# Performance and Recommended Use of AD222A, AD393A, AD221A Combination 4-Gbit/s Fibre Channel / Gigabit Ethernet Cards

From Results on an HP rx6600 Server


June 2008

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# Introduction

This article highlights the excellent performance and high availability of HP's first generation of PCI Express® based multifunction cards AD221A, AD222A and AD393A. The AD222A (Figure 1) combines 2-ports for 4-Gbit/s Fibre Channel mass storage and 2 ports for Gigabit Ethernet (Copper) networking. The AD393A (Figure 2) combines 2 ports for 4-Gbit/s Fibre Channel mass storage and 2 ports for Gigabit Ethernet (Fiber) networking. The AD221A (Figure 3) combines 1-port for 4-Gbit/s Fibre Channel mass storage and 1 port for Gigabit Ethernet (Copper) networking. Performance numbers for the AD221A are equivalent to single port numbers for the AD222A. Performance numbers for the AD393A are equivalent to AD222A. Please refer to table 1 for details on the PCI Express based multifunction cards.

**Table 1 Product Details**

| Product Number | Fibre Channel Ports | Number of Ethernet Ports |
|---|---|---|
| AD221A | 1 Port 4-Gbit/s | 1 Port 1000BT |
| AD222A | 2 Port 4-Gbit/s | 2 Ports 1000BT |
| AD393A | 2 Port 4-Gbit/s | 2 Ports 1000SX |

This article also provides suggestions based on the performance and technology that will help you to optimize the use of these products.

**Figure 1: AD222A HP PCIe 2p 4-Gbit/s FC and 2p 1000BT Adptr**

**Figure 2: AD393A HP PCIe 2p 4-Gbit/s FC and 2p 1000BSX Adptr**

**Figure 3: AD221A HP PCIe 1p 4-Gbit/s FC and 1p 1000BT Adptr**

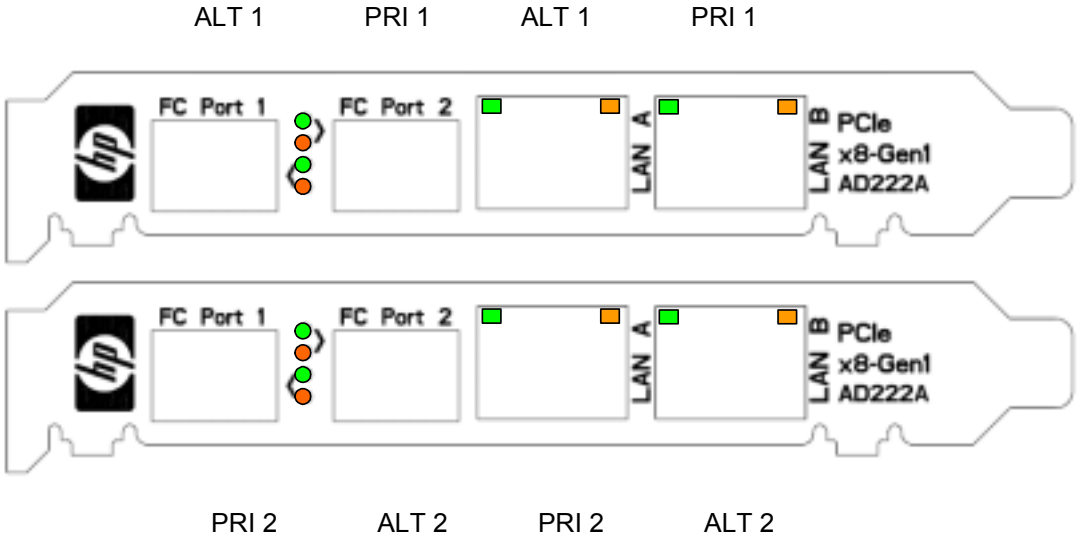
# Recommended Use Based on Performance and Design

The AD222A can be thought of as a combination of an HP AD355A 2-port 4-Gbit/s Fibre Channel card connected by a PCIe to PCIe switch with an AD337A 2-port 1000Base-T card and sharing a common PCIe® bus. All the connections sharing this single common resource perform exceptionally well in a variety of configurations.

HP recommends the following usage model to achieve the best performance:

- Run the AD222A cards in the highest performing PCIe slots. Slots 5 and 6 are the recommended high performance PCIe slots in the HP Integrity rx6600 used in our performance testing.
- Set up a pair of cards for high availability as shown in Figure 4. On the first card, configure 1 Fibre Channel port and 1 Gigabit Ethernet port as *primary* or active and the second Fibre Channel port and Gigabit Ethernet port as alternates for the second card. On the second card, configure 1 Fibre Channel port and 1 Gigabit Ethernet port as *primary* or active and the second Fibre Channel port and Gigabit Ethernet port as alternates for the first card. This setup would provide the best performance and high availability. Achieving a similar level of high availability would require using twice the number of AD355A (2-port 4-Gbit/s Fibre Channel) or AD337A (2-port GigE) cards.

