

# PCI Gigabit Ethernet Performance The Design Makes the Difference!

Includes Gigabit Performance Test Results Using  
HP 9000 N-Class (Mid-range) Servers



September 11, 2000

U.S.A.

©2000 Hewlett-Packard Company



## Legal Notices

The information in this document is subject to change without notice.

Hewlett-Packard makes no warranty of any kind with regard to this white paper, including but not limited to the implied warranties of merchantability and fitness for a particular purpose. Hewlett-Packard shall not be held liable for errors contained herein or direct, indirect, special, incidental or consequential damages in connection with the furnishing, performance, or use of this material.

Copyright Notices. ©copyright 2000 Hewlett-Packard Company, all rights reserved.

Reproduction, adaptation, or translation of this document without prior written permission is prohibited, except as allowed under the copyright laws.

Trademark Notices. UNIX is a registered trademark of the Open Group.

## Introduction

HP leads the industry in overall PCI Gigabit Ethernet (GbE) performance and reliability with the balanced system approach built into the HP 9000 N-class servers.

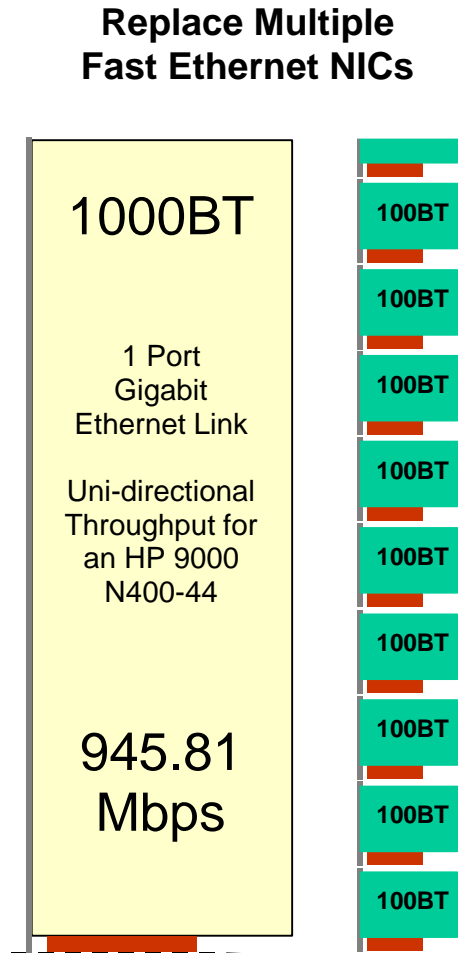
The goal of this paper is to show what HP customers can expect in GbE performance from N-Class servers, using HP PCI 1000BASE-T and PCI 1000BASE-SX GbE NICs. This paper discusses the following GbE performance issues:

- **Tested Products:** Overview of the HP GbE products used to conduct the performance tests described in this article.
- **Server-to-Switch GbE Throughput Performance:** Performance data generated using an N-Class server with HP, Cisco switches, and multiple, aggregating 1000BASE-TX clients.
- **Back-to-Back GbE Throughput Performance:** Performance data generated using five HP N-Class servers.
- **Balanced System Design:** The goal of a balanced system design, is to obtain comparable performance levels from the server's processor, system memory and I/O.

The need for balanced system approach to high speed Ethernet connectivity has resulted from ever-increasing levels of network bandwidth capacity and traffic loads. Consequently, some legacy PCI topologies are becoming problematic at these higher speeds.

HP's balanced system approach overcomes these legacy problems with a point-to-point, switch-like I/O topology in the HP 9000 N-Class servers.

This section will discuss how HP servers and GbE NICs are used to offer world-class Gigabit Ethernet performance with a balanced system approach.



## Tested Products

The performance test results presented in this paper were obtained with HP Gigabit Ethernet NICs and N-Class servers.

### Products Used for Performance Tests With NetPerf



#### HP 9000 N4000-55

- 8 550Mhz CPUs
- 8Gb System Memory
- HP-UX 11.0 General Patch Release B.11.00.48



#### A4926A 1000BASE-T PCI NIC

- IEEE 802.3z Compliant
- PCI-4x (64 bit/ 66 Mhz)
- Jumbo Frames Support
- HP-UX 11.0 GbE Driver B.11.00.11

**Note:** HP also offers 1000BASE-SX PCI NICs. The performance characteristics of the 1000BASE-SX and 1000BASE-T NICs are identical.

## Turbo and Twin Turbo PCI Slots

The HP 9000 N-Class servers offer two types of PCI slots:

- **Twin Turbo:** These ports support 32 and 64 bit universal PCI NICs at speeds of 33Mhz and 66Hhz.
- **Turbo:** These ports support 32 and 64 bit universal PCI NICs at speeds of 33Mhz only.

