WHITE PAPER

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Compaq Computer Corporation

CONTENTS

Monitoring Network Performance With Compaq NetFlex-3/Netelligent Performance Counters in a Microsoft Windows NT System

This document describes the Compaq Network Interface Controller (NIC) Performance Counters in a Microsoft Windows NT system and explains how to use the counters to monitor network performance.

The information presented in this document is intended for system administrators, network managers, and Computer Information System engineers with a knowledge of Compaq server products, Microsoft Windows NT, and Ethernet LAN terminology. This white paper is not intended to provide conclusive network performance information that correlates to customers network environment specifics.

This document describes how to:

- *Identify which counters apply to the network hardware.*
- *Detect potential network bottlenecks and implement corrective action.*
- *Correlate counters that affect other counters.*
- *Interpret the counter values to determine if they are acceptable or unacceptable.*

The appendix contains general information about the Microsoft Windows NT Performance Monitor program.

NOTE: For an alphabetical listing of the performance counters and the pages where you can find information on them, see Table 1 on page 4.

On-Line Resources from Compaq

Compaq maintains a library of technical documents on its World-Wide Web site. Many of these documents are related to Microsoft Windows NT Server, such as the following:

- *Compaq Value-Added Support Software for Microsoft Windows NT*
- *Compaq Hardware Abstraction Layer for Microsoft Windows NT Version 3.5x*
- *Installing Microsoft Windows NT Server 3.5 with Custom Setup*
- *Monitoring Network Performance with Compaq NetFlex-3 Netelligent Performance Counters in a Microsoft Windows NT System*
- *Migrating to the Compaq ProLiant 5000 Server in Microsoft Windows NT Server Environments*
- *Compaq Advanced Network Error Correction Support in a Microsoft Windows NT Server Environment*

You can download these and many other documents by accessing the Compaq Web site at:

http://\www. compaq. com

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Monitoring Network Performance With Compaq NetFlex-3/Netelligent Performance Counters in a Microsoft Windows NT System

Third Edition (September 1996)
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COMPAQ NETFLEX-3/NETELLIGENT PRODUCTS OVERVIEW

Compaq NetFlex-3/Netelligent products provide higher network performance by delivering faster data throughput and by lowering system processor utilization. The combination of the ThunderLAN (TLAN) chip set, co-developed by Texas Instruments and Compaq, and the Compaq device drivers produce optimal Network Interface Controller (NIC) performance.

The TLAN chip facilitates system upgrades because it includes an embedded Media Independent Interface (MII) that provides a direct, non-proprietary connection to 10Base-T/10Base-2, 100Base-TX, and 100VG-AnyLAN networks. The MII provides Compaq NetFlex-3 customers with unimpeded data throughput for any supported Ethernet topology on networks that employ industry-standard cabling.

Compaq NetFlex-3/Netelligent Performance Counters

These performance counters function within the Windows NT Performance Monitor program. The counters help you track network throughput and server utilization within the networking communication subsystem.

The Compaq NIC Performance Counters are supported on the following products containing the ThunderLAN (TLAN) chip set:

- Compaq NetFlex-3/E and Compaq NetFlex-3/P Controllers configured with:
  - 10Base-T UTP-BNC Module
  - 100VG-AnyLAN UTP Module
  - 10/100Base-TX UTP Module
- Compaq Netelligent 10/100TX PCI UTP Controller
- Compaq Netelligent 10 T PCI UTP Controller

NOTE: Unless otherwise designated, the Compaq products listed above support all of the performance counters.

The following sections describe the Compaq NetFlex-3/Netelligent Performance Counters for Windows NT. These counters are included in the *Compaq Resource Kit for Microsoft Windows NT* under the Performance Monitor section. You can also obtain them by extracting the file *SP1978.EXE* from the Compaq World-Wide Web site (http://www.compaq.com/Support) located in the Microsoft Windows NT section.

Performance counters are available for all Compaq TLAN network controllers. For information on obtaining the *Compaq Resource Kit for Microsoft Windows NT*, visit the Compaq World-Wide Web site at:

http://www.compaq.com

The following sections also provide performance counter definitions and their correlation to other network counter parameters. Counters are grouped by categories and are presented in a format that represents each counter's name, counter complexity, and the Compaq controller types supported. The counter complexity is divided into three knowledge levels:

- Basic - the simplest counter, requires some introductory-level knowledge of a network subsystem
- Advanced - requires system administration-level knowledge of a network subsystem
- Expert - requires extensive knowledge of network subsystems

NOTE: This performance information is also available remotely via the Compaq Insight Management Agents. This information is returned via SNMP to Compaq Insight Manager and to enterprise management consoles. For more information on this capability of Compaq Insight Manager, refer to the *Compaq Insight Manager Users Guide*, in the section, "Network Interface Statistics". This document is available on the Compaq Systems Management CD. For more information on integrating this and other performance information into enterprise management consoles, refer to the TechNote, *Integrating Compaq Insight Manager with Enterprise Management Platforms*, also on the Management CD.

Alphabetical Listing of Performance Counters

This table contains an alphabetical listing of the performance counters and the pages where you can find information on them.

