	TFT5600RKM	TFT5600 RKM
Lights-Out Management	iLO Advanced	iLO Advanced	iLO Standard or iLO Advanced
IP Connections	1 x 48 Port 10/100 Ethernet Switch (44+4)* for iLO 6 x 16 Port Gigabit Ethernet Switch for data	2 x 24 Port 10/100 Ethernet Switch (22+2)** for iLO 1 x 48 Port Gigabit Ethernet Switch (44+4)* for data	2 x 24 Port 10/100 Ethernet Hub for iLO 2 x 48 Port Gigabit Ethernet Switch (44+4)* for data
* 44 10/100 ports plus 4 Gigabit uplink ports ** 22 10/100 ports plus 2 Gigabit uplink ports			

Configuration A: Maximum Performance Density

Table 7 describes a suggested configuration for a 42U rack with 42 HP ProLiant DL360 G4 or G4p servers powered from a single or dual high-voltage AC power supplies.

Table 7. Configuration A Summary

Configuration A Summary
Rack Contents **Rack** HP ProLiant Model 10462 rack with 42U of mounting space **Units** 42 Servers with all fixed or all sliding rails with cable trays 4 High-voltage 40-A Modular PDUs **Internal Cables** 42 Standard IEC-TO-IEC jumper cords going to the servers from the extension bars mounted at the rear of the rack **External Cables** • 42 management network cables from the iLO RJ-45 connector to external 48 port Ethernet switches with 44 10/100 ports and 4 Gigabit ports • 84 data network cables from the on-board 10/100/1000 NICs RJ-45 connectors to 6 external 24-port Gigabit Ethernet switches, assuming use of two LAN connections per server • 2 high-voltage input power cords hardwired from the PDUs to facility AC power feeds **Site Utility Requirements (worst-case)** **Power:** 2 dedicated 200 V - 240 V 50-A branch circuits. **Thermal:** Up to 80,000 BTUs/hour (This number is a worst-case. The actual BTUs/hour will depend on the OS/application software running and the server hardware configurations.) **Weight:** Up to 907.18 kg (2,000 lb) (with sliding-rails) (The network cables are not accounted for since most implementations route the network cables to the ceiling-hung cable rails outside of the rack.)

The optional iLO Advanced Pack is recommended for all console management (local and remote) for this configuration (Figure 9). The network cables originating from each server connect to network switches outside this rack enclosure.

The use of the double-bar mounting brackets for the Modular PDU is highly recommended. This will allow the maximum number of outlets to be mounted on the same side of the rack enclosure as the server power supply connection. The fixed length cord PDU significantly reduces cable bulk from power cords. The PDU is 20 cm (8 in) long, and the cables are each 33 cm (13 in) long.

Note: No KVM switches are used in Configuration A. The iLO Advanced Pack handles all the local consoles. See Figure 9 for the Ethernet Cable Diagram.

Figure 8 is a maximum performance density power cabling diagram. The 42 HP ProLiant DL360 G4 or G4p servers are connected to redundant power feeds.

