cisco Systems

A Performance Analysis of the cisco Systems AGS+

a report to
cisco Systems, Inc.
from LanQuest Labs

Network Tested
LanQuest Labs™

CISCO SYSTEMS

Due to customer requests for performance data, cisco Systems engaged LanQuest Labs to run extensive performance tests on a cisco AGS+ multiprotocol router running Release 8.2 of cisco software. This forward introduces the LanQuest report, which includes test results on the AGS+ and provides some insight into how the results were achieved.

There is increasing interest in the data communications industry in defining a standard set of tests to determine various performance "metrics," such as packet switching speeds, which could be used to objectively evaluate equipment from many vendors. Cisco fully supports the standardization efforts recently being promoted by several parties. Impartial tests, such as the ones conducted by LanQuest in this report, should help to reduce much of the current confusion and hyperbole.

We believe you will find that the performance documented in these tests sets new industry standards. One example documented in this report is that the cisco AGS+ achieved a cumulative data throughput of 32,668 kilobits per second (Kbps) and 56,816 packets per second (pps) while simultaneously routing four separate data streams.

Cisco recognizes that performance throughput is only one of several criteria that may be used to select an internetworking vendor. At the same time, we are pleased to excel in this aspect as well as other significant aspects of performance — protocol completeness, maintainability, and reliability.

We thank our many customers for our success and pledge to continue to earn your on-going support.

cisco Systems
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Introduction

Under the support of cisco Systems, Inc., LanQuest Labs conducted a series of router performance tests using the cisco AGS+ router. The objectives of this project were to a) develop a standardized set of protocol-based throughput tests and b) use these tests to measure the performance of the cisco AGS+ router.

The tests were conducted at LanQuest Labs by lab personnel, assisted by Lee Pang of cisco September 17-28, 1990.

Definitions

Special terms used in this report are defined below.

Data Stream: A regular flow of data packets from a source device through the router to a destination device.

Port-to-Port and Slot-to-Slot: Most multiport routers use a backplane into which multiple router cards can be placed and each card typically supports multiple ports. This means there are two paths that a data stream can take through the router: port-to-port (input and output use ports on the same card so the data stream never reaches the backplane) and slot-to-slot (input and output use ports on different boards, so the data moves across the backplane from one card to another).

Router Channel: A path through the router form input port to output port.

The Tests

A variety of tests were designed and conducted to measure the cisco router performance under many different operating conditions. Test variables included the number of data streams, packet sizes, internal router setups, and protocol type. Tests were run with both single and multiple protocol data streams. Except as noted, all tests were run in port-to-port mode. Test parameters are described below.

Single Stream

Single stream tests were conducted to test the router performance with a single data stream. These tests were conducted using data streams comprising packets based on either a single protocol or on multiple protocols.

Single Protocol

Two sets of variables were used in the single stream, single protocol tests: packet size and protocols. For the single protocol runs, individual test runs were conducted for each protocol at each packet size.

Three packet sizes were used in the single protocol tests:

64
512
1518

The protocols used in the single protocol tests included:

AppleTalk Phase 2
CLNS (DECnet V)
DECnet IV
TCP/IP
Novell IPX
XNS

We should note that the AppleTalk Phase 2 protocol does not permit packets larger than 600 bytes. We used larger packet sizes in our test data streams to keep the data input streams consistent across protocols.

Variations of Single Protocol Tests

Two variations of the single protocol tests were conducted: operation as a bridge and operation in slot-to-slot rather than port-to-port. Both these tests were conducted using the TCP/IP single stream, single protocol test described above.

Operation as a Bridge

The cisco AGS+ can be configured to operate as a learning bridge. This test compared performance as a learning bridge to performance as a router.

Slot-to-Slot Versus Port-to-Port Operation

This test compared the operation of the cisco router in both port-to-port and slot-to-slot modes to see if moving data across the backplane generated any performance degradation. (See definitions on Page 1.)

Multiple Protocols

Four multiple protocols tests were run, mixing protocols and packet sizes as shown below. The data stream was created of replications of a message set using the protocols and packet sizes listed below. Each message set included a packet of each size for each protocol.

IPX, learning bridge, XNS with packet sizes (in bytes) of 64 and 1518

TCP/IP, Novell IPX, DECnet IV with packet sizes (in bytes) of 64 and 1518

TCP/IP, AppleTalk Phase 2, DECnet IV with packet sizes (in bytes) of 64 and 1518

TCP/IP, DECnet IV, Novell IPX, AppleTalk Phase 2, learning bridges,
XNS with packet sizes (in bytes) of 64 and 1518

Multiple Stream Tests

Multiple stream tests were conducted to assess the performance of the router when processing multiple data streams.

The test bed was configured with eight networks — four input and four output. Each pair of networks was connected to a router channel (0-3). Tests were performed using 1, 2, 3 and 4 channels simultaneously. Each data stream was generated by a pair of HP4972A Ethernet analyzers. Output was measured by another HP4972A.

Multiple stream operation was tested with a streams of 64-byte TCP/IP protocol packets.

Test Setup

Two test setups were used, one for single data stream testing, the other for multiple data stream testing.

Single Stream Tests

Two routers were used for the single stream tests. One served as the unit under test (UUT), the other as the host router, or "data sink," which was used to receive the transmitted data. (Only the performance of the UUT router was measured during the tests, and the presence of the host had no impact on the results.) The routers were individually configured for each test. The configuration files are shown in Appendix 1.

The input data stream was created using an HP4972A LAN analyzer and a Network General Sniffer. Output was measured with a second HP4972A. LAN analyzers were used as data sources to ensure easy replication of the test setup. Two analyzers were required because a single analyzer could not generate sufficient load for the tests. The HP4972A, for example, can only generate a data stream representing 45 percent of the data carrying capacity of Ethernet. Two analyzers simultaneously feeding a single channel were sufficient to generate the load required for these tests.

The single stream test setup is shown in Figure 1.

One Stream

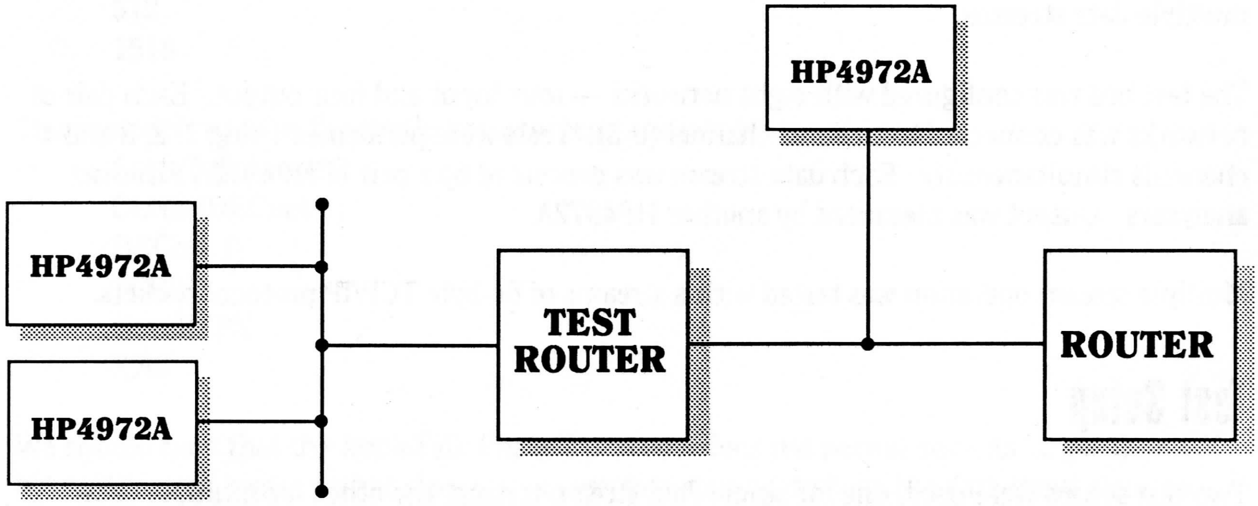


Figure 1. Single data stream test setup for the cisco AGS+.