TABLE 1
PERFORMANCE COUNTERS

Counter Name	Page	Counter Name	Page
Bytes Received/Sec	5	Receive EOC	9
Bytes Transmitted/Sec	5	Receive EOF	9
Bytes Total/Sec	5	Receive Errors	10
Error-Training	6	Receive Frame Errors	10
Error-Adapter Check	6	Receive Frames OK	10
Error-Link Changes	6	Receive No Buffer Errors	10
Error-Network Errors	6	Receive Overruns	10
Error-Receive Runts	7	Receive Pended	10
Error-Resets	7	Received Pended Peak	10
Error-Statistic Overflows	7	Times CRS Lost	16
Frames Received	8	Transmit EOC	12
Frames Received Broadcast	8	Transmit EOF	12
Frames Received Directed	8	Transmit Frame Error	12
Frames Received Multicasts	9	Transmit Frames OK	13
Frames Received Not at EOF	8	Transmit Late Collisions	13
Frames Received/EOF	8	Transmit Max Collisions	14
Frames Sent	11	Transmit More Collisions	13
Frames Transmitted Not at EOF	11	Transmit No Buffers Available	14
Frames Transmitted/EOC	11	Transmit No Lists Available	15
Frames Transmitted/EOF	11	Transmit One Collision	13
Frames/Sec	8	Transmit Queued	15
Heart Beat Failures	17	Transmit Threshold	15
Interrupt Pace Timer	16	Transmit Underruns	15
Interrupt/Sec	16	Transmits Deferred	15
Receive Alignment Errors	9	Transmits Queued Peak	15
Receive CRC Errors	9		

PERFORMANCE COUNTERS GROUPED BY CATEGORIES

The following pages contain the performance counters grouped into five categories:

- NIC Throughput Counters
- Network or Hardware Error Counters
- Frames Received Counters
- Frames Transmitted Counters
- NIC Interrupt and Heartbeat Failure Counters

NIC Throughput Counters

The basic counters that encompass network throughput are: **Bytes Total/Sec**, **Bytes Received/Sec**, and **Bytes Transmitted/Sec**. Table 2 describes these counters.

TABLE 2
NIC THROUGHPUT COUNTERS

Counter Name: **Bytes Total/Sec**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter includes the sum total of the bytes out-going (**Bytes Transmitted/Sec**) and in-coming bytes (**Bytes Received/Sec**) relative to the NIC.

The **Bytes Total/Sec** counter report includes data bytes sent as part of the network protocol (for example, IPX, TCP/IP and NetBEUI) overhead. Commonly, network throughput is measured or reported in Megabits/Sec. The formula for converting network throughput from Bytes/Sec to Megabits/Sec is:

Megabits/Sec=((Bytes Total/Sec * 8)/1024)/1024

The maximum bandwidth for a 100Base-TX LAN and for a 100VG-AnyLAN is 100,000,000 bits/sec, for a 10Base-T LAN it is 10,000,000 bits/sec.

Counter Name: **Bytes Received/Sec**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the rate at which network data bytes are received by the NIC. This counter value is one of two parts that make up the **Bytes Total/Sec** counter value. Refer to the **Bytes Total/Sec** counter for additional information.

Counter Name: **Bytes Transmitted/Sec**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the rate at which network data bytes are transmitted from the NIC. This counter value is one of two parts that make up the **Bytes Total/Sec** counter value. Refer to the **Bytes Total/Sec** counter for additional information.

Network or Hardware Error Counters

These counters indicate the condition of the NIC and/or the hardware connected to the LAN. Poor wiring, a faulty NIC or network hub can cause these counters to increment.

The counters **Error-Adapter Check**, **Error-Link Changes**, **Error-Network Errors**, and **Error-Resets** operate in a cause-and-effect mode. An error in the TLAN chip set might cause multiple counters to increment: **Error-Adapter Check**, **Error-Resets**, and **Error-Network Errors**.

The error counter values are accumulative. When an error occurs the Windows NT Performance Monitor program keeps a record of the error(s) until the server is reset. The following table describes the network or hardware error counters.

TABLE 3
NETWORK OR HARDWARE ERROR COUNTERS

Counter Name: **Error-Adapter Check**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter represents the number of adapter check interrupts the driver has processed. As a result of this error, the adapter resets. If the TLAN driver cannot get a proper response from the NIC, the driver assumes the NIC is disconnected from the LAN.

Counter Name: **Error-Link Changes**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter represents the number of link state transitions in a network environment. The counter indicates a loss of network connectivity, that is, the NIC is disconnecting and/or reconnecting to the hub. This error condition affects the **Error-Network Errors** counter, which also increments.

Counter Name: **Error-Network Errors**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter represents the number of network error interrupts the driver has processed. This counter increments as a result of a loss of network connectivity.

Counter Name: **Error-Training**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3 (100VG-AnyLAN only)

This counter indicates the number of unverifiable links between the network hub and the NIC. Link training is a process that prepares a hub and connecting device for communication. During the link training process, the operation on the cable link is verified. Training enables the hub to learn the device type of the node, operational mode, and Media Access Control-level address.

Training errors could indicate a physical problem with the NIC, hub, or cable between the device receiving the training errors and the hub. This error condition affects the **Error-Network Errors** and **Error-Resets** counters, which increment.

continued

Network or Hardware Error Counters *continued*

Counter Name: **Error-Receive Runts**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the number of runt frames detected. Runts are frames that are less than the minimum Ethernet frame length. The minimum Ethernet frame length is 64 bytes.

This counter is only available when using a network analyzer in the promiscuous mode. Promiscuous mode is not a parameter configurable by a user. Promiscuous mode is used by network analyzers when troubleshooting networks. It allows network traffic from all communicating ports on a segment to be captured and analyzed.

An application that requires promiscuous mode to be enabled will notify the NetFlex-3/Netelligent driver to enable promiscuous mode. Compaq NetFlex-3/Netelligent NICs support the promiscuous mode.

The **Error-Receive Runts** counter might indicate a network hardware failure, network collisions, or late collisions.