**Figure 4: Setting Up a Pair of AD222A Cards for High Availability**




The recommendations mentioned here were followed to achieve the results shown in this article. Card throughput will be affected with configurations other than those recommended.

Besides providing exceptional performance, the AD222A, AD393A and AD221A provide increased connectivity compared to other HP cards such as the AD355A, AD337A. Please

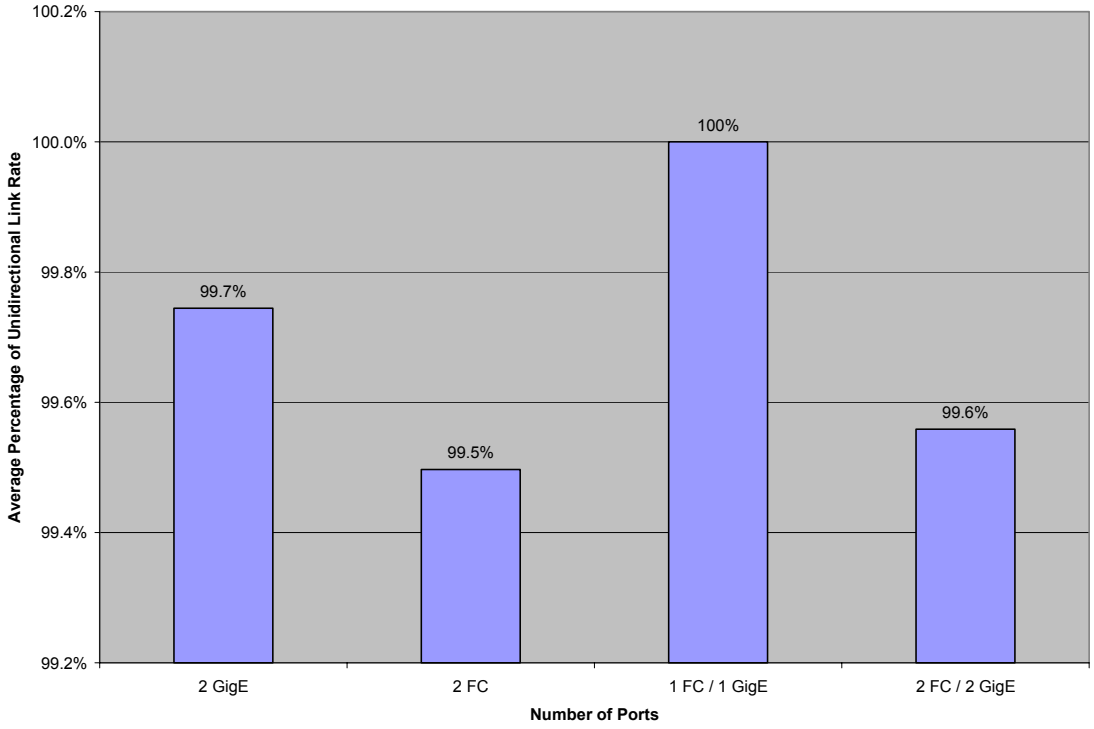
contact an HP representative for additional help in understanding how to best deploy the AD222A, AD393A and AD221A multifunction cards.

When used as recommended, the AD222A, AD393A and AD221A provide equivalent performance to the ports on AD355A and AD337A cards. In addition the AD222A or AD393A provides the benefit of high availability (HA) with no additional slot usage.

# Performance Summary

The AD222A card provides excellent performance when used in accordance with the recommendations in this paper. Figure 5 summarizes the performance results possible when many different types of traffic combinations are used with the recommended models.

**Figure 5 : AD222A Performance Summary in rx6600**




The graph shows the *average sustained throughput relative to link rate* measured on:

- 2 Gigabit Ethernet ports
- 2 Fibre Channel ports
- A mix of 1 Fibre channel port and 1 Gigabit Ethernet port
- A mix of 2 Fibre channel ports and 2 Gigabit Ethernet ports

The AD222A has very good performance. Averages range from 99.5% -100% of link rate on the rx6600 system with different combinations of traffic types. The summary includes results for all 4 ports running sustained simultaneous traffic!