Multiple Stream Tests

The multiple data stream used a single router. Each data stream was generated by a pair of HP4972A LAN analyzers. Output streams were measured individually with an HP4972A and the results summed across four runs (one for measuring each output stream.)

The multiple stream test setup is shown in Figure 2.

Multiple Streams

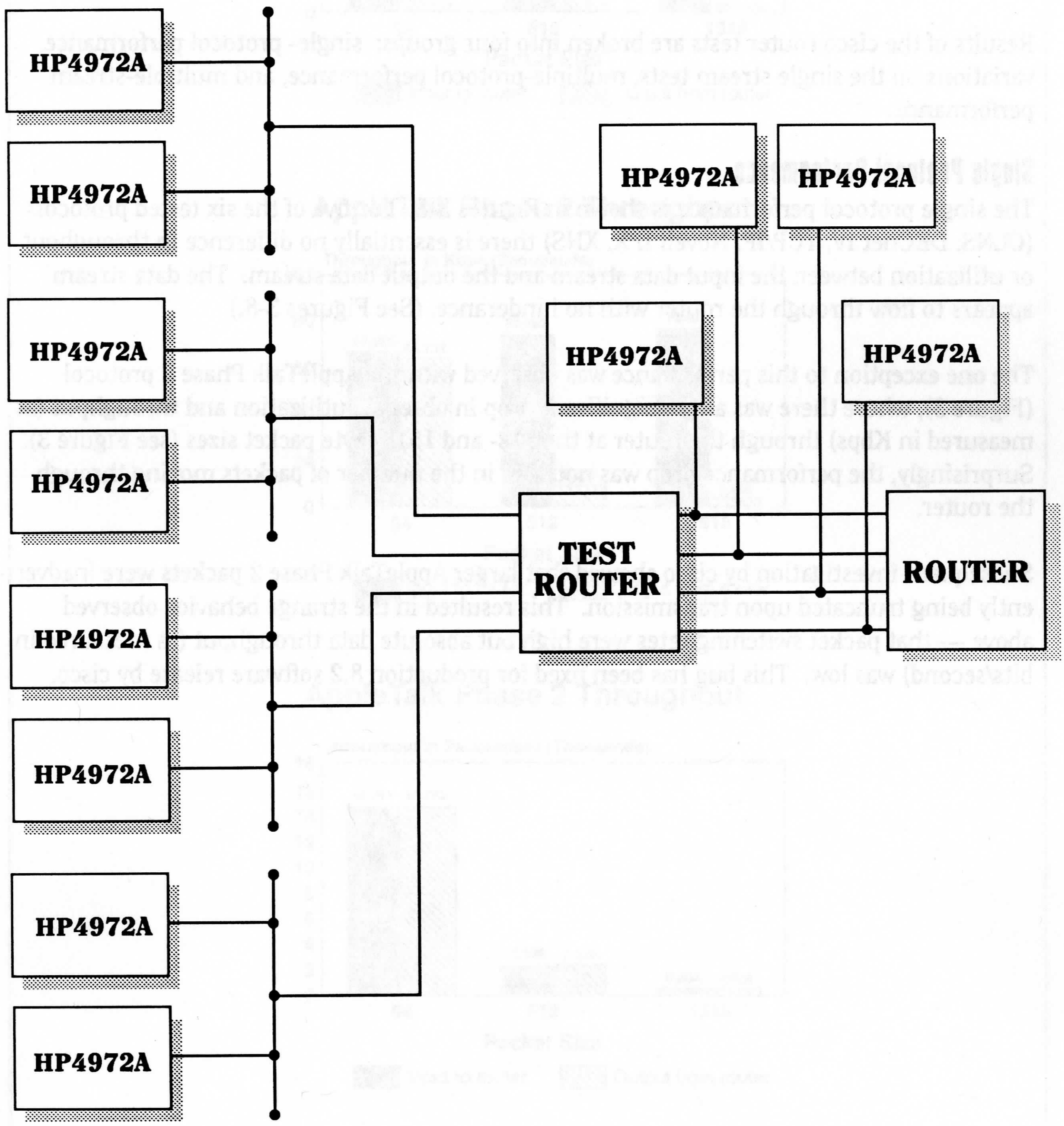


Figure 2. Multiple data stream setup for the cisco AGS+.

Conducting the Tests

A standardized procedure was used for all tests. Under this procedure each experiment was started and ran for a minimum of 30 seconds before any utilization or throughput measures were read. This allowed time for the router to "learn" the network and for the data stream to stabilize.

Test Results

Results of the cisco router tests are broken into four groups: single- protocol performance, variations on the single stream tests, multiple-protocol performance, and multiple-stream performance.

Single Protocol Performance

The single protocol performance is shown in Figures 3-8. For five of the six tested protocols (CLNS, DECnet IV, TCP/IP, Novell IPX, XNS) there is essentially no difference in throughput or utilization between the input data stream and the output data stream. The data stream appears to flow through the router with no hinderance. (See Figures 3-8.)

The one exception to this performance was observed with the AppleTalk Phase 2 protocol (Figure 3), where there was a very significant drop in observed utilization and throughput (as measured in Kbps) through the router at the 512- and 1518- byte packet sizes (see Figure 3). Surprisingly, the performance drop was not seen in the number of packets moving through the router.

Subsequent investigation by cisco showed that larger AppleTalk Phase 2 packets were inadvertently being truncated upon transmission. This resulted in the strange behavior observed above — that packet switching rates were high but absolute data throughput (as measured in bits/second) was low. This bug has been fixed for production 8.2 software release by cisco.

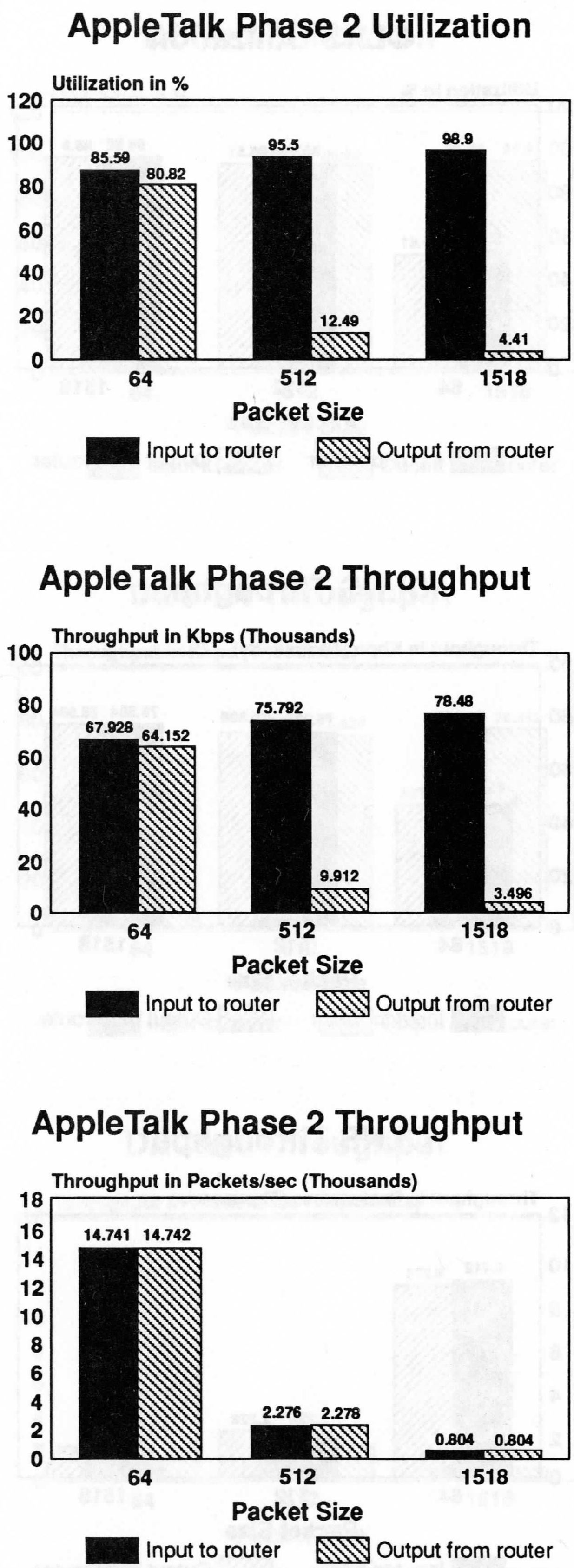


Figure 3. AppleTalk Phase 2 single stream performance of the cisco AGS+. See text for description of observed (and corrected for release) software bug.