Figure 8. Maximum Performance Density Power Cabling Diagram

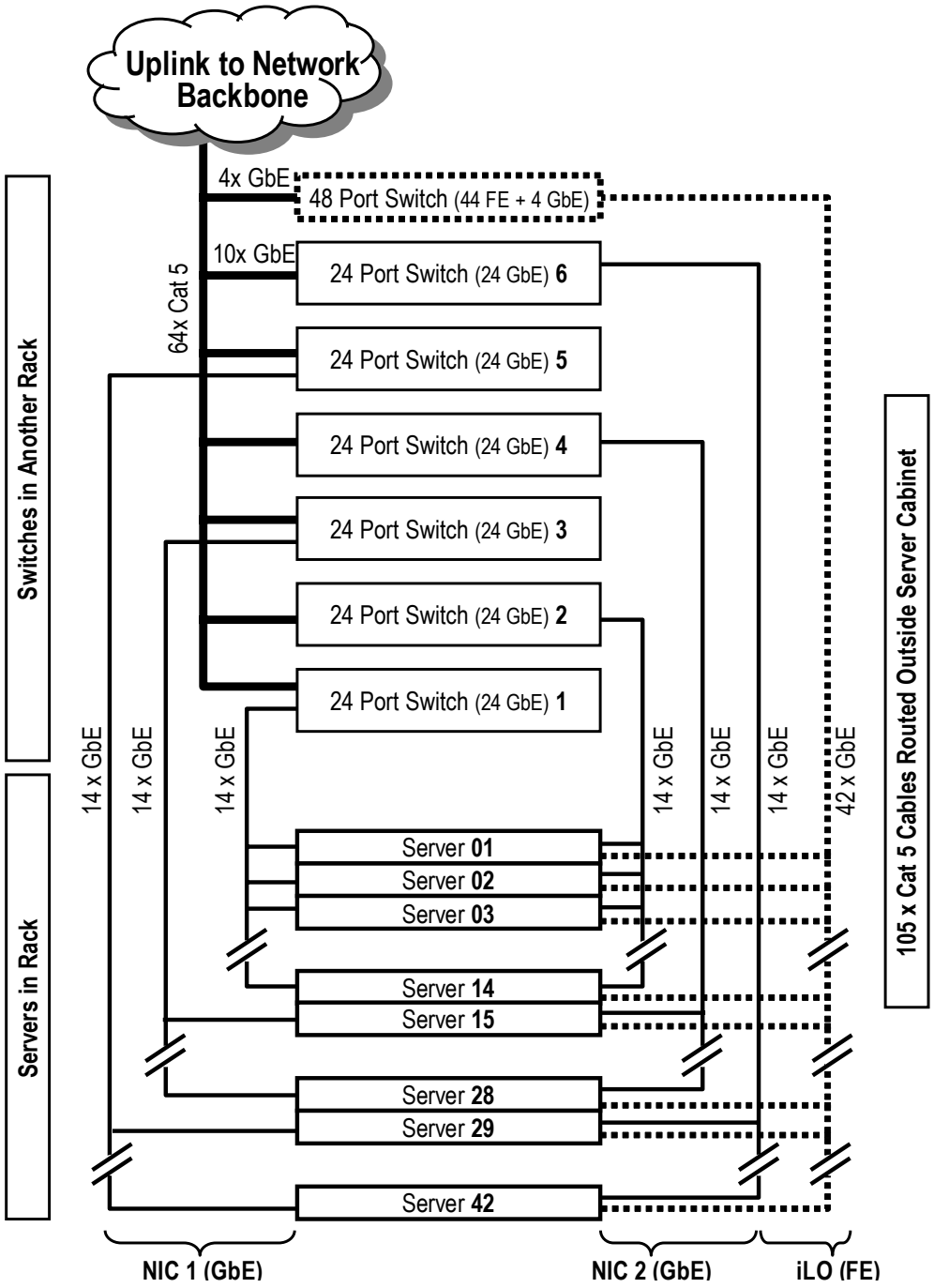
Feed A	PDU1	S1A	S2A	S3A	S4A	S5A			
		S6A	S7A	S8A	S9A	S10A			
		S11A	S12A	S13A	S14A	S15A			
		S16A	S17A	S18A	S19A	S20A	S21A		
	PDU2	S22A	S23A	S24A	S25A	S26A			
		S27A	S28A	S29A	S30A	S31A			
		S32A	S33A	S34A	S35A	S36A			
		S37A	S38A	S39A	S40A	S41A	S42A		
Feed B (optional)	PDU3 (Optional)	S1B	S2B	S3B	S4B	S5B			
		S6B	S7B	S8B	S9B	S10B			
		S11B	S12B	S13B	S14B	S15B			
		S16B	S17B	S18B	S19B	S20B	S21B		
	PDU4 (Optional)	S22B	S23B	S24B	S25B	S26B			
		S27B	S28B	S29B	S30B	S31B			
		S32B	S33B	S34B	S35B	S36B			
		S37B	S38B	S39B	S40B	S41B	S42B		

Note: S1A= server 1 with power supply A and S1B= Server 1 with power supply B

One 40A Modular PDU connects to power feeds A and B to support 21 HP ProLiant servers with redundant power supplies.