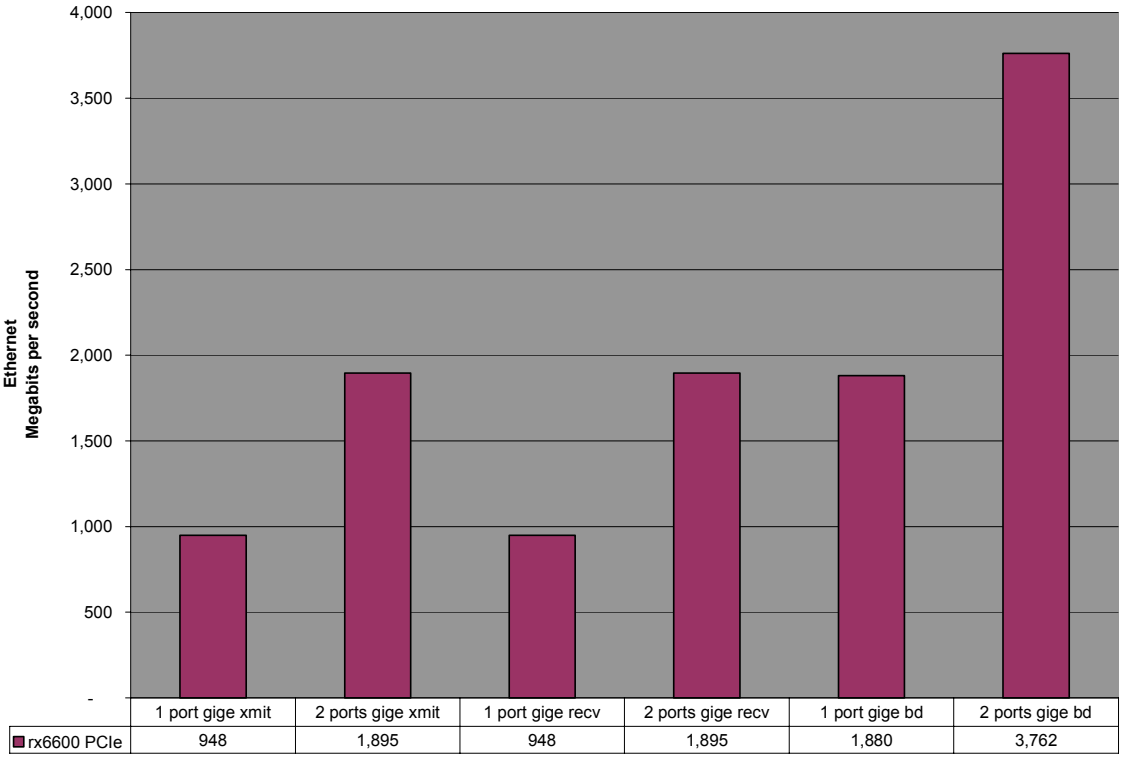
Many of the different types of traffic combinations achieve link rate and will be discussed in more detail later in the document.

# Gigabit Ethernet Only Performance

Figure 6 shows the performance results of the Gigabit Ethernet ports using a standard 1500-byte MTU is being run through the card.

The following highlights show the exceptional performance achieved during Gigabit Ethernet traffic testing:

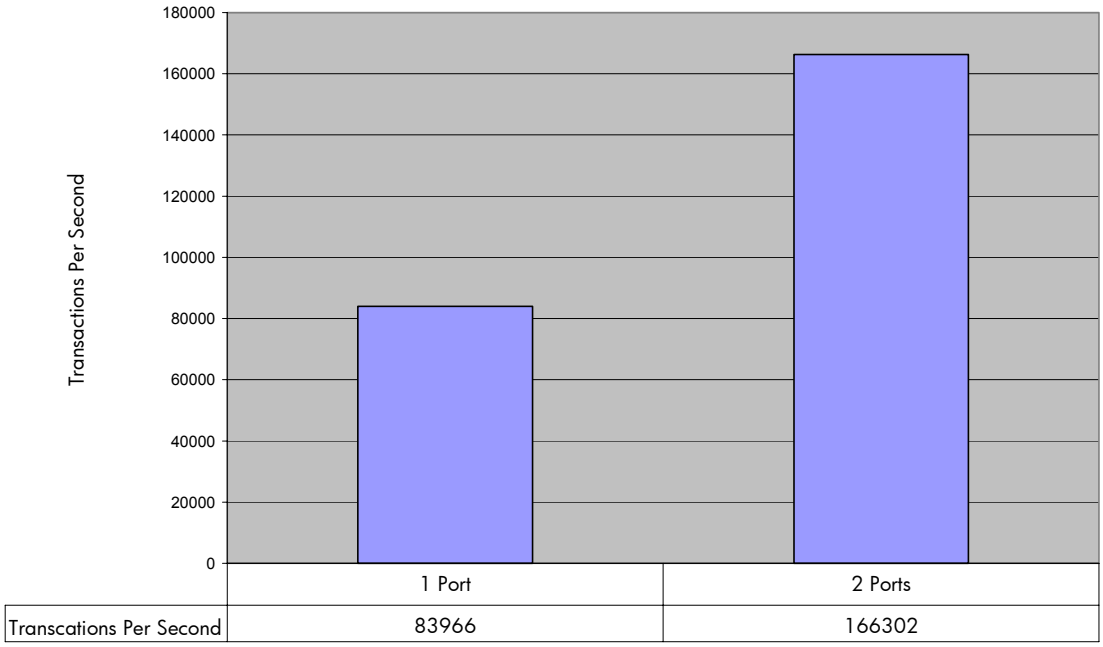
**Figure 6: AD222A Gigabit Ethernet Throughput in rx6600**