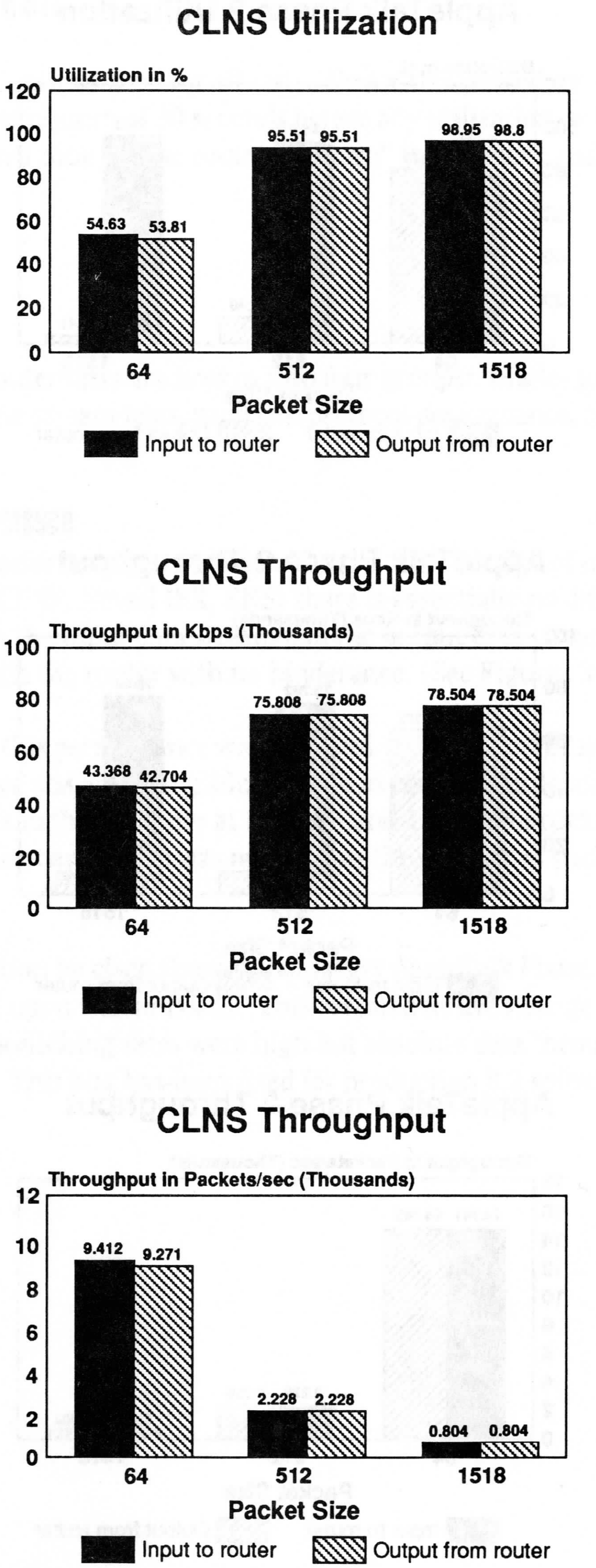


Figure 4. CLNS (DECnet V) single stream performance of the cisco AGS+.

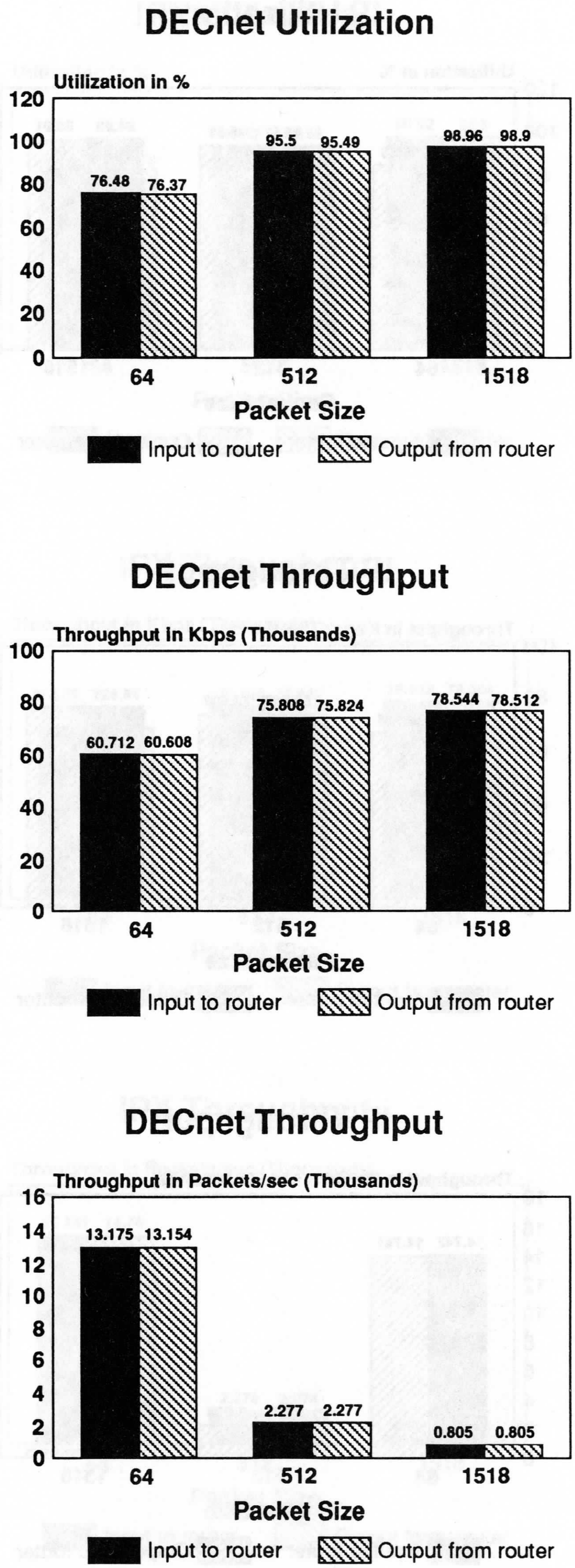


Figure 5. DECnet IV single stream performance of the cisco AGS+.

