

# **Router Tests V.3**

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## Testing the Devices

Just how does one find out  
what is real?

Test Design-1

## PTA

- Performance Testing Alliance
- vendor & user group
- device testing
- adapter testing
- software testing

Test Design-3

## BMWG

Benchmarking Methodology Working Group

- Part of IETF  
Internet Engineering Task Force
- Sanctioned by IAB  
Internet Activities Board
- Addressing:
  - 1 - define terms  
throughput  
latency  
etc
  - 2 - define device classes  
stand alone  
bridges  
routers  
gateways  
host dependent  
network interfaces  
software
  - 3 - define specific tests
  - 4 - define reporting terminology
- Mailing list  
bmwg-request@harvisr.harvard.edu

Test Design-2

## Life on a real world network:

Pathological conditions:

### Peak load

- arp storms
- broadcast storms
- rwho on diskless nodes
- bootp
- tftp booting

### Back-to-back packets

- NFS traffic
- routing updates

Test Design-4

## Life on a real world network:

### "Normal" conditions

- NFS servers
- named
- NNTP
- SMTP
- PC clusters
- FTP
- terminal servers

Test Design-5

## Potential zaps

### Network management

- standards  
SNMP, CMOT
- proprietary

### Documentation

- Fit for human consumption?

### User interface

- How expensive a guru is needed?

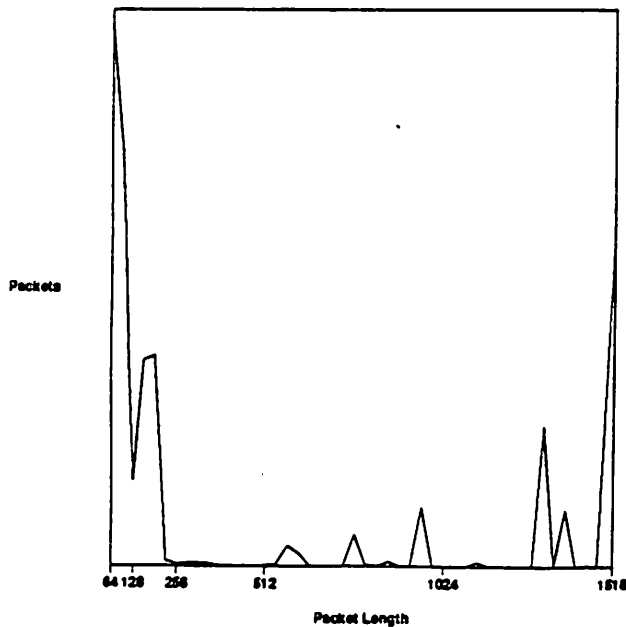
### Reachability

- Can it be managed over the network?
- How easy is it to crash the router so that it requires manual intervention?
- How easy is it to overload the router so that the processor does not respond to commands on the serial line?

Test Design-7

## Life on a real world network:

### Packet length distribution on Harvard subnet



Test Design-6

## Life on a real world network:

### Security

- What access controls on router?
- What sorts of filtering can be done on traffic?
  - On source of traffic
  - On destination of traffic
  - On protocol type?

Test Design-8

## Testing, how to simulate real world

- Can't do a very good job of simulating the "real world"
- Easy to check simple things
  - Idle state
  - Delay through router
  - Effects of various filtering options
  - Accuracy of counters
  - Reaction to error packets
  - Effect of different protocols
- Not too hard to simulate the pathological conditions
  - High offered load
  - Back to back packets
- Much harder to test for table space related limits
  - Routing table size
  - Arp cache size
  - Filtering list space

We put together a setup that would do some of the easy tests, and punted on the harder ones

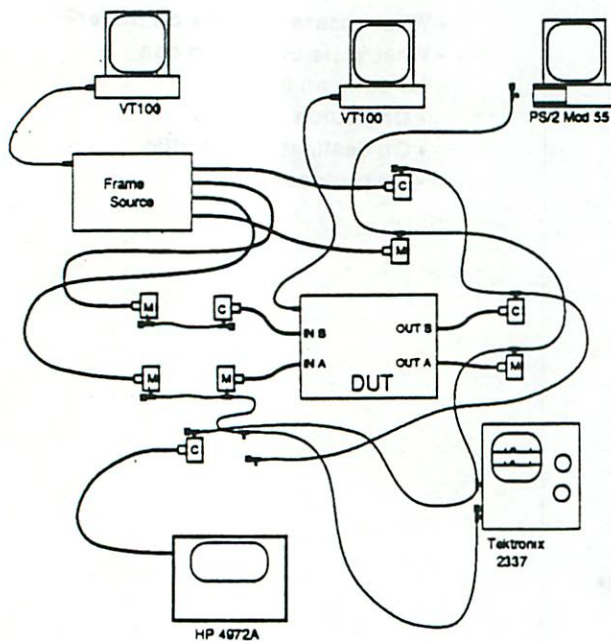
Test Design-9

## Traffic generator

- built by Terry Bradley of Wellfleet Communications
- based on the Wellfleet platform (LN & CN)
- Includes controls for protocol type, packet size, speed (from 1 to 14,500 packets per second), and count (1 to 10,000,000)
- designed to be able to implement some of the BMWG tests

Test Design-11

## Test set up



Test Design-10

## Terry

Terry was one of nine founding engineers at Wellfleet and has contributed to the Architecture of the Bridge/Router, developed the lower layer protocols in the product and was one of the pioneer implementors of SNMP.

Terry is currently managing Wide-Area protocol development and also runs the QA group at Wellfleet.

Prior to Wellfleet, Terry worked for AT&T Bell Labs and Logica UK.

Test Design-12

## Packet source

- Wellfleet router with special software

- command line:

source slot count protocol ifg length

slot:

3 = Source A

4 = Source B

count: number of packets to transmit

protocol: Slot 3

0. AppleTalk Phase 1

1. Novell IPX

2. DECnet 1.1 -> 1.3

3. UDP/IP 192.32.100.1 -> 192.32.200.1

4. Bridgeable Protocol 0900 (UB net debug)

5. AppleTalk Phase 2

protocol: Slot 4

3. UDP/IP 192.32.101.1 -> 192.32.201.1

4. Bridgeable Protocol 0900 (UB net debug)

ifg: wait loop count between frames

length: frame length (w/o CRC)

Test Design-13

## Source data rate

- on Ethernet

size	theor	slot 3	slot 4
64	14880	14489	14549
128	8445	8324	8340
256	4528	4494	4498
512	2349	2340	2341
1024	1197	1195	1195
1518	812	812	812

Test Design-15

## Start command

- separate command to start the frame stream

e 31.slot.4.1 [ 31.slot.4.1 ]

- two data streams will be started if the e command has two arguments

Test Design-14

## Keep Alive source

- many protocols require "keep alive" traffic

- slots 2 & 5 of the modified router can produce "keep alives"

- support for:

ARP

AppleTalk I

AppleTalk II

DECNET

IPX

bridge

Test Design-16

### Device configuration

- device to be tested is configured at the start of the tests
- all of the protocols to be tested are configured
- configuration kept the same until filtering tests
- filters added without changing any other setup
- bridging test configured & run separately

Test Design-17

### Procedure: raw rate

- HP 4972A lan analyzer connected to the router output
- HP analyzer running the `stats` program
- send about 20 sec worth of frames at min 1fg
- reset `stats` after the start of the frame stream
- watch the "10 sec avg" to get the output rate

Test Design-19

### Procedure: delay

- send 2000 frames of IP traffic with a 1fg of "5000"
- using the scope, measure the time between the end of the input frame and the beginning of the output frame

Test Design-18

### Procedure: max rate

- HP 4972A lan analyzer connected to the router output
- HP analyzer running the `stats` program
- reset `stats`
- send 20 to 30 sec worth of frames through device with a specific 1fg
- after all frames have been sent, look at the "total frames" count on the HP.  
  
If received count is less than sent, increase the 1fg and try again  
If received count is the same as sent (+ any keep alives) reduce the 1fg and try again
- the "max rate" is the point at which if the 1fg is reduced by 1 the full count of frames will not get passed
- after getting the 1fg value, reconnect the HP to the packet source and rerun the frame stream.  
  
use the HP "10 sec avg" to determine the "max rate"

Test Design-20

## Procedure: dual stream

- HP 4972A lan analyzer connected to the first of the router outputs
- HP analyzer running the stats program
- set both the slot 3 and slot 4 generators up:  
with a "0" ifg  
using IP  
with the same frame count and size
- start both slot 3 and 4 with a single e command
- reset stats
- use the "10 sec avg" to determine the rate
- reconnect the HP to the other output
- rerun test to get 2nd rate

Test Design-21

## Test Frames

• IP frame  
192.32.100.1->192.32.200.1

```
ip2_frame[60] = (  
0xAA, 0x00, 0x04, 0x00, 0x02, 0x04,  
0xAA, 0x00, 0x04, 0x00, 0x01, 0x04,  
0x08, /* type field hiby */  
0x00, /* type field loby */  
0x45, 0x00, 0x00, 0x1c, 0x00, 0x00, 0x40, 0x00,  
0x0a, 0x11, 0x04, 0x04, 0x00, 0x20, 0x64, 0x01,  
0x00, 0x20, 0x08, 0x01, 0x00, 0x81, 0x00, 0x07,  
0x00, 0x08, 0x52, 0x52, 0x00, 0x00, 0xff, 0x1f,  
0x00, 0x02,  
"DoD IP test"  
);
```

• DECnet frame  
1.1->1.3

```
dn_frame[60] = (  
0xAA, 0x00, 0x04, 0x00, 0x02, 0x04,  
0xAA, 0x00, 0x04, 0x00, 0x01, 0x04,  
0x60, /* type field hiby */  
0x03, /* type field loby */  
0x19, 0x00, 0x81, 0x04, 0x00, 0x00, 0xAA, 0x00,  
0x04, 0x00, 0x03, 0x04, 0x00, 0x00, 0xAA, 0x00,  
0x04, 0x00, 0x01, 0x04, 0x00, 0x00, 0x00, 0x00,  
"WCI, 1989 DECnet test"  
);
```

Test Design-23

## between vs within

- "between interface cards" means  
input on a port on one interface card  
output on a port on a 2nd interface card
- "within interface card" means  
input and output ports are on the same  
interface card
- in dual stream case: "between" means  
2 input ports on one interface card  
2 output ports on 2nd card
- in dual stream case: "within" means  
one input and one port on each of  
two interface cards, data stream kept  
within card

Test Design-22

## Test Frames, contd.

• Novell frame  
0260.08c2.adb0.00050000->0000.000d.0001.00000002

```
ipx_frame[60] = (  
0xAA, 0x00, 0x04, 0x00, 0x02, 0x04,  
0x02, 0x60, 0x8c, 0x2a, 0x0b, 0x0a,  
0x00, /* length field hiby */  
0x26, /* length field loby */  
/* no ssap dsap ctrl */  
/* start IPX PDU ... */  
0xff, 0xff, /* milled checksum */  
0x00, 0x26, /* length */  
0x00, 0x11, /* ? */  
0x00, 0x0d, 0x00, 0x01, /* IPX dest */  
0x00, 0x00, 0x00, 0x00,  
0x00, 0x02, 0x40, 0x03,  
0x00, 0x03, 0x00, 0x00, /* IPX src */  
0x02, 0x60, 0x8c, 0x2a, 0x0b, 0x0a, /* MAC src */  
0x04, 0x51, 0x33, 0x33, 0x52, 0x02, 0x00, 0x00,  
0x00, 0x00, 0x59, 0x33, 0x3a, 0x4a, 0x55, 0x4e,  
0x4b, 0x77  
);
```

Test Design-24

## Test Frames, contd.

### • AppleTalk II frame 5.65->107.3

```
apt2_frame[60] = (  
0xAA, 0x00, 0x04, 0x00, 0x02, 0x04,  
0x02, 0x60, 0x8C, 0x01, 0x82, 0x59,  
0x00, /* length field hi by */  
0x23, /* length field lo by */  
0xAA, 0xAA, /* ssap dsap ctrl */  
0x03,  
0x08, 0x00, 0x07, /* snap */  
0x80, 0x9B,  
0x04, 0x1B, 0x00, 0x00, 0x00, /* start APT PDU..*/  
0x6B, 0x00, 0x05, 0x03, 0x06, 0xFF, 0xFC, 0x03,  
0x60, 0x01, 0x02, 0x66, 0x02, 0x00, 0x00, 0x0F,  
0x11, 0x00, 0xFF, 0xFF, 0x00, 0x48, 0x00, 0x00,  
0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00,  
0x00  
);
```

### • bridge test frame 0000.3333.3333->aa00.0333.3333

```
lb2_frame[60] = (  
0xAA, 0x00, 0x03, 0x33, 0x33, 0x33,  
0x00, 0x00, 0xA3, 0x33, 0x33, 0x33,  
0x09, /* type field hi by */  
0x00, /* type field lo by */  
"Wellfleet Communications, 1990 LB test Slt=3"  
);
```

