

# WHITE PAPER

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## Compaq ProLiant 6000 Power Management using Windows NT Performance Monitor

*The focus of this white paper is to describe redundant power supplies and power supply performance counters on a Compaq ProLiant 6000 system running Microsoft Windows NT 4.0. It explains how to monitor redundant hot-pluggable power supply modules using the Microsoft Windows NT Performance Monitor with the Compaq performance health counters.*

*The information presented in this document is intended for system administrators, network managers, and system/network engineers with knowledge of Compaq server products and Microsoft Windows NT.*

*This document describes how to:*

- *evaluate information provided by the power supply performance counters to determine total power consumption*
- *interpret performance counter values to determine power supply redundancy*
- *calculate power usage to predict effects of adding additional components to your system*
- *provide test scenarios that demonstrate power utilization and its effects on redundancy*
- *denote caveats to help eliminate single points of failure*

*This document assumes that you know how to use the Windows NT Performance Monitor. For instructions on using the utility, please refer to the Windows NT Resource Guide and/or the Windows NT Performance Monitor Help file.*

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**Compaq ProLiant 6000 Power Management using Windows NT  
Performance Monitor**

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## INTRODUCTION

This document describes how to use the performance health counters using the Microsoft Windows NT Performance Monitor (PerfMon), while making you aware of other applications available to analyze the performance counters and monitor the health of the power supply.

## COMPAQ MICROPROCESSOR-BASED POWER SUPPLY AND SYSTEM OVERVIEW

To further increase server reliability, Compaq offers hot-pluggable N+1 redundant power supplies with the Compaq ProLiant 6000. Under maximum load conditions a ProLiant 6000 will require one or two power supplies to operate. Depending upon the system configuration, a third power supply may be necessary to provide redundancy. These power supplies are microprocessor-based. The programming code used in the power supply module allows monitoring and reporting of several output voltages, output currents, output power, and power supply temperatures. Each supply is dual-rated, providing 500W at 120V or 750W at 240V. All testing for this white paper has been completed using the low line voltage; however, Compaq strongly recommends operating at the high line of 240 volts when the system is fully configured. Operating at 240 volts increases the power supply rating from 500 watts to 750 watts.

The ProLiant 6000 does not completely turn OFF. It will either be in the ON mode or in the STANDBY mode, rather than being ON or OFF. When the AC power is plugged into the power supply, the system goes into STANDBY mode. When the power switch at the front of the unit is pressed, the unit goes into ON mode. In STANDBY mode, power is removed from most of the electronics and drives, but portions of the power supply, LCD, and internal circuitry remain active. To completely remove all power from the system, you must disconnect all power cords from the server.

## Things to Consider

Some important factors to remember when using the information provided in this white paper are:

- The amount of load (disk I/O, network traffic, CPU usage, caching, video activity, etc.) applied to any given system affects the current (amp) usage and power consumption.
- Values shown represent full load conditions, unless otherwise noted.
- It is not possible to simulate every possible configuration for testing; the data provided is based on averages. It is important that you verify all theory by testing in your particular environment.
- The only definite method for confirming power supply redundancy is to disconnect one of the power cords.
- If only one power supply is installed, the system is not redundant. A server that is not redundant, using two low line (120V) power inputs, may become redundant by changing the power inputs to the high line voltage (240V) or by adding a third power supply.

## Description of Power Supply LEDs

Each power supply has two LEDs on the back panel, as indicated in Figure 1. The top LED indicates the DC power status. Green indicates that the power supply is functioning and no faults have been reported. The lower LED is the AC power indicator. A green power indicator LED means that AC power is OK, and power is currently being applied to the module. At initial start up, the status LED changes from amber to dark after a successful self-test. The status LED changes to green when DC power is present and functional. Other possible states of the LEDs are described in Table 1.