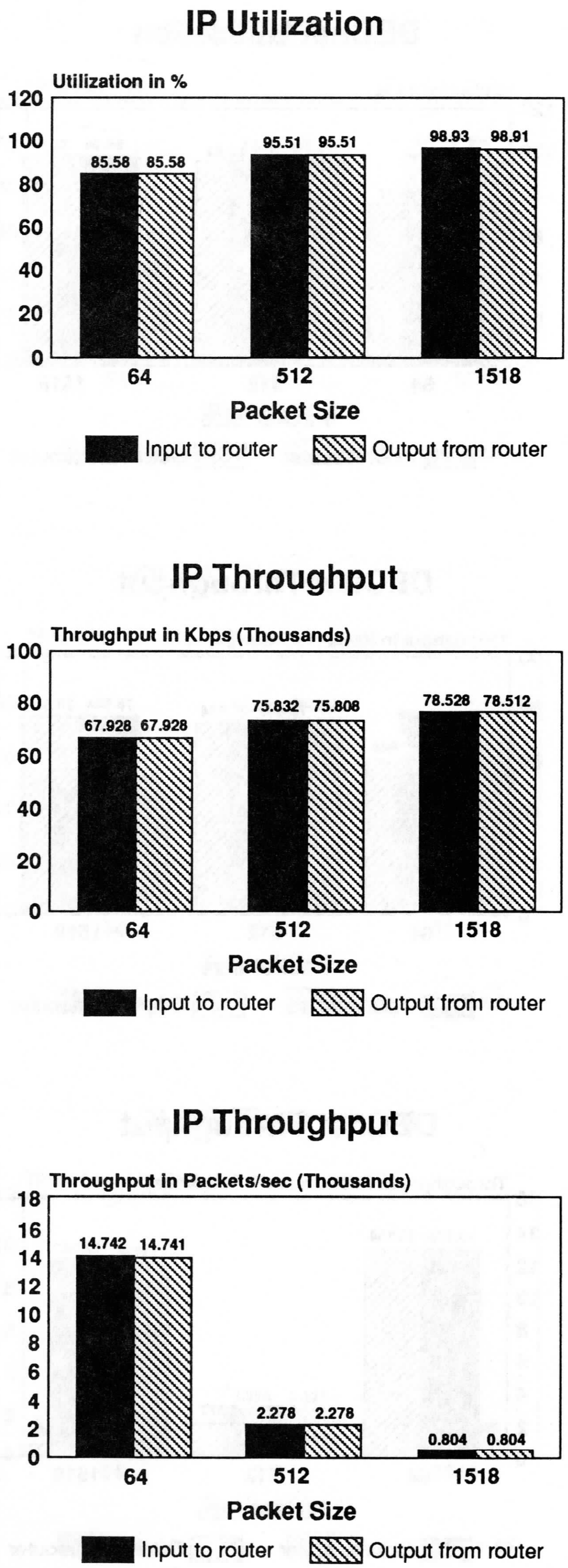


Figure 6. TCP/IP single stream performance of the cisco AGS+.

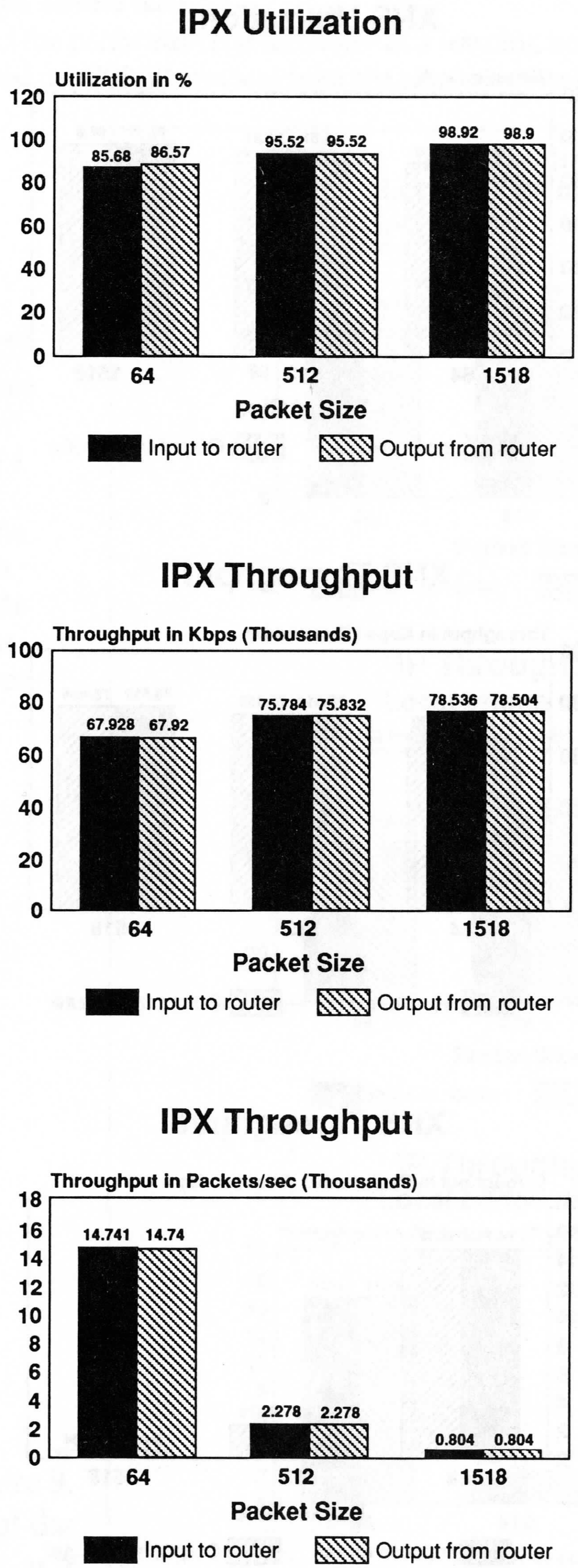


Figure 7. Novell IPX single stream performance of the cisco AGS+.

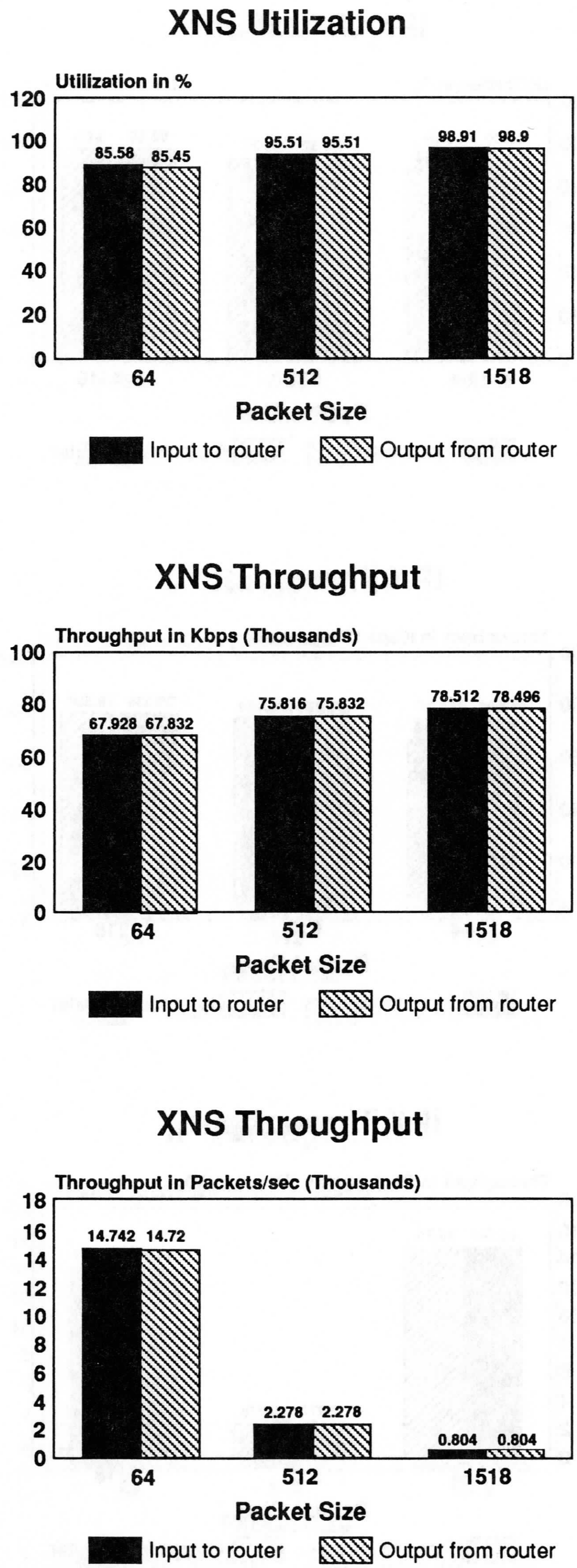


Figure 8. XNS single stream performance of the cisco AGS+.