Test Design-25

## Keep Alive Frames, contd.

### • IPX keepalive frame

```
ipx_keepalive_frame[78] = (  
0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF,  
0xAA, 0x00, 0x04, 0x00, 0x04, 0x04,  
0x00, /* length field hi by */  
0x40, /* length field lo by */  
/* no ssap dsap ctrl */  
/* start IPX PDU ... */  
0xFF, 0xFF, /* null'd checksum */  
0x00, 0x40, /* length */  
0x00, 0x01, /* ? */  
0x00, 0x06, 0x00, 0x00, /* IPX dest */  
0xFF, 0xFF, 0xFF, 0xFF,  
0xFF, 0xFF, 0x04, 0x53,  
0x00, 0x06, 0x00, 0x00, /* IPX src */  
0xAA, 0x00, 0x04, 0x00, 0x04, 0x04, /* MAC src */  
0x04, 0x53, 0x00, 0x02, 0x00, 0x01, 0x00, 0x00,  
0x00, 0x01, 0x00, 0x01, 0x00, 0x02, 0x00, 0x00,  
0x00, 0x01, 0x00, 0x01, 0x00, 0x08, 0x00, 0x00,  
0x00, 0x02, 0x00, 0x03,  
0x00, 0x0D, 0x00, 0x01, /* IPX node address */  
0x00, 0x02, 0x00, 0x03  
);
```

Test Design-27

## Keep Alive frames

### • arp frame

```
arpl_frame[60] = (  
0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF,  
0xAA, 0x00, 0x04, 0x00, 0x03, 0x04,  
0x08, /* type field hi */  
0x06, /* type field lo */  
0x00, 0x01, /* media */  
0x08, 0x00, /* proto id */  
0x06, /* hw adr len */  
0x04, /* proto adr len */  
0x00, 0x02, /* opcode req/res */  
0xAA, 0x00, 0x04, 0x00, 0x03, 0x04, /* phantom's MAC */  
0xC0, 0x20, 0xC8, 0x01, /* phantom's IP */  
0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, /* router's MAC */  
0xC0, 0x20, 0xC8, 0x02, /* router's IP */  
"200.1's ARP frame"  
);
```

### • DECNET hello frame

```
dn_hello_frame[60] = (  
0xAB, 0x00, 0x00, 0x03, 0x00, 0x00,  
0xAA, 0x00, 0x04, 0x00, 0x03, 0x04,  
0x60, /* type field hi by */  
0x03, /* type field lo by */  
0x22, 0x00, 0x0D, 0x02, 0x00, 0x00,  
0xAA, 0x00, 0x04, 0x00, 0x03, 0x04,  
0x03, 0xDA, 0x05, 0x01, 0x00, 0x00,  
0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0xAA, 0x00,  
0x04, 0x00, 0x02, 0x04, 0xFF, 0x1F, 0xFF, 0x02,  
0xAA, 0xAA, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00,  
0x00, 0x00, 0x00, 0x00  
);
```

Test Design-26

## Keep Alive Frames, contd.

### • AppleTalk II AARP response frame

```
aarp_frame[64] = (  
0x09, 0x00, 0x07, 0xFF, 0xFF, 0xFF,  
0xAA, 0x00, 0x04, 0x00, 0x03, 0x04,  
0x00, /* length field hi by */  
0x24, /* length field lo by */  
0xAA, 0xAA, /* ssap dsap ctrl */  
0x03,  
0x00, 0x00, 0x00, /* snap */  
0x80, 0xF3,  
0x00, 0x01, /* hw type */  
0x80, 0x9B, /* proto */  
0x06, /* MAC len */  
0x04, /* proto len */  
0x00, 0x02, /* response */  
0xAA, 0x00, 0x04, 0x00, 0x03, 0x04, /* phantom's MAC */  
0x00, 0x00, 0x6B, 0x03, /* 107.3 phantom's ATP */  
0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, /* router's MAC */  
0x00, 0x00, 0x6B, 0xFD, /* 107.253 router's ATP */  
0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00, 0x00,  
0x00, 0x00, 0x00, 0x00, 0x00, 0x00  
);
```

### • bridge learning frame

```
learn2_frame[60] = (  
0x00, 0x00, 0xA3, 0x33, 0x33, 0x33,  
0xAA, 0x00, 0x03, 0x33, 0x33, 0x33,  
0x07, /* type field hi by */  
0x00, /* type field lo by */  
"Wellfleet Communications, 1990 LB learn Slt=2"  
);
```

Test Design-28



## Test Results: Routers

How fast is fast?

## oops

- this round is of Ethernet to Ethernet local routers
- announcement sent on comp.protocols.tcp-ip
- some vendors missed
- a number of requests for ka9q & pcroute ran out of time

## Thanks

- Wellfleet Communications, Inc.  
test equipment & software
- Terry Bradley of Wellfleet  
software
- Scott Baker of Proteon  
much help in debugging procedures
- Dan Lanciani  
original test software  
future test hardware & software
- BMWG  
test design
- Cheryl Chapman  
tired fingers

## Devices: 3com NETBuilder

- vendor  
3Com Corporation  
5400 Bayfront Plaza, P.O. Box 58145  
Santa Clara, CA 95052-8145  
1-800-NET-3Com
- device tested  
NETBuilder Brouter - BR/2000
- transport protocols supported  
TCP/IP, OSI - CLNP, XNS
- interconnect protocols supported
- bridge mode supported?  
Yes
- routing protocols supported  
RIP, EGP, RIP-XNS
- interface types supported  
serial from 9.6KB to 6MB  
Ethernet, 802.3, SNAP
- management protocols supported  
SNMP agent, CMOT agent, TELNET server  
"remote" facility (UDP datagram access  
to the user interface.)

**Devices: BBN Communications T/20**

- vendor  
BBN Communications  
US Corporate Headquarters  
150 CambridgePark Drive  
Cambridge, MA, 02140  
(617) 873-3268  
FAX (617) 354-1349
- device tested  
T/20 Internet Router
- transport protocols supported  
TCP/IP
- interconnect protocols supported  
DDN X.25, Blacker X.25, PPP,  
BBN-Trunk, HDLC pass-through
- bridge mode supported  
no
- routing protocols supported  
EGP, BBN-SPF
- interface types supported  
serial from 600B - 10Mb  
Ethernet/IEEE 802.3, 4MB Token Ring,  
16MB Token Ring
- management protocols supported  
SNMP agent, HMP agent/poller, TELNET

**Device: Network Systems Corp. EN640-8**

- vendor  
Network Systems Corporation  
7600 Boone Av. North  
Minnapious MN 55428  
612-424-4888
- device tested  
EN642-8
- transport protocols supported  
TCP/IP, DECnet Phase IV, OSI (CLNP)  
AppleTalk II
- interconnect protocols supported  
HDLC
- bridge mode supported  
no
- routing protocols supported  
RIP, EGP
- interface types supported  
serial from 9.6KB to 45MB  
Ethernet, 802.3, fddi, mainframe  
computer channels (IBM, Cray, Univac,  
Honeywell...) computer bus (BI, VME, HPIB,  
multibus...)
- management protocols supported  
SNMP client, TELNET

**Devices: cisco AGS+**

- vendor  
cisco Systems, Inc.  
1525 O'Brien Rd.  
Menlo Park, CA 94025  
1-800-553-NETS
- device tested  
AGS+
- transport protocols supported  
TCP/IP, DECnet Phase IV, Phase V,  
Novell IPX, XNS, OSI (CLNP), AppleTalk I,  
AppleTalk II, Apollo Domain, Banyon Vines
- interconnect protocols supported  
HDLC framing, LAPB, X.25, PPP
- bridge mode supported  
YES
- routing protocols supported  
RIP, EGP, IGRP
- interface types supported  
serial from 9.6KB to 4MB  
Ethernet, 802.3, 4MB Token Ring, FDDI
- management protocols supported  
SNMP client, TELNET

**Device: Novell NetWare 386 - TCP/IP**

- vendor  
Novell, Inc.  
2180 Fortune Drive  
San Jose, CA 95131  
1-408-473-8375
- device tested  
NetWare 386 TCP/IP Beta release software  
on an AST 486/25E PC  
with two Novell NE3200 EISA Ethernet interface boards
- transport protocols supported  
TCP/IP, IPX, OSI (CLNP),  
AppleTalk I, AppleTalk II
- interconnect protocols supported
- bridge mode supported  
no
- routing protocols supported  
rip
- interface types supported  
Ethernet, 802.3, 4MB Token Ring,  
16MB Token Ring, ARCnet, 10 Base T
- management protocols supported  
SNMP client, SNMP server

### Devices: Proteon P4200

- vendor  
Proteon, Inc.  
Two Technology Drive  
Westboro, MA 01581  
(508) 898-2800 ext. 2330
- device tested  
p4200 Multi-protocol Internetworking Router
- transport protocols supported  
TCP/IP, IPX, DECnet Phase IV, OSI,  
AppleTalk I, XNS, Apollo Domain
- Interconnect protocols supported  
X.25, IEEE 802.6
- Bridge mode supported  
No
- Routing protocols supported  
RIP, OSPF, EGP
- Interface types supported  
serial from 9.6KB to 2.048MB  
Ethernet, 802.3, 4Mb Token-Ring, FDDI
- Management protocols supported  
SNMP client, SNMP server, TELNET

### Device: Timeplex TIME/LAN 100

- vendor  
Timeplex  
400 Chestnut Ridge Rd.  
Woodcliffe Lake, NJ 07675  
201-930-4600
- device tested  
TIME/LAN 100 Router
- transport protocols supported  
TCP/IP
- Interconnect protocols supported  
X.25
- bridge mode supported  
no
- routing protocols supported  
GGP, RIP, EGP
- interface types supported  
serial from 9.6KB to 1.6MB,  
Ethernet, 802.3, FDDI
- management protocols supported  
SNMP agent

### Device: Proteon XP 20000

- vendor  
Proteon, Inc.  
Two Technology Drive  
Westboro, MA 01581  
(508) 898-2800 ext. 2330
- device tested  
XP 20000 Multi-protocol Internetworking Router
- Transport protocols supported  
TCP/IP, DECnet, IPX, OSI, XNS,  
DECnet Phase IV & V, AppleTalk I & II
- Interconnect protocols supported  
X.25, Frame Relay
- Bridge mode supported  
Yes; spanning-tree, source-routing
- Routing protocols supported  
RIP, OSPF, EGP, IS-IS
- Interface types supported  
serial from 9.6KB to 2048MB, Ethernet, 802.3,  
4Mb Token-Ring, 16Mb Token-Ring, FDDI
- Management protocols supported  
SNMP client, SNMP server, TELNET

### Device: Wellfleet Link Node

- vendor  
Wellfleet Communications Inc  
15 Crosby Drive,  
Bedford, MA 01730  
617-275-2400
- device tested  
Link Node Communications Server
- network protocols supported  
TCP/IP, DECnet, XNS, Novell IPX, AppleTalk II
- Interconnect protocols supported  
X.25, Frame Relay, LLC1 point to point,  
LLC2 point to point
- bridge mode supported?  
Yes
- routing protocols supported  
Extended RIP, EGP, OSPF
- Interfaces supported  
serial from 9.6KB to 6MB,  
Ethernet, 802.3, 4 MB Token Ring,  
16 MB Token Ring, FDDI, 10BaseT
- management protocols supported  
TELNET, SNMP Client,  
SNMP server, EMA

## Perspective

- 6 M frame per second router on a 9.6KB link not all that useful
- theoretical frame rates for link speeds  
64 octet frames  
"ideal" serial links, i.e. no MAC address rounded up

link speed	fps
2.4KB	5
9.6KB	19
56KB	110
64KB	125
.5T1	1508
T1	3016
Ethernet	14,880
T3	>85,000
FDDI	>175,000

## Throughput

- getting faster  
3 "wire speed" routers  
(for some frame sizes)  
  
impressive performance from PC
- cluster of mid range devices  
much like new bridges  
~6K FPS

## Delay

- in all but one case  
max delay < 1ms  
variability < .5ms
- one case  
even distribution from .2 to 10ms  
looks like software loop

## protocols

- good range of protocols supported
- most devices were a bit slower in non-ip case
- bridge mode quite good  
less need to use two devices

## Multi stream

- hard to do good multi-stream test, hard to see actual peak rates

### Proteon XP 20000

combined rate of about 16K FPS  
with full speed input

about 20K if inputs slowed to ~10K FPS each

- may be useful, better test needed

## ests

- fastest: (alpha order)  
BBN, cisco, Wellfleet
- best pkg:  
3com
- most like a mainframe:  
NSC
- most surprising:  
Novell
- ruggest (& most compact):  
Timeplex
- most promising development:  
Proteon XP 20000

## Back to back

- good test of queue size
- software bug in tester prevented testing

## Software versions

- versions of system software used in the tests

3com

1.1

BBN

1.0

cisco

8.20

Novell

1β3

NSC

(oops)