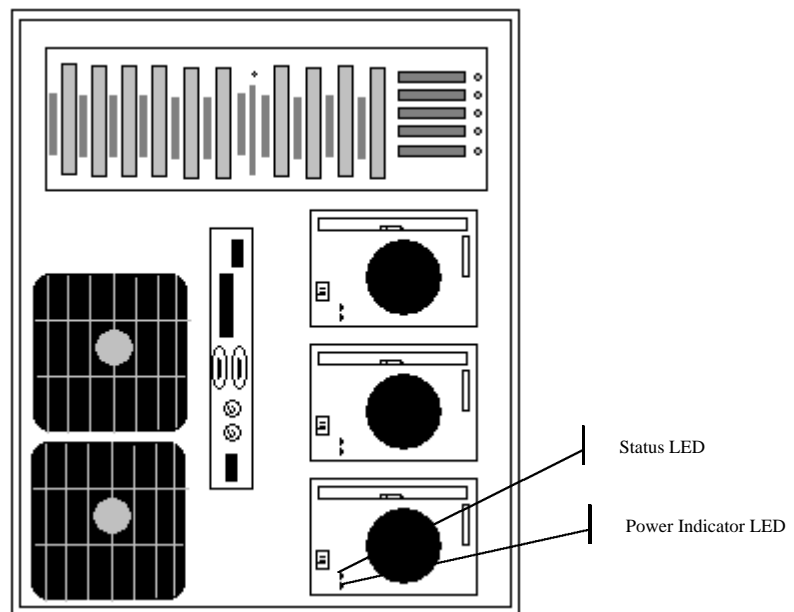


Figure 1: Back Panel View

TABLE 1  
POWER SUPPLY LEDES

LED Indicator	LED State	Meaning
Status LED	Green	Power supply functional, no faults detected.
	Amber	Power supply failure.
	Flashing Green	Sleep mode, or system waiting for the restart delay to expire before restarting.
	Flashing Amber	Self-test failure.
	Dark/Off	Local standby. Panel open or memory card not connected.
	Alternating Green/Amber	Multiple restart attempts failed.
Power Indicator LED	Green	Power connected to the power module.
	Dark/Off	No power connected to the power module.

## COMPARISON OF UTILITIES AVAILABLE TO MONITOR POWER CONSUMPTION

This section describes the tools available for monitoring power consumption for the hot-pluggable, redundant power supplies.

### Performance Monitor

The Performance Monitor (PerfMon) utility allows you to monitor the behavior of a specific hardware or software component of a Windows NT workstation or server using performance counters. When you investigate the performance of a component, you are likely to use many of the counters in the performance object associated with the component. A thorough investigation typically requires that you monitor counters from several different performance objects.

PerfMon allows you to track variations in the use of system components over time, monitor systems remotely, and measure operating system and application performance. Inherent to Windows NT, it provides a means of adding counters for software and hardware monitoring without the trouble of writing all the code needed to monitor performance and usage of application and system components. The focus of this paper is to monitor the power supply performance counters provided by Compaq to determine power consumption and redundancy in a Compaq ProLiant 6000 server.

For PerfMon usage instructions, please refer to the Windows NT Resource Guide and/or the Windows NT Performance Monitor Help file.

### Compaq Insight Manager

Compaq Insight Manager is a comprehensive management tool used to monitor and control the operation of Compaq servers and clients. Insight Agents make health, configuration, and performance data available for key subsystems. Working in conjunction with hardware and firmware, Insight Manager provides the ability to observe information concerning the power supply status. Insight Agents determine whether all power supplies are functional, report power supply failures, and discern if power supplies are redundant.

## **INSTALLING THE POWER SUPPLY PERFORMANCE COUNTERS**

In order to use the performance counters, the System Management Driver must be installed on the server. The System Management Driver can be obtained from the Compaq SmartStart and Support Software CD or the Compaq internet site at:

<http://www.compaq.com/support/files/server/WINNT/index.html>.

The power supply performance counters can be obtained from the Compaq Resource Paq Version 2.5 - Cool Stuff for Windows NT. For information on obtaining the Resource Paq, see the following section.

The counters will only be installed on hardware for which relevant information can be displayed. Steps for installing the performance health counters are as follows:

1. Install the Compaq System Management Driver (SYSMGMT.SYS).
2. Reboot your system.
3. Install the performance monitor files. This can be done by installing directly from the Compaq Resource Paq or launching the executable file, PFSYS.EXE, which can be copied from the Resource Paq.

### **Obtaining the Compaq Resource Paq for Windows NT**

The Compaq Resource Paq (Part No. 185939-003) is free of charge. However, you must pay the applicable shipping and handling charges.

Information on obtaining the Compaq Resource Paq can be found on the web at:

<http://www.compaq.com/solutions/frontline/winnt/ordering.html>

You can place an order electronically via the Internet, or via fax. Refer to the web site for details.

## List of Performance Counters

The following table provides a list of the performance health counters available for the power supply, and a description of each.