Figure 9 is a maximum performance density Ethernet cable diagram.

Figure 9. Maximum Performance Density Ethernet Cable Diagram



Configuration B: Maximum Flexibility

Table 8 describes a suggested configuration for a 42U rack with 35 HP ProLiant DL360 G4 or G4p servers powered from a high-voltage AC power supply.

Table 8. Configuration B Summary

Configuration B Summary
Rack Contents
Units
35 Servers with all fixed or all sliding rails with cable trays
2 X 40 A PDUs
2 x 48 Port Ethernet switches
2 x 24 Port Ethernet switches
1 IP Console KVM Switch
35 Interface Adapters
4 Expansion Modules
1 TFT5600RKM
Internal Cables
70 standard IEC-TO-IEC jumper cords going to the servers from the extension bars mounted at the rear of the rack
Cables External to Rack
35 management network cables from the iLO RJ-45 connector to two external 24-port Ethernet switches, each with 22 10/100 ports and 2 Gigabit ports
70 data network cables from the on-board 10/100/1000 NICs RJ-45 connectors to external 48-port Ethernet switches with 44 10/100 ports and 4 Gigabit ports, assuming use of two LAN connections per server
4 high-voltage input power cords connecting from the PDUs to the facility AC power feeds
Site Utility Requirements (worst-case)
Power: 4 dedicated 200V - 240V 50A branch circuits (2 from each separate feed, assuming redundant power supply configuration).
Thermal: Up to 70,000 BTUs/hour (This number is a worst-case. The actual BTUs/hour will depend on the OS/application software running and the server hardware configurations.)
Weight: Up to 907.18 kg (2,000 lb). The network cables are not accounted for since most implementations route the network cables to the ceiling-hung cable rails outside of the rack.

HP recommends the use of the double-bar mounting brackets for the Modular PDU. This enables the maximum number of outlets to be mounted on the same side of the rack enclosure as the server power supply connection. The fixed length cord PDU significantly reduces cable bulk from power cords. The PDU is 20 cm (8 in) long, and the cables are each 33 cm (13 in) long.

Figure 10 illustrates the maximum flexibility power cabling diagram.

Figure 10. Maximum Flexibility Power Cabling Diagram

Feed A	PDU1	S1A	S2A	S3A	S4A	KVM			
		S5A	S6A	S7A	S8A				
		S9A	S10A	S11A	S12A				
		S13A	S14A	S15A	S16A	S17A			
	PDU2	S18A	S19A	S20A	S21A				
		S22A	S23A	S24A	S25A				
		S26A	S27A	S28A	S29A	S30A			
		S31A	S32A	S33A	S34A	S35A			
Feed B	PDU3	S1B	S2B	S3B	S4B	TFT			
		S5B	S6B	S7B	S8B				
		S9B	S10B	S11B	S12B				
		S13B	S14B	S15B	S16B	S17B			
	PDU4	S18B	S19B	S20B	S21B				
		S22B	S23B	S24B	S25B				
		S26B	S27B	S28B	S29B	S30B			
		S31B	S32B	S33B	S34B	S35B			

Note: S1A= server 1 with power supply A and S1B= Server 1 with power supply B.
One 40-A Modular PDU connects to power feeds A and B to support 17 or 18 ProLiant servers with redundant power supplies.

Figure 11 illustrates a maximum flexibility KVM switch cabling diagram.