Proteon

p4200 - 9.1x

XP 20000 - 9.1x

Timeplex

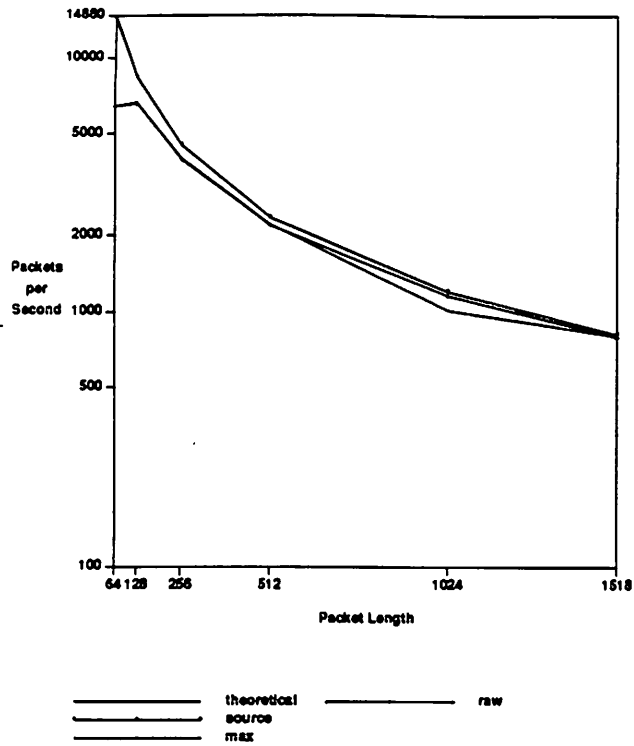
1.X7

Wellfleet

5.40

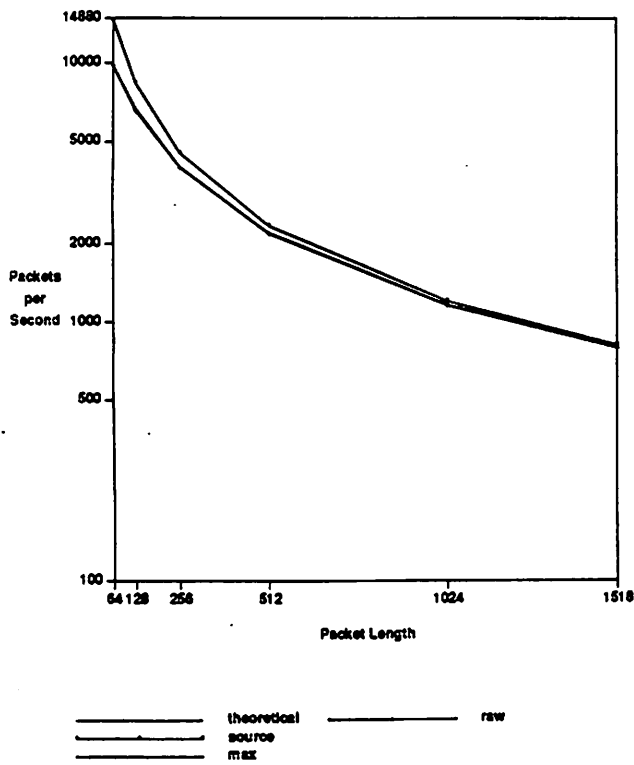
**Performance:**

**3com NETBuilder - TCP/IP**  
configuration: within interface card



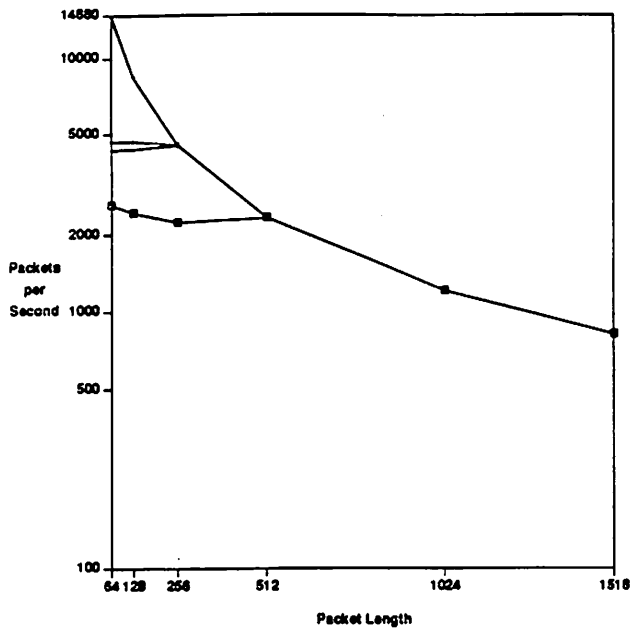
**Performance:**

**3com NETBuilder - Bridge Mode**  
configuration: within interface card



**Performance:**

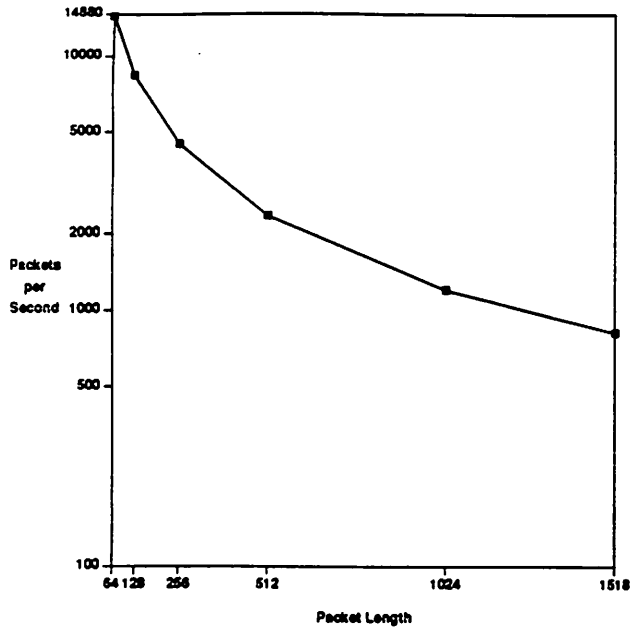
**BBN T20 - TCP/IP**  
configuration: within interface card



theoretical      raw  
source            filter 1  
max                filter 10

**Performance:**

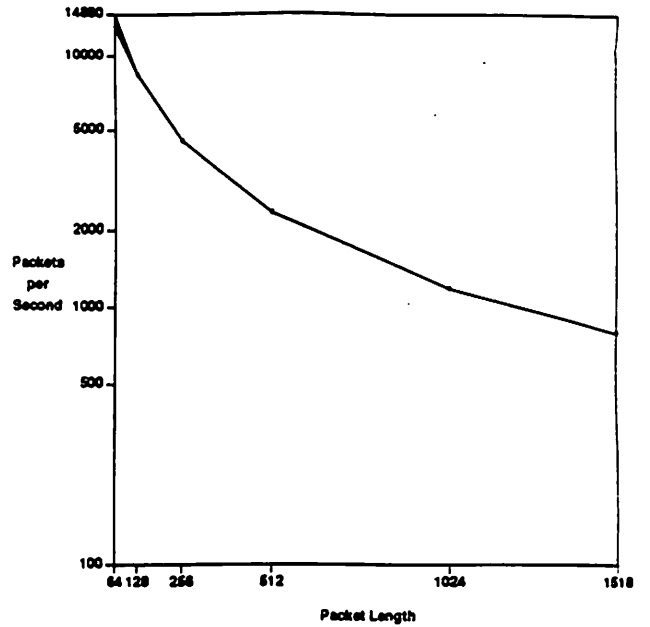
**cisco AGS+ - TCP/IP**  
configuration: between interface cards



theoretical source max raw filter 1 filter 10

**Performance:**

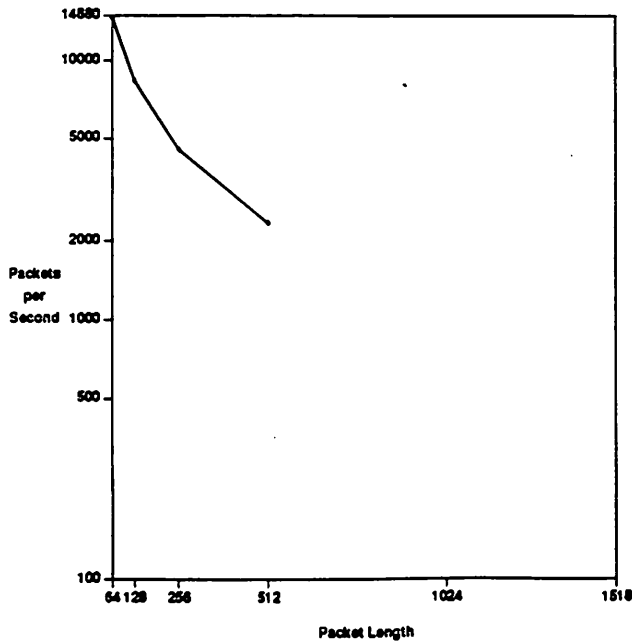
**cisco AGS+ - DECNET**  
configuration: between interface cards



theoretical source max raw

**Performance:**

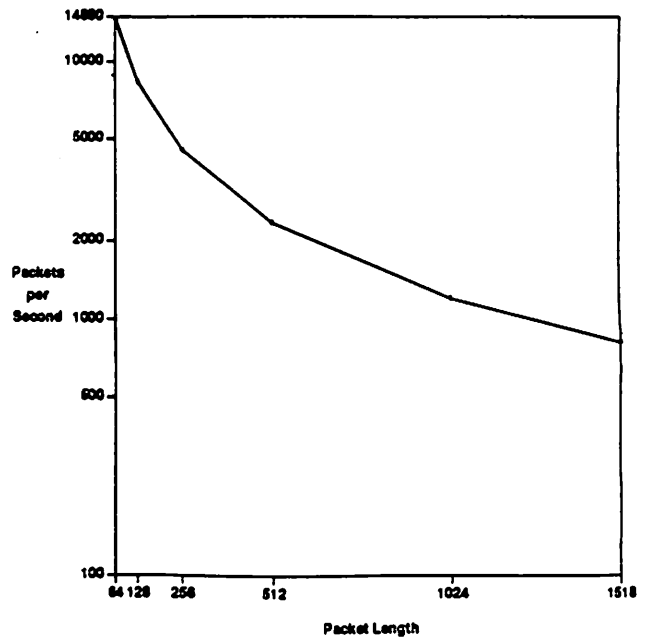
**cisco AGS+ - AppleTalk II**  
configuration: between interface cards