**TABLE 2**  
**POWER SUPPLY PERFORMANCE COUNTERS**

COUNTER	DESCRIPTION
%12V channel power capacity	Percentage of power capacity currently used on the 12V channel
%5V channel power capacity	Percentage of power capacity currently used on the 5V channel
%3V channel power capacity	Percentage of power capacity currently used on the 3V channel
% Power capacity	Percentage of total power capacity currently being used
% Temperature threshold	Percentage of temperature limit reached
12V channel current (mA)	Total output current on the 12V channel
12V channel power (mW)	Total output power on the 12V channel
12V channel voltage (mV)	Total output voltage on the 12V channel
5V channel current (mA)	Total output current on the 5V channel
5V channel power (mW)	Total output power on the 5V channel
5V channel voltage (mV)	Total output voltage on the 5V channel
3V channel current (mA)	Total output current on the 3V channel
3V channel power (mW)	Total output power on the 3V channel
3V channel voltage (mV)	Total output voltage on the 3V channel
Line voltage (mV)	AC incoming voltage
Power (mW)	Total power consumption
Redundancy	Indicates whether or not the power supplies are redundant
Temperature (Celsius)	Temperature of the power supply in Celsius
Temperature (Fahrenheit)	Temperature of the power supply in Fahrenheit

## HOW TO DETERMINE POWER CONSUMPTION

The ProLiant hot-pluggable redundant power supply 750/500 watts N+1 with support for up to three units per system allows a 240V or 120V AC input, and provides three primary output channels: 3V, 5V and 12V. The primary channels we are concerned with are 12V and 5V, since most Compaq-provided options operate on either the 12V or 5V channels (see Table 3). The product of the current (amp) multiplied by the voltage yields the amount of power being consumed. Table 3 represents current (amp) consumption for each component mentioned. It can be used to help identify how the addition of a component affects a server, see the following examples:

### *Example 1: Effects of Adding a Network Interface Controller*

A Netelligent 10/100TX PCI network interface controller consumes power on the 5V channel only, so adding one network controller to a server will only affect power on the 5V channel. This controller consumes .84 amps under typical load conditions, adding one will

· increase power consumption on the 5V channel by 9.2 watts. Adding two controllers will increase the power consumed on the 5V  
· channel by 18.4 watts. For information on performing the calculations see the section entitled "Power Predictions Before Adding  
· Components" on Page 12 of this white paper.

· *Example 2: Effects of Adding Memory*

· Memory operates on the 3V channel, so if a 64MB DIMM is added it will only affect power consumption on the 3V channel. At this time,  
· few components operate on the 3V channel so this addition will not adversely affect power consumption. Primary concern should be  
· placed on the 5V and 12V channels.

· *Example 3: Effects of Adding a CD-ROM Drive*

· A CD-ROM drive consumes power on the 5V and 12V channel. When typical load is applied the CD-ROM drive will consume .7 amps on  
· the 5V channel and .21 amps on the 12V channel. If one CD-ROM drive is added to a server it will consume an additional 3.5 watts on  
· the 5V channel and 2.52 watts on the 12V channel. For information on performing the calculations see the section entitled "Power  
· Predictions Before Adding Components" on Page 12 of this white paper.



The information provided in Table 3 can be very beneficial when used in conjunction with the information provided in the section entitled “Power Predictions Before Adding Components” on Page 12 of this white paper.

**Note:** As new products are developed, their power consumption requirements may differ from the test results presented in this white paper. All components mentioned are Compaq-provided options, either standard on the ProLiant 6000 system or available for purchase through Compaq.

**Important:** The information provided in Table 3 should be used as a guide only.

TABLE 3  
CURRENT USAGE PER VOLTAGE CHANNEL

Component	12V Channel	5V Channel	3V Channel
CD-ROM <sup>1</sup>	Approx. 77% <sup>2</sup>	Approx. 23%	
Eisa Adapters <sup>3</sup>		Yes	
Fans	Yes		
Floppy Drive		Yes	
Hard Drives	Approx. 66%	Approx. 34%	
Internal Slot Board		Yes	
Keyboard		Yes	
Memory			Yes
Memory board			Yes
Mouse		Yes	
PCI Adapters <sup>4</sup>		Yes	
Processors	Approx. 92%	Approx. 7%	Approx. 1%
Tape Drives <sup>5</sup>	Yes	Yes	

<sup>1</sup>Percentages are based upon typical usage, percentages will change under maximum load conditions.

<sup>2</sup>Percentage values mean that the total current consumption is divided accordingly. See Example 3 above.