Figure 11. Maximum Flexibility KVM Switch Cabling Diagram

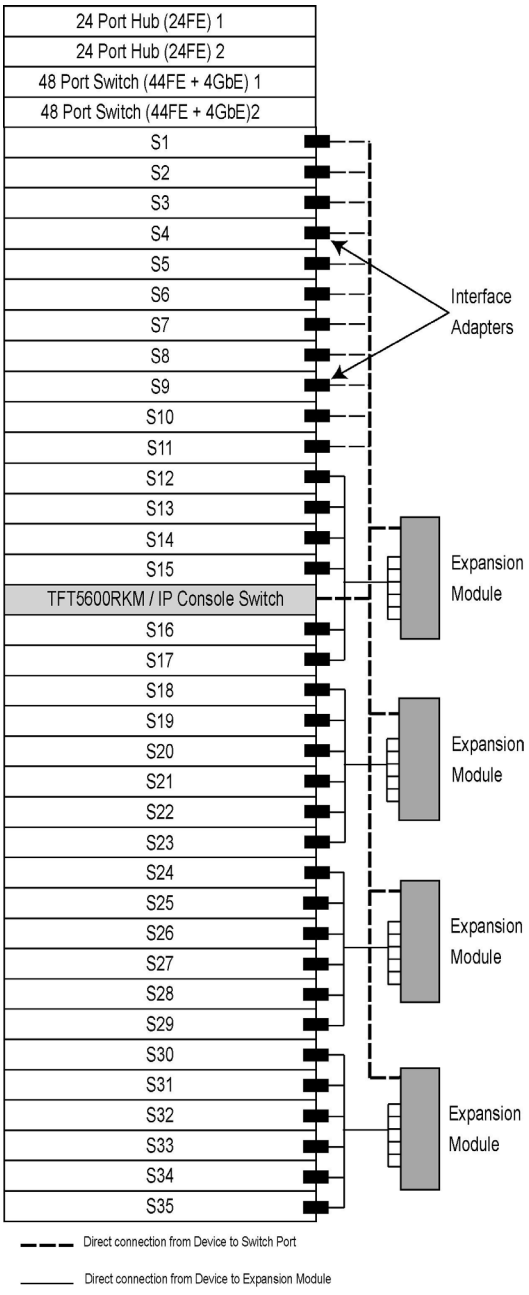
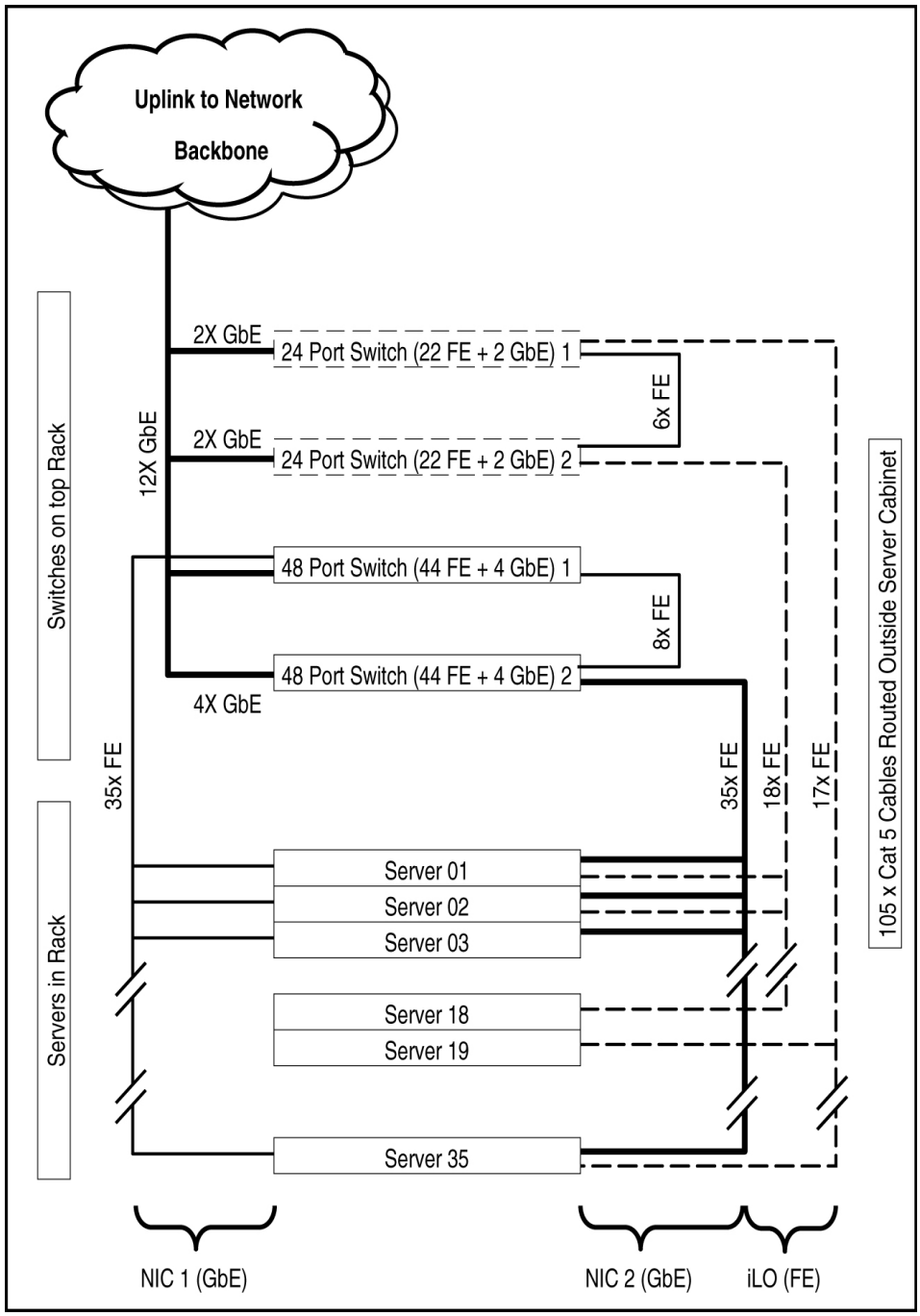