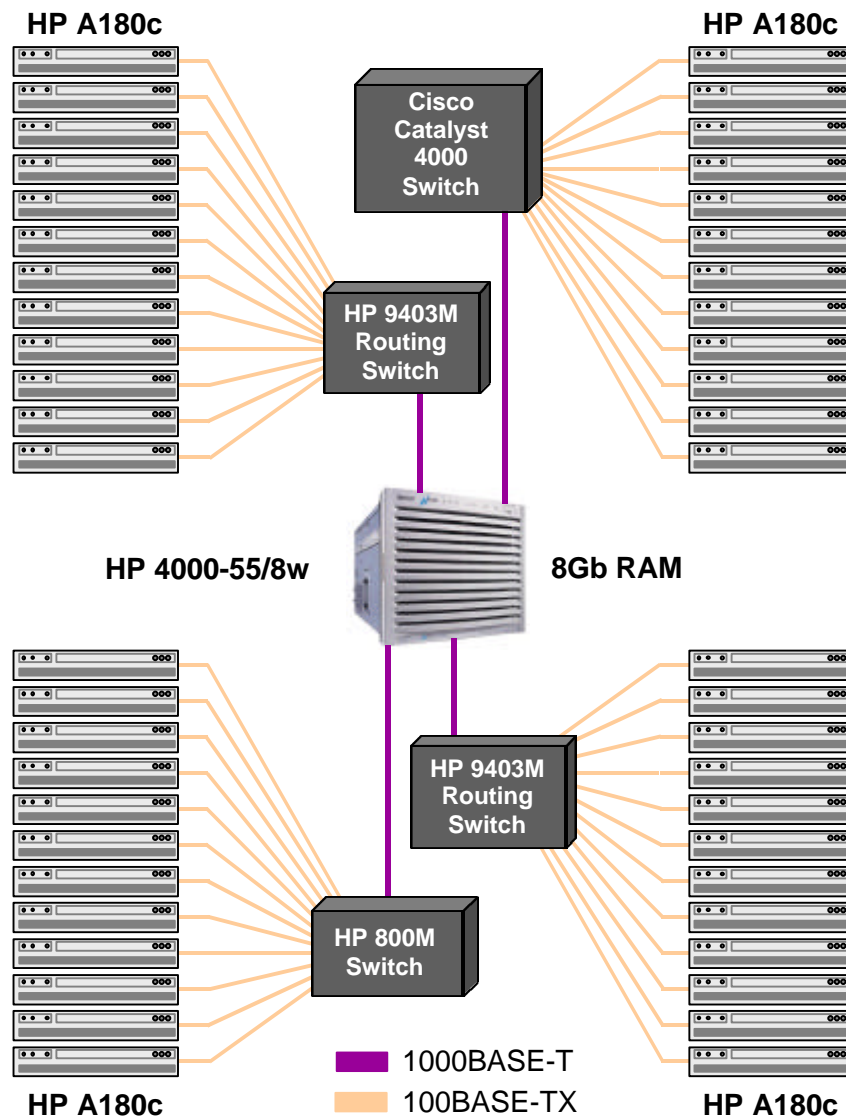
All of the NICs used in these performance tests were 64-bit/66Mhz HP 1000BASE-T and 1000BASE-SX products. All were installed in Twin Turbo PCI slots.

## Server-to-Switch GbE Throughput Performance

All server-to-switch tests were conducted using NetPerf software and used the same HP N4000-55/8w server with one Cisco Catalyst 4000 switch, two HP 9403M routing switches, and one HP 8000M switch. All test results are the average of five runs.

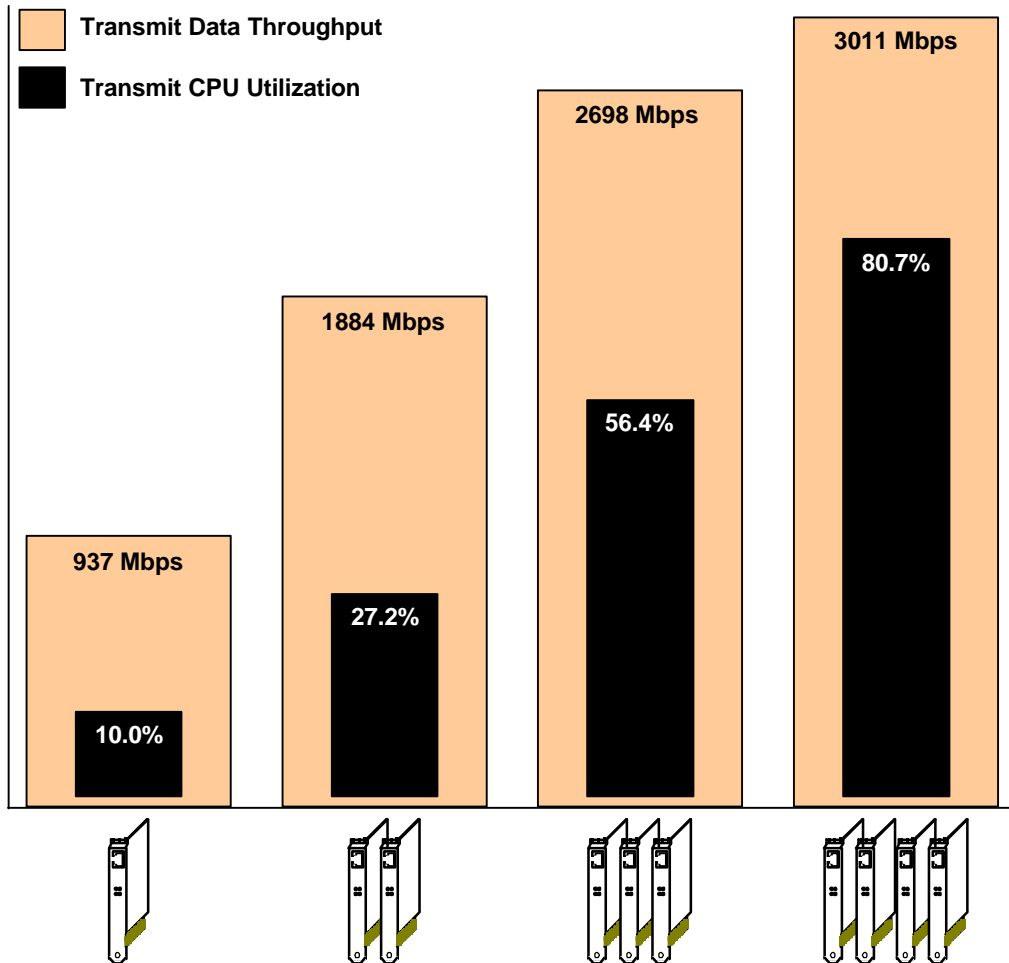
The tested system was an HP 4000-55 configured with eight 550Mhz CPUs and 8GB of RAM system memory. All sever-to-switch links used HP PCI 1000BASE-T or PCI 1000BASE-SX NICs. All switch-to-client links used HP PCI 100BASE-TX NICs on the client side.