<sup>3</sup>Currently most Compaq-provided EISA adapters primarily operate on the 5V channel however new (and future) boards may operate on the 12V channel.

<sup>4</sup>Currently most Compaq-provided PCI adapters operate primarily on the 5V channel however new (and future) boards may operate on the 3V or 12V channel.

<sup>5</sup>Current Distribution is almost even on both channels, utilization varies depending on the type of tape drive.

The power supply current and voltage values provided in Table 4 can also be used to help determine power availability for each voltage channel. These values can be used in conjunction with performance monitor counters and the information provided in Table 3 to determine the effects of adding additional components to your system.

**TABLE 4  
TYPICAL POWER SUPPLY VOLTAGE, CURRENT,  
AND POWER VALUES**

Voltage Range	Low Range (120V) Full Load Current Limit	High Range (240V) Full Load Current Limit	Power Limit	
			Low	High
12.25V +/-2%	20 Amps	37 Amps	245W	453W
5.1V +/- 3%	32 Amps	39 Amps	163W	199W
3.3V +/- 5%	18 Amps	27 Amps	59W	89W

To make the power wattage per channel data provided in Table 4 more practical for your configuration, you can substitute the output voltage values in Table 4 with the values obtained from the channel voltage performance counter in PerfMon (see Figure 3, page 12). Multiply the voltage by the full load current to get approximate power available per channel for your system when fully loaded. For example:

$$\text{Channel Voltage (V)} \times \text{Full Load Current (A)} = \text{Power Per Channel (W)}$$

$$12.42\text{V} \times 20\text{A} = 248\text{W}$$

The new table values using performance counter data from Figure 3, page 12 are shown in Table 5.

**TABLE 5  
NEW POWER SUPPLY VOLTAGE, CURRENT AND  
POWER VALUES**

Voltage Avg. (Value Obtained from PerfMon)	Low Range (120V) Full Load Current Limit	High Range (240V) Full Load Current Limit	Power	
			Low	High
12.45 Volts	20 Amps	37 Amps	249W	461W
5.12 Volts	32 Amps	39 Amps	164W	200W
3.34 Volts	18 Amps	27 Amps	60W	90W

The new power wattage values can be substituted for the theoretical values provided in Table 6. The new results yield actual power consumption per channel values for the server being used. This provides you with data realistic to your environment to help determine redundancy.

## ANALYZING PERFORMANCE COUNTERS USING PERFORMANCE MONITOR

The following graphs are based on a ProLiant 6000 server with typical load applied. This configuration consisted of ample disk access, minimal network access, extensive video activity, and heavy CPU usage. The following options were installed for Figures 2 and 3:

- 12 4.3-GB Hard Drives
- 5 PCI Network controllers
- 2 EISA Network controllers
- 4 PCI Smart-2SL SCSI array controllers
- 1 Power Supply
- 1 ProLiant Storage System

Note: All hardware components used for testing are Compaq-provided options, either standard on the ProLiant 6000 server or available for purchase through Compaq.