Figure 12 illustrates a maximum flexibility Ethernet cabling diagram.

Figure 12. Maximum Flexibility Ethernet Cable Diagram



Configuration C: Conventional

Table 9 describes a suggested configuration for 24 servers powered from a LV AC power supply.

Table 9. Configuration C Summary

Configuration C Summary
Rack Contents
Units
24 Servers with all fixed or all sliding rails with cable trays
4 Low-voltage 24-A 0U/1U PDUs
2 x 48-Port Ethernet switches
2 x 24-Port Ethernet hubs
1 IP Console Switch
24 Interface Adapters
2 Expansion Modules
1 x 1U Keyboard/Monitor
Internal Cables
24 power cords going to 4 PDUs in the side panels (These cables are supplied with the servers.)
28 KVM cables going from switch to server, switch to switch, and switch to 1U keyboard/monitor
24 management network cables from the iLO RJ-45 connector to two 24-port 10/100 Ethernet hubs
48 data network cables from the on-board 10/100/1000 NICs RJ-45 connectors to two 48-port Ethernet switches each with 44 10/100T ports and 4 Gigabit ports, assuming the use of two LAN connections per server
Cables External to Rack
4 LV input power cords connecting from the PDUs to facility AC power feeds
Site Utility Requirements (worst-case)
Power: 4 dedicated 100V - 120V 30-A branch circuits.
Thermal: Up to 48,000 BTUs/hour (This number is a worst-case. The actual BTUs/hour will depend on the OS/application software running and the server hardware configurations.)
Weight: Up to 907.18 kg (2,000 lb). The network cables are not accounted for since most implementations route the network cables to the ceiling-hung cable rails outside of the rack.

The use of the double-bar mounting brackets for the Modular PDU is highly recommended. This enables the maximum number of outlets to be mounted on the same side of the rack enclosure as the server power supply connection. The fixed length cord PDU significantly reduces cable bulk from power cords. The PDU is 20 cm (8 in) long, and the cables are each 33 cm (13 in) long.

Figure 13 illustrates a conventional power connection.

