



# Technology for remote management of power distribution

technology brief

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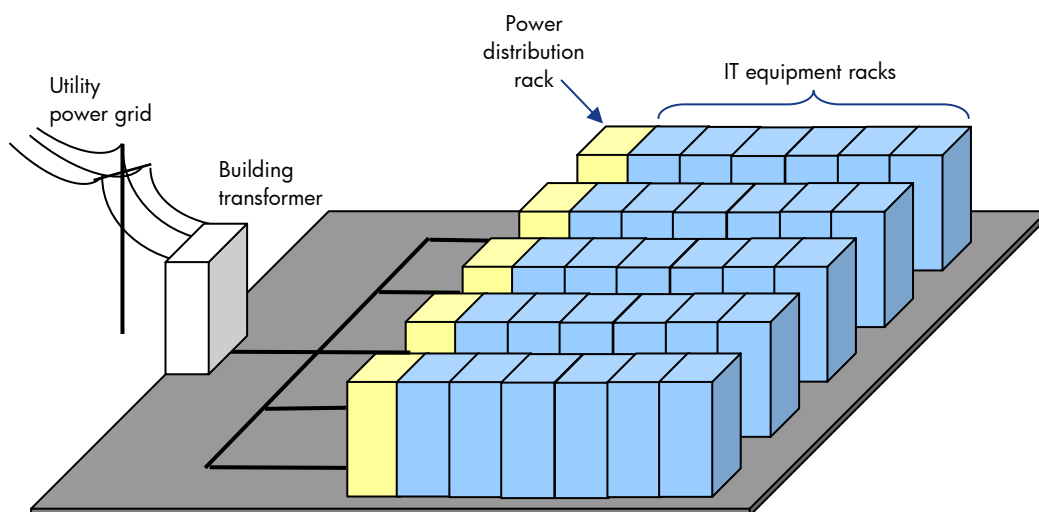
## Abstract

Energy usage in enterprise data centers has increased to the point where it is second only to labor in operating costs. The efficient distribution of AC power to IT equipment is an important factor in minimizing consumption costs. This paper informs IT infrastructure architects and facility managers of the importance of energy management and describes an HP solution for distributing, balancing, and monitoring AC power.

## Introduction

The trend in data centers is to de-centralize power distribution by employing a zoned system. In a zoned system, high-line (415 or 208 VAC) three-phase power from the AC mains is distributed across a number of power distribution racks, one for each IT equipment row (Figure 1). Each equipment row includes its own zone or sub-infrastructure of power, using either three-phase<sup>1</sup> or split-phase distribution. With distribution panels dedicated for each zone, systems are more adaptable to change and growth. Cable clutter can also be reduced, since the AC mains can be run directly to each row or zone before being branched out.

**Figure 1.** Data center using zoned power distribution



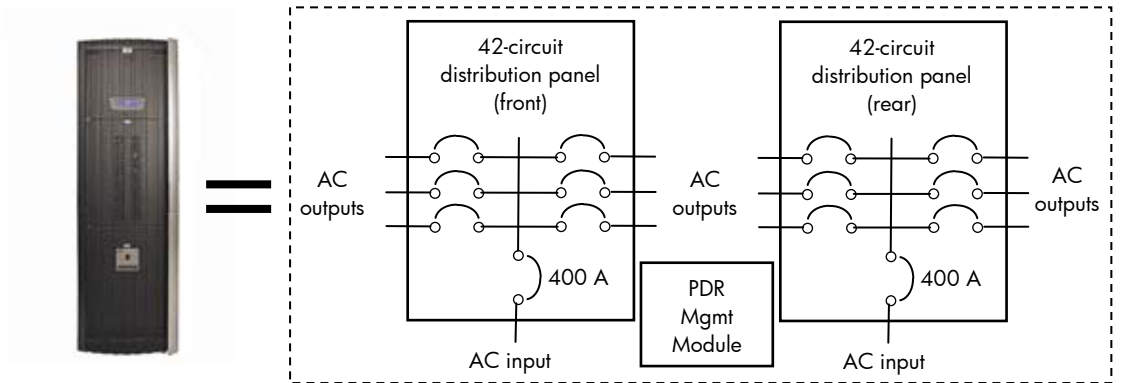
A zoned system also allows the creation of a more structured and balanced power budget and precise management of power consumption to improve cooling efficiency. The power budget for a data center is best maintained using proper management techniques such as:

- Load balancing—The current loads across all AC circuit branches should be as even as practical for maximum efficiency.
- Circuit monitoring—Data center power consumption and loading is dynamic and should be constantly monitored for increases or imbalances.