The tested system and its 24 HP 9000 A180c clients were configured with HP-UX 11.0 General patch release B.11.00.48 and HP-UX 11.0 Gigabit Ethernet software driver B.11.00.11 for Jumbo Frames and conventional Ethernet frame tests.



## Server-to-Switch Transmit Performance

The tested system and HP A180c clients were configured with a socket size of 57,344 bytes and a message size of 16,384 bytes. All twelve HP A180c assigned to each switch were used.

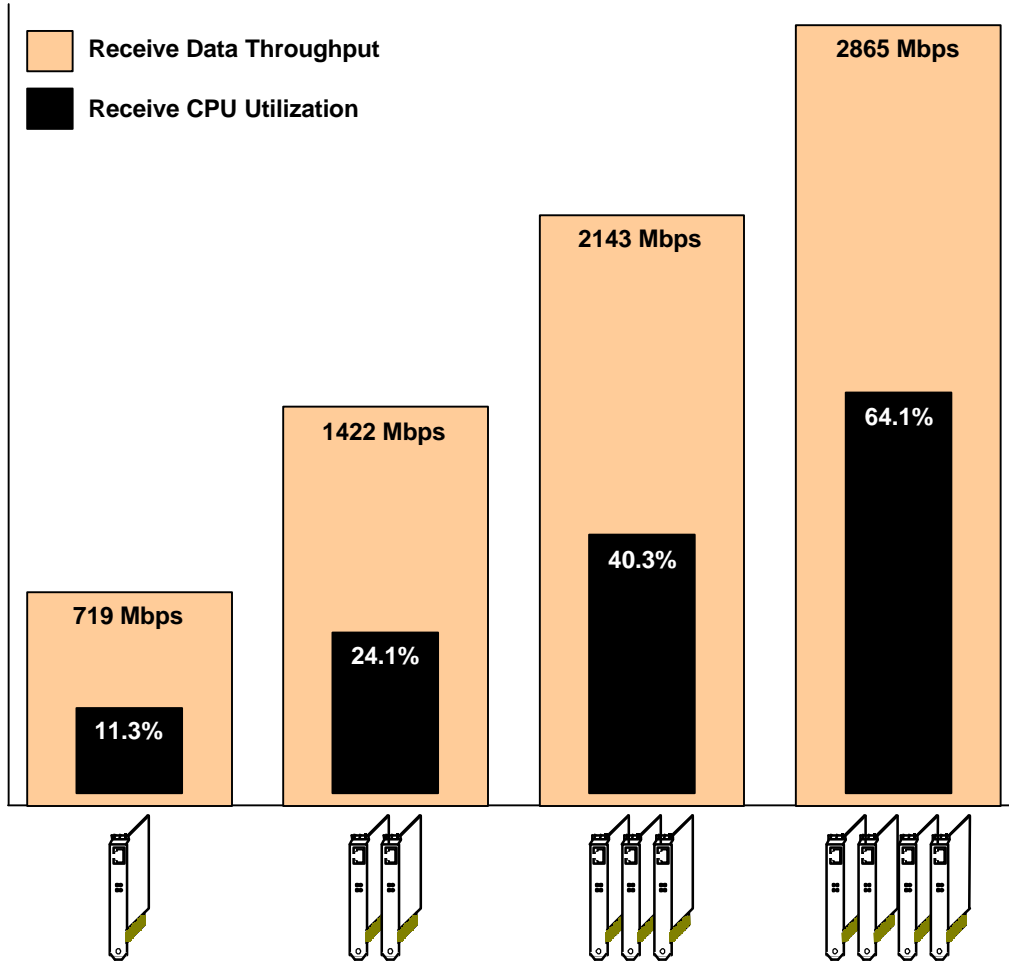


Server-to-Switch transmit throughput ratios are linear through the third NIC. Based on a factor of 1x, where 1x equals the transmit throughput of the first NIC at 796 Mbps. Based on the throughput of the first NIC, the second, third, and fourth NICs scale at relative factors of 2.01x, 2.88x and 3.21x.

In those situations where mid-range servers like the N-Class are designated for heavy transmit roles such as media streaming and backup, the optimal number of NICs is three. The fourth NIC adds additional throughput of 313 Mbps, while increasing CPU demand by 24.3% to a total of 80.7%.

### Server-to-Switch Receive Performance

The SUT and HP A180c clients were configured with a socket size of 131,072 bytes and a message size of 16,384 bytes. Of the 12 HP A180c assigned to each switch, 10 were used.