- Transmit traffic achieved link rate on the rx6600 reaching 948 megabits per second on one port and 1.895 gigabits of application data per second of throughput using both 1000 Base-T ports.
- Receive Traffic achieved link rate on the rx6600 reaching 948 megabits per second on one port and 1.895 gigabits per second using both 1000 Base-T ports.
- Bi-directional Traffic achieved link rate on the rx6600 reaching 1880 megabits per second on one port and 3.762 gigabits per second using both 1000 Base-T ports.

Request-Response tests were also run to demonstrate the capability of how the adapter handles traffic of this nature. TCP Request-Responses tests were run using a request size of 1-byte and a response size of 1-byte. The aggregate number of transactions that could be sustained with a processor per port running close to saturation was captured. Figure 7 below shows the number of transactions per second.

**Figure 7: AD222A Gigabit Ethernet Request Response Transactions**




Service demand and CPU Utilization are also measured for each throughput test. Table 2 shows the details. Service demand is the amount of time (in microseconds) it takes a CPU to handle one kilobyte of data. It is a normalized measurement because it eliminates disparities due to differences in quantities, types, or frequencies of CPUs. CPU utilization is normalized over 8 CPUs.

**Table 2 Gigabit Ethernet Service Demand**

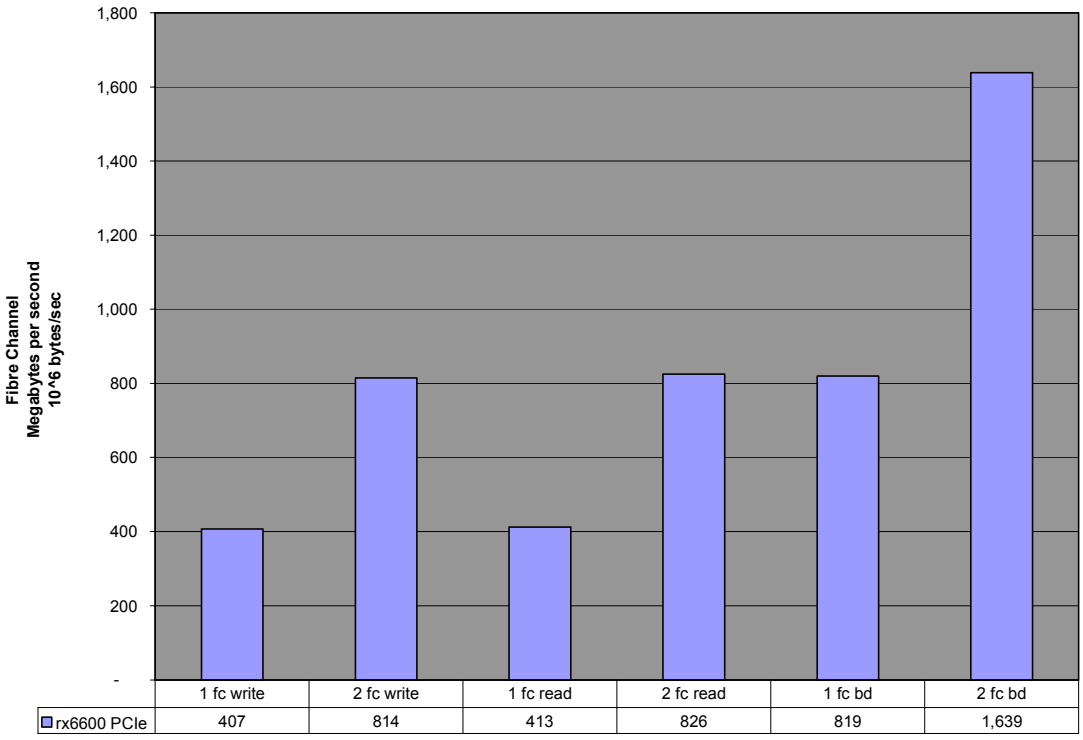
| | 1 Gigabit Ethernet Port | | | 2 Gigabit Ethernet Ports | | |
|---|---|---|---|---|---|---|
| 1500-byte MTUs | Throughput mbit/s | SD usec/KB | CPU Utilization | Throughput mbit/s | SD usec/KB | CPU Utilization |
| Transmit | 948 | 2.098 | 3% | 1,895 | 2.077 | 6% |
| Receive | 948 | 3.333 | 5% | 1,895 | 3.368 | 10% |
| Bi-directional | 1,880 | 2.959 | 8% | 3,762 | 3.017 | 17% |

# Fibre Channel Only Performance

Figure 8 shows the performance results for the 4-Gb Fibre Channel ports using 256KB sequential read, write, and bi-directional disk traffic being run through the card.