Figure 13. Conventional Power Cabling Diagram

Feed A	PDU1	S1A	S2A						
		S3A	S4A						
		S5A	S6A						
		24PH	48PS						
	PDU2	S7A	S8A						
		S9A	S10A						
		S11A	S12A						
		TFT							
	PDU3	S13A	S14A						
		S15A	S16A						
		S17A	S18A						
		24PH	48PS						
	PDU4	S19A	S20A						
		S21A	S22A						
		S23A	S24A						
		IPCS							

Note: S1A= server 1 (single Power Supply) 24PH= 24 Port Ethernet Hub; 48PS= 48 Port Ethernet Switch; IPCS= IP Console Switch; TFT= TFT5600 1U Keyboard/Monitor

Figure 14 is a conventional Ethernet cable diagram.

Figure 14.Configuration C (Conventional) Ethernet Cable

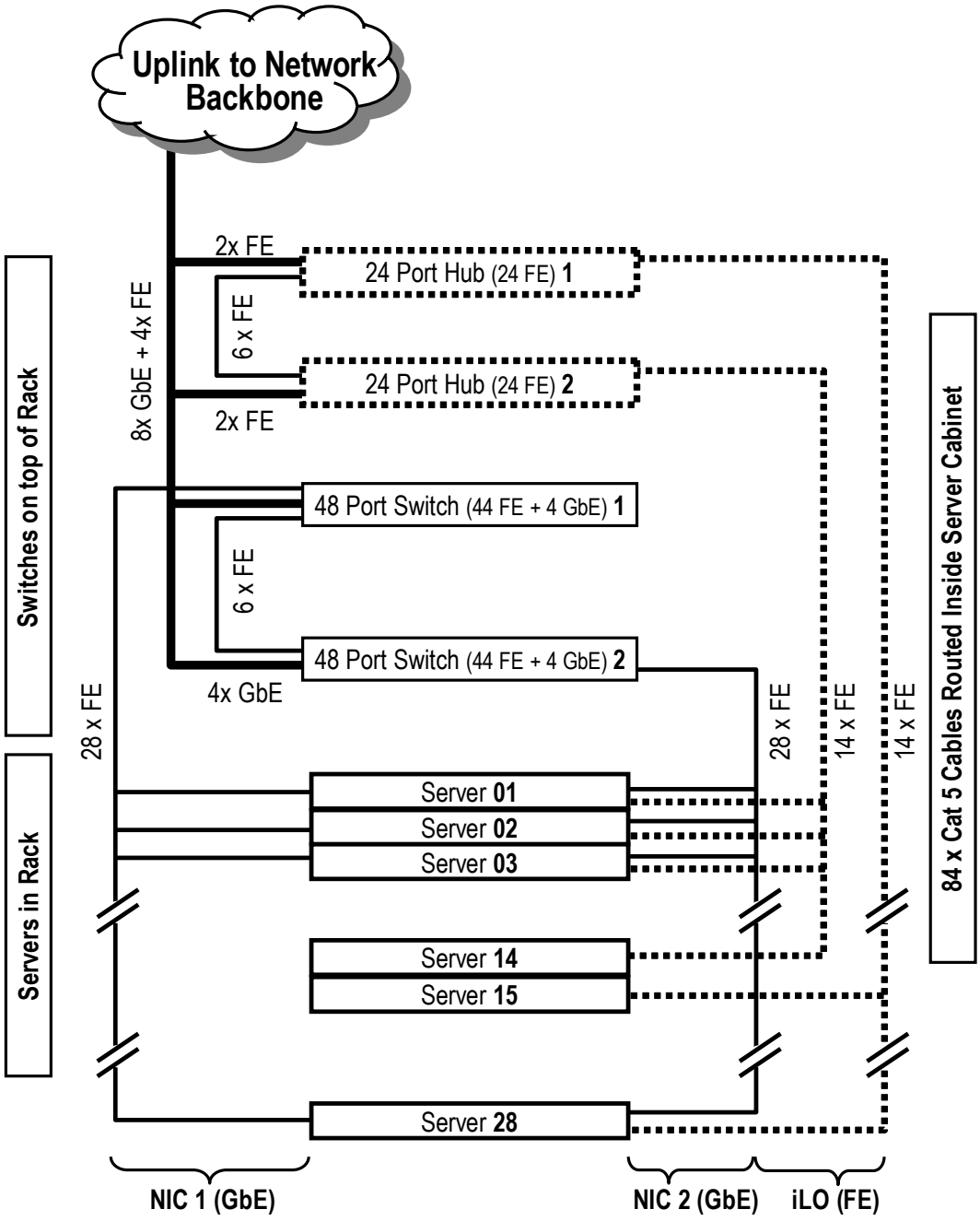