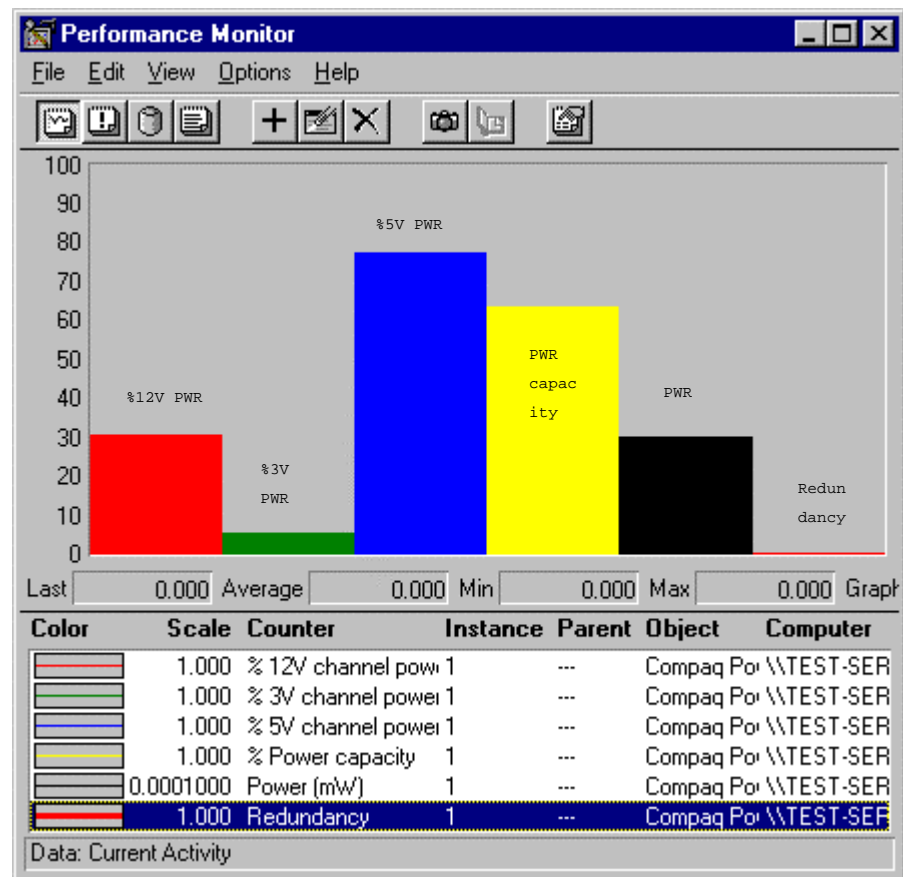


Figure 2: Power Usage Chart

The following conclusions can be derived from Figure 2:

- %12V channel power capacity = 30%
- %3V channel power capacity = 6%
- %5V channel power capacity = 78%

- ❑ %Power Capacity = 64%
- ❑ Redundancy = 0

Only one power supply has been installed and the server is not redundant.

Figure 3 will be used for the purpose of interpreting the data. Changes made to the initial load are additional hard disk usage, extensive floppy drive usage, heavy network access from 50 clients applied and an additional power supply has been inserted.

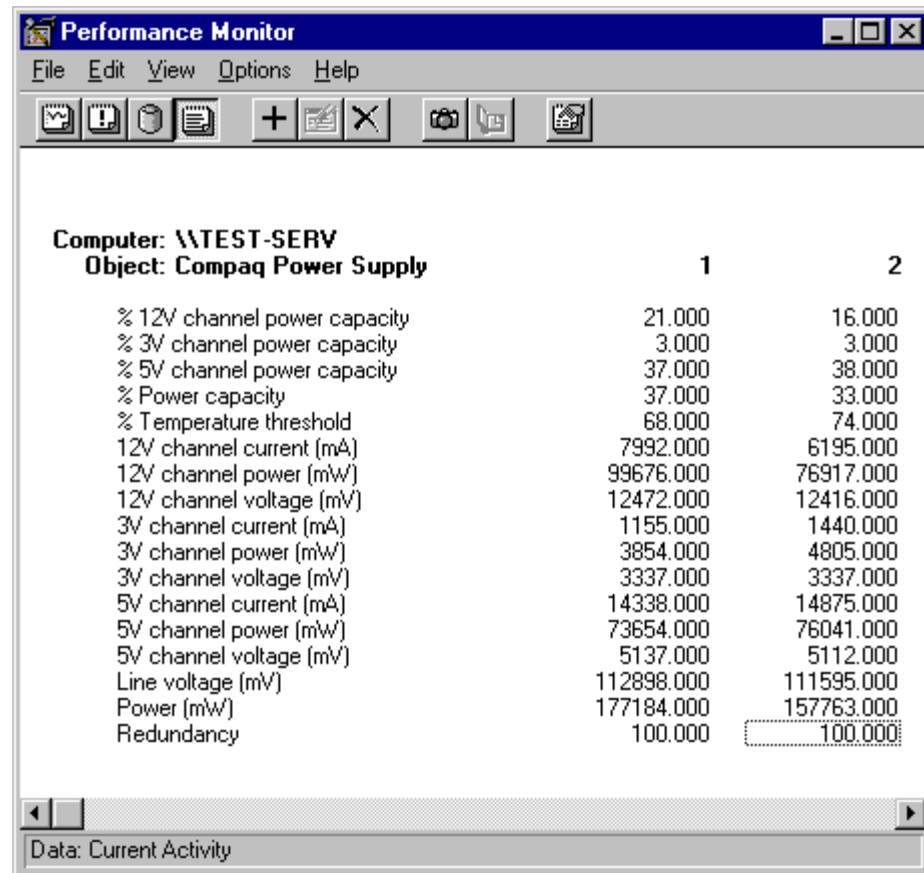


Figure 3: Power Supply Counters Report

### Determining Redundancy

Redundancy can be easily determined by evaluating the redundancy performance counter. A value of 100 indicates redundancy and 0 means the power subsystem is not redundant.