The following highlights show the excellent performance achieved during Fibre Channel traffic testing:

**Figure 8: AD222A Fibre Channel Throughput in rx6600**




- Disk write traffic achieved link rate on the rx6600 with one port achieving 407 MB/s and two ports reaching 814 MB/s.
- Disk read traffic achieved link rate on the rx6600 with one port achieving 413 MB/s and two ports reaching 826 MB/s.
- Disk bi-directional traffic achieved link rate on the rx6600 with one port achieving 819 MB/s and two ports reaching 1639 MB/s.

**NOTE:**

* **bd** = Bidirectional Operation (reads and writes simultaneously).

** **MB/s** = 1,000,000 ($10^6$) bytes/second.

† **Theoretical max** = theoretical maximum throughput of a 4-Gb Fibre Channel link. This is slightly greater than 400 MB/s because the 4-Gb FC specification allows for operation up to 4.25 Gb/s.

The above performance data is obtained by installing the AD222A adapter in a PCIe slot of the rx6600 (slot 5 or 6).

IOPS tests were also run to demonstrate the capability of the adapter to handle traffic of this nature. IOPS tests were obtained by using a block size of 1KB.

**Figure 9: AD222 Fibre Channel IOs per Second**

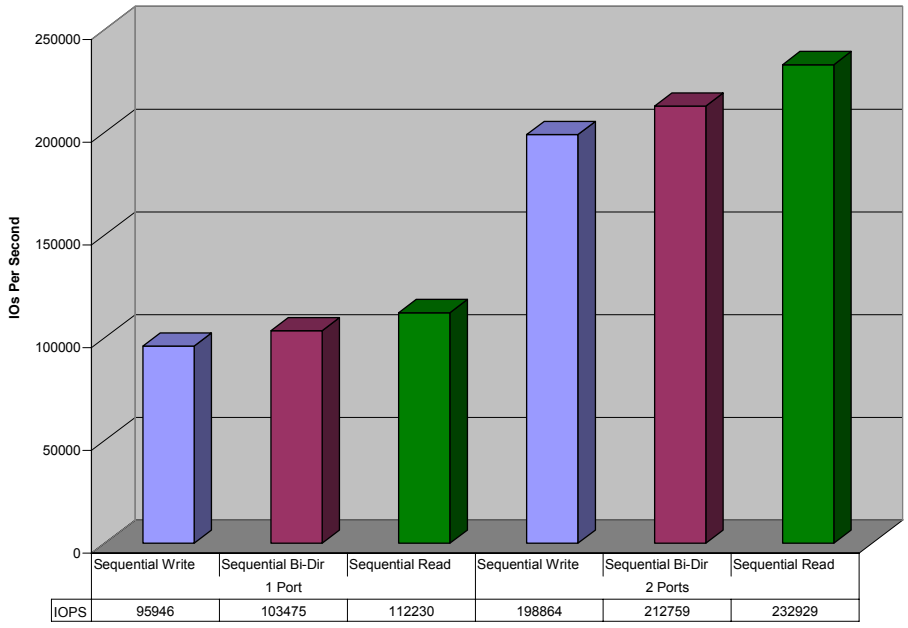



Figure 9 shows the number of I/O transactions per second for sequential read, writes and bi-directional operations on single and dual ports of the AD222A measured on an 8-way rx6600. The X-axis is the number of ports and the Y-axis the number of I/O operations per second.