<sup>1</sup> For more information on three-phase power distribution technology, refer to the HP white paper "Increasing Energy Efficiency with Modular HP Three-Phase Power Distribution" at <http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01173322/c01173322.pdf>

The HP Power Distribution Rack (PDR) is designed for end-of-row power distribution for data centers using a zoned infrastructure. Each HP PDR (Figure 2) consists of an HP 10000-series rack configured with two 400-amp 42-pole (North America) distribution panels for a maximum of 84 output circuits. Each 42-pole distribution panel is protected by a 400-amp three-pole (3P) input circuit breaker (lower amperage configurations are acceptable as well). The distribution panels support 1P, 2P, and 3P breakers of a wide range of amperage ratings to allow a variety of three-phase or split-phase distribution configurations.

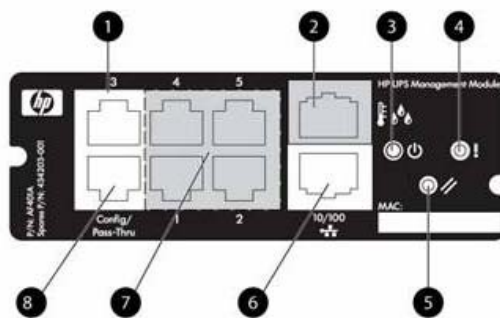
**Figure 2.** Functional block diagram of HP Power Distribution Rack



The HP PDR offers two methods of power monitoring: local and remote. The Local display provides a readout of AC voltage/frequency/current, total power factor, total/peak kilowatts and kilowatt/hours at the distribution panel level. Remote monitoring provides comprehensive power data from individual branch circuits to a remote terminal and/or to other management systems.

Remote monitoring is facilitated with the HP PDR Management Module (Figure 3), mounted inside the HP PDR. The HP PDR Management Module enables facility administrators to monitor PDR power status through a serial or network interface using RTU or TCP protocols.

**Figure 3.** HP PDR Management Module



Item	Description
1	RJ-11 serial port
2	(not for PDR use)
3	Power LED
4	Error LED
5	Reset button
6	RJ-45 10/100 Ethernet port
7	(not for PDR use)
8	RJ-11 configuration/pass-through port

# Implementation strategies

Zoned power distribution systems offer greater flexibility for load balancing and for precise circuit monitoring. The HP PDR supports a variety of strategies for power distribution and management.