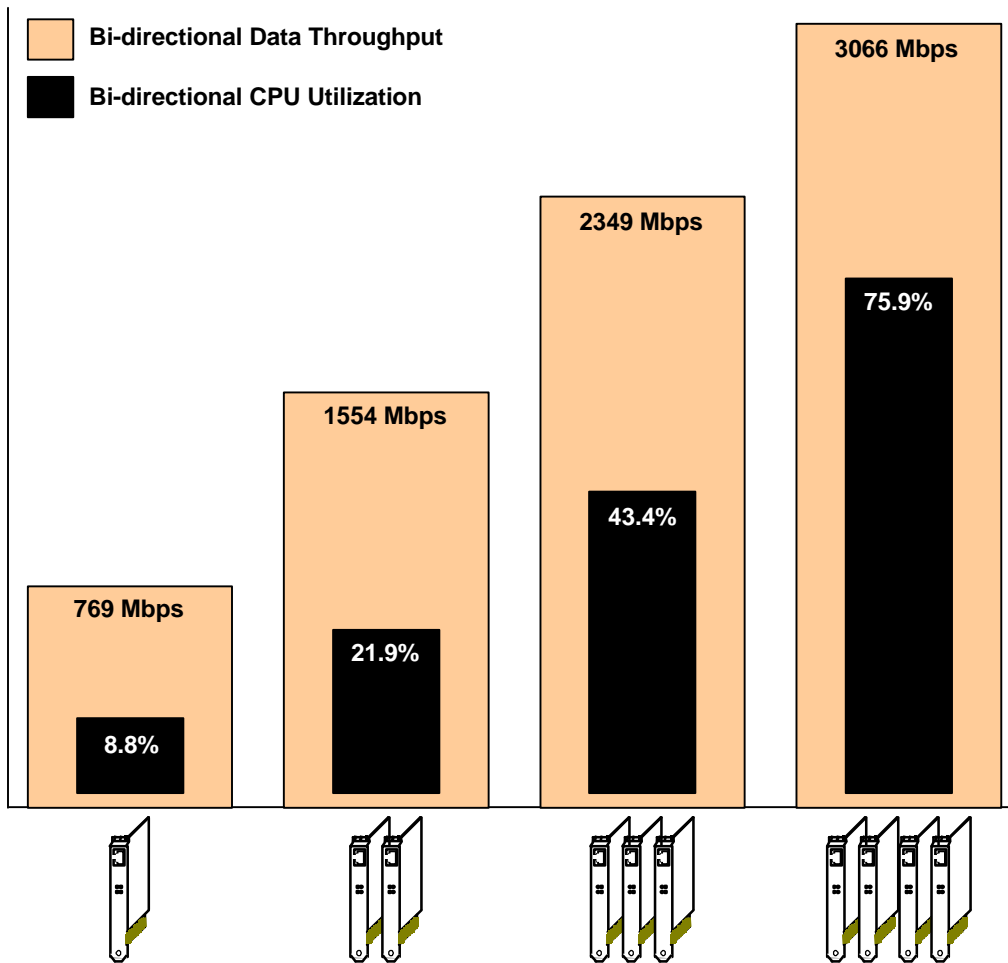


Server-to-Switch transmit throughput ratios are linear through the fourth NIC. Based on a factor of 1x, where 1x equals the transmit throughput of the first NIC at 719 Mbps. Based on the throughput of the first NIC, the second, third, and fourth NICs scale at relative factors of 1.98, 2.98x and 3.98x.

In those situations where mid-range servers like the N-Class are designated for heavy receive roles such as backup, the optimal number of NICs is four. It is important to note that an N-Class server can process 2865 Mbps of incoming data and still have 35.9% of its CPU processing cycles free for system and application tasks.

## Server-to-Switch Bi-directional Performance

The tested system and HP A180c clients were configured with a socket size of 57,344 bytes and a message size of 16,384 bytes. All twelve HP A180c assigned to each switch were used.



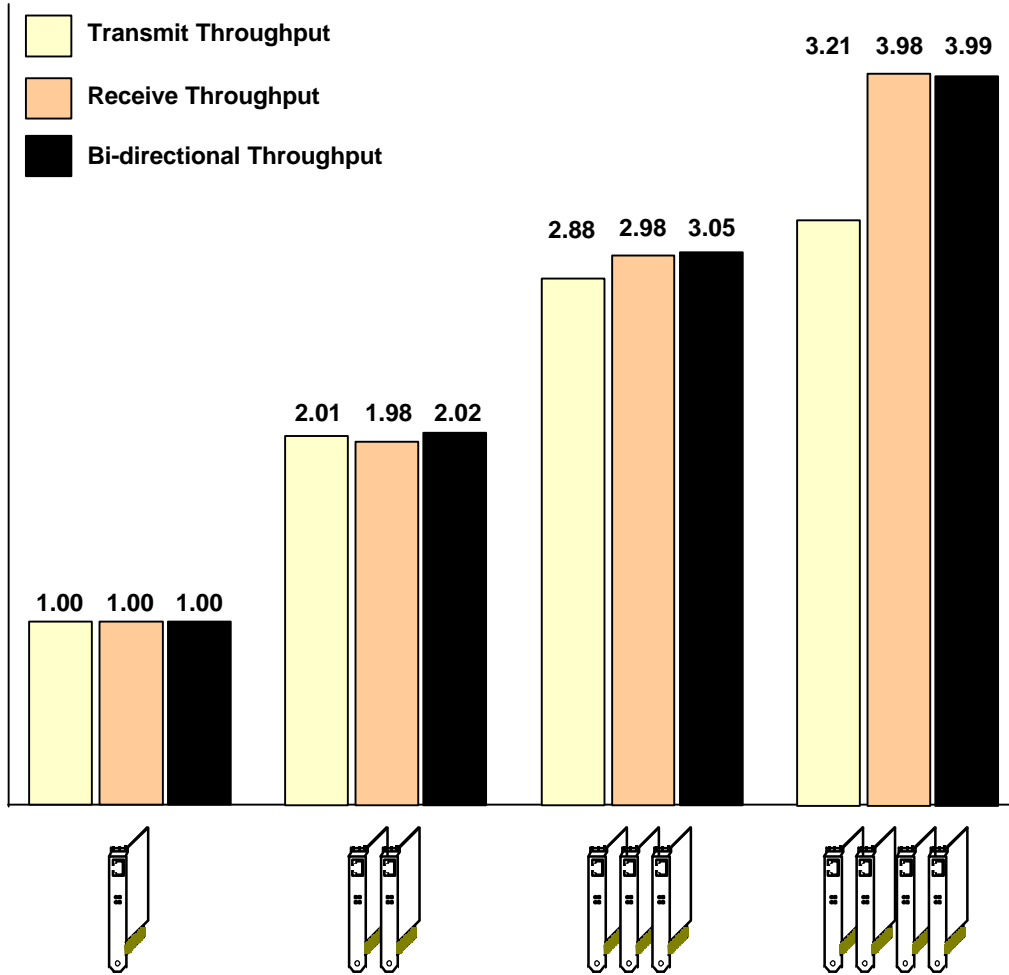
Server-to-Switch bi-directional throughput ratios are linear through the fourth NIC. Based on a factor of 1x, where 1x equals the transmit throughput of the first NIC at 769 Mbps. Based on the throughput of the first NIC, the second, third, and fourth NICs scale at relative factors of 2.02x, 3.05x and 3.99x.