Variations on the Single Stream Tests

These tests measured the performance of the AGS+ as a learning bridge and in slot-to-slot mode. Both tests used the TCP/IP protocol from the single protocol tests described above.

Operation as a Learning Bridge

Figure 9 shows the performance of the AGS+ as a learning bridge with the TCP/IP protocol. Performance is essentially identical with performance as a router (compare to Figure 6). As with the router mode, there is essentially no degradation of throughput as the data stream moves through the router.

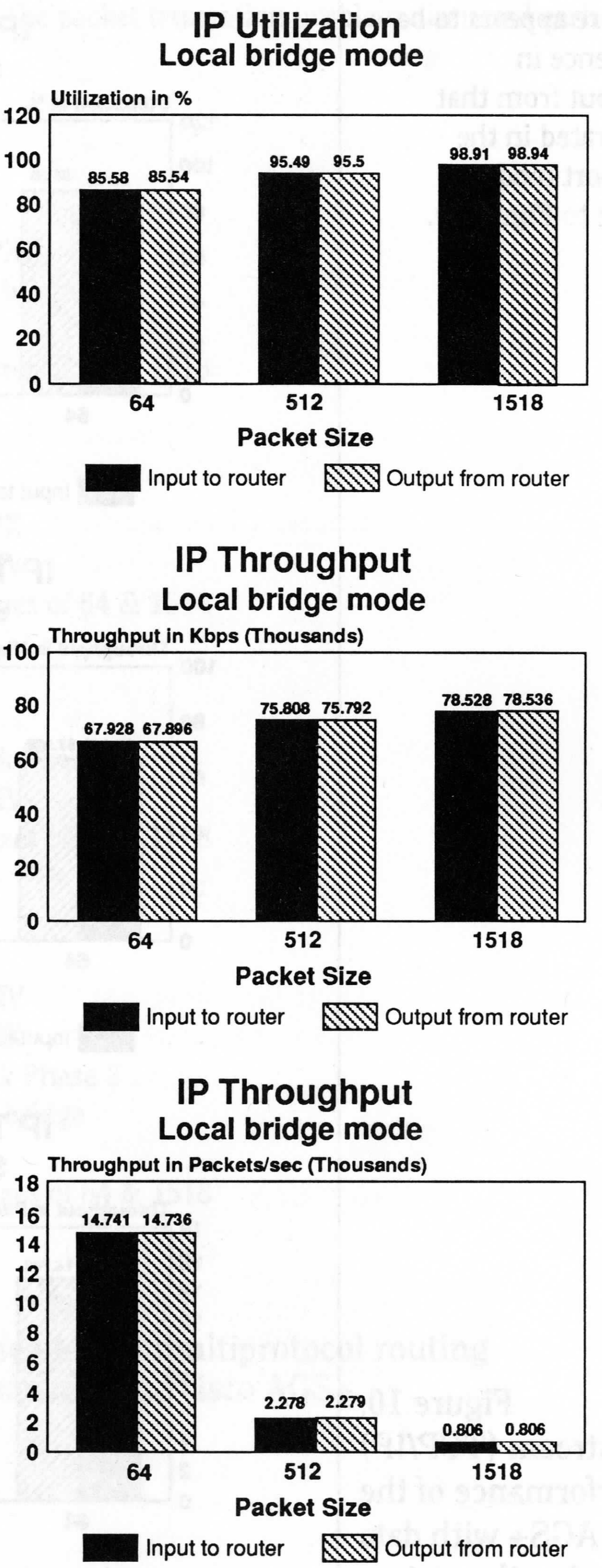


Figure 9. Performance of the cisco AGS+ as a learning bridge with TCP/IP.

Port-to-Port Versus Slot-to-Slot Performance

Figure 10 shows the performance of the AGS+ in slot-to-slot mode, where the data stream must pass from the port on one card (port one) across the bus and back out through the port on a second card (port six). There appears to be no difference in throughput from that demonstrated in the port-to-port mode (compare to Figure 6).

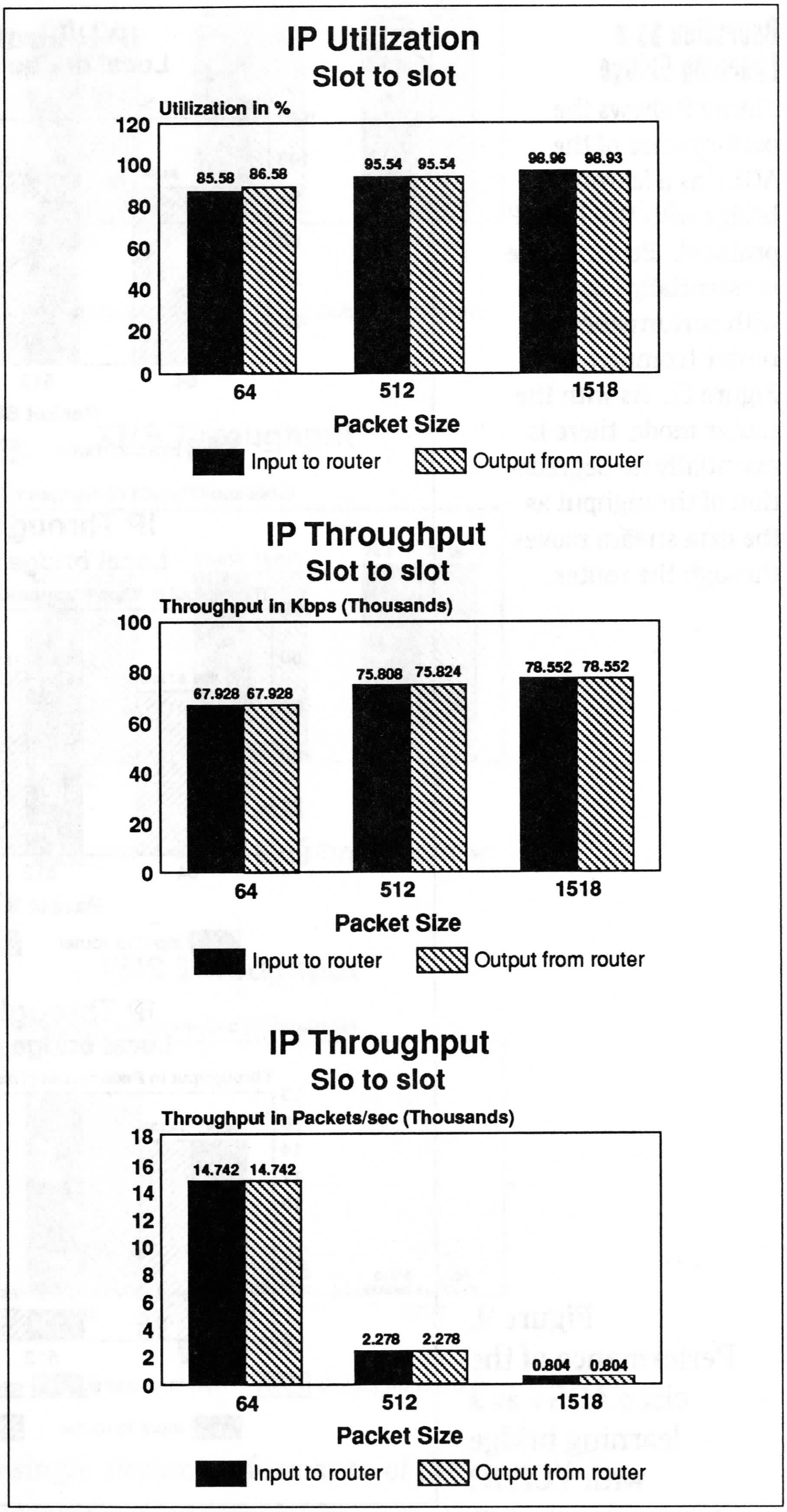


Figure 10. Single stream (TCP/IP) performance of the cisco AGS+ with data traversing the system backplane.