## Power distribution strategies

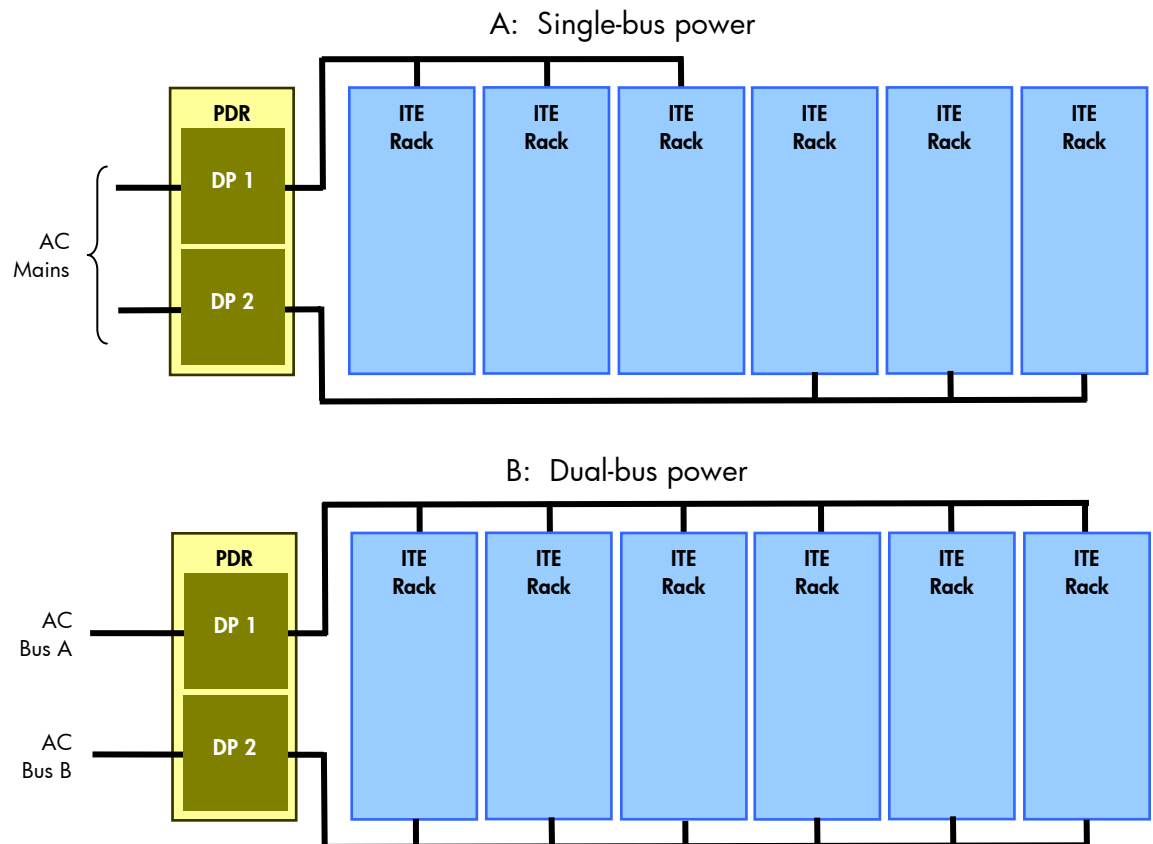
With two distribution panels each with an AC input, the HP PDR supports a number of possible distribution scenarios. Figure 4 shows two basic configurations: single bus power for a row of IT racks and dual bus power to a row of IT racks.

In a single-bus configuration (Figure 4A), the PDR receives the load from the AC mains and each distribution panel (DP 1 or DP 2) provides power to specific ITE racks in the row. Backup power for the row would typically be provided from uninterruptible power supplies (UPSs) on both mains directly before the PDR.

In a dual-bus configuration (Figure 4B), each distribution panel provides the full load of power from an AC bus to all racks in the row. Backup power for the row could be provided from UPSs before or after the PDR on the power bus designated to have redundancy.

Actual configurations depend on the specific power requirements of the each IT equipment rack. Zoning allows each row to be uniquely configured based on ITE rack contents and redundancy requirements.

**Figure 4.** HP PDR power distribution configurations



## Power management strategies

The flexibility of zoned distribution systems allows data center configurations to be dynamic. Growth and expansion in zoned systems can occur easily, so extra care must be taken to avoid an unbalanced load or overload situation. Any sudden unscheduled downtime of IT equipment from a tripped circuit breaker can be costly. The ability to easily monitor individual power circuits is essential to avoiding downtime and, if downtime occurs, to minimize the mean-time-to-repair (MTTR).