theoretical source max raw

**Performance:**

**cisco AGS+ - IPX**  
configuration: between interface cards

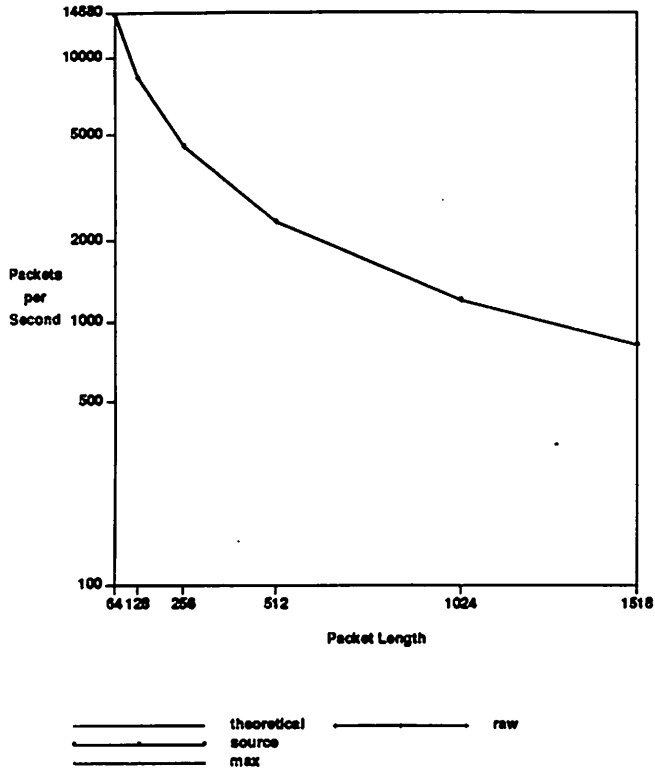


theoretical source max raw



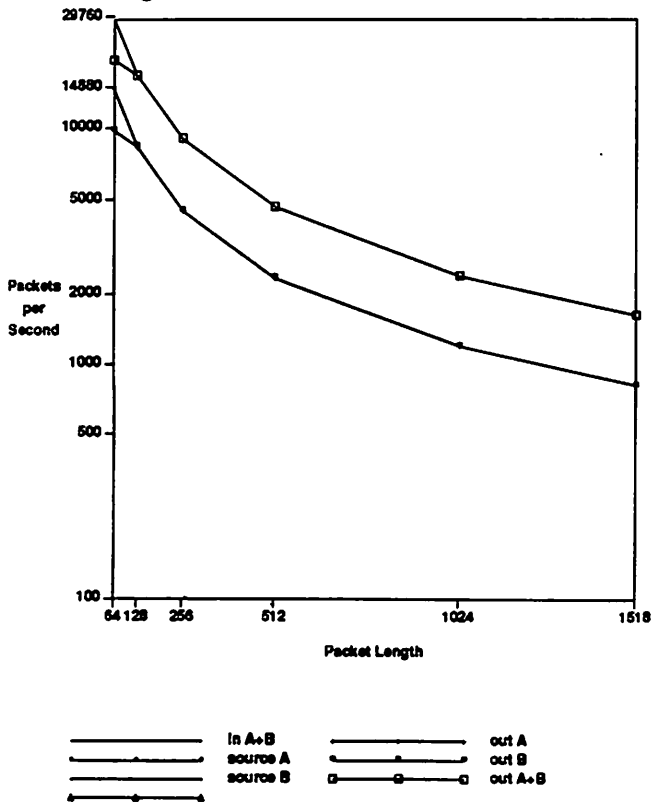
**Performance:**

**cisco AGS+ - Bridge Mode**  
**configuration: between interface cards**



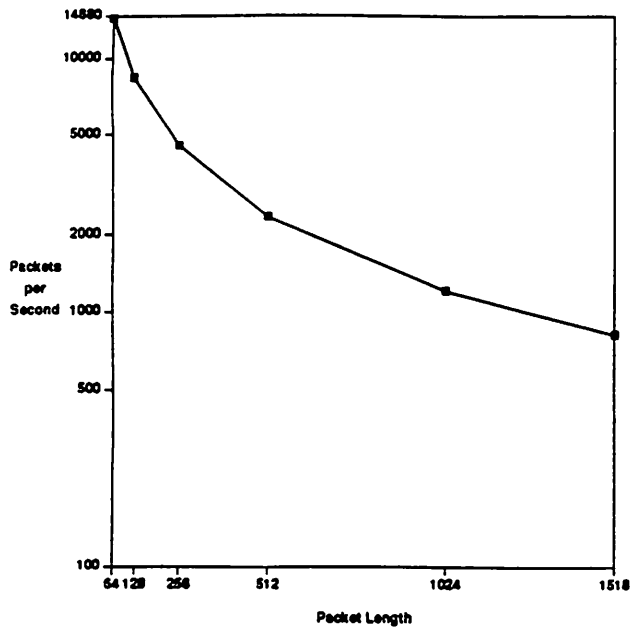
**Performance:**

**cisco AGS+ - Dual IP Streams**  
**configuration: between interface cards**



**Performance:**

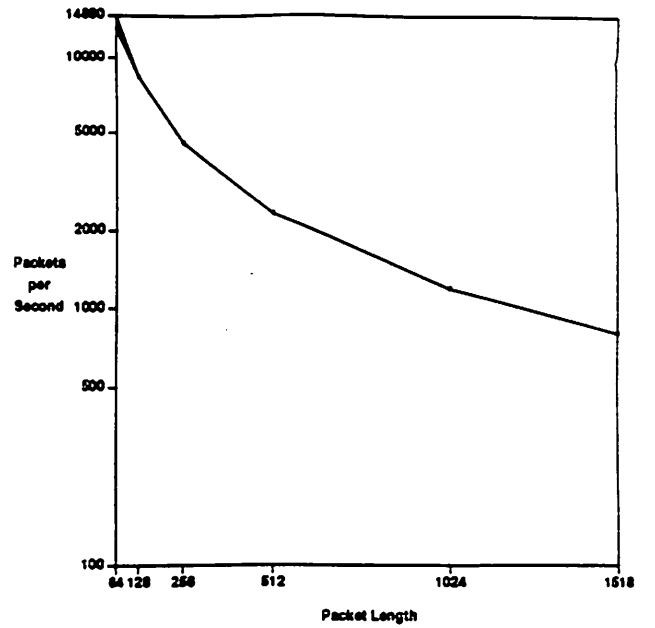
**cisco AGS+ - TCP/IP**  
configuration: within interface card



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ raw  
 filter 1  
 filter 10

**Performance:**

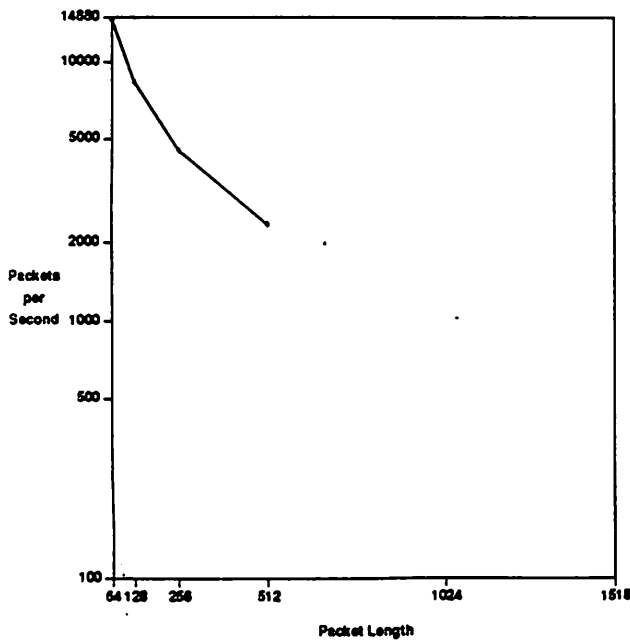
**cisco AGS+ - DECNET**  
configuration: within interface card



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ raw

**Performance:**

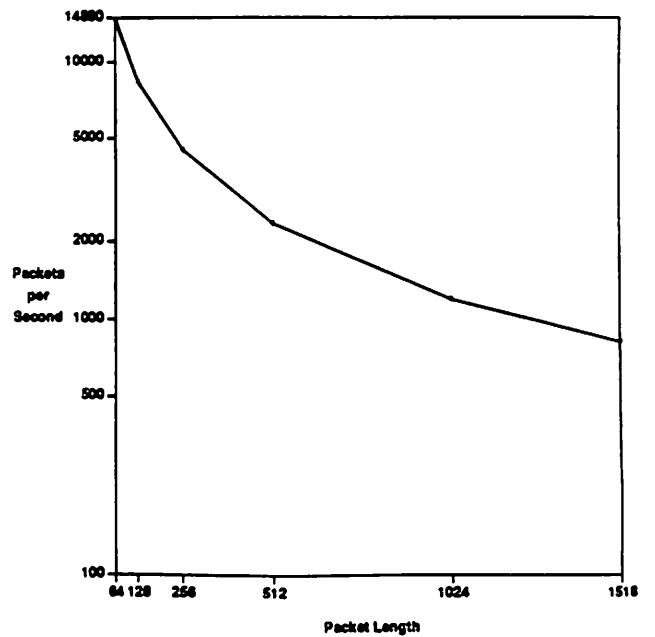
**cisco AGS+ - AppleTalk II**  
configuration: within interface card



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ raw

**Performance:**

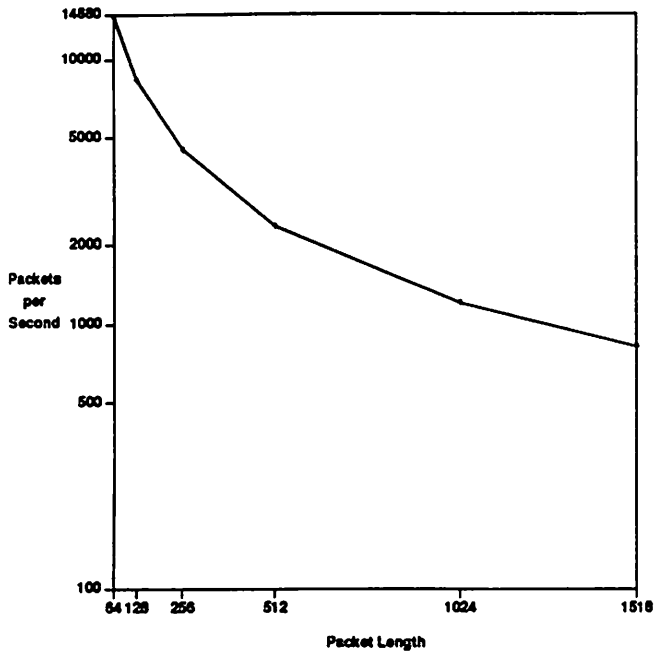
**cisco AGS+ - IPX**  
configuration: within interface card



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ raw

**Performance:**

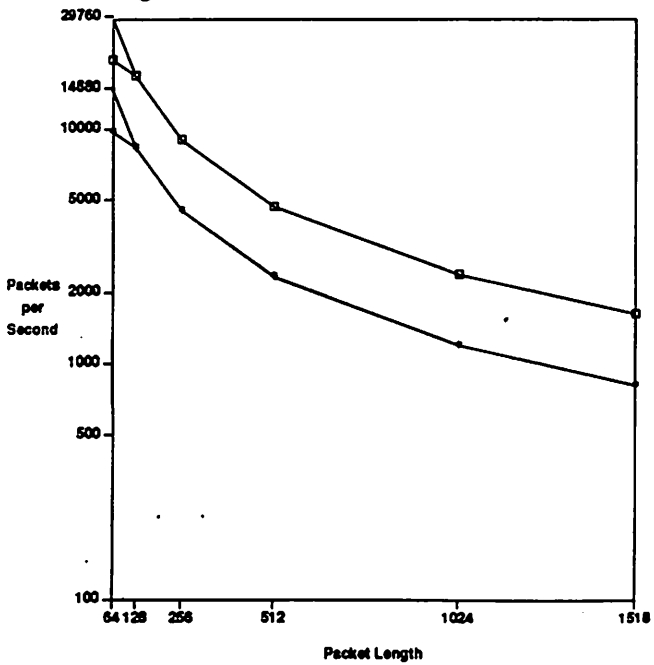
**cisco AGS+ - Bridge Mode**  
**configuration: within interface card**



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ raw

**Performance:**

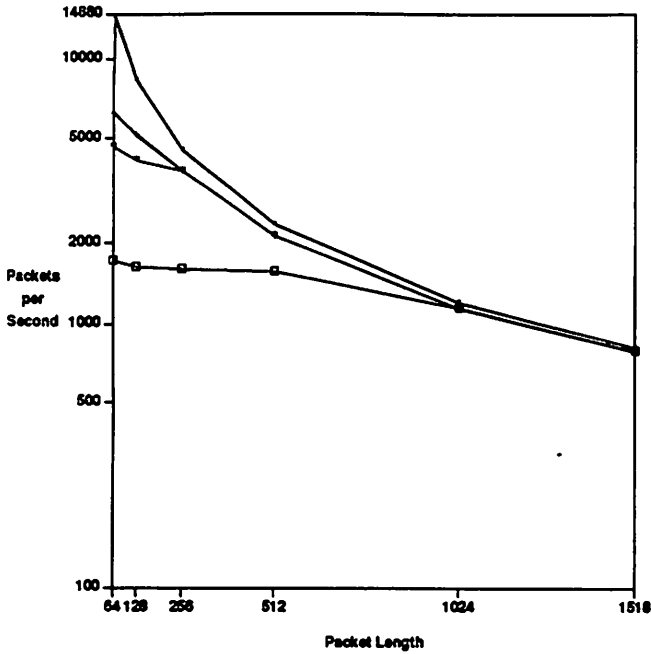
**cisco AGS+ - Dual IP Streams**  
**configuration: within interface card**



\_\_\_\_\_ in A+B  
 \_\_\_\_\_ source A  
 \_\_\_\_\_ source B  
 \_\_\_\_\_ out A  
 \_\_\_\_\_ out B  
 \_\_\_\_\_ out A+B

**Performance:**

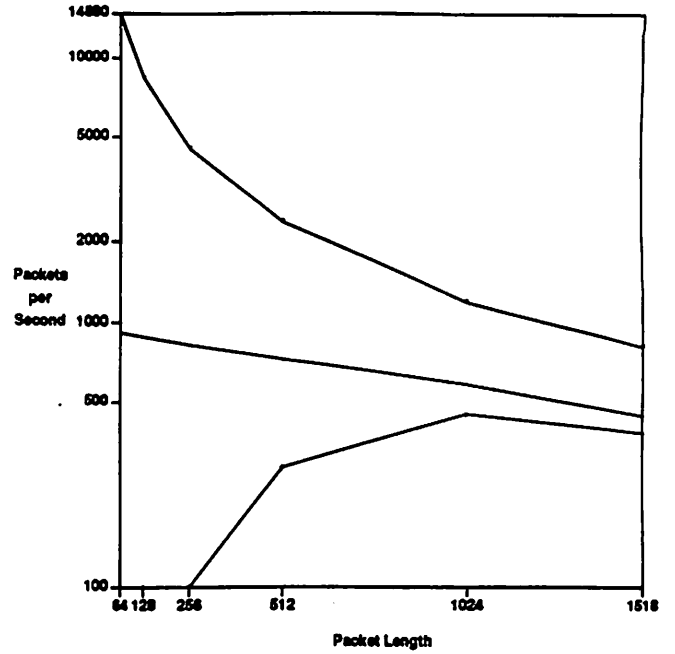
**Network Systems Corporation EN640-8 - TCP/IP configuration: between interface cards**