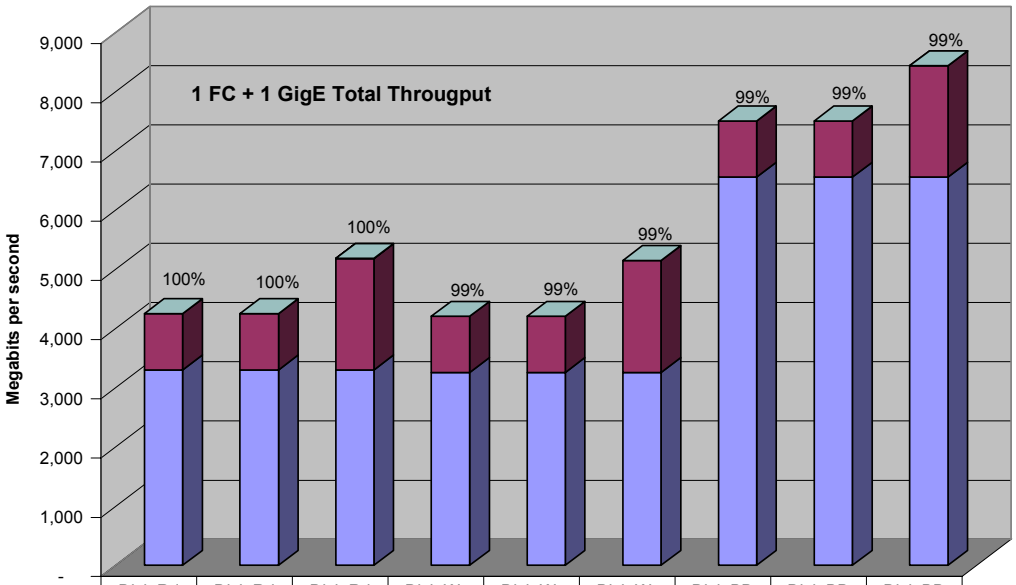
Figure 9 shows excellent linear scaling of IOPS for single and dual ports. The number of read operations per second for single port and dual ports are 112,230 and 232,929 respectively. The number of write operations per second for single port and dual ports are 95,946 and 198,864 respectively. While the number of bi-directional operations per second for single port and dual ports are 103,475 and 212,759 respectively. The IOPS metric is limited by the I/O processing overhead on the AD222A. The chart demonstrates excellent IOPS numbers on both the ports of the AD222A.

# 1 FC Port and 1 GbE Port Combined Traffic Performance

Figure 10 shows the performance results when mixed traffic is run simultaneously through one 4-Gb Fibre Channel port and one Gigabit Ethernet port on the AD222A or AD393A or AD221A card.

The following highlights show the exceptional performance the AD222A achieved during combination traffic testing:

**Figure 10: AD222A Throughput with 1 Fibre Channel and 1 GbE**




| | Disk Rd GigE Xmit | Disk Rd GigE Recv | Disk Rd GigE BD | Disk Wr GigE Xmit | Disk Wr GigE Recv | Disk Wr GigE BD | Disk BD GigE Xmit | Disk BD GigE Recv | Disk BD GigE BD |
|---|---|---|---|---|---|---|---|---|---|
| Link Utilization | 100% | 100% | 100% | 99% | 99% | 99% | 99% | 99% | 99% |
| 1 Port GigE | 948 | 948 | 1,882 | 947 | 947 | 1,890 | 948 | 948 | 1,882 |
| 1 Port FC | 3,302 | 3,302 | 3,302 | 3,257 | 3,257 | 3,257 | 6,556 | 6,556 | 6,556 |

- The first three blue bars show disk read traffic consistently achieved greater than 99% of link rate on the rx6600 system. The active port achieved 405 MB/s or greater of disk read throughput. This was while continuous, full standard-Ethernet-frame traffic was occurring on the active 1000Base-T port.
- The middle three blue bars show disk write traffic achieved greater than 99% of link rate on the rx6600 system. The active FC port achieved 405 MB/s disk write throughput. This was while continuous, full standard-Ethernet-frame traffic was occurring on the active 1000Base-T port.
- The last three blue bars show disk bi-directional traffic achieved greater than 99% of link rate on the rx6600 system. The active FC port achieved 1640 MB/s disk

bidirectional throughput. This was while continuous, full standard-Ethernet-frame traffic was occurring on the active 1000Base-T port.

- The small red bars on each bar show Ethernet traffic achieved link rate on the rx6600 reaching 948 megabits of application data per second for transmit, 947 megabits per second for receive and 1882 bi-directional traffic on the active Gigabit Ethernet port. This was while continuous disk traffic was occurring on the active FC port.