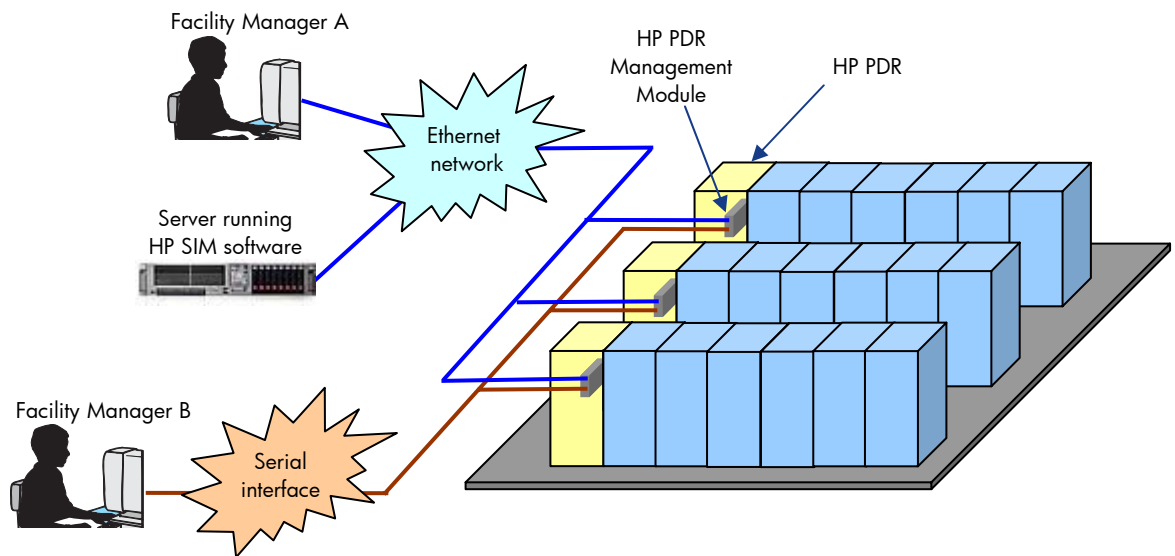
The HP PDR Management Module allows monitoring the HP PDR directly from a terminal or PC located in the data center or anywhere that has network access. The module includes both a serial interface and a 10/100 Ethernet port. It allows managing a row of ITE racks through a single IP address, which simplifies the management infrastructure. In addition, the HP PDR Management Module can be configured to provide alert traps to HP Systems Insight Manager (SIM) or other SNMP management programs.

Figure 5 shows the possible methods for managing the HP PDR. Facility Manager A operates a PC running a compatible web browser that accesses the web interface of the HP PDR Management Module over a 10/100 Ethernet network. The Ethernet network can be an isolated management network for ultimate security or a part of a wide area network with internet access. The web interface includes security measures for preventing unauthorized access.

Facility Manager B operates a PC or terminal that accesses the HP PDR Management Module through a serial interface using a terminal emulation or telnet session.

The HP PDR can also be configured to provide traps to a server running HP SIM management software. Note that a data center can implement all methods for redundant management of the HP PDR.