Multiple Protocol Performance

Figure 11 defines protocol sets 1-4 that were used to measure the performance of the AGS+ in routing multiple protocol packets shown in Figure 12. The drops in utilization and throughput (Kbps) shown in protocol sets 3 and 4 appear to be caused by the presence of AppleTalk Phase 2 in these two protocol sets and the packet truncation problem discussed earlier in this report.

Protocol Set 1:

- Novell IPX
- learning bridge
- XNS
- packet sizes of 64 & 1518

Protocol Set 2:

- TCP/IP
- Novell IPX
- DECnet IV
- packet sizes of 64 & 1518

Protocol Set 3:

- TCP/IP
- AppleTalk Phase 2
- DECnet IV
- packet sizes of 64 & 1518

Protocol Set 4:

- TCP/IP
- DECnet IV
- Novell IPX
- AppleTalk Phase 2
- learning bridge
- XNS
- packet sizes of 64 & 1518

Figure 11.
Protocol sets used to test multiprotocol routing performance of the cisco AGS+.

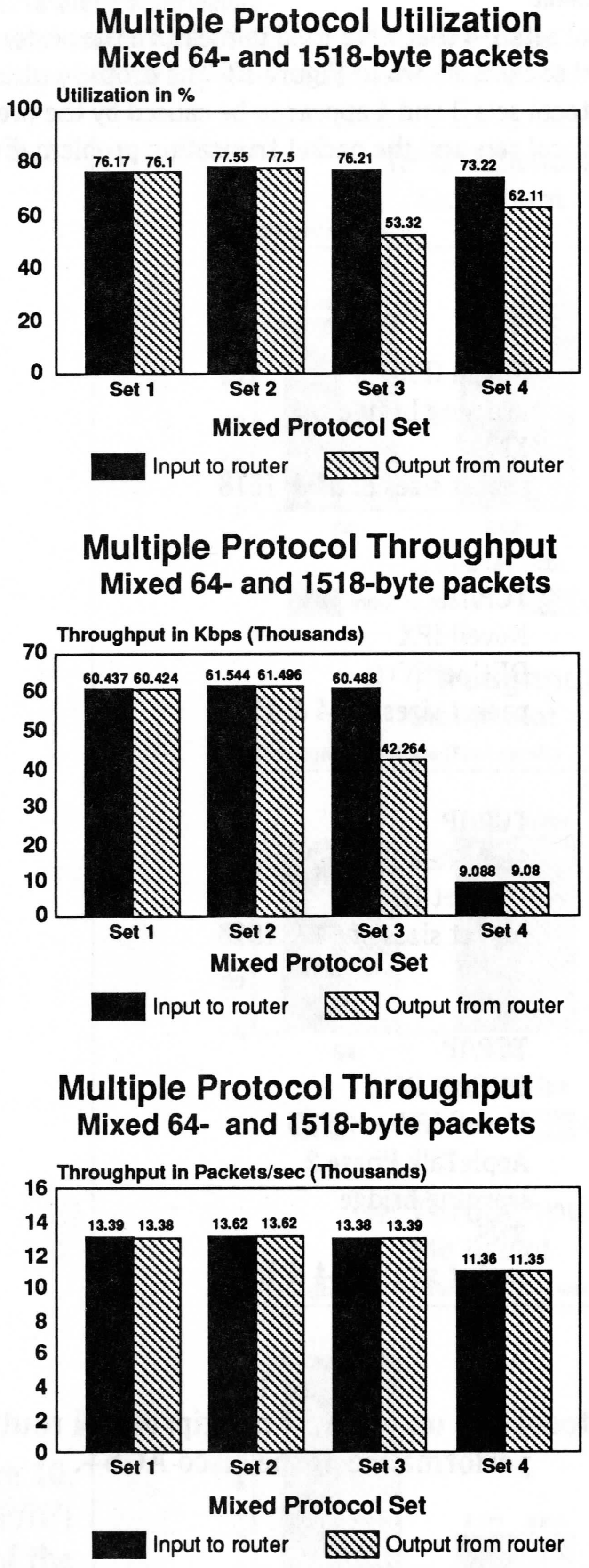


Figure 12. Routing performance of the cisco AGS+ using the protocol sets defined in Figure 11.

Multiple Stream Performance

The performance of the AGS+ was also tested while simultaneously routing multiple data streams as shown in Figure 2. Throughput while simultaneously routing two, three and four data streams was measured and compared against the throughput observed while processing a single data stream. All these tests were conducted with a data stream of 64-byte TCP/IP packets. The results of these tests are shown in Figures 13-16.