Bi-directional throughput performance is the “acid test” for any server, and this is where the balanced system design of the N-Class really shines with impressive linear scaling.

It is important to note that an N-Class server can process 3066 Mbps of bi-directional data and still have 24.1% of its CPU processing cycles free for system and application tasks.

### Server-to-Switch NIC Throughput Scale

This utilization scale is based on a factor of 1x, where 1x equals the bi-directional throughput of the first NIC. Scaling of the second, third, and fourth NICs is relative to the first NIC.



Receive and bi-directional sever-to-switch throughput performance is linear through the fourth NIC. Transmit switch throughput performance is linear through the third NIC.

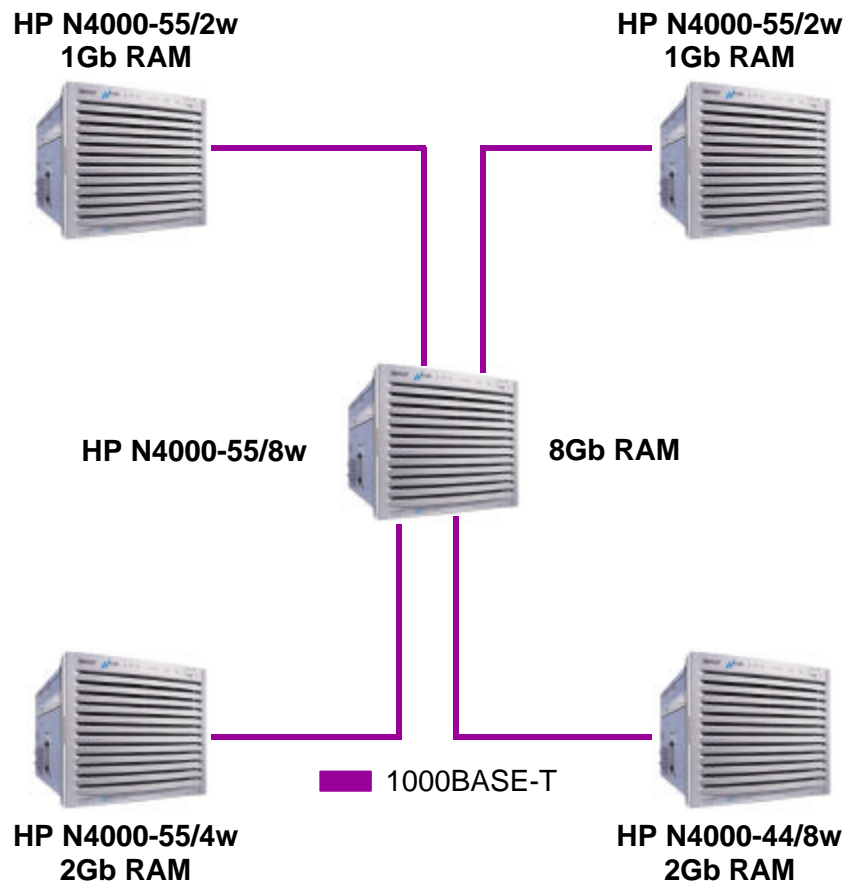
As web and application servers, the N-Class servers offer solid linear performance value that is scalable and consistently reliable because of the balanced system design of this versatile mid-range server.

## Back-to-Back GbE Throughput Performance

All back-to-back tests were conducted using NetPerf software and used the same three N4000-55 servers and one HP 9000 N4000-44 server. All test results are the average of five runs.