**Figure 5.** HP PDR management methods

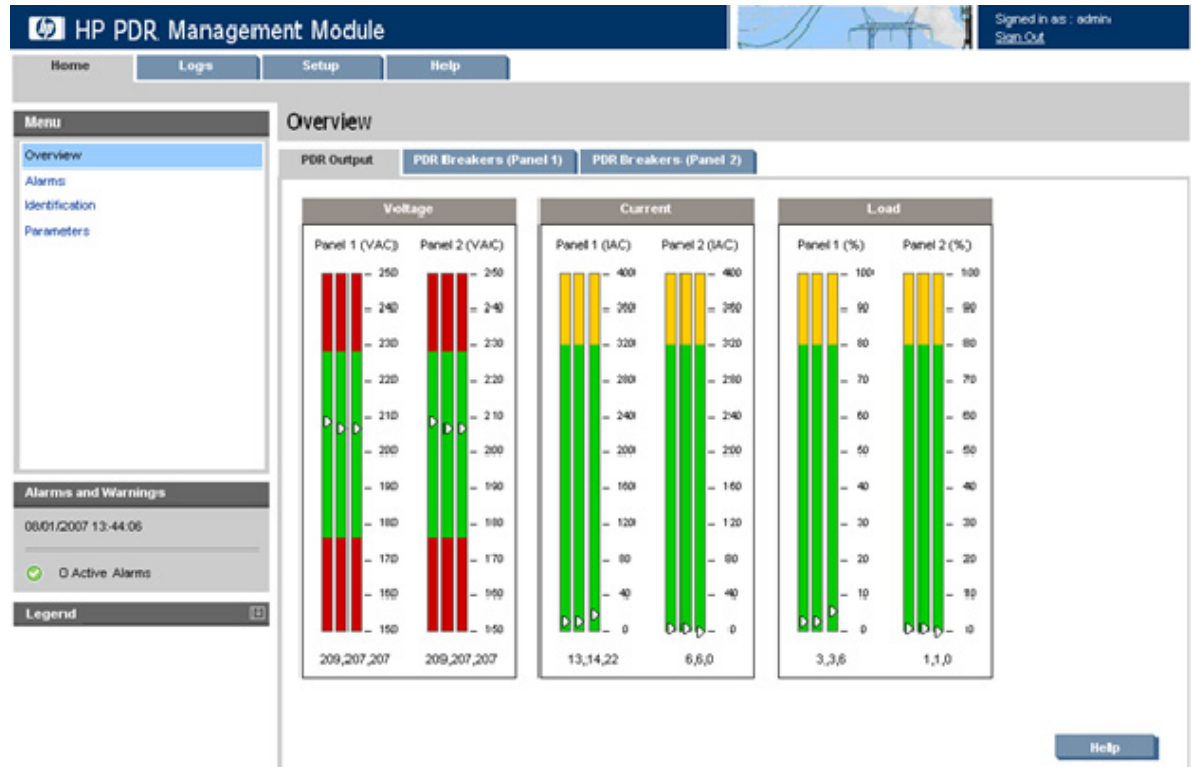


## Management through the web interface

The HP PDR Management Module includes a web interface that provides comprehensive, graphical status of the PDR. The web interface allows an authorized user designated as an administrator to access, set, or change management module settings over a 10/100 Ethernet network.

As shown in Figure 6, the Overview screen of the web interface displays the overall voltage, current, and load status of both distribution panels of the PDR.

**Figure 6.** Overview, PDR Output screen of the HP PDR Management Module web interface (North American version)



The example shown in Figure 6 indicates the following:

- Output voltage across each phase is 209, 207, and 207 VAC (for both distribution panels)
- Output current for each phase is:
  - 13, 14, and 22 amperes for panel 1
  - 6, 6, and 0 amperes for panel 2
- Percentage of maximum load for each phase is:
  - 3, 3, and 6 percent for panel 1
  - 1, 1, and 0 percent for panel 2

The outputs of all 42 circuits of each distribution panel can be viewed by selecting the PDR Breakers tab for Panel 1 or Panel 2. Figure 7 shows a sample PDR Breakers screen for Panel 1.

**Figure 7.** Overview, PDR Breakers (Panel 1) screen of the HP PDR Management Module web interface



The screen in Figure 7 provides the following information:

- Phase position of each breaker
- Connection position of each breaker
- Power in kilowatts through each breaker
- Output current (I rms) through each breaker
- Current rating (A) of each breaker
- Percent of load (I rms / Current rating (A) x 100%) through each breaker

Color graphs are displayed only for connected circuits.

The HP PDR Management Module monitors all circuits against a comprehensive list of alarm conditions, including (but not limited to) the following:

- Under- and over-voltage for inputs and outputs
- Input phase rotation error
- Neutral overload
- Primary and secondary breaker status
- Ground current
- Output current/kW overload
- Output over-voltage
- Neutral overload

These conditions are based on parameters specified by the user through the PDR Input and Output Menu (Figure 8) and the PDR Thresholds menu (Figure 9).

**Figure 8.** PDR Input and Output screen of the HP PDR Management Module web interface

The screenshot displays the HP PDR Management Module web interface. The top navigation bar includes the HP logo, the title 'HP PDR Management Module', and a user status indicator 'Signed in as: admin' with a 'Sign Out' link. Below the navigation bar are tabs for 'Home', 'Logs', 'Setup', and 'Help'. The left sidebar contains a 'Menu' section with links for 'Overview', 'Alarms', 'Identification', and 'Parameters' (which is highlighted). Below the menu is an 'Alarms and Warnings' section showing the date '2008/03/10 20:31:53' and '0 Active Alarms'. A 'Legend' section is also visible at the bottom of the sidebar.

The main content area is titled 'Parameters' and has two tabs: 'PDR Input & Output' (selected) and 'PDR Thresholds'. The 'PDR Input & Output' tab displays two data panels, Panel 1 and Panel 2, each containing a table of parameters and their values. All parameters in both panels are marked with a green checkmark, indicating they are within normal limits.