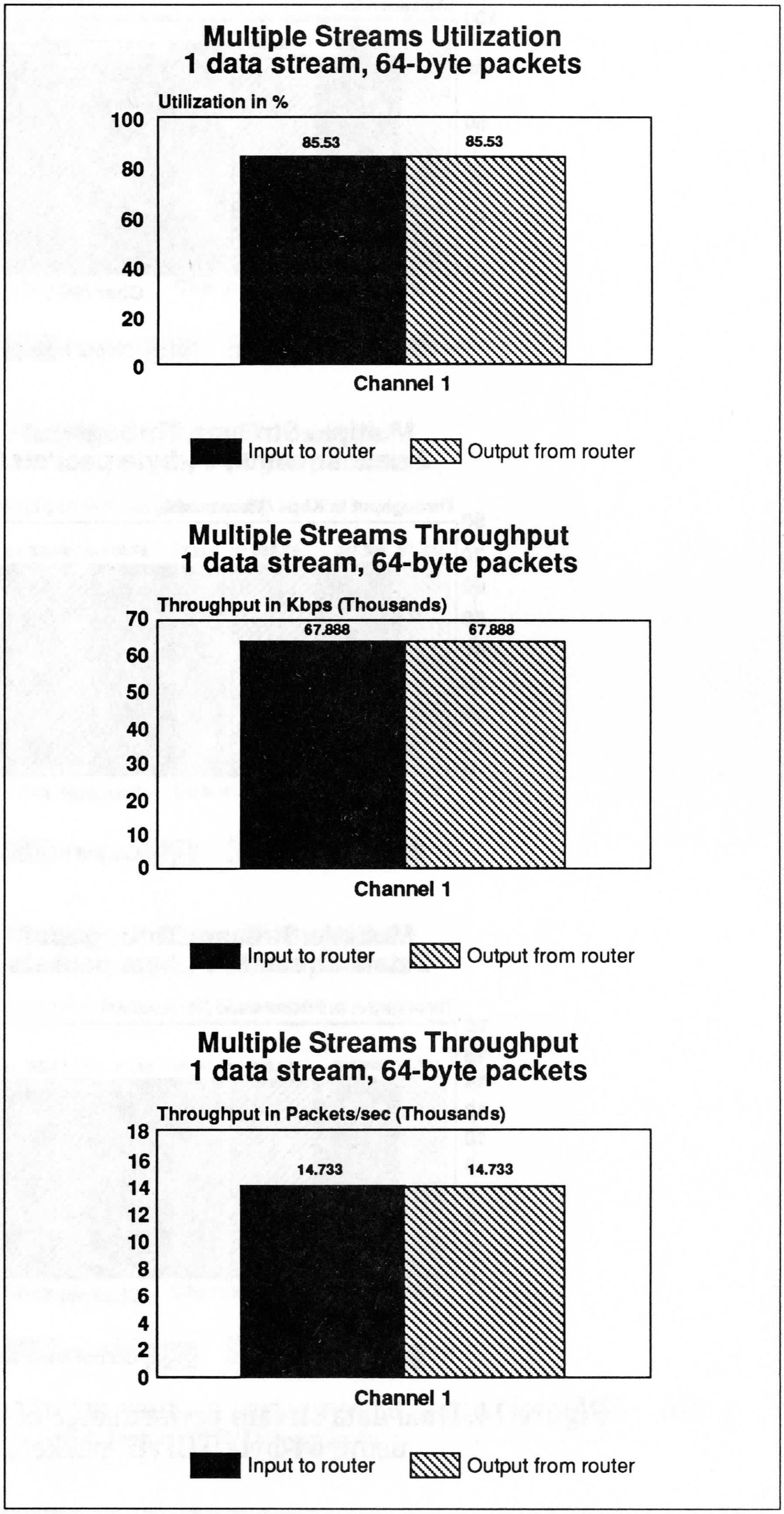


Figure 13. Single data stream performance of the cisco AGS+ using 64-byte TCP/IP packets.

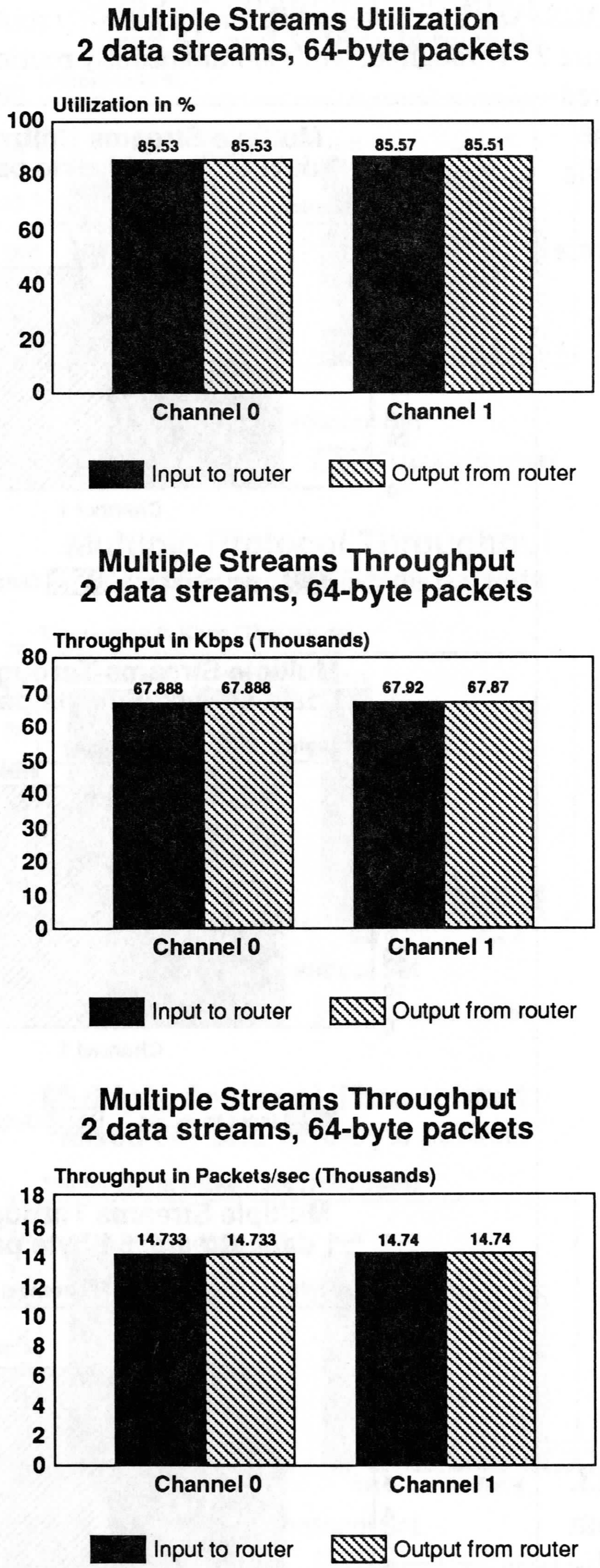


Figure 14. Dual data stream performance of the cisco AGS+ using 64-byte TCP/IP packets.

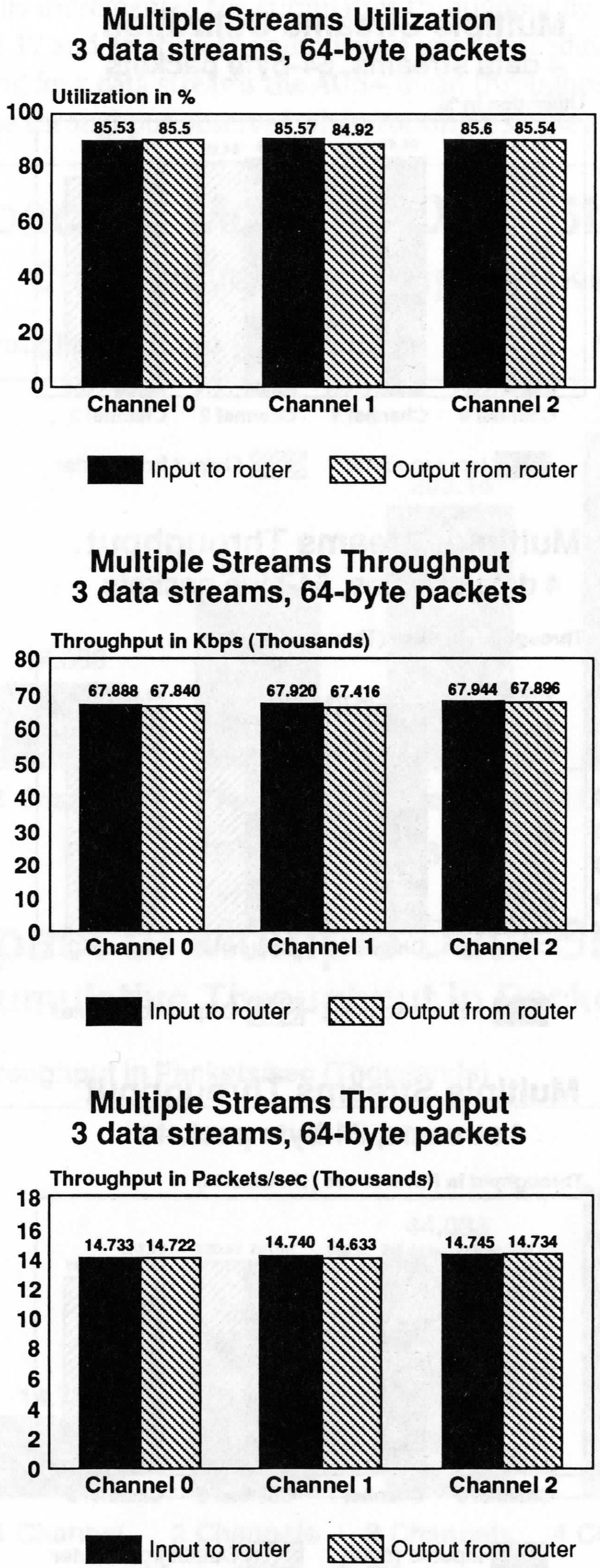


Figure 15. Three data stream routing performance of the cisco AGS+ using 64-byte TCP/IP packets.