— theoretical  
 — source  
 — max  
 — filter 10

**Performance:**

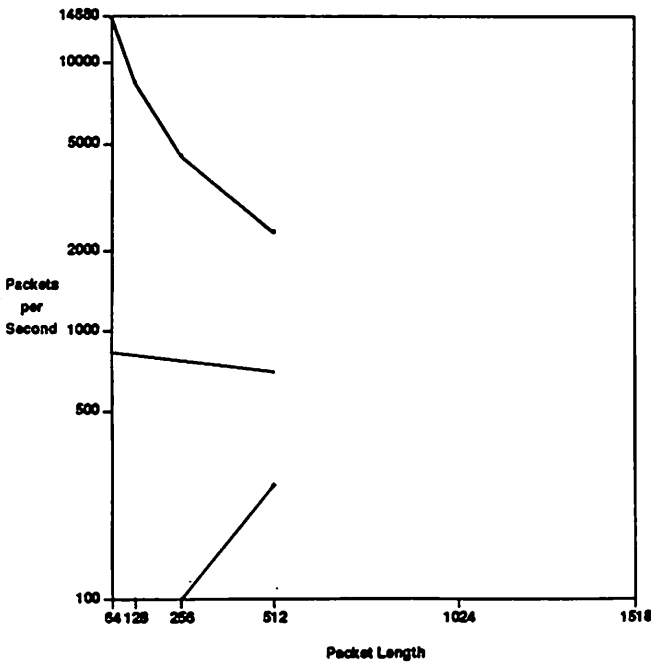
**Network Systems Corporation EN640-8 - DECNET configuration: between interface cards**



— theoretical  
 — source  
 — max  
 — raw

**Performance:**

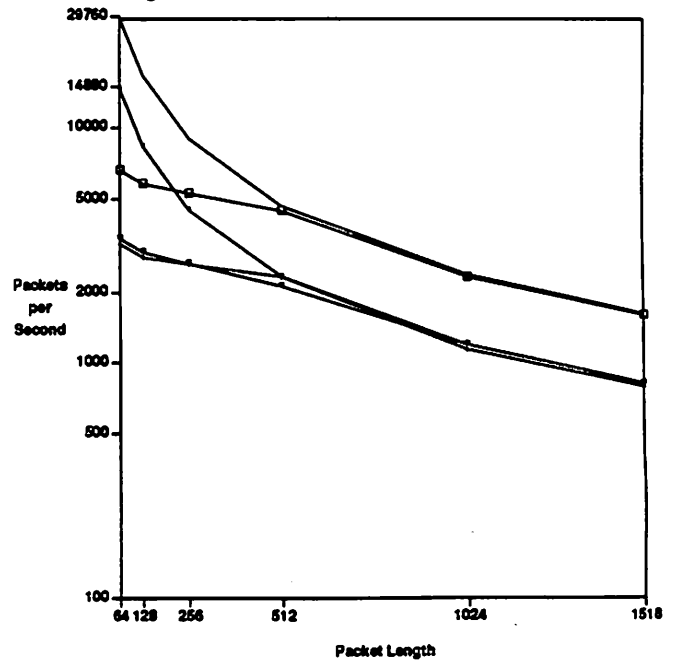
**Network Systems Corporation EN640-8 - AppleTalk II configuration: between interface cards**



— theoretical  
 — source  
 — max  
 — raw

**Performance:**

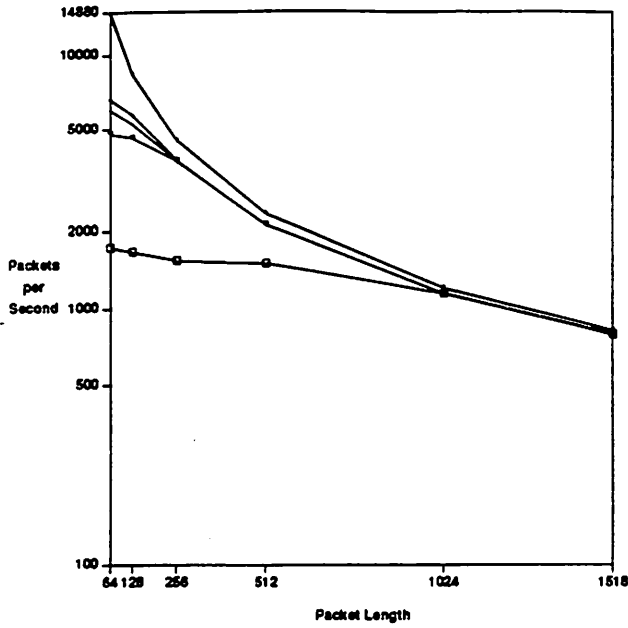
**Network Systems Corporation EN640-8 - Dual IP Stream configuration: between interface cards**



— in A+B  
 — source A  
 — source B  
 — out A  
 — out B  
 — out A+B

**Performance:**

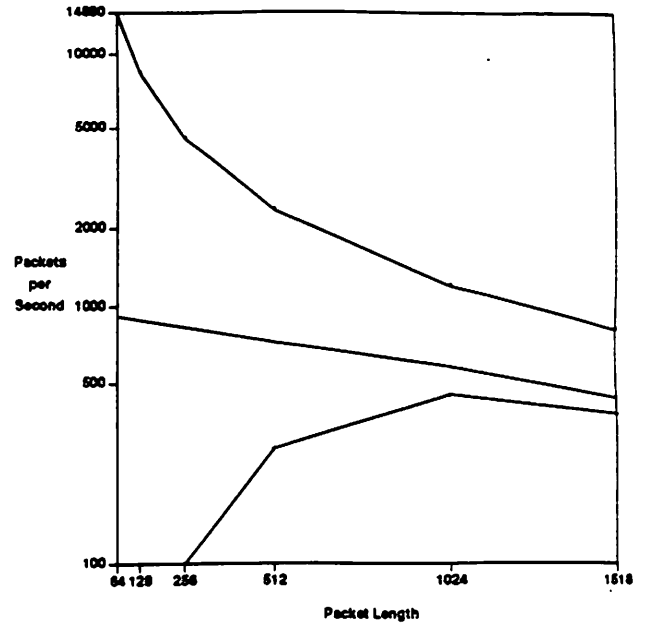
**Network Systems Corporation EN640-8 - TCP/IP  
configuration: within interface card**



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ filter 1  
 ○ ○ ○ filter 10

**Performance:**

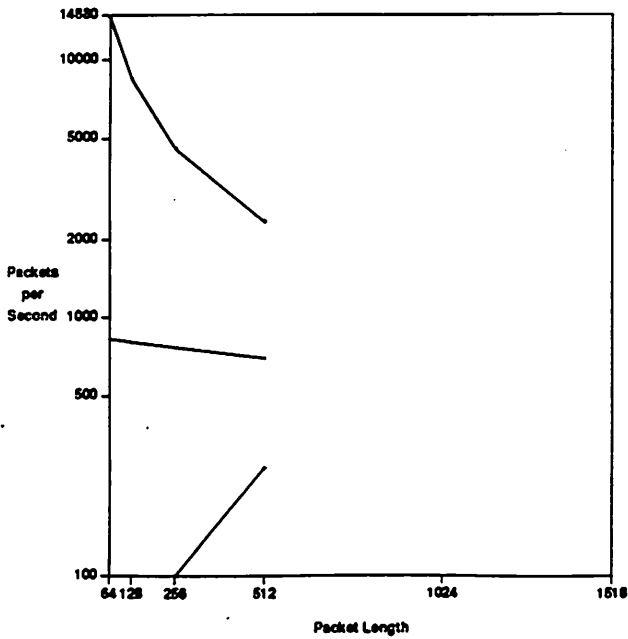
**Network Systems Corporation EN640-8 - DECNET  
configuration: within interface card**



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ raw

**Performance:**

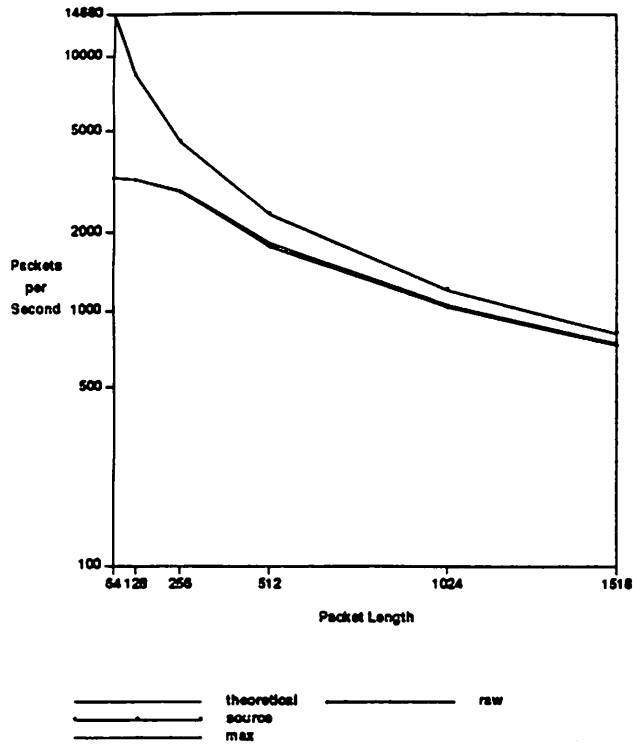
**Network Systems Corporation EN640-8 - AppleTalk II  
configuration: within interface card**



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ raw

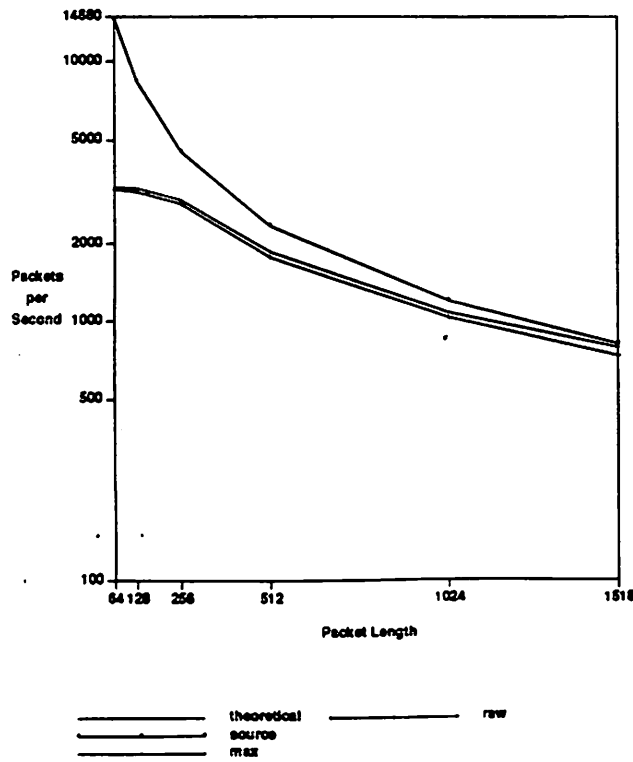
**Performance:**

**Novell NetWare 386 - TCP/IP**  
configuration: between interface cards



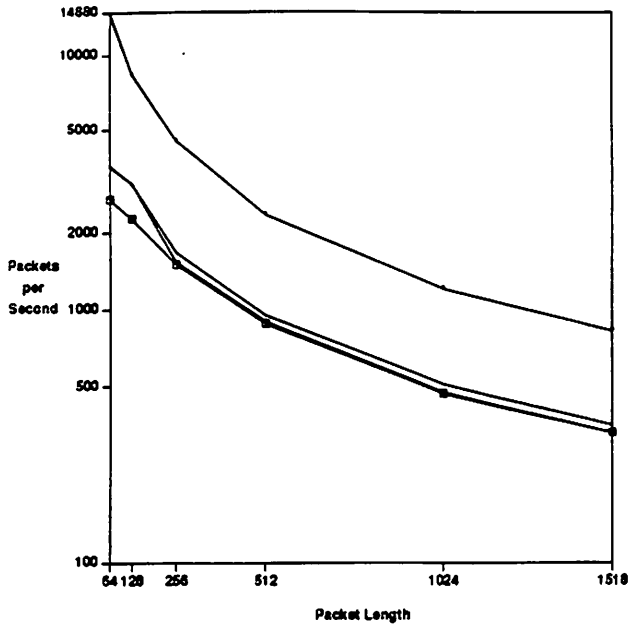
**Performance:**

**Novell NetWare 386 - IPX**  
configuration: between interface cards



**Performance:**

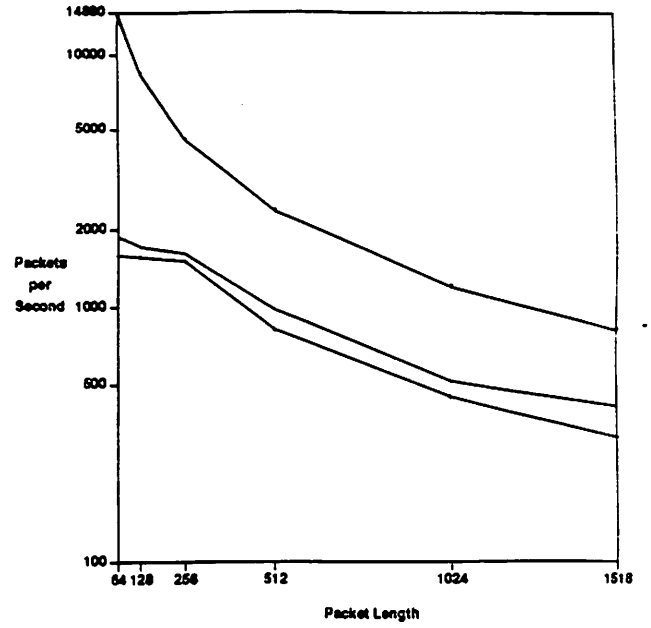
**Proteon P4200 - TCP/IP**  
configuration: between interface cards