Counter Name: **Error-Resets**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter represents the number of resets the driver has performed. It is a warning of potential hardware problems. For example, if a NIC is disconnected from the hub, the **Error-Resets** counter continues to increment periodically until the NIC is reconnected to the hub or the network error is resolved.

Counter Name: **Error-Statistic Overflows**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the number of statistic interrupts that the driver has processed. This error occurs when the counter in the TLAN chip set reaches 50 percent of its maximum value.

Frames Received Counters

A frame is a logical grouping of information sent as a physical layer unit over a transmission medium. The Ethernet maximum frame size per frame transfer is 1514 bytes plus Cyclic Redundancy Check (CRC) and the minimum is 64 bytes plus CRC per transfer.

Some applications do not transfer frames efficiently. Therefore, it is beneficial to understand the ratio of network data bytes to frames being transferred. The following formula determines the average bytes per frame:

$$\text{Average Bytes/Frame} = \frac{\text{Bytes/sec}}{\text{Frames/sec}}$$

Table 4 on the following page describes the frames received counters.

TABLE 4
FRAMES RECEIVED COUNTERS

Counter Name: **Frames/Sec**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the total number of all transmitted and received frames per second. The **Frames/Sec** value is the sum of the **Frames Sent** and the **Frames Received** counter values.

Counter Name: **Frames Received**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the total number of frames coming into the NIC per second.

Counter Name: **Frames Received/EOF (End of Frame)**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the number of frames received per End of Frame interrupt signal. A counter value of one indicates that for each frame received, an End of Frame interrupt signal is issued. For busy networks, higher counter values indicate more efficient functioning of the network subsystem.

Counter Name: **Frames Received Not at EOF (End of Frame)**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the number of frames received that do not include the EOF interrupt signal.

Counter Name: **Frames Received Broadcast**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the number of broadcast frames received per second. A broadcast frame is a message sent to all network destinations on a physical LAN segment. Every broadcast frame causes each station on a network to generate an interrupt.

This counter function is *not* enabled and will always be zero.

Counter Name: **Frames Received Directed**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the number of frames received that were directly addressed to this station.

This counter function is *not* enabled and will always be zero.

continued

Frames Received Counters *continued*

Counter Name: **Frames Received Multicasts**

Knowledge Level : Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the number of multicast frames received per second. A multicast is a frame that has an address referring to multiple network devices. A group of stations on the network receive the same frame.

This counter function is *not* enabled and will always be zero.

Counter Name: **Receive Alignment Errors**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter represents frames that are not aligned or do not end on an 8-byte boundary. When the frame does not end on a byte boundary, this counter flags an error and increments. A consistent value greater than one might indicate a hardware problem.

Counter Name: **Receive CRC Errors**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates frames received with CRC errors. CRC errors occur when the frame received contains corrupt data. CRC is an error-checking technique. A consistent value greater than one might indicate a hardware problem.

Counter Name: **Receive EOC (End of Channel)**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the number of Receive End of Channel interrupts serviced per second by the NIC driver. An EOC interrupt occurs when there are no receive buffers available. A value of zero for this counter indicates receive buffers were available for incoming frames. If an average value above one is recorded, the **MaxReceiveBuffers** value might be too low.

This is a registry tunable parameter. To modify this resource increase the **MaxReceiveBuffers** in the Windows NT Registry. The default **MaxReceiveBuffers** value is 10 for 10Mbps NICs and 30 for 100Mbps NICs. Default values depend upon the Compaq SSD for Windows NT version installed. For registry tuning, refer to the *Compaq Resource Kit for Microsoft Windows NT* and the Windows NT Readme help file section on registry editing.

Counter Name: **Receive EOF (End of Frame)**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the number of Receive End of Frame interrupts serviced per second by the NIC driver. An EOF interrupt occurs when the NIC has received one or more frames. This value is affected by the server processor speed and the operating system application response time.

continued

Frames Received Counters *continued*

Counter Name: **Receive Errors**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the sum of overrun, cyclic redundancy check, and byte alignment. Basically, a network data frame was received with errors. A consistent value greater than one might indicate a potential performance problem.

Counter Name: **Receive Frame Errors**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the sum of overrun, cyclic redundancy check, and byte alignment errors. This counter is the same as the **Receive Errors** counter. A consistent value greater than one might indicate a potential performance problem.

Counter Name: **Receive Frames OK**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the number of frames received without frame errors being detected. On a network with no receive frame errors, the **Receive Frames OK** counter value might equal the **Frames Received** counter value.

Counter Name: **Receive No Buffer Errors**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates there is not enough driver receive buffers available. The frame information is rejected because there are no available receive buffers. A consistent value greater than one might indicate a potential performance problem or a hardware problem.

Counter Name: **Receive Overruns**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the operating system data transfer to the NIC exceeds the number of receive lists available. The **Receive Overruns** counter correlates with the **Receive No Buffer Errors** counter. Both indicate there are no *receive* buffers available. A consistent value greater than one indicates a potential performance problem or a hardware problem.

Counter Name: **Receive Pended**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the current maximum number of the **Receive Frames** serviced within a single interrupt time.

Counter Name: **Received Pended Peak**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the maximum number of frames received during the performance monitor logging time (refer to Appendix for logging information).

Frames Transmitted Counters

A frame is a logical grouping of information sent as a physical layer unit over a transmission medium. The Ethernet maximum frame size per frame transfer is 1514 bytes plus CRC and the minimum is 64 bytes plus CRC per transfer.

To transfer a record size of 2048 data bytes across the network, at least two frames must be transmitted across the network to encompass the entire 2048 bytes of the data record. Larger record sizes transfer the data more efficiently because the driver processes fewer NIC interrupts.