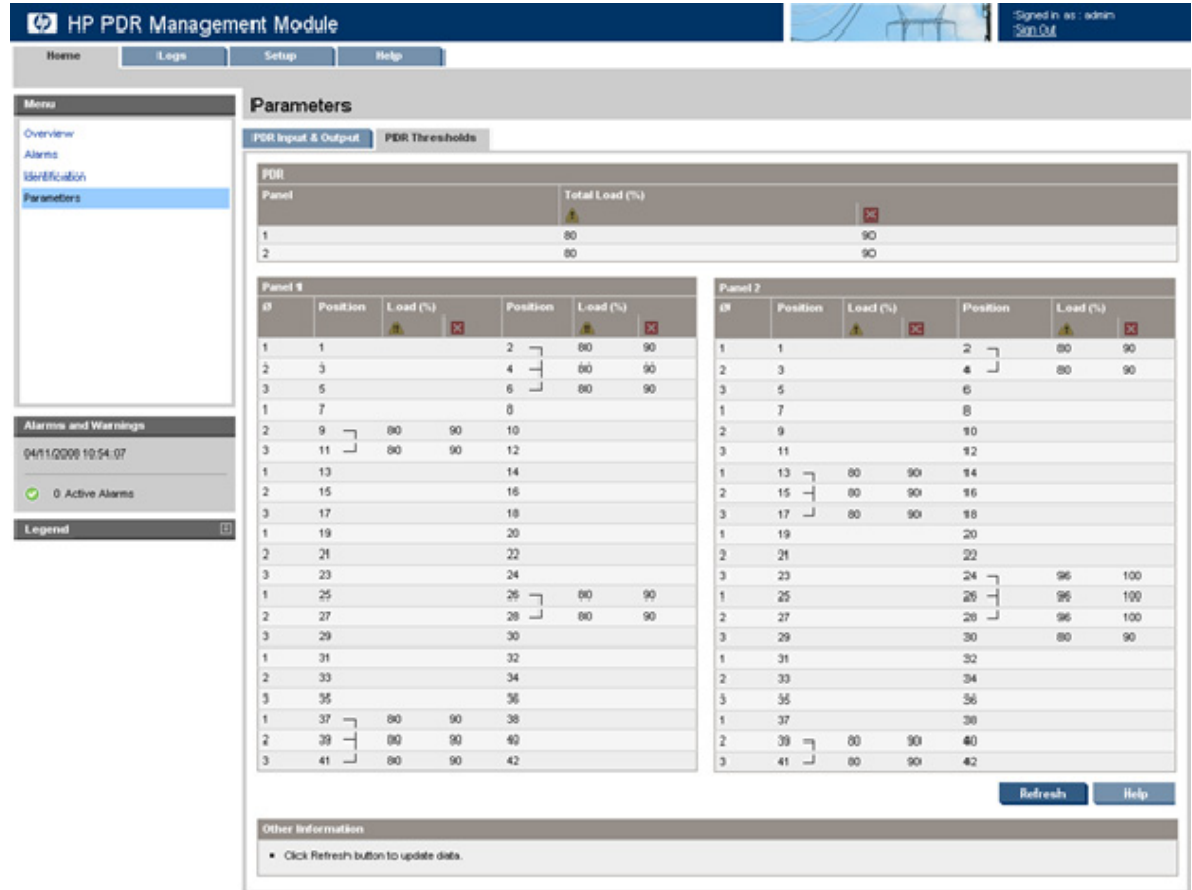
Severity	Description	Value
✓	Current L1	3.0 A
✓	Current L2	3.9 A
✓	Current L3	4.6 A
✓	Frequency	60.0 Hz
✓	Load L1	3.0 %
✓	Load L2	3.9 %
✓	Load L3	4.6 %
✓	Power	1400 VA
✓	Watts	1200 W
✓	Voltage L1	211.6 V
✓	Voltage L2	210.2 V
✓	Voltage L3	208.5 V

Severity	Description	Value
✓	Current L1	4.7 A
✓	Current L2	0.0 A
✓	Current L3	0.0 A
✓	Frequency	60.0 Hz
✓	Load L1	4.7 %
✓	Load L2	0.0 %
✓	Load L3	0.0 %
✓	Power	500 VA
✓	Watts	100 W
✓	Voltage L1	211.6 V
✓	Voltage L2	210.2 V
✓	Voltage L3	208.5 V

At the bottom right of the main content area, there are 'Refresh' and 'Help' buttons.