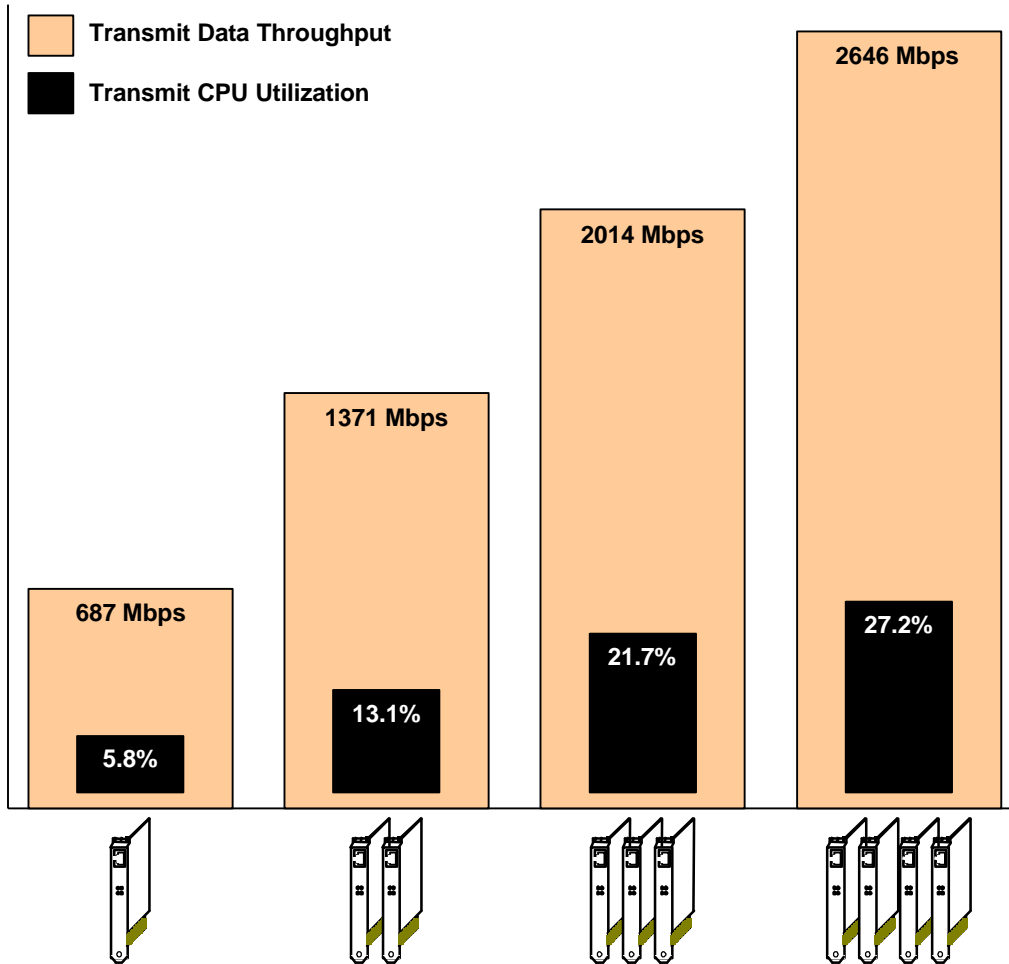
The tested system was an N4000-55 configured with eight 550Mhz CPUs and 8GB of RAM system memory. All sever-to-server links used HP PCI 1000BASE-T or 1000BASE-SX NICs.

The tested system and clients were configured with HP-UX 11.0 General patch release B.11.00.48 and HP-UX 11.0 Gigabit Ethernet software driver B.11.00.11 for Jumbo Frames and conventional Ethernet frame tests.



### Back-to-Back Transmit Performance

The tested system and clients were configured with a socket size of 131,072 bytes and a message size of 32,768 bytes.