**NOTE:**

*** bd** = Bidirectional Operation (reads and writes simultaneously).

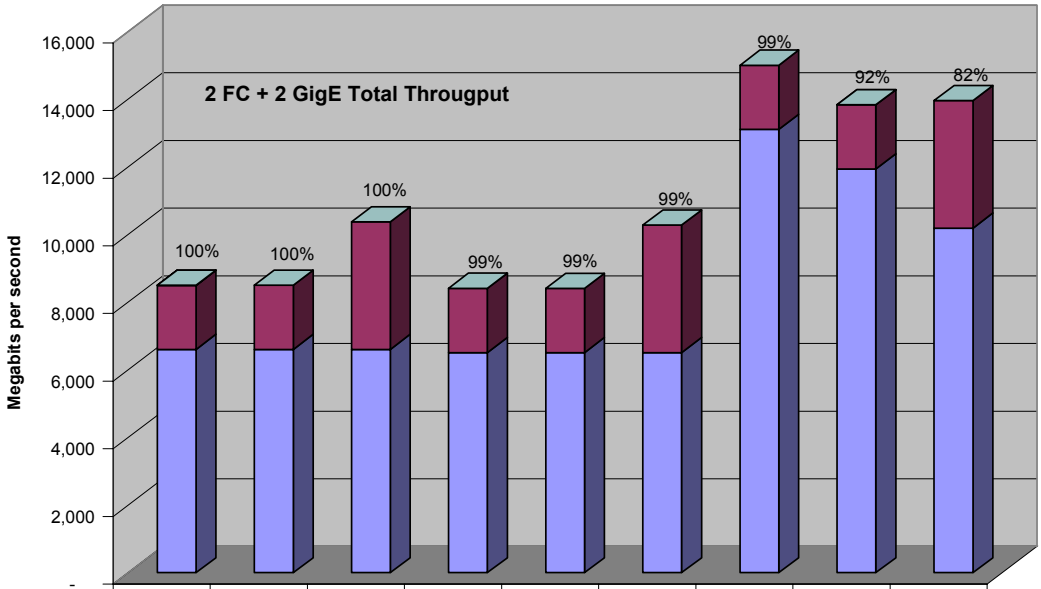
**** MB/s** = 1,000,000 ($10^6$) bytes/second.

# 2 FC Port and 2 GbE Port Combined Traffic Performance

Figure 11 shows the performance results when mixed traffic is run simultaneously through two 4-Gb Fibre Channel ports and two Gigabit Ethernet ports on the AD222A or AD393A card.

The following highlights show the exceptional performance the AD222A achieved during combination traffic testing:

**Figure 11: AD222A Throughput with 1 Fibre Channel and 1 GbE**




| | Disk Rd GigE Xmit | Disk Rd GigE Recv | Disk Rd GigE BD | Disk Wr GigE Xmit | Disk Wr GigE Recv | Disk Wr GigE BD | Disk BD GigE Xmit | Disk BD GigE Recv | Disk BD GigE BD |
|---|---|---|---|---|---|---|---|---|---|
| Link Utilization | 100% | 100% | 100% | 99% | 99% | 99% | 99% | 92% | 82% |
| 2 Port GigE | 1,895 | 1,896 | 3,770 | 1,896 | 1,895 | 3,768 | 1,895 | 1,896 | 3,768 |
| 2 Port FC | 6,604 | 6,604 | 6,604 | 6,513 | 6,513 | 6,513 | 13,111 | 11,941 | 10,191 |

- The first three blue bars show disk read traffic consistently achieved greater than 99% of link rate on the rx6600 system. The active port achieved 820 MB/s or greater of disk read throughput. This was while continuous, full standard-Ethernet-frame traffic was occurring on the active 1000Base-T port.
- The middle three blue bars show disk write traffic achieved greater than 99% of link rate on the rx6600 system. The active FC port achieved 814 MB/s disk write throughput. This was while continuous, full standard-Ethernet-frame traffic was occurring on the active 1000Base-T port.
- The last three blue bars show disk bi-directional traffic achieved greater than 70% of link rate on the rx6600 system. The active FC port achieved 1275 MB/s disk

bidirectional throughput. This was while continuous, full standard-Ethernet-frame traffic was occurring on the active 1000Base-T port.

- The small red bars on each bar show Ethernet traffic achieved link rate on the rx6600 reaching 1895 megabits of application data per second for transmit, 1895 megabits per second for receive and 3768 bi-directional traffic on the active Gigabit Ethernet ports. This was while continuous disk traffic was occurring on the active FC port. .
- The overall link utilization is 82% or greater while continuous Fibre channel and Ethernet traffic was occurring on all the active ports.

**NOTE:**

*** bd** = Bidirectional Operation (reads and writes simultaneously).

**** MB/s** = 1,000,000 ($10^6$) bytes/second.

# How We Measured GbE and Fibre Channel Efficiency

This article highlights the AD222A, AD393A and AD221A throughput. Throughput is the data transfer rate, or data rate – the amount of time it takes data to move from one place to another. In this article, it's shown for one-way signals as well as 2-way. Throughput measures how well programs run with a certain workload and how quickly user requests can be handled.

This article also provides the Service Demand for each throughput test. Service demand is the amount of time (in microseconds) it takes one CPU to handle one kilobyte of data. It is a normalized measurement because it eliminates disparities due to differences in quantities, types, or frequencies of CPUs. Service Demand is an important capacity planning & performance metric that is sometimes considered when comparing different server models.