**Figure 9.** PDR Thresholds screen of the HP PDR Management Module web interface



When an alarm condition occurs or a threshold is exceeded, the module records the description, severity, date, and time in an event log. In addition, the web interface can be configured to send event notifications to user-designated email addresses of facility managers. Event notifications can also be sent as SNMP traps to as many as ten user-designated servers.

The web interface is accessed through one of the compatible web browsers listed in Table 1.

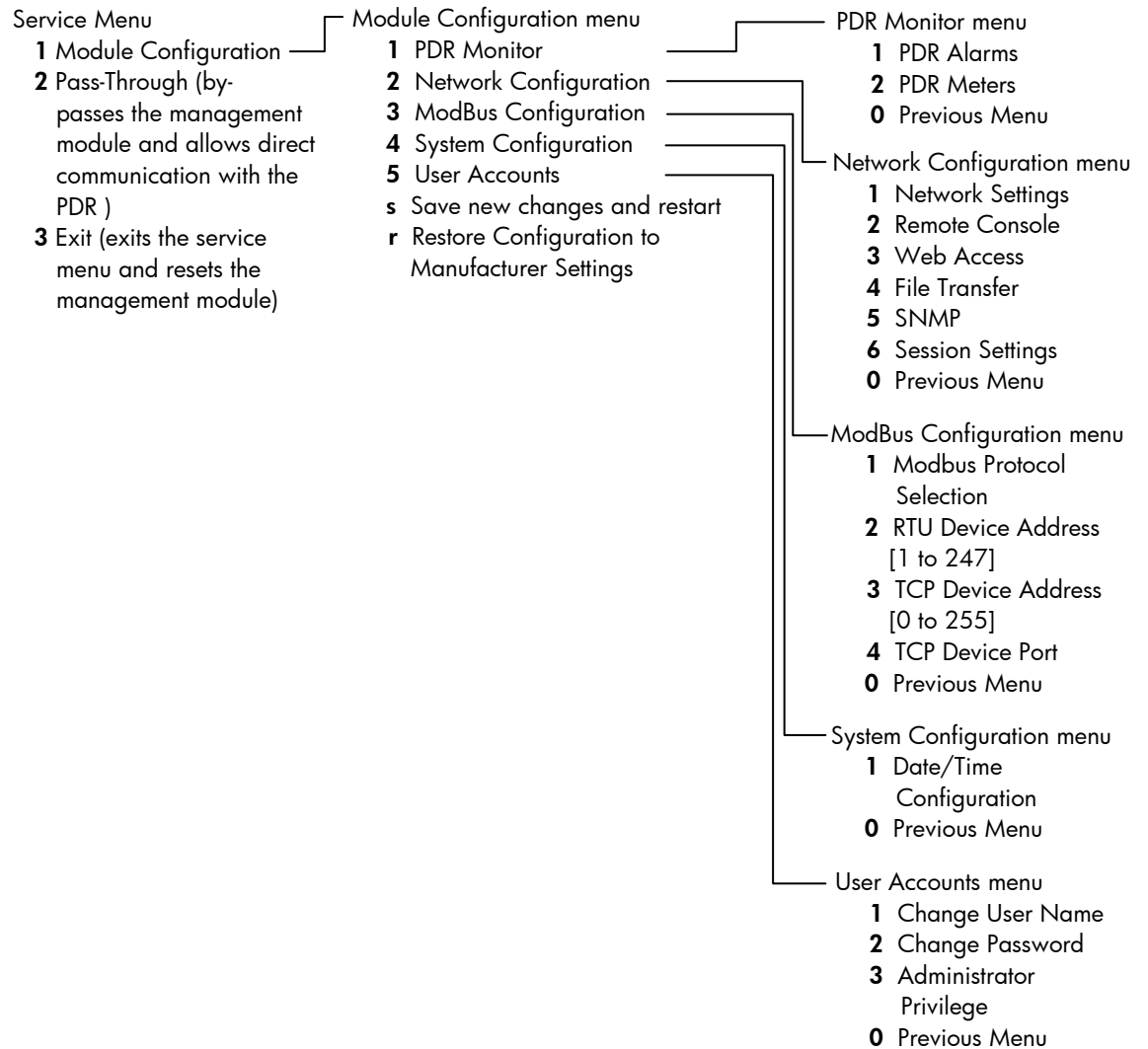
**Table 1.** Web interface requirements

Operating system (32-bit only)	Browser
Microsoft	Microsoft® Internet Explorer 6.0 with SP1 Microsoft Internet Explorer 7.0
Red Hat Linux	Firefox 1.5.x SeaMonkey 1.0.1
SUSE Linux	Firefox 1.5.x Mozilla 1.7.8