Some applications do not transfer frames efficiently. Therefore, it is beneficial to understand the ratio of network data Bytes to frames being transferred. The following formula determines the average Bytes per frame:

$$\text{Average Bytes/Frame} = \frac{\text{Bytes/sec}}{\text{Frames/sec}}$$

Table 5 describes the frames received counters.

TABLE 5
FRAMES TRANSMITTED COUNTERS

Counter Name: **Frames Sent** Knowledge Level: Basic Controller Supported: Compaq NetFlex-3/Netelligent This counter is the total number of frames out-going from the NIC per second. The **Frames/Sec** value is the sum of the **Frames Sent** and the **Frames Received** counter values.
Counter Name: **Frames Transmitted/EOF (End of Frame)** Knowledge Level: Expert Controller Supported: Compaq NetFlex-3/Netelligent This counter is the number of frames transmitted per End-of-Frame interrupt signal.
Counter: **Frames Transmitted Not at EOF (End of Frame)** Knowledge Level: Expert Controller Supported: Compaq NetFlex-3/Netelligent This counter is the number of frames transmitted from the NIC that does not include the End-of-Frame interrupt signal. The closer this counter value is to the **Transmit Frames OK** counter value, the more efficiently the driver is functioning.
Counter: **Frames Transmitted/EOC (End of Channel)** Knowledge Level: Expert Controller Supported: Compaq NetFlex-3/Netelligent This counter is the number of frames transmitted from the NIC per End-of-Channel interrupt signal. A counter value of one means that for every frame transmitted, an EOC interrupt is generated.

continued

Frames Transmitted Counters *continued*

Counter Name: **Transmit EOC (End of Channel)**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the number of EOC network data transmission interrupts serviced per second. A transmit EOC interrupt occurs when the transmission is stalled. A stall condition is when the operating system has not provided any new frames for transmission within the same time period that the previously queued frame transmission has completed.

This counter value is affected by the operating system, the application, and the processor speed. For instance, an operating system application might elect to transfer the data to the NIC at a rate that does not fill up the transmit buffer queue. In this case, EOC interrupts are generated because there is no additional data to transmit. This counter value might be less than or equivalent to the **Transmit EOF** counter value.

See Table 8 - Interpretation of NetFlex-3/Netelligent Transmit Counter Values.

Counter Name: **Transmit EOF (End of Frame)**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the number of network EOF data transmission interrupts serviced per second. A transmit EOF interrupt occurs when one or more frames are transmitted. During heavy network transfers this value might be above 1000.

Counter Name: **Transmit Frame Error**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter represents frame errors that occur as a result of :

1. Transmit underruns - network data transmission that aborts during data transfer due to unavailable frame data (latency).
2. Excessive collisions - the occurrence of 16 or more collisions before data transmission.
3. Carrier loss - the loss of a cable connection or a network hardware problem.
4. Late collisions - network data transmission interrupted by collisions after the slot time.

   A consistent counter value of 1 or above might indicate a network problem.

See Table 8 - Interpretation of NetFlex-3/Netelligent Transmit Counter Values.

continued

Frames Transmitted Counters *continued*

Counter Name: **Transmit Frames OK**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter is the number of frames transmitted without errors. On an error-free network, this counter value should be equivalent to the **Frames Sent** counter value.

Counter Name: **Transmit More Collisions**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent (10B/100B TX only)

This counter represents frames that encounter 2 to 15 collisions before being retransmitted successfully onto the network.

The **Transmit More Collisions** counter increases as network traffic increases. Although collisions are a normal part of an Ethernet shared-media environment, a massive quantity of network collision errors results in the network data transmission becoming inefficient. This can happen when the collisions errors exceed 15 percent of the total number of out-going frames transmitted (**Frames Sent**).

Excessive collisions are a major cause of network bottlenecks. These collisions can sometimes be attributed to multiple workstations trying to access the server resources simultaneously. This simultaneous transmission results in a collision(s) which then causes these stations to stop sending and wait a random amount of time ("backoff time") before retransmitting. As more collisions occur on a network segment, network performance degradation becomes evident.

See Table 8 - Interpretation of NetFlex-3/Netelligent Transmit Counter Values.

Counter Name: **Transmit One Collision**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent (10B/100B TX only)

This counter represents frames that have encountered a single network collision within one frame of data transfer, before being retransmitted successfully onto the network.

See Table 8 - Interpretation of NetFlex-3/Netelligent Transmit Counter Values.

Counter Name: **Transmit Late Collisions**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3/Netelligent (10B/100B TX only)

This counter indicates the interruption of frames being transmitted due to collisions that occur after a specified slot time. Slot time indicates collisions that have occurred after the sending station has stopped listening for a possible collision. The network controller cannot backoff because the collisions occurred too far into the transmission process.

See Table 8 - Interpretation of NetFlex-3/Netelligent Transmit Counter Values.

continued

Frames Transmitted Counters *continued*

Counter Name: **Transmit Max Collisions**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent (10B/100B TX only)

This counter represents the number of frames **not** transmitted due to excessive collisions. A station will attempt to transmit up to 16 times before it must abort the attempt. The aborted transmission causes this counter to increment. The following is a list of items that might cause the **Transmit Max Collision** counter to increase:

- A network segment with excessively long nodes at the far end of the cabling system transmits, unaware that a station at the other end has already gained control of the medium by transmitting the first 64 bytes of a frame.
- A failing cable segment; data traveling through shorted or damaged cabling becomes corrupt before reaching the destination station.
- A network segment which is not grounded properly; improper grounding allows ground-induced noise to corrupt the data flow.
- An improper termination, a cable segment is not properly terminated; this allows the signal to be absorbed upon reaching the end of the segment, and a partial signal bounces back and collides with existing signals.
- A noisy cable; interference or electrical noise produced by motors or other devices distorts the signals and causes frame errors.
- A faulty station exists (a deaf node) which cannot hear the activity.
- A failing repeater, transceiver, or faulty NIC disrupts the network signal, transmits erroneous signals on the medium, or ignores incoming packets.