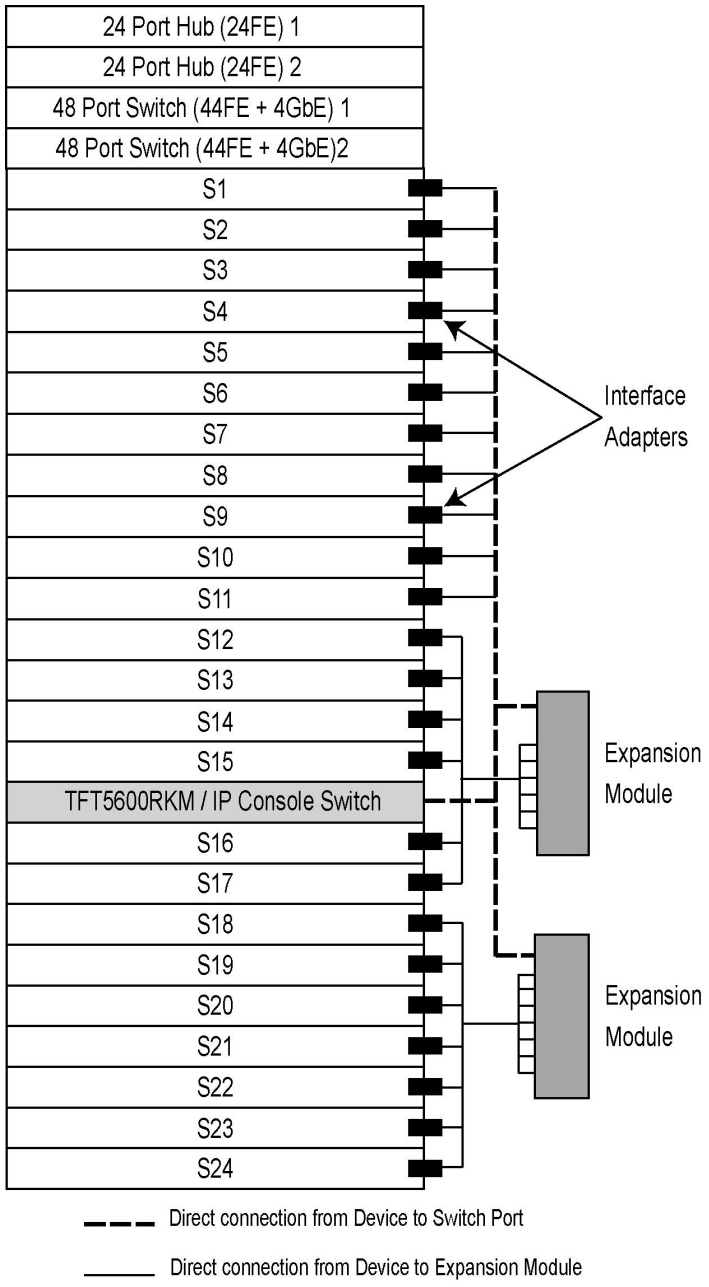


Figure 15 is a conventional KVM switch cabling diagram.

Figure 15. Configuration C (Conventional) KVM Switch Cabling Diagram



Completing the Installation

To complete the installation:

1. Install side panels on the outside of the end racks.
2. Install the front and rear doors.
3. Connect the PDUs to the power source.
4. Power up the servers.

Conclusion

The load requirements of high-density server installations can be significant. Careful planning using accurate calculations and providing adequate additional capacity allowance for peripheral devices can greatly reduce the likelihood of downtime because of power problems.