— theoretical      — raw  
 — source            — filer 1  
 — max                — filer 10

**Performance:**

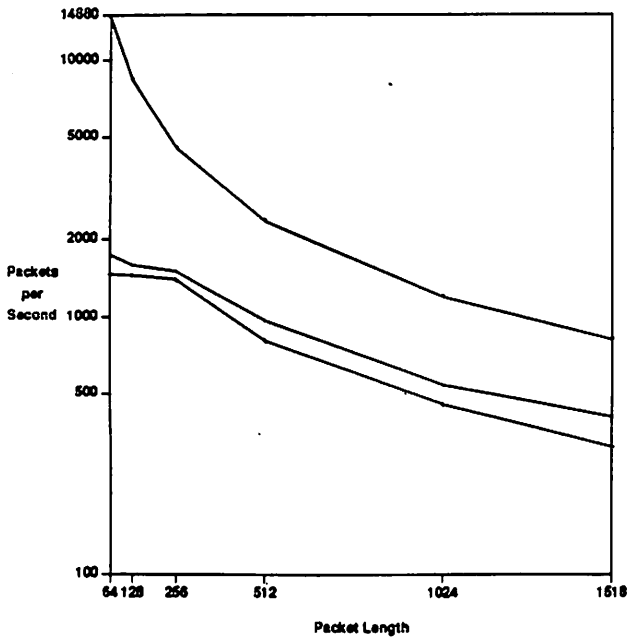
**Proteon P4200 - IPX**  
configuration: between interface cards



— theoretical      — raw  
 — source  
 — max

**Performance:**

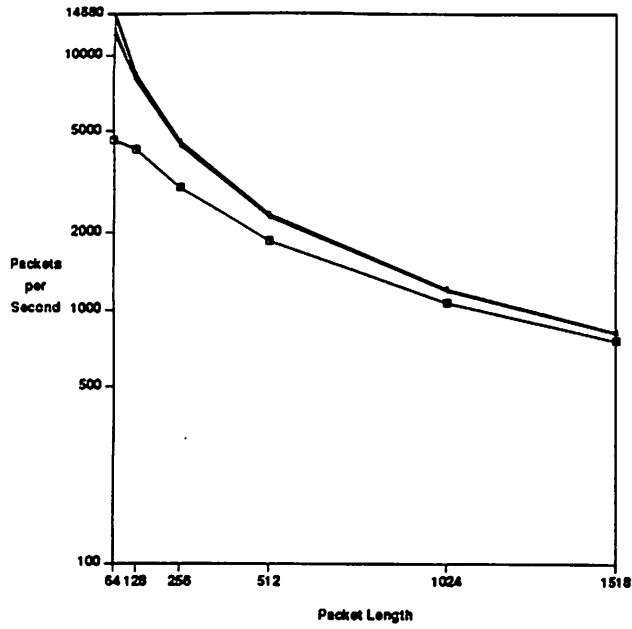
**Proteon P4200 - DECNET**  
configuration: between interface cards



— theoretical      — raw  
 — source  
 — max

**Performance:**

**Proteon XP 20000 - TCP/IP**  
**configuration: between interface cards**

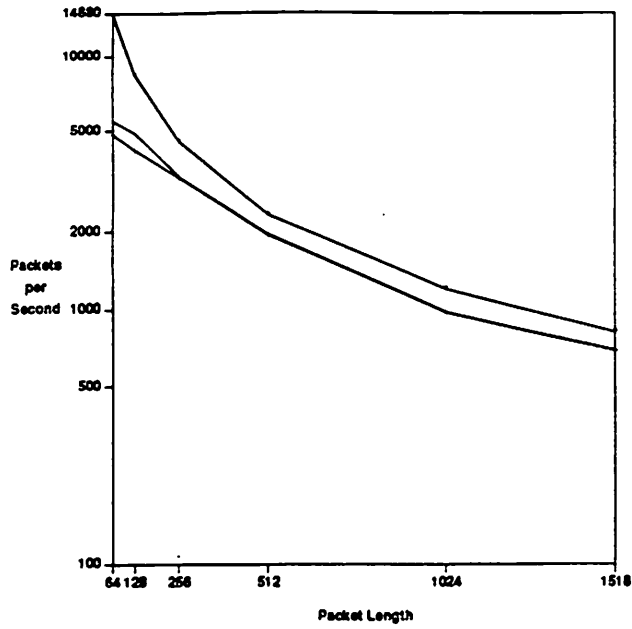


theoretical      raw  
source            filter 1  
max                filter 10



**Performance:**

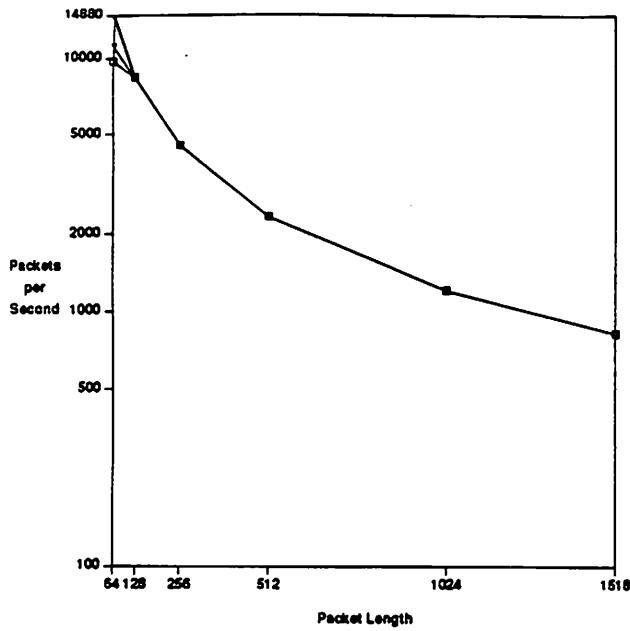
**Timeplex TIME/LAN 100 - TCP/IP  
configuration: within interface card**



theoretical      raw  
source  
max

**Performance:**

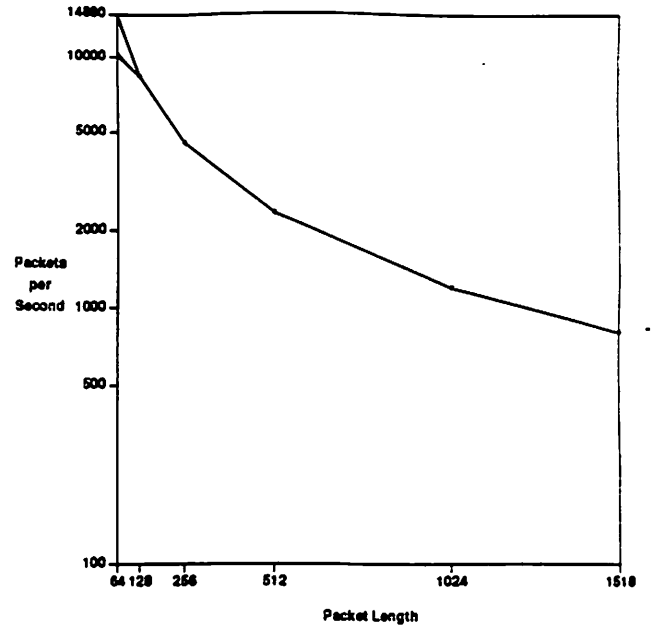
**Wellfleet Link Node - TCP/IP**  
configuration: between interface cards



theoretical source max  
 raw filter 1 filter 10

**Performance:**

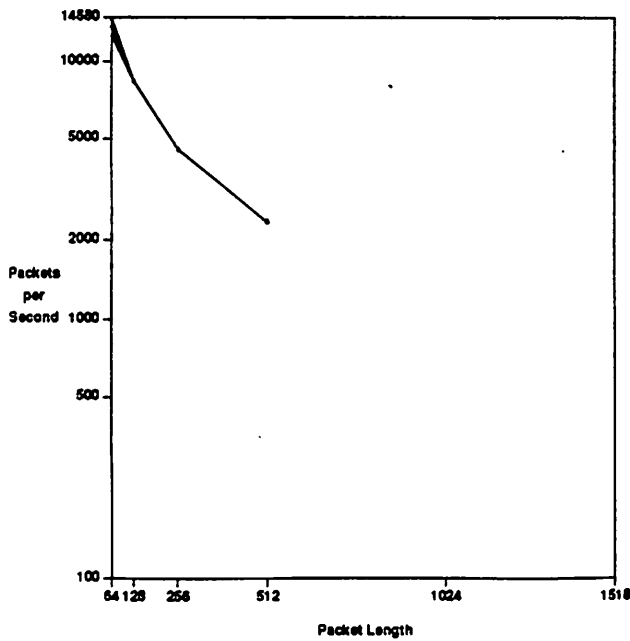
**Wellfleet Link Node - DECNET**  
configuration: between interface cards



theoretical source max  
 raw

**Performance:**

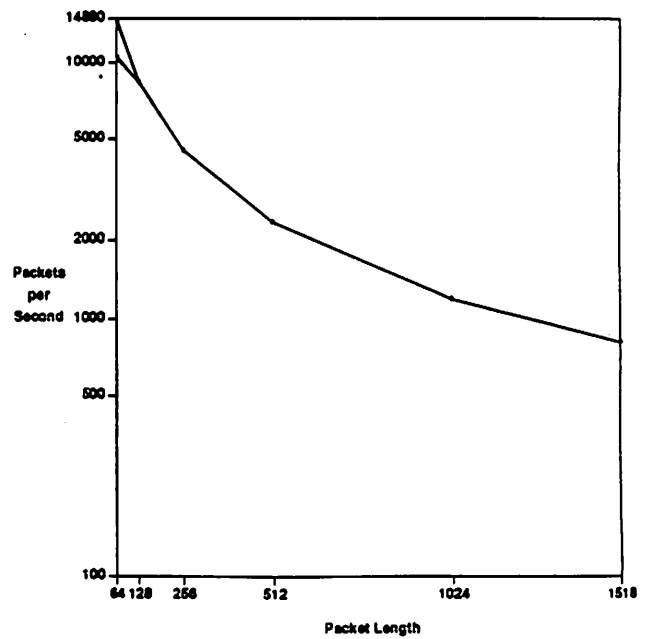
**Wellfleet Link Node - AppleTalk II**  
configuration: between interface cards



theoretical source max  
 raw

**Performance:**

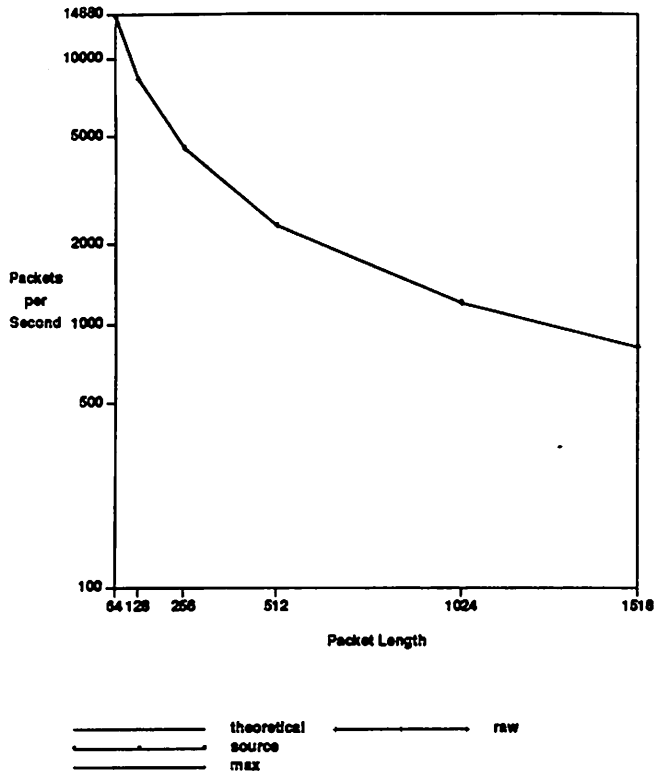
**Wellfleet Link Node - IPX**  
configuration: between interface cards