Excessive collisions are a major cause of network bottlenecks. These collisions can sometimes be attributed to multiple workstations trying to access the server resources simultaneously. This simultaneous transmission results in a collision(s) which then causes these stations to stop sending and wait a random amount of time ("backoff time") before retransmitting. As more collisions occur on a network segment, network performance degradation becomes evident.

See Table 8 - Interpretation of NetFlex-3/Netelligent Transmit Counter Values.

Counter Name: **Transmit No Buffers Available**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the number of times the frame transfer was lost because no buffers were available.

continued

Frames Transmitted Counters *continued*

Counter Name: **Transmit No Lists Available**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the number of times the frame transfer was lost because transmit lists were not available.

Counter Name: **Transmit Threshold**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter determines the number of frames which should be transmitted before the TLAN generates an EOF interrupt signal. The **Transmit Threshold** value is set to **two** for Compaq Support Software for Microsoft Windows NT 3.51 (SSD), Version 117C.

This counter can be tuned by editing the Windows NT Registry. Refer to the Windows NT Resource Kit (Volume 2) for registry editing techniques.

Counter Name: **Transmit Underruns**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the number of frames aborted during transmission due to frame data not being available. In other words, underruns might be caused by an application not processing the data fast enough for network data transmission or by hardware bus latency issues.

Counter Name: **Transmits Deferred**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter represents the number of frames per second that were deferred to a later time before being transmitted across the wire, possibly due to network collisions or other network issues.

Counter Name: **Transmit Queued**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent

This counter represents the number of transmit frames queued to the controller for transmission. This can happen when the system processor processes frames faster that the NIC can send them. If a large percentage of packets are queued and not transmitted, this can indicate a bottleneck at the server NIC or on the physical network.

Counter Name: **Transmits Queued Peak**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3/Netelligent

This counter represents the maximum number of packets placed in the transmit queue since the system was booted.

NIC Interrupts and Heartbeat Failure Counters

These counters directly relate to the internal functionality of the NIC. In other words, they monitor the condition or state of the network subsystem hardware.

Table 6 describes the NIC Interrupts and Heartbeat Failure Counters

TABLE 6
NIC INTERRUPTS AND HEARTBEAT FAILURE COUNTERS

Counter Name: **Interrupt Pace Timer**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3/Netelligent

This counter specifies the amount of delay between back-to-back controller interrupts. This value is dynamically tuned by the system. You can tune this counter by editing the Windows NT Registry key *IntTimer*. For additional information on registry tuning, refer to the Microsoft Windows NT Resource Kit (Volume 2) for registry editing techniques.

Counter Name: **Interrupt/Sec**

Knowledge Level: Basic
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the total number of NIC interrupts handled per second. The **Interrupt/Sec** is the sum of all the network interrupts generated by the NIC, including the **Transmit EOC/EOF** and **Receive EOC/EOF** interrupt values.

Counter Name: **Times CRS Lost**

Knowledge Level: Expert
Controller Supported: Compaq NetFlex-3/Netelligent

This counter indicates the number of times that the carrier sense signal from the physical layer interface was not asserted or was deasserted during transmission of a frame without a collision. The carrier sense signal is an on-going activity. The signal detects when a station transmits a frame but does not detect its own signal on the medium.

If the **Times CRS Lost** counter is non-zero, check the following items:

- Failing cable - Frame data traveling through shorted or damaged cabling can cause signal loss.
- LAN segment not grounded properly - Improper grounding of a LAN segment can allow ground-induced noise to interrupt the signal.
- Noisy cable - Interference or electrical noise produced by motors or other devices can interrupt signals and cause errors.
- Deaf/Partially deaf node - A faulty station that cannot sense the activity on the medium is considered a deaf node. If you suspect a deaf node, replace the NIC or transceiver.
- Failing repeater, transceiver, or NICs - These can disrupt the network signal or cause erroneous data to be transmitted through the network medium.

continued

NIC Interrupts and Heartbeat Failure Counters *continued*

Counter Name: **Heart Beat Failures**

Knowledge Level: Advanced
Controller Supported: Compaq NetFlex-3/Netelligent (10BaseT/100 Base-TX only)

This counter is a transmission sent by a transceiver on the NIC and is used to determine if the collision circuitry is functional. If the **Heart Beat Failures** counter is non-zero, you might have a network problem, or possibly a faulty hub or NIC.

Summary of Counters

The Compaq NetFlex-3/Netelligent Windows NT object counters can play a key role in monitoring server network utilization. The Windows NT Performance Monitor program can display network logged information in two forms: graphical (charts) or tabular (report files). A Performance Monitor chart displays a counter's last value, average value, minimum value, maximum value, and graph time (total log time). A Windows NT Performance Monitor report file reports the last value only, that is, an instantaneous count. For detailed information on Performance Monitor, refer to the *Microsoft Windows NT Resource Kit: Vol. 4, Optimizing Windows NT*.