Reference Information

Table 10. Reference Information Sources

Topic	Where to Find
Information focal point for the HP ProLiant server	http://h18000.www1.hp.com/products/servers/platforms/index.html
Specifications, options, and a list of other HP products and options compatible with the HP ProLiant server	*HP ProLiant DL360 Generation 4 or 4p QuickSpecs*
Installation and service guidelines for the HP ProLiant server	www.compaq.com/support/servers/ProLiantDL360 Generation 4.html *HP ProLiant DL360 Generation 4 Server Setup and Installation Guide* *HP ProLiant DL360 Generation 4 Server Maintenance and Service Guide* www.compaq.com/support/servers/ProLiantDL360 Generation 4p.html *HP ProLiant DL360 Generation 4p User Guide* *HP ProLiant DL360 Generation 4p Server Maintenance and Service Guide*
Best practices	http://h200005.www2.hp.com/bc/docs/support/SupportManual/c00064724/c00064724.pdf

Glossary

Table 11. Glossary of Power Terms

Term	Description
High Voltage	180 - 264 VAC (200-240 VAC nominal) supplied to areas where load requirements are such that high voltage is more economical. Common in commercial applications in North America, numerous foreign countries also use this range as the AC appliance standard.
Inrush Current	A high, momentary current draw occurring when power is first applied to electrical systems. This current drain is not relative to the power-on requirements of equipment. It is due to the capacitive and inductive properties of components in the power supply.
Keyboard/ Video/Mouse	Keyboard/video/mouse (KVM) peripherals. A KVM switch is an accessory that switches a single KVM set between two or more server units.
Ground Leakage Current	Residual current flow through the grounding conductor, which is always undesirable. With data processing occurring at ever-increasing speeds, most IT equipment these days includes capacitors in the power circuits to filter radio frequency (RF) signals to ground. While effective at filtering RF, these components tend to allow a small amount of AC current to pass to the ground. Leakage current is additive, so that as more equipment is connected to the AC mains, the amount of leakage can increase.
Low Voltage	90 - 132 VAC (100-120 VAC nominal) supplied at utility outlets in homes and offices. This is the AC appliance standard used in North America, Latin America, and Japan.
Power Density	The amount (product) of amperage and voltage provided to a system (VA). A 120-VAC 30-amp circuit will deliver a power density of 3600 VA while a 208-VAC 30-amp circuit (single-phase) will deliver a power density of 6240 VA.
Power Distribution Unit (PDU)	Rackmounted component that connects directly to the AC power infrastructure of the building. The PDU typically provides circuit-breaker protection for groups of AC outlets into which separate AC components of the rack are plugged. Some PDU designs offer primary/secondary switching.
Power Factor (Pf)	An efficiency rating that indicates the amount of watts actually consumed by a load from the volt-amperes delivered to it. The rating is expressed as either a decimal number between 0 and 1, or percentage of the formula of dividing watts by volt-amperes. A power factor of 1 indicates that a device receiving 1 VA is consuming 1 watt.
Power Service	Point at where electrical power enters a building or equipment room.
Volt-Ampere (VA)	A unit of apparent power (i.e., the amount of AC power that is available to or can be handled by utility equipment) measured with a volt meter and an ammeter. In single-phase systems, VA = E × I, where E = volts, I = current in amperes. In three-phase systems, VA = 1.73 × E × I.
Watt (W)	A unit of true power consumed by the product and measured with an input power meter. In single-phase systems, W = E x I x pf, where E = volts, I = current in amperes, and pf = power factor.

For more information

Product information: 1-325-345-1518

Pre-sales: 1-325-282-6672

Post-sales: 1-325-652-6672

Business partner sales consulting: 1-325-888-5874

For more information on HP ProLiant servers, visit www.hp.com/servers/proliant

For more information on HP 9000 and 10000 series racks and options, visit www.hp.com/products/racks

Learn more about optional rack features at www.hp.com/products/rackoptions

Learn more about HP ProLiant server power protection and management at www.hp.com/products/ups

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