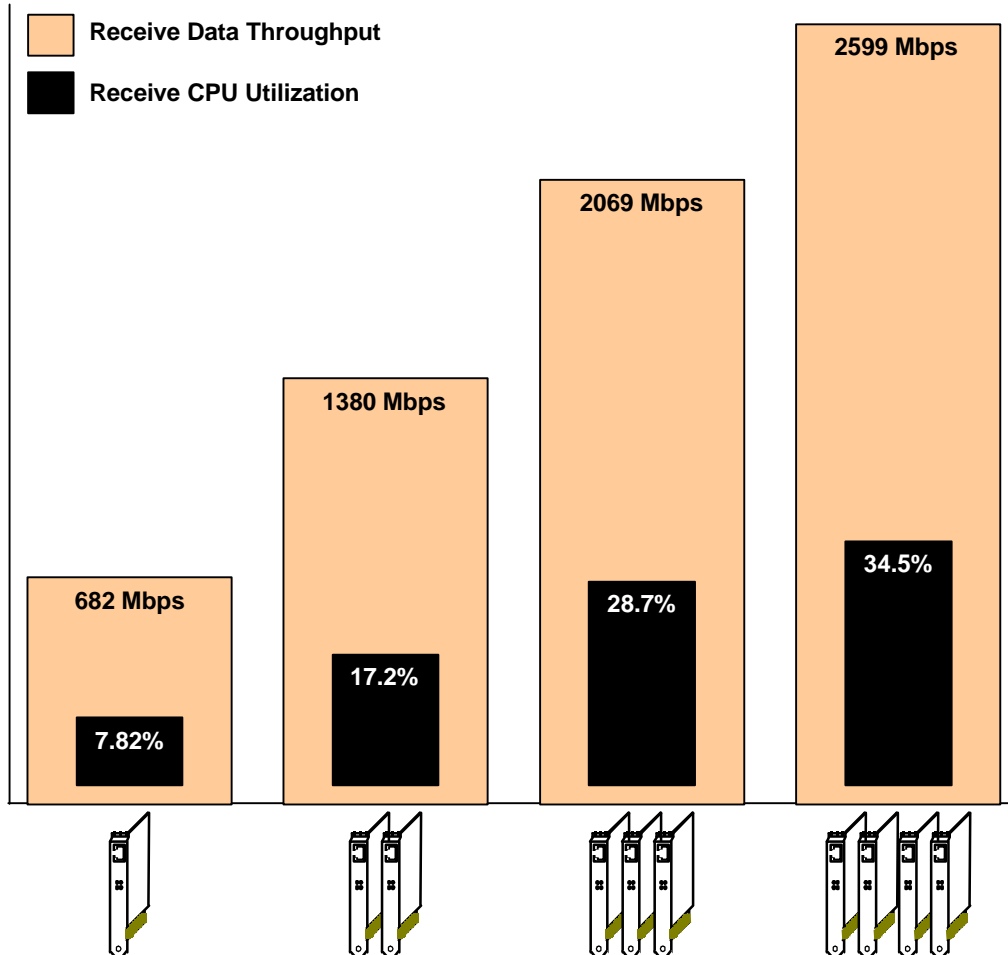


Back-to-back transmit throughput ratios are linear through the fourth NIC. Based on a factor of 1x, where 1x equals the transmit throughput of the first NIC at 687 Mbps. Based on the throughput of the first NIC, the second, third, and fourth NICs scale at relative factors of 2.00x, 2.93x and 3.85x.

It is important to note that an N-Class server can process 3066 Mbps of transmit data and still have 72.8% of its CPU processing cycles free for system and application tasks.

## Back-to-Back Receive Performance

The tested system and clients were configured with a socket size of 131,072 bytes and a message size of 32,768 bytes.

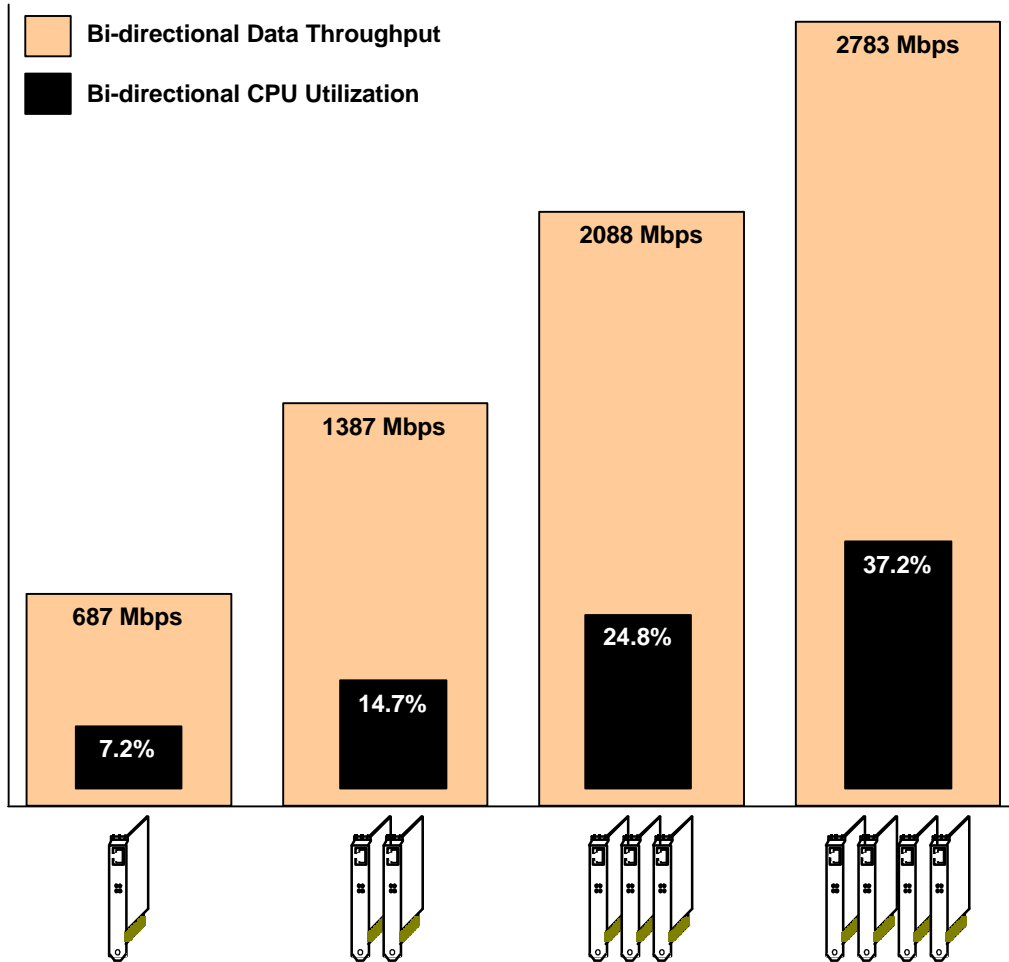


Back-to-back receive throughput ratios are linear through the fourth NIC. Based on a factor of 1x, where 1x equals the transmit throughput of the first NIC at 682 Mbps. Based on the throughput of the first NIC, the second, third, and fourth NICs scale at relative factors of 2.02x, 3.03x and 3.81x.

It is important to note that an N-Class server can process 2599 Mbps of receive data and still have 65.5% of its CPU processing cycles free for system and application tasks.

### Back-to-Back Bi-directional Performance

The tested system and clients were configured with a socket size of 131,072 bytes and a message size of 32,768 bytes.