Note: The current measurement circuitry of the power supply is not accurate below 20% of full scale. This means there will be slight inaccuracy in current measurements in lightly loaded systems.

### Power Predictions Before Adding Components

You can get a general idea of the effect the addition of a component will have on your system if you know the current consumed by a component and the voltage channel it will use. This information may be obtained from a label on the actual component, the hardware specification for the component, or by measuring the value once inserted into a functional system. Table 6 illustrates the approximate maximum power and current available for each channel and the number of power supplies necessary when these values are exceeded. Adding the value to the appropriate

channel will show the impact of adding a component and whether an additional power supply will be necessary.

**TABLE 6**  
**POWER SUPPLY (PS) REDUNDANCY DETERMINATION**

Channel	Total Consumption PS 1 value + PS 2 value + PS 3 value	# of PS's Needed for Redundancy
a) 12V channel power ⇒ ⇒ and b) 5V channel power ⇒ ⇒	Less than 245 watts +/- 2% Less than 163 watts +/- 3% ⇒ ⇒	2
a) 12V channel power ⇒ ⇒ and b) 5V channel power ⇒ ⇒	Greater than 245 watts +/- 2% Greater than 163 watts +/- 3% ⇒ ⇒	3
a) 12V channel current ⇒ ⇒ and b) 5V channel current ⇒ ⇒	Less than 20 amps +/- 2% Less than 32 amps +/- 3% ⇒ ⇒	2
a) 12V channel current ⇒ ⇒ and b) 5V channel current ⇒ ⇒	Greater than 20 amps +/- 2% Greater than 32 amps +/- 3% ⇒ ⇒	3

You can multiply the current by the voltage for each channel; the result will be the estimated increase in power consumption. The product of the multiplication can be added to the value for the appropriate channel power counter in the performance monitor. The example below predicts power consumption on a floppy drive that consumes .7 amps of current on the 5V channel when a typical load has been applied.

*Example 1: Calculations to predict power consumption on the 5V channel, values used are from Figure 3.*

- Calculate the total power being consumed on the specified channel  
 $PS(\text{total}) = PS1 + PS2 + PS3$   
 $PS(\text{total}) = 73.7 \text{ W} + 76 \text{ W} + 0 = 149.7 \text{ W}$
- Calculate the power that will be used by the new component.  
 Component Power Usage (W) = voltage (V) x current (A)  
 Component Power Usage (W) =  $5.1 \text{ V} \times .7 \text{ A} = 3.57 \text{ W}$
- Calculate the total power consumption after the component is added  
 Power Usage after Component Addition =  $PS(\text{total}) + \text{Component Power Usage}$   
 Power Usage after Component Addition =  $149.7 \text{ W} + 3.57 \text{ W} = 153.27 \text{ W}$
- Compare the result to Table 6 Power Supply Redundancy Determination to see if it will be necessary to add another power supply for redundancy.  
 5V channel power is less than 163 watts. The power supplies will still be redundant after adding the floppy drive.

Note: Unless the value you are using has been measured in a system with load applied, your results are theoretical. The actual amount of power consumed will vary.

## Event Logging

When a power supply is inserted or removed, you receive two alerts on the LCD display on the ProLiant 6000 and two Windows NT Event log warning messages. When a power supply is inserted the LCD displays:

POWER SUPPLY INSERTED

When a power supply is removed, it displays:

POWER SUBSYSTEM NO LONGER REDUNDANT

Followed by:

POWER SUPPLY REMOVED

When a power supply is inserted, the Windows NT Event Log displays:

Event ID:	4157	Event ID:	4154
Source:	SysMgmt	Source:	SysMgmt
Type:	Warning	Type:	Warning
Description:	The Compaq Systems Management Driver has detected that the power subsystem is redundant	Description:	The Compaq Systems Management Driver has detected that a power supply (Power Supply #x) has been inserted.

When a power supply is removed, the Windows NT Event Log displays:

Event ID:	4154	Event ID:	4152
Source:	SysMgmt	Source:	SysMgmt
Type:	Warning	Type:	Warning
Description:	The Compaq Systems Management Driver has detected that the power subsystem is no longer redundant	Description:	The Compaq Systems Management Driver has detected that a power supply (Power Supply #x) has been removed.