theoretical source max  
 raw

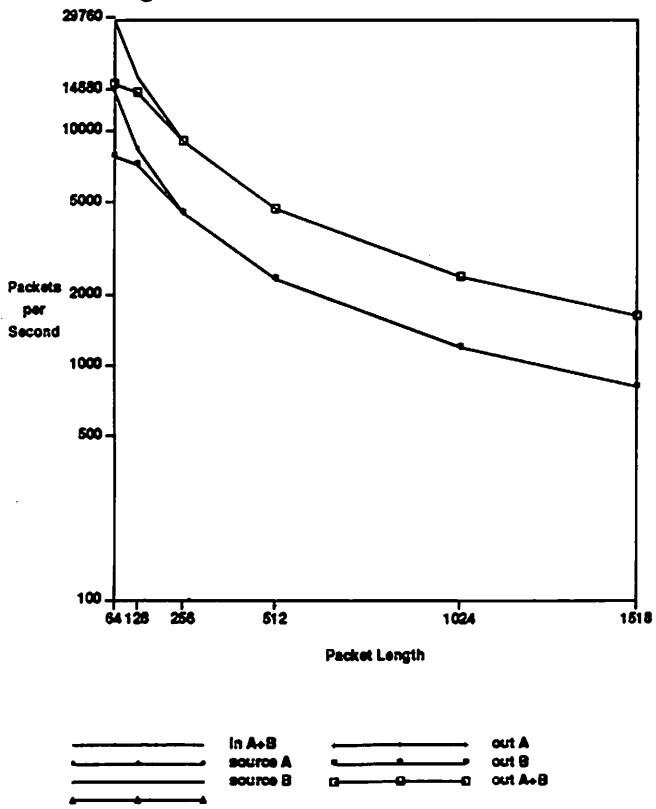
**Performance:**

**Wellfleet Link Node - Bridge Mode  
configuration: between interface cards**



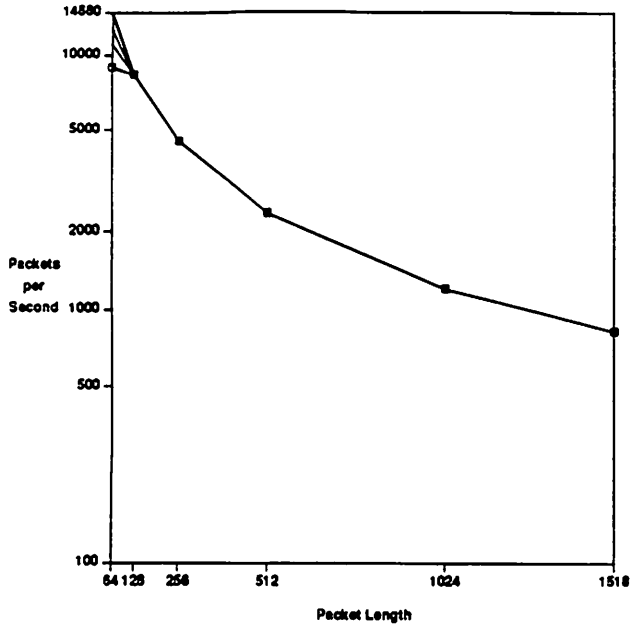
**Performance:**

**Wellfleet Link Node - Dual IP Streams  
configuration: between interface cards**



**Performance:**

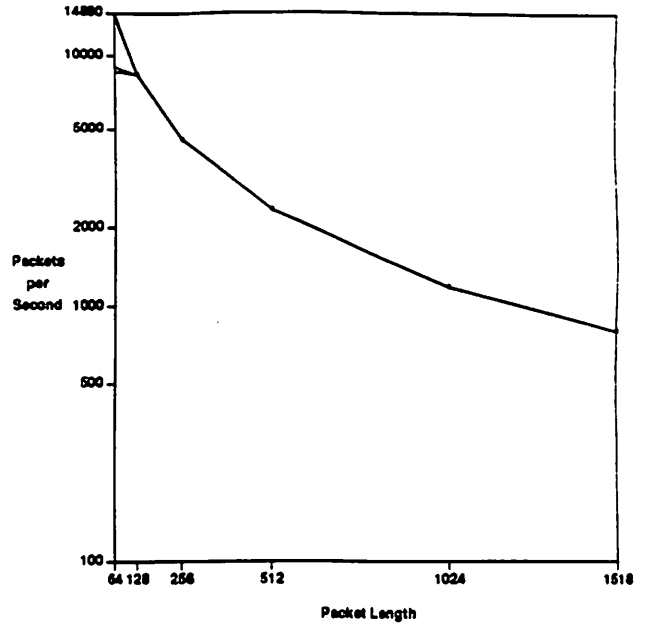
**Wellfleet Link Node - TCP/IP**  
configuration: within interface card



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ raw  
 \_\_\_\_\_ filter 1  
 \_\_\_\_\_ filter 10

**Performance:**

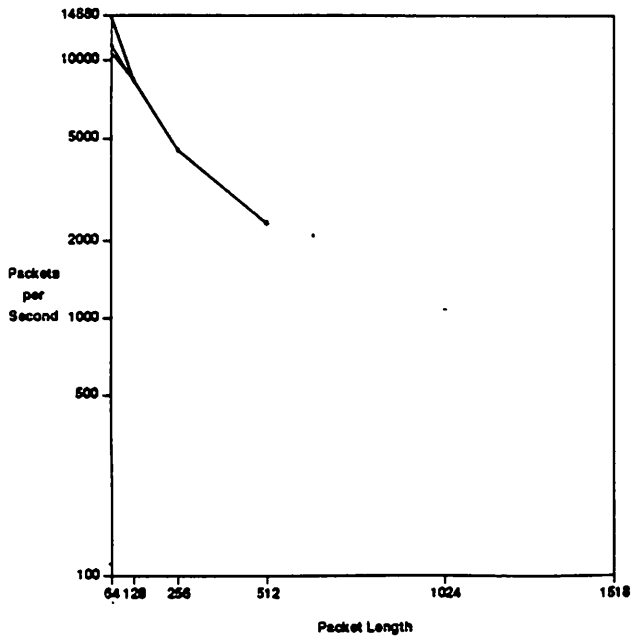
**Wellfleet Link Node - DECNET**  
configuration: within interface card



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ raw

**Performance:**

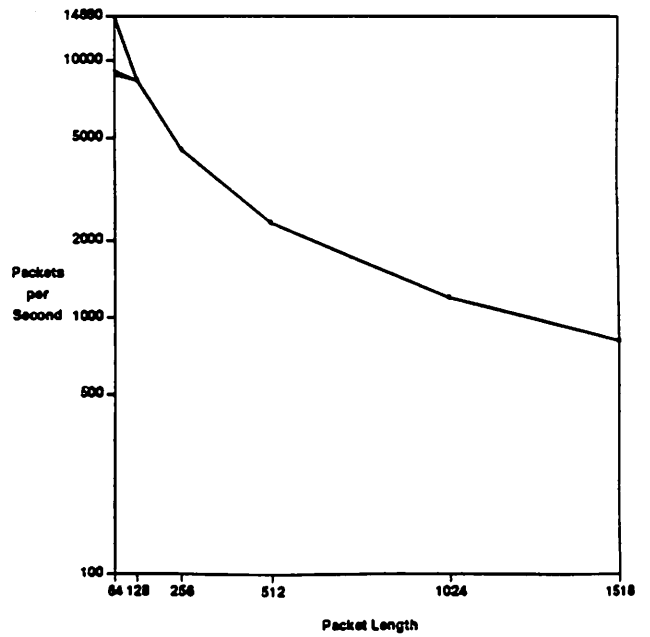
**Wellfleet Link Node - AppleTalk II**  
configuration: within interface card



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ raw

**Performance:**

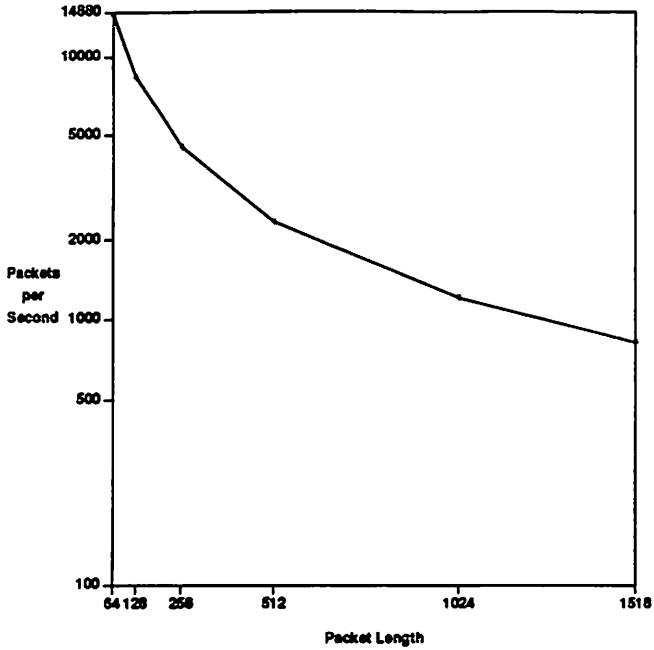
**Wellfleet Link Node - IPX**  
configuration: within interface card



\_\_\_\_\_ theoretical  
 \_\_\_\_\_ source  
 \_\_\_\_\_ max  
 \_\_\_\_\_ raw

**Performance:**

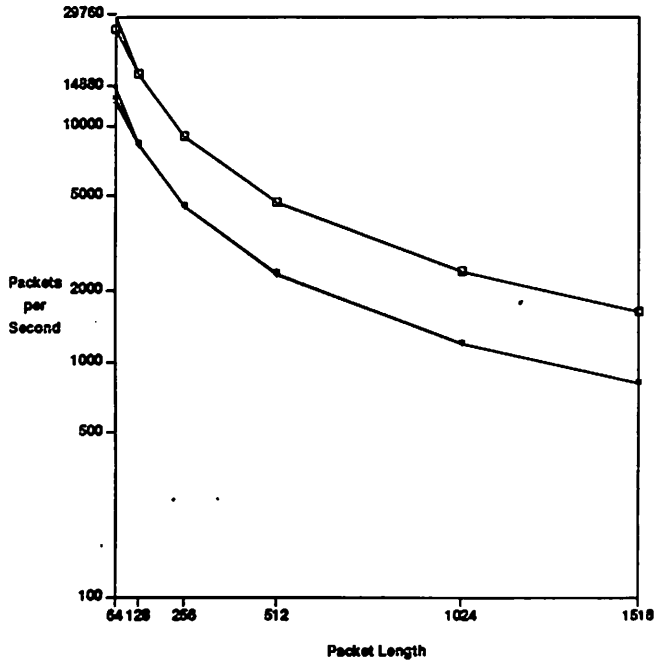
**Wellfleet Link Node - Bridge Mode  
configuration: within interface card**



————— theoretical source max  
 ————— raw

**Performance:**

**Wellfleet Link Node - Dual IP Streams  
configuration: within interface card**



————— in A+B  
 ————— source A  
 ————— source B  
 ————— out A  
 ————— out B  
 ————— out A+B

## Performance: 3com

3com NETBuilder - TCP/IP - within interface card

size	theo	test	ip_max	ip_fld
64	14880	14489	4404	4401
128	8445	8324	4648	4553
256	4528	4494	4004	3953
512	2349	2340	2202	2183
1024	1197	1195	1010	1153
1518	812	812	799	792

3com NETBuilder - Bridge Mode - within interface card

size	theo	test	br_max	br_fld
64	14880	14489	5830	5750
128	8445	8324	4735	4564
256	4528	4494	3994	3953
512	2349	2340	2202	2183
1024	1197	1195	1159	1153
1518	812	812	805	792

## Performance: cisco

cisco AGS+ - TCP/IP - between interface cards

size	theo	test	ip_max	ip_fld	lf_max	lf_fld	lof_max	lof_fld
64	14880	14489	14488	14488	14488	14488	14488	14488
128	8445	8324	8324	8324	8324	8324	8324	8324
256	4528	4494	4493	4493	4494	4494	4494	4494
512	2349	2340	2340	2340	2340	2340	2340	2340
1024	1197	1195	1194	1194	1195	1195	1195	1195
1518	812	812	811	811	812	812	812	812

cisco AGS+ - AppleTalk II - between interface cards

size	theo	test	at2_max	at2_fld
64	14880	14489	14488	14488
128	8445	8324	8324	8324
256	4528	4494	4494	4494
512	2349	2340	2340	2340

cisco AGS+ - DECNET - between interface cards

size	theo	test	dn_max	dn_fld
64	14880	14489	13097	13270
128	8445	8324	8324	8324
256	4528	4494	4494	4494
512	2349	2340	2340	2340
1024	1197	1195	1195	1195
1518	812	812	812	812

cisco AGS+ - IPX - between interface cards

size	theo	test	ipx_max	ipx_fld
64	14880	14489	14488	14488
128	8445	8324	8324	8324
256	4528	4494	4494	4494
512	2349	2340	2340	2340
1024	1197	1195	1195	1195
1518	812	812	812	812