The performance results shown in this article were measured with the netperf4 benchmarking software. Tests were run with one AD222A card residing in slot 6 in an 8-way HP Integrity rx6600 server. Details of the systems used and the software versions are shown in Table 3. The Gigabit Ethernet transmit, receive, and bidirectional tests were run using netperf4 with a socket size of 128K bytes, a message size of 32K bytes, and a maximum transmission unit (MTU) size of 1500 bytes. The Fibre Channel read, write, and bidirectional tests were run using netperf4 with a block size of 256K bytes.

TCP Request-Responses tests were run using a request size of 1-byte and a response size of 1-byte.

Performance will vary when this product is used on different systems or software.

NOTES:

- The observed performance results are consistent across all of the same type of I/O slots of the system.
- The core I/O card in the rx6600 carried minimal site LAN traffic during performance tests.
- The line rate for GbE is 1.25 Gbit/s, removing the 8b/10b encoding overhead yields 1 Gbit/s un-encoded payload. The line rate for 4-Gb FC is 4.25 Gbit/s, removing the 8b/10b encoding overhead yields 3.4-Gbit/s un-encoded payload. The total full-duplex un-encoded payload is therefore:
  6.8 Gbit/s (FC) +2 Gbit/s (GigE) = 8.8 Gbit/s.

# Test Setup

Table 3 summarizes products used to measure the performance.

**Table 3 Products Used in the Performance Measurement Tests**

| | | |
|---|---|---|
| **Server Tested** |  | HP Integrity rx6600 Server.<br>Four 1.6 GHz Itanium2 CPUs<br>18 MB cache per CPU<br>Operating System - HP-UX 11i version 3.0 of March 2008 (B.11.31.0803). |
| **Card Tested** |  | AD222A HP PCIe 2p 4Gb FC AND 2p 1000BT Adptr<br>• PCIe x8 Gen1<br>• GigE LAN Driver version – IEther-00 B.11.31.0803<br>• Fibre Channel Driver version – Fibre Channel-02 B.11.31.0803 |
| **Clients generating the test load for Gigabit Ethernet** |  | Two rx2600 servers<br>• Two, 1.5 GHz Intel Itanium2 CPUs each<br>• HP-UX 11i version (B.11.23.0303.4)<br>• One A7012A PCI-X 1000Base-T card per rx2600<br>• LAN Driver version – IEther-00 B.11.23.05 |
| **SANBlaze VirtualLUN Fibre Channel Target Emulator with 4 Target Ports** |  | SANBlaze Fibre Channel target emulators. Each Fibre Channel Port of AD222 card is connected with a SANBlaze Emulator through a Fibre Channel switch.<br>• 4 Target Ports<br>• 8 Luns Per Target Port<br>http://www.sanblaze.com/media/pdf/SANBlaze_VirtuaLUN_datasheet.pdf |
| **Benchmark software for Gigabit Ethernet tests** |  | Netperf 2.2pl4 is the benchmarking software suite that generated LAN and disk traffic performance tests. For more information about netperf or to get a free copy, go to<br>http://www.neperf.org |

# Features and Benefits of the AD222A, AD393A and AD221

Features and benefits of the AD222A, AD393A and AD221A include:

- The Gigabit Ethernet ports support virtual LANs (VLANs). A Virtual LAN (VLAN) is a logical or virtual network segment that can span multiple physical network segments. VLANs isolate broadcast and multicast traffic by determining which destinations should receive that traffic, thereby making better use of switch and end-station resources. With VLANs, broadcasts and multicasts go only to the intended nodes in the virtual LAN.
- Supports 16k LUNs on the Fibre Channel ports.
- Auto speed sensing on the Fibre Channel and LAN ports.
- Supports readout of Vital Product Data (VPD) for Fibre Channel and LAN.
- Supports Virtual Partitions (vPars 5.01 or higher) on specified systems. Boot over vPars is supported on the Fibre Channel ports.
- Supports Ignite UX. Ignite-UX (IUX) is an HP-UX administration toolset to help you install and configure (or recover) HP-UX systems.
- Supports HP Serviceguard and Auto-Port Aggregation (APA) for high availability.
- Supports PCIe online addition/replacement (OLA/R) on specified systems.
- Offline and online diagnostic tools available for both Fibre Channel and LAN.
- Excellent Performance.

# For More Information

For more information about the products described in this paper such as a current list of tested HP products or supported systems, please go to:

http://www.hp.com/products1/unixserverconnectivity

This paper is the latest in a series of white papers detailing the performance of HP's link and server products. For a complete list of white papers on HP's networking and I/O products including Gigabit Ethernet and Fibre Channel solutions, go to:

http://docs.hp.com/en/netcom.html

For further assistance including a detailed analysis of your specific requirements and needs, please contact your local HP Sales Representative.

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