## Setting Alerts

You can monitor several counters simultaneously using Performance Monitor. When a counter exceeds a given value, the date and time of the event are recorded in the Alert window of PerfMon and you can set the option to log an event in the Application Log of Event Viewer.

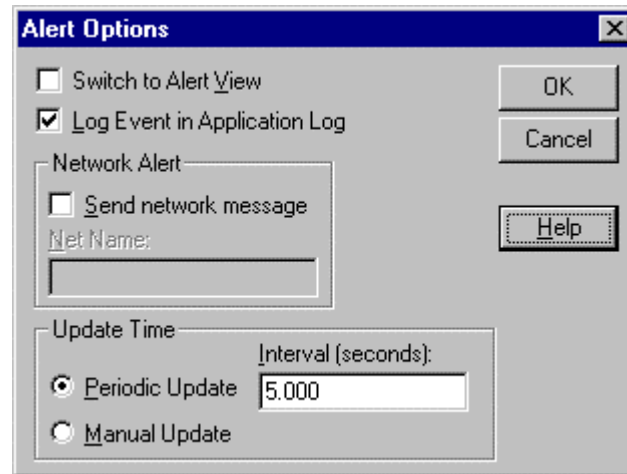


Figure 4: Alert Options

An alert file holds a total of one thousand events, after which the oldest event is discarded as each new one is added. Each alert value is usually an average over the last two data reads, which are separated by the length of the time interval.

When an alert occurs while you are not in the Alert view, an alert icon appears in the status bar showing the number of alerts that have occurred since you were last in the Alert view (see Figure 5).

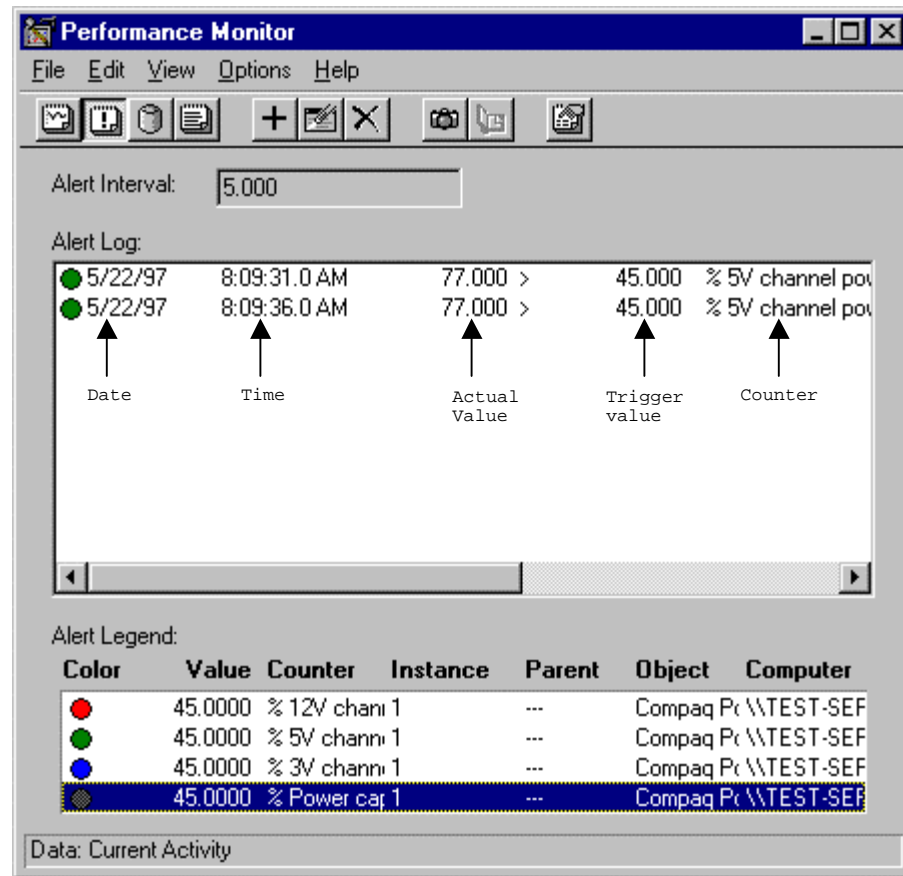


Figure 5: Alert Window

A threshold value must be supplied for each counter you want an alert on. For power supply management purposes, alerts can be set to monitor the % (voltage (V)) channel power capacity performance counter. This will allow you to be alerted before the power supply subsystem is no longer redundant. If the % (voltage (V)) channel power capacity value exceeds 50%, the power supply subsystem is not redundant. For example: if the %5V channel power capacity is greater than 50 then the system is not redundant; if it is less than 50, the system is redundant. Therefore, if you set the alert threshold value over 45%, you will receive notification before the system is no longer redundant.