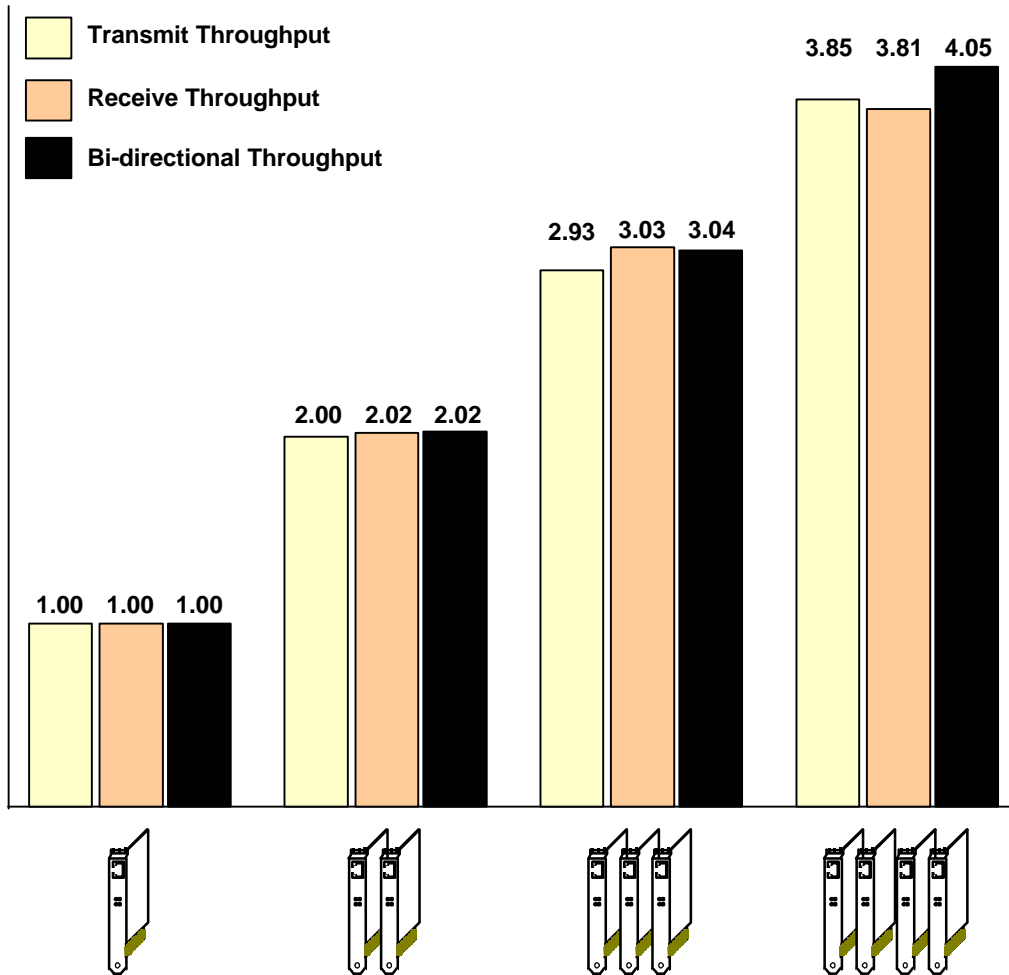


Back-to-back bi-directional throughput ratios are linear through the fourth NIC. Based on a factor of 1x, where 1x equals the transmit throughput of the first NIC at 687 Mbps. Based on the throughput of the first NIC, the second, third, and fourth NICs scale at relative factors of 2.02x, 3.04x and 4.05x.

It is important to note that an N-Class server can process 2783 Mbps of receive data and still have 62.8% of its CPU processing cycles free for system and application tasks.

## Back-to-Back NIC Throughput Scale

This utilization scale is based on a factor of 1x, where 1x equals the bi-directional throughput of the first NIC. Scaling of the second, third, and fourth NICs is relative to the 1st NIC.



Transmit, receive and bi-directional sever-to-switch throughput performance is linear through the fourth NIC with a maximum CPU utilization ratio of 37.2%. The result is that N-Class servers are back-to-back rockets because they off scaleable, world class throughput, with a nominal CPU load.

When used in conjunction with co-located collaborating server, the N-Class servers offer solid linear performance value that is scaleable and consistently reliable because of the balanced system design of this versatile mid-range server.

## Balanced System Design

The goal of a balanced system design is to obtain comparable performance levels from the server's processor, system memory and I/O and this is exactly what every N-Class server delivers.

## Optimizing PCI I/O Performance

The PCI standard was readily adopted in the early 1990s and a major part of its widespread popularity is its ability to provide a substantial volume of I/O bandwidth. However, Ethernet speeds have increased 20x since the initial introduction of the PCI standard. For this reason, many legacy common-bus designs are becoming problematic when pushed to these new PCI throughput demands.

The N-Class balanced system design eliminates the annoying PCI congestion and reliability problems that have continually dog some common bus legacy designs, with an integrated I/O subsystem.

These integrated I/O subsystems enable N-Class servers to offer world-class, scaleable Gigabit Ethernet performance because their independent I/O subsystem controllers manage all I/O traffic, thereby isolating the main system bus from I/O failures.

The net result is that the HP N-Class server and PCI NICs can perform and scale at their maximum performance levels at all times.

## A True End-to-End Solution

HP offers two different Gigabit Ethernet NICs: 1000BASE-SX (up to 550m of multi-mode fiber cable) and 1000BASE-T (up to 100m of CAT5 UTP cable)-. Both NICs offer the same levels of throughput performance. The only difference is cost and distance.

When these NICs are used in the HP 9000 N-Class servers, the result is an end-to-end solution that offers true world-class performance.

## Taking The Next Step

For a current list of tested products and a detailed analysis of your specific requirements and needs regarding HP's N-Class server and Gigabit Ethernet products, contact your HP Sales Representative.