COMPAQ NETFLEX-3/NETELLIGENT COUNTER INTERPRETATION

A good starting point would be to establish a Network-Server baseline profile, which includes gathering performance information on all subsystems within the Server . The following tables can serve as a general guideline in reading and interpreting the results of a Performance Monitor NetFlex-3/Netelligent object counter report file. Recording average values can more effectively represent the overall system performance levels. These tables are not intended to serve as a concise troubleshooting tool, but to provide additional information to aid in understanding the NetFlex-3/Netelligent counters and how they interact with other performance monitor object counters.

Tables 7-8 represent general counter information relative to the values recorded in a network test environment. The interpretation is based on results generated under specific test conditions. The following remarks are as indicated in each respective table:

- Good - values indicate good performance or no errors
- Average - values are acceptable; no problems exist
- Poor - system not optimized or high rate of errors
- Indeterminant - insufficient information to properly evaluate performance

TABLE 7
INTERPRETATION OF NETFLEX-3/NETELLIGENT
RECEIVE COUNTER VALUES

NetFlex-3/Netelligent Counter Name	Good Value	Average Value	Poor Value
Frames Received/EOF	Value > 2	Value < 2	Value = 0
Frames Received Not at EOF	Value > 25% of Frames Received	Value < 25% of Frames Received	N/A
Receive Alignment Error	Value< 1	Value =1	Value > 1
Receive CRC Errors	Value < 1	Value =1	Value > 1
Receive Frames Errors	Value <1	Value =1	Value > 1
Receive EOC	Value = 0	Value < 25% of Frames Received	Indeterminant
Receive EOF	Value < 25% of Frames Received	Value < 50% of Frames Received	Indeterminant
Receive Frames OK	Value > 75% of Frames Received	Value > 10% < 75% of Frames Received	Indeterminant
Receive No Buffer Error/ Receive Overruns	Value = 0	Value < 1% of Frames Received	Indeterminant
Receive Pended	Value > 2% of Frames Received	Value < 2% of Frames Received	N/A
Received Pended Peak	Value > 2% of Frames Received	Value < 2% of Frames Received	N/A

continued

TABLE 8
INTERPRETATION OF NETFLEX-3/NETELLIGENT
TRANSMIT COUNTER VALUES

NetFlex-3/Netelligent Counter Name	Good Value	Average Value	Poor Value
Frames Transmitted/EOF	Value > 2 of Transmit Frames OK	Value < 2 of Transmit Frames OK	N/A
Frames Transmitted Not at EOF	Value > 25% of Transmit Frames OK	Value < 25% of Transmit Frames OK	N/A
Transmit EOC	Value < 25% of Transmit EOF	Value < 75% of Transmit EOF	Indeterminant
Transmit Frames OK	Value > 80% of Frames Sent	Value < 80% of Frames Sent	N/A
Transmit Frame Error	Value = 0	Value < 1% of Frames Sent	Indeterminant
Transmit One Collision	Value = 0	Value <15% of Frames Sent	Indeterminant
Transmit More Collisions	Value= 0	Value <15% of Frames Sent	Indeterminant
Transmit Max Collisions	Value= 0	Value <15% of Frames Sent	Indeterminant
Transmit Deferred	Value= 0	Value <10% of Frames Sent	Indeterminant
Transmit No Buffers Available/Transmit No Lists Available	Value= 0	Value <10% of Frames Sent	Indeterminant
Transmit Underruns	Value= 0	Value <5% of Frames Sent	Indeterminant

NetFlex3/Netelligent Counters That Can Directly Relate to Network Performance

Consistently monitoring network utilization of the server aides in understanding your LAN traffic. In 100Base-TX and 10Base-T environments the shared-media access method is used to transfer data across the network. This method involves the Carrier Sense Multiple Access/Collision Detect (CSMA/CD) scheme.

In the shared-media method, an Ethernet station transmits data when the network appears clear of traffic. If the first transmission collided with a transmission from another station, it retransmits the data after a random delay. As network traffic increases, collisions between transmissions become more frequent, which could cause the network to be bottlenecked or congested.

A congested LAN limits the effective bandwidth utilization of a LAN. This is also true for Demand Priority LANs (for example, 100-VG-AnyLAN). In the Demand Priority method, the hub determines which NIC has access to the network and allows only one port to transmit data at a time, in port order (collisionless by definition).

Table 9 itemizes the counters affected by excessive collisions and the counters that can indicate an over usage of the server network resources.

TABLE 9
NETWORK RESOURCE USAGE AND COLLISIONS

Counters	Description
Bytes Total/Sec, Frames/Sec	Depending upon the network load, the typical network sustained throughput at the server should not exceed an estimated maximum of 60 percent of the LAN bandwidth. That is, for a 100 Megabits/s LAN segment, the maximum sustained server throughput would be 60 Megabits/s. In this case, additional network bandwidth will be needed to improve performance significantly. In general, if the server throughput is 60 percent of NIC bandwidth and the NIC usage is over 70 percent of the processor utilization, the network subsystem might be the major server bottleneck. To determine the total processor **Interrupts/Sec** counter value, select the processor object module in the Windows NT Performance Monitor program. Next, select the **Interrupts/Sec** counter. The percentage of processor interrupts that can be attributed to the NIC subsystem is: $$\text{Percentage of NIC interrupts per total processor interrupts} = \frac{\text{NIC Interrupts/Sec}}{\text{CPU Interrupts/Sec}} \times 100$$ For example: $$\frac{\text{70 Interrupts/Sec}}{\text{100 Interrupts/Sec}} \times 100 = 70\%$$ There can be cases where 60 percent server network throughput utilization is acceptable. Monitor the processor subsystem object counter values to determine whether corrective action is warranted.