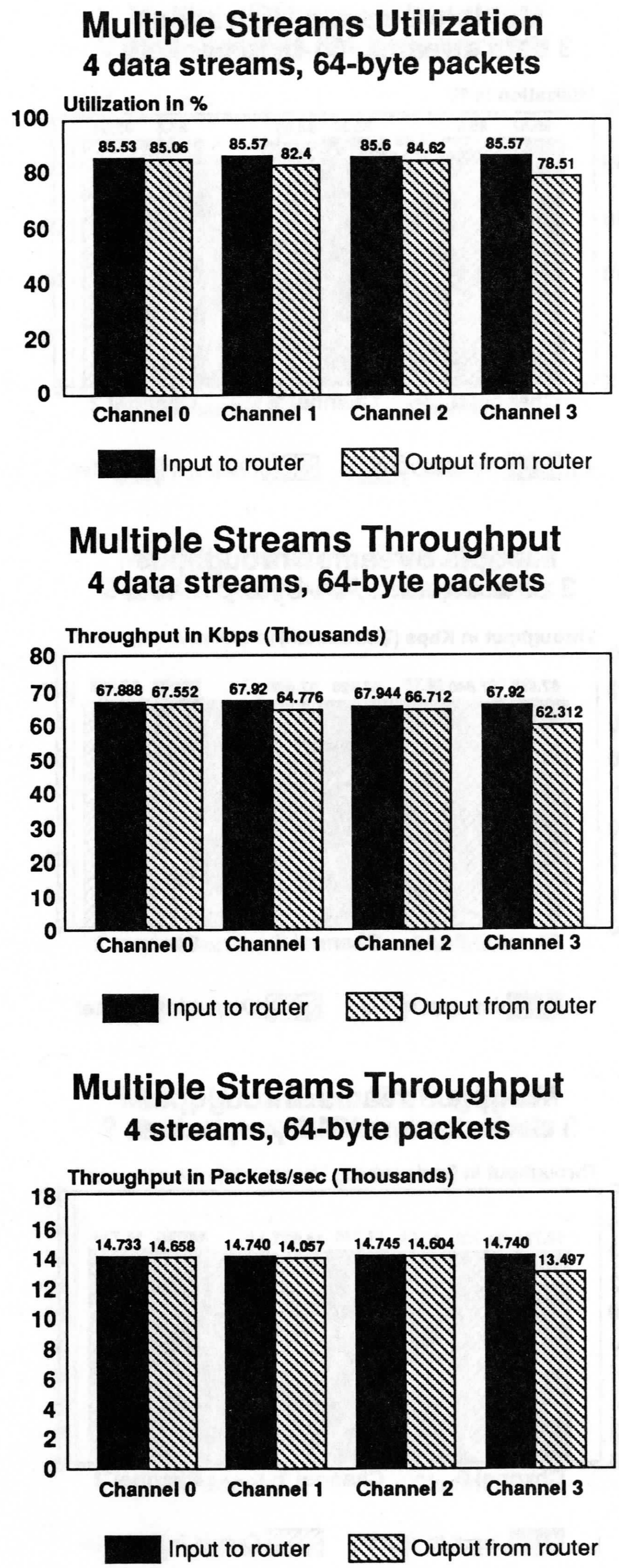


Figure 16. Four data stream routing performance of the cisco AGS+ using 64-byte TCP/IP packets.

Throughput with a single data stream was 8,484 Kbps and 14,733 packets per second. Adding data streams essentially incremented the cumulative throughput by these amounts of each stream added. Figure 17 and 18 show the cumulative impact of adding data streams. When simultaneously routing four data streams the AGS+ mean throughput per channel was only four percent below the throughput observed when routing a single stream.

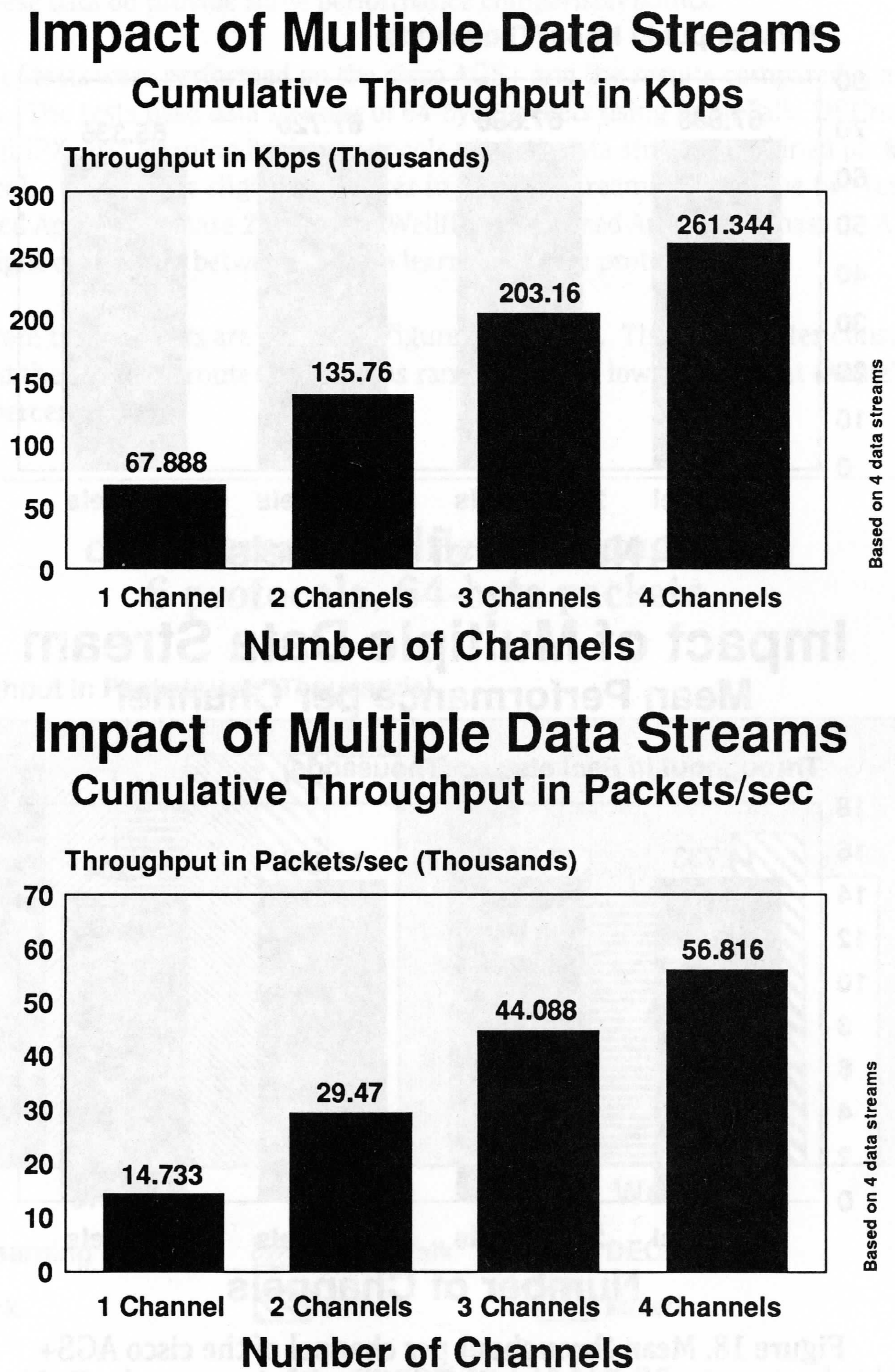