Figure 5 shows a threshold (trigger) value of 45% for the % 12V channel power capacity, %5V channel power capacity, %3V channel power capacity, and the % Power capacity performance counters. On 5/22/97 at 8:09 a.m. the %5V channel power capacity exceeded 45%, the data value that was read was 77%. The alert interval is set to the default value of 5 seconds. The specified counters will be checked for the alert condition every 5 seconds.



**Power Consumption Test Scenarios**

Table 7 provides information on Compaq ProLiant 6000 servers tested under maximum load conditions. The following options were standard in all configurations:

- 4 Processors
- 3.3-GB RAM
- 1 Monitor
- 1 Keyboard and Mouse
- 1 Floppy drive
- 1 CD-ROM drive
- 2 DLT 7000 Tape drives

**TABLE 7  
COMPAQ PROLIANT 6000 POWER SUPPLY REDUNDANCY  
SYSTEM CONFIGURATIONS WITH MAXIMUM LOADS APPLIED**

Components	Configuration 1	Configuration 2	Configuration 3	Configuration 4
No. of EISA/PCI expansion boards	9	11	11	6
No. of hard drives	6	18	12	6
Input voltage	100V – 120V	200V – 240V	100V – 120V	200V – 240V
No. of power supplies recommended for redundancy	2	2	3	2

Table 8 provides power supply recommendations for Compaq ProLiant 6000 servers tested under typical load conditions. The following options are considered standard for all recommendations:

- 1 Monitor
- 1 Keyboard and mouse
- 1 Floppy drive
- 1 CD-ROM drive
- 1 ProLiant Storage System (fully loaded)

**TABLE 8  
POWER SUPPLY RECOMMENDATIONS**

Components	Configuration 1	Configuration 2	Configuration 3
No. of Processors	UP TO 4	UP TO 4	UP TO 4
No. of EISA/PCI expansion boards	UP TO 11	UP TO 9	MAXIMUM
Memory	64MB – 4GB	64MB – 4GB	64MB – 4GB
No. of hard drives	UP TO 18	UP TO 18	MAXIMUM
Additional removable media	UP TO 2	0	MAXIMUM
Input voltage	200V – 240V	100V- 120V	200V – 240V
No. of Power Supplies recommended for redundancy	2	2	3

### Considerations to Eliminate Single Points of Failure

The hot-pluggable redundant power supplies provide the ProLiant 6000 with consistent, reliable power to operate your system. The N+1 redundancy scheme eliminates the possibility of overloading the power supply by adding too many power-consuming devices. Under maximum load conditions, a fully loaded ProLiant 6000 will not require more than two power supplies with a third to provide redundancy. However, there are other situations that can affect the power supplied to your computer. Power failures, surges, and sags can cause the system to crash and can damage the electronics. For this reason, apply AC input to power modules from different electrical sources whenever possible.

To protect against damage and loss of data from temporary power outages, consider the purchase of multiple uninterruptible power supplies for individual power modules, critical systems, and the network itself, including hubs, bridges, and routers. Windows NT has uninterruptible power supply (UPS) support on individual computers. These UPSs typically provide power for five to 20 minutes, which is long enough for Windows NT to do an orderly shutdown when power fails. If there is a history of frequent or prolonged power outages, you should investigate ways to provide power for your critical computers other than from your local power company. To prevent power surges that can destroy your data, obtain quality individual power surge suppressors for each power module.

If the weather at the location of your company requires heating or cooling within the building to keep your computers and network devices within required operating temperatures, consider making the climate control system fault-tolerant as well.

**SUMMARY**

The ProLiant 6000 hot-pluggable N+1 redundant power supplies greatly increase the reliability and availability of the server. This paper was designed to describe a means of monitoring power consumption and utilization on a Compaq ProLiant 6000 using an application inherent to the operating system, Windows NT Performance Monitor. However, the intent was not to imply that PerfMon was to be used for comprehensive fault management. At this time, the only way to get comprehensive fault management, including pre-failure alerting for the power supply, is by using Compaq Insight Manager.