continued

Counters for Determining Network Resource Usage *continued*

Counters	Description
Bytes Total/Sec, Frames/Sec	Collisions exceeding 15 percent of the frames being transferred can limit the bandwidth at the network hubs, thereby directly affecting the network throughput. If the **Transmit More Collisions** counter registers more than 15 percent of the **Frames Sent/Sec** value, then investigate the potential component problems mentioned in the **Transmit Max Collisions** counter information. Using a switching hub will also minimize the number of collisions. Another factor that can affect network throughput is data transfer of small frames. An application transferring frames that are less than 512 bytes reduces the overall network throughput (**Bytes Total/Sec**) compared to transferring 1514 bytes per frame. Being aware of the factors that limit network throughput can be beneficial in understanding system tuning.
Receive EOC , Receive EOF, Frames Received/EOF	The **Receive EOF** counter correlates with the **Frames Received/EOF**. If the **Frames Received/EOF** counter is one, there is one EOF interrupt generated for every frame received. In this case, the Receive EOF interrupt value might be high (over 1000). If the **Receive EOC** counter is non-zero (indicating no **Receive Buffers** are available) performance degradation might become evident. The **Max Receive Buffers** can be modified in the Windows NT Registry to increase the **Receive Buffer** size. The Windows NT registry key name for Compaq NIC is *CPQNF3X* for each instance of the NIC, where X is the NetFlex-3 instance.
Interrupts/Sec, Transmit Threshold	The **Interrupt/Sec** counter is the sum of all the network interrupts being generated by the NIC, including the **Transmit EOC/EOF** and **Receive EOC/EOF** interrupt values. If the NIC **Interrupt/Sec** value is greater than 70 percent of the processor **Interrupts/Sec**, the network subsystem might be bottlenecked. You can modify the **Transmit Threshold** registry parameter to reduce the processor network utilization. The default registry value is 2, the maximum is 255.
Receive No Buffer Errors, Transmit Frame Errors, Transmit No Buffers Available, Transmit No Lists Available, Transmit Max Collisions, and Transmit Threshold	These counters indicate network efficiencies. A value other than zero can show that the network is experiencing transmission latency or excessive collisions are being detected. Possible solutions to these problems are: • Determine if the LAN is congested; is the throughput above 60 percent of the LAN bandwidth. • Determine if the excessive collisions are a result of marginal hardware.

NetFlex3/Netelligent Counters That Do Not Directly Affect Network Performance

Compaq provides NetFlex-3/Netelligent counter information that indicates if there has been a network hardware failure or discontinuity on the LAN. In the following table the network error counters are tabulated and correlated with each other. In the left-most column of Table 10, the "Cause" column indicates the counters which receive an error initially. The "Effect" columns indicate the counters which respond or increment as a result of an error initiated by the "Cause" counters. This table shows how one error might affect more than one counter.

TABLE 10
CAUSE AND EFFECT

Cause	Effect					
	Adapter Check	**Error Link Changes**	**Network Errors**	**Resets Errors**	**Training Errors**	**Receive Errors**
Adapter Check		yes	possibly	possibly	possibly	possibly
Error Link Changes	no		yes	no	possibly	possibly
Network Errors	no	yes		possibly	possibly	possibly
Resets Errors	possibly	yes	possibly		possibly	possibly
Training Errors	no	possibly	yes	yes		no
Receive Errors	no	no	yes	possibly	possibly	

For example, if the **Error Link Changes** counter is incremented, the **Network Errors** counter usually also increments. This is indicated by a "yes" in the appropriate columns. A "no" in this table means that a counter is not affected by the other counter. A "possibly" means that the counters could increment depending on the root cause of the network error.

In general, it is helpful to know which counter are affected by each other. However, non-zero values could mean there is a hardware problem, which has the potential for network downtime. In such a case, corrective action that can be taken is to inspect cabling, hub connections, hub "error" lights or LED's, as well as the NIC connections.

APPENDIX

Network Monitoring Overview

Network monitoring includes assessing network performance and monitoring the LAN. This appendix describes the Windows NT Performance Monitor program, a utility used to identify and isolate network performance problems in a Windows NT Server environment.

Monitoring Network Performance Parameters or Counters

Managing network performance parameters requires additional time and hard disk space to record the monitored data. Once you implement the network, monitor all subsystems regularly to ensure adequate performance.

Here are a few ideas you can implement to help manage your network and maintain an awareness of how the network is performing.

- Create procedures for managing and implementing network changes.
- Regularly schedule a baseline performance analysis of the network.
- As performance symptoms develop, have a plan of systematic procedures to follow for isolating the problem(s).
- Make only one change at a time, and test each change thoroughly before making another.
- Document your solutions and conclusions for future reference.

Microsoft Windows NT Performance Monitor

The Microsoft Windows NT Performance Monitor program provides an easy and effective way to monitor the network resource utilization of a Windows NT server. Performance Monitor is provided with the base Windows NT Server operating system for monitoring all subsystems resource utilization on a server. After you configure Windows NT Server, Performance Monitor becomes an important process in tracking the load on the server and planning for future growth.

Performance Monitor collects values for subsystem utilization through counters. The counters reside within a hierarchical structure of different categories. Figure 1 shows the hierarchical structure of the Performance Monitor information.