## Management through telnet or terminal emulation

The HP PDR Management Module can be accessed through a service menu that provides an alternate interface for situations where the web interface is not feasible or is temporarily unavailable. The service menu is accessed through a serial port using either a local device running a terminal emulator program or a remote device running a telnet session. The service menu provides a number of functions through a hierarchy of submenus shown in Figure 10.

**Figure 10.** Service menu hierarchy (top three levels)



### Note

All information and functions found in the service menu are available in the web interface.

## Integration with HP SIM

The HP PDR Management Module can be integrated with HP SIM for a comprehensive data center management solution. HP SIM allows facility managers to discover (detect) newly installed HP PDR Management Modules, launch the web interface of a management module from within HP SIM, and receive SNMP traps from management modules.

The following basic procedure describes setting up a new PDR for management through HP SIM:

1. The HP PDR Management Module is installed and connected into the management network used by the HP SIM server.
2. HP SIM is launched and automatically detects the new management module.
3. The HP SIM All Systems page lists the newly detected management module with a hyperlink to its web interface.
4. The facility manager launches the web interface of the newly discovered module and configures the module to send SNMP traps the server running HP SIM.

An SNMP trap sent to HP SIM can include a URL that allows a facility manager to launch the web interface of the originating management module and open the specific page for the event. A trap resulting from a tripped circuit breaker, for instance, can include the URL for the PDR breakers Panel 1 page (Figure 7) of the web interface for quick review of the problem.

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### Note

The correct MIB file (cpqpower.mib) must be compiled into HP SIM before traps can be received. The HP Power MIB file is available from the following HP web site:

[http://h18013.www1.hp.com/products/servers/management/hpsim/dl\\_windows.html](http://h18013.www1.hp.com/products/servers/management/hpsim/dl_windows.html)

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## ModBus support

The HP PDR Management Module supports ModBus protocol. ModBus is an industry-standard communications protocol for monitoring and managing facility devices. The HP PDR Management Module supports both ModBus/RTU (serial) and ModBus/TCP (Ethernet) protocols, although only one ModBus protocol can be used at a time.

The management module includes over 140 ModBus data register and alarm types, and therefore provides much of the functionality of the web interface. Information such as monthly/yearly/total kW hours per breaker is recorded, and alarms such as input/output voltage and current warnings are triggered when thresholds are exceeded.

## Conclusion

A data center's power infrastructure has become as important as the IT equipment it supports. A zoned distribution system incorporating the HP PDR with remote management allows the facility manager to precisely monitor and control power to avoid unscheduled downtime and wasted power.

## For more information

For additional information on topics discussed in this document, refer to the resources listed below.

Resource description	Web address
HP PDR Information	<a href="http://www.hp.com/go/pdr">http://www.hp.com/go/pdr</a>
HP PDR manuals	<a href="http://h20000.www2.hp.com/bizsupport/TechSupport/DocumentIndex.jsp?contentType=SupportManual&amp;lang=en&amp;cc=us&amp;docIndexId=64179&amp;taskId=101&amp;prodTypeId=329290&amp;prodSeriesId=3635723">http://h20000.www2.hp.com/bizsupport/TechSupport/DocumentIndex.jsp?contentType=SupportManual&amp;lang=en&amp;cc=us&amp;docIndexId=64179&amp;taskId=101&amp;prodTypeId=329290&amp;prodSeriesId=3635723</a>
HP SIM	<a href="http://h18004.www1.hp.com/products/servers/management/hpsim/index.html">http://h18004.www1.hp.com/products/servers/management/hpsim/index.html</a>

## Call to action

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