## Performance: BBN

BBN T20 - TCP/IP - within interface card

size	theo	test	ip_max	ip_fld	lf_max	lf_fld	lof_max	lof_fld
64	14880	14489	4315	4664	2620	2778	2620	2775
128	8445	8324	4339	4654	2433	2777	2433	2777
256	4528	4494	4493	4493	2231	2772	2231	2774
512	2349	2340	2340	2340	2340	2340	2340	2340
1024	1197	1195	1194	1194	1194	1194	1194	1194
1518	812	812	811	811	811	811	811	811

cisco AGS+ - Bridge Mode - between interface cards

size	theo	test	br_max	br_fld
64	14880	14489	14488	14488
128	8445	8324	8324	8324
256	4528	4494	4494	4494
512	2349	2340	2340	2340
1024	1197	1195	1195	1195
1518	812	812	812	812

cisco AGS+ - Dual IP Streams - between interface cards

size	theo	test1	test2	d1_fld	d2_fld
64	14880	14489	14549	9682	9700
128	8445	8324	8340	8324	8340
256	4528	4494	4498	4493	4498
512	2349	2340	2341	2340	2341
1024	1197	1195	1195	1194	1195
1518	812	812	812	812	812

## Performance: cisco

cisco ACS+ - TCP/IP - within interface card

size	theo	test	ip_max	ip_fid	lf_max	lf_fid	lof_max	lof_fid
64	14880	14489	14488	14488	14488	14488	14488	14488
128	8445	8324	8324	8324	8324	8324	8324	8324
256	4528	4494	4494	4494	4494	4494	4494	4494
512	2349	2340	2340	2340	2340	2340	2340	2340
1024	1197	1195	1195	1195	1194	1194	1194	1194
1518	812	812	812	812	811	811	811	811

cisco ACS+ - AppleTalk II - within interface card

size	theo	test	at2_max	at2_fid
64	14880	14489	14488	14488
128	8445	8324	8324	8324
256	4528	4494	4494	4494
512	2349	2340	2340	2340

cisco ACS+ - DECNET - within interface card

size	theo	test	dn_max	dn_fid
64	14880	14489	13097	13256
128	8445	8324	8323	8323
256	4528	4494	4494	4494
512	2349	2340	2340	2340
1024	1197	1195	1195	1195
1518	812	812	812	812

cisco ACS+ - IPX - within interface card

size	theo	test	ipx_max	ipx_fid
64	14880	14489	14488	14488
128	8445	8324	8324	8324
256	4528	4494	4494	4494
512	2349	2340	2340	2340
1024	1197	1195	1195	1195
1518	812	812	812	812

cisco ACS+ - Bridge Mode - within interface card

size	theo	test	br_max	br_fid
64	14880	14489	14488	14488
128	8445	8324	8324	8324
256	4528	4494	4494	4494
512	2349	2340	2340	2340
1024	1197	1195	1195	1195
1518	812	812	812	812

cisco ACS+ - Dual IP Streams - within interface card

size	theo	test1	test2	d1_fid	d2_fid
64	14880	14489	14549	9689	9698
128	8445	8324	8340	8323	8340
256	4528	4494	4498	4494	4498
512	2349	2340	2341	2340	2341
1024	1197	1195	1195	1194	1195
1518	812	812	812	812	812

## Performance: Network Systems Corporation

Network Systems Corporation EN640-8 - TCP/IP - between interface cards

size	theo	test	ip_max	ip_fid	lf_max	lf_fid	lof_max	lof_fid
64	14880	14489	8327	8233	4636	4413	1718	1670
128	8445	8324	5105	5189	4111	3875	1629	1576
256	4528	4494	3755	3752	3745	3756	1599	1536
512	2349	2340	2124	2123	2122	2123	1565	1493
1024	1197	1195	1137	1136	1138	1138	1141	1135
1518	812	812	786	784	787	786	788	784

Network Systems Corporation EN640-8 - AppleTalk II - between interface cards

size	theo	test	at2_max	at2_fid
64	14880	14489	827	0
128	8445	8324	808	0
256	4528	4494	770	0
512	2349	2340	702	269

Network Systems Corporation EN640-8 - DECNET - between interface cards

size	theo	test	dn_max	dn_fid
64	14880	14489	919	0
128	8445	8324	886	0
256	4528	4494	825	0
512	2349	2340	727	280
1024	1197	1195	588	452
1518	812	812	443	381

Network Systems Corporation EN640-8 - Dual IP Streams - between interface cards

size	theo	test1	test2	d1_fid	d2_fid
64	14880	14489	14549	3224	3396
128	8445	8324	8340	2832	2975
256	4528	4494	4498	2638	2651
512	2349	2340	2341	2335	2123
1024	1197	1195	1195	1138	1195
1518	812	812	812	786	812

## Performance: Network Systems Corporation

Network Systems Corporation EN640-8 - TCP/IP - within interface card

size	theo	test	ip_max	ip_fid	lf_max	lf_fid	lof_max	lof_fid
64	14880	14489	5986	5604	4775	4630	1732	1702
128	8445	8324	5259	5732	4605	4164	1642	1629
256	4528	4494	3727	3757	3729	3641	1541	1523
512	2349	2340	2128	2123	2122	2123	1508	1450
1024	1197	1195	1140	1138	1139	1135	1139	1135
1518	812	812	788	784	788	783	780	782

Network Systems Corporation EN640-8 - AppleTalk II - within interface card

size	theo	test	at2_max	at2_fid
64	14880	14489	828	0
128	8445	8324	805	0
256	4528	4494	767	0
512	2349	2340	701	266

Network Systems Corporation EN640-8 - DECNET - within interface card

size	theo	test	dn_max	dn_fid
64	14880	14489	919	0
128	8445	8324	885	0
256	4528	4494	826	0
512	2349	2340	719	278
1024	1197	1195	580	453
1518	812	812	439	381

## Performance: Novell

Novell NetWare 386 - TCP/IP - between interface cards

size	theo	test	ip_max	ip_fid
64	14880	14489	3273	3270
128	8445	8324	3207	3202
256	4528	4494	2892	2886
512	2349	2340	1822	1764
1024	1197	1195	1050	1030
1518	812	812	744	731

Novell NetWare 386 - IPX - between interface cards

size	theo	test	ipx_max	ipx_fid
64	14880	14489	3295	3240
128	8445	8324	3274	3172
256	4528	4494	2953	2852
512	2349	2340	1861	1768
1024	1197	1195	1078	1031
1518	812	812	787	731

## Performance: Proteon

Proteon rig - TCP/IP - between interface cards

size	theo	test	ip_max	ip_fid	lf_max	lf_fid	lof_max	lof_fid
64	14880	14489	12802	12142	4422	4513	4605	4530
128	8445	8324	7896	7998	4233	4212	4222	4204
256	4528	4494	4351	4350	2944	2944	2964	2943
512	2349	2340	2287	2294	1850	1835	1850	1837
1024	1197	1195	1186	1181	1060	1047	1060	1048
1518	812	812	812	805	749	741	749	742

Proteon rig - Dual IP Streams - between interface cards

size	theo	test1	test2	d1_fid	d2_fid
64	14880	14489	14549	8516	7749
128	8445	8324	8340	6027	6989
256	4528	4494	4498	4494	3936
512	2349	2340	2341	2333	4098
1024	1197	1195	1195	1193	1192
1518	812	812	812	810	809

## Performance: Proteon

Proteon P4200 - TCP/IP - between interface cards

size	theo	test	ip_max	ip_fid	lf_max	lf_fid	lof_max	lof_fid
64	14880	14489	3616	3576	2675	2054	2675	2050
128	8445	8324	1081	3058	2247	1674	2258	1668
256	4528	4494	1667	1529	1493	1253	1493	1248
512	2349	2340	948	896	875	815	876	814
1024	1197	1195	508	473	465	447	465	447
1518	812	812	348	325	324	313	325	313

Proteon P4200 - DECNET - between interface cards

size	theo	test	dn_max	dn_fid
64	14880	14489	1747	1469
128	8445	8324	1595	1433
256	4528	4494	1505	1401
512	2349	2340	968	804
1024	1197	1195	539	452
1518	812	812	405	310

Proteon P4200 - IPX - between interface cards

size	theo	test	ipx_max	ipx_fid
64	14880	14489	1881	1593
128	8445	8324	1718	1560
256	4528	4494	1608	1503
512	2349	2340	970	812
1024	1197	1195	519	450
1518	812	812	411	310

Proteon P4200 - Dual IP Streams - between interface cards

size	theo	test1	test2	d1_fid	d2_fid
64	14880	14489	14549	1085	1181
128	8445	8324	8340	0	0
256	4528	4494	4498	825	833
512	2349	2340	2341	665	1107
1024	1197	1195	1195	1109	665
1518	812	812	812	270	433

## Performance: Timeplex

Timeplex TIME/LAN 100 - TCP/IP - between interface cards

size	theo	test	ip_max	ip_fid
64	14880	14489	5480	4822
128	8445	8324	4865	4162
256	4528	4494	3287	3253
512	2349	2340	1969	1949
1024	1197	1195	977	973
1518	812	812	691	687



## Performance: Wellfleet

### Wellfleet Link Mode - TCP/IP - between interface cards

size	theo	test	ip_max	ip_fid	lf_max	lf_fid	lof_max	lof_fid
64	14880	14489	14473	14473	11107	10778	9708	9998
128	8445	8324	8322	8322	8322	8322	8324	8324
256	4528	4494	4493	4493	4494	4494	4494	4494
512	2349	2340	2340	2340	2340	2340	2340	2340
1024	1197	1195	1196	1196	1193	1193	1195	1195
1518	812	812	811	811	811	812	812	812

### Wellfleet Link Mode - AppleTalk II - between interface cards

size	theo	test	at2_max	at2_fid
64	14880	14489	14474	13629
128	8445	8324	8324	8324
256	4528	4494	4493	4493
512	2349	2340	2341	2341

### Wellfleet Link Mode - DECNET - between interface cards

size	theo	test	dn_max	dn_fid
64	14880	14489	10151	10404
128	8445	8324	8322	8322
256	4528	4494	4494	4494
512	2349	2340	2340	2340
1024	1197	1195	1194	1194
1518	812	812	812	812

### Wellfleet Link Mode - IPX - between interface cards

size	theo	test	ipx_max	ipx_fid
64	14880	14489	10420	10642
128	8445	8324	8324	8324
256	4528	4494	4493	4493
512	2349	2340	2340	2340
1024	1197	1195	1194	1194
1518	812	812	812	812

## Performance: Wellfleet

### Wellfleet Link Mode - TCP/IP - within interface card

size	theo	test	ip_max	ip_fid	lf_max	lf_fid	lof_max	lof_fid
64	14880	14489	11086	12646	8983	9636	8930	9655
128	8445	8324	8322	8322	8324	8324	8324	8324
256	4528	4494	4493	4493	4494	4494	4494	4494
512	2349	2340	2340	2340	2340	2340	2340	2340
1024	1197	1195	1196	1196	1193	1193	1193	1193
1518	812	812	811	811	811	811	811	811

### Wellfleet Link Mode - AppleTalk II - within interface card

size	theo	test	at2_max	at2_fid
64	14880	14489	10707	11390
128	8445	8324	8322	8322
256	4528	4494	4493	4493
512	2349	2340	2339	2339

### Wellfleet Link Mode - DECNET - within interface card

size	theo	test	dn_max	dn_fid
64	14880	14489	8634	8982
128	8445	8324	8322	8322
256	4528	4494	4494	4494
512	2349	2340	2340	2340
1024	1197	1195	1193	1193
1518	812	812	811	811

### Wellfleet Link Mode - IPX - within interface card

size	theo	test	ipx_max	ipx_fid
64	14880	14489	8780	9109
128	8445	8324	8322	8322
256	4528	4494	4494	4494
512	2349	2340	2340	2340
1024	1197	1195	1194	1194
1518	812	812	811	811

### Wellfleet Link Mode - Bridge Mode - between interface cards

size	theo	test	br_max	br_fid
64	14880	14489	14488	14488
128	8445	8324	8324	8324
256	4528	4494	4494	4494
512	2349	2340	2340	2340
1024	1197	1195	1195	1195
1518	812	812	812	812

### Wellfleet Link Mode - Dual IP Streams - between interface cards

size	theo	test1	test2	d1_fid	d2_fid
64	14880	14489	14549	7790	7780
128	8445	8324	8340	7186	7196
256	4528	4494	4498	4491	4493
512	2349	2340	2341	2340	2339
1024	1197	1195	1195	1194	1194
1518	812	812	812	811	811

### Wellfleet Link Mode - Bridge Mode - within interface card

size	theo	test	br_max	br_fid
64	14880	14489	14488	14488
128	8445	8324	8324	8324
256	4528	4494	4494	4494
512	2349	2340	2340	2340
1024	1197	1195	1195	1195
1518	812	812	812	812

### Wellfleet Link Mode - Dual IP Streams - within interface card

size	theo	test1	test2	d1_fid	d2_fid
64	14880	14489	14549	12632	13024
128	8445	8324	8340	8324	8337
256	4528	4494	4498	4491	4497
512	2349	2340	2341	2334	2341
1024	1197	1195	1195	1195	1195
1518	812	812	812	811	811