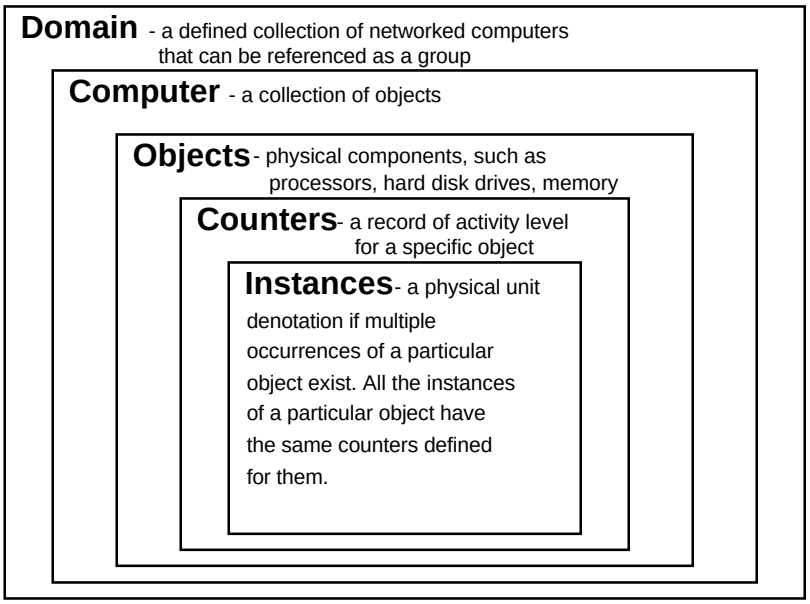

Figure 1. *Performance Monitor Counter Hierarchy*

Performance Monitor only records those objects in the server which support counters. You can use Performance Monitor to create a chart or a report that tracks specifically selected counters. Figure 2 illustrates the Performance Monitor screen used to specify the computer, object, counter, and instance selections for monitoring.

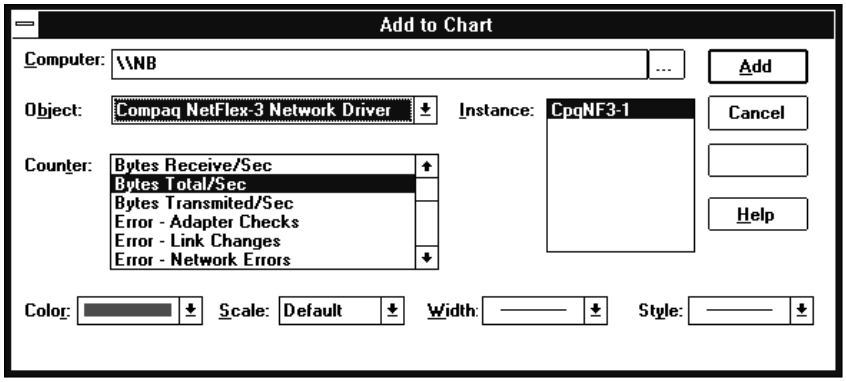

Figure 2. *Configuring Performance Monitor with Objects and Counters*

The main mechanisms for reporting Windows NT counter values are:

- Chart of counter activity – a graphical representation of counters selected from an Object. A chart can display an infinite amount of captured data from the server.
- Report of counter value – at any one sample time, the last value of the counter is reported and displayed in a tabular form.
- Log of counter activity – all counter activity can be logged into a file for analysis at some later time. The monitoring time period can range from one second to infinity.

You can also export all of the preceding output forms to a spreadsheet for distribution and further analysis. A graphical view of a monitoring session is illustrated by Figure 3.

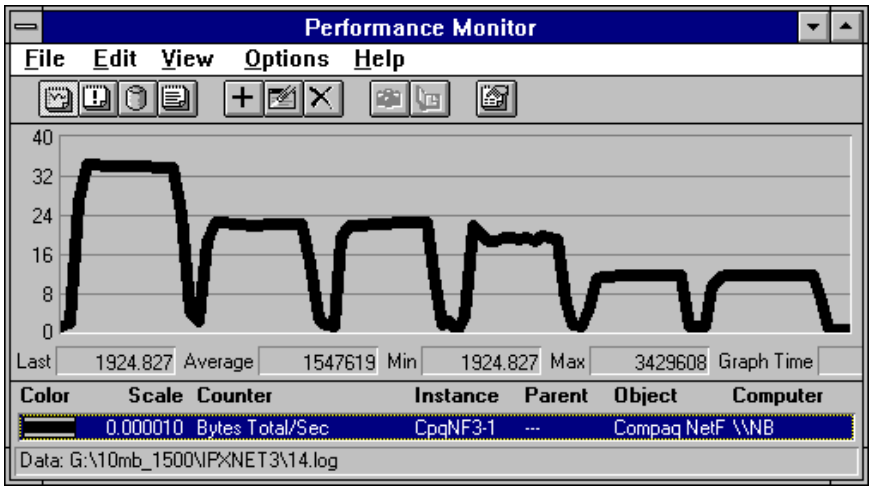

Figure 3. *Performance Monitor Chart of Counter Activity*

To interpret the monitored result, it is important to understand that Windows NT Performance Monitor chart information is relative to the sample time of the log file. That is, the chart displays a counter's last value, average value, minimum value, maximum value, and graph time. A Windows NT Performance Monitor report file reports the last value only. For detailed information on Performance Monitor, refer to the *Microsoft Windows NT Resource Kit: Vol. 4, Optimizing Windows NT*.

Performance Monitor Summary

This section has provided a brief overview of Windows NT Performance Monitor program. Our intent for this document is to focus on the network resource utilization of a server. To monitor the NetFlex-3/Netelligent Performance Counters, you must select the *Compaq NetFlex-3 Network Driver* object counter in Windows NT Performance Monitor program. The NetFlex3/Netelligent network counter feature can only be obtained via the Compaq Resource Kit for Microsoft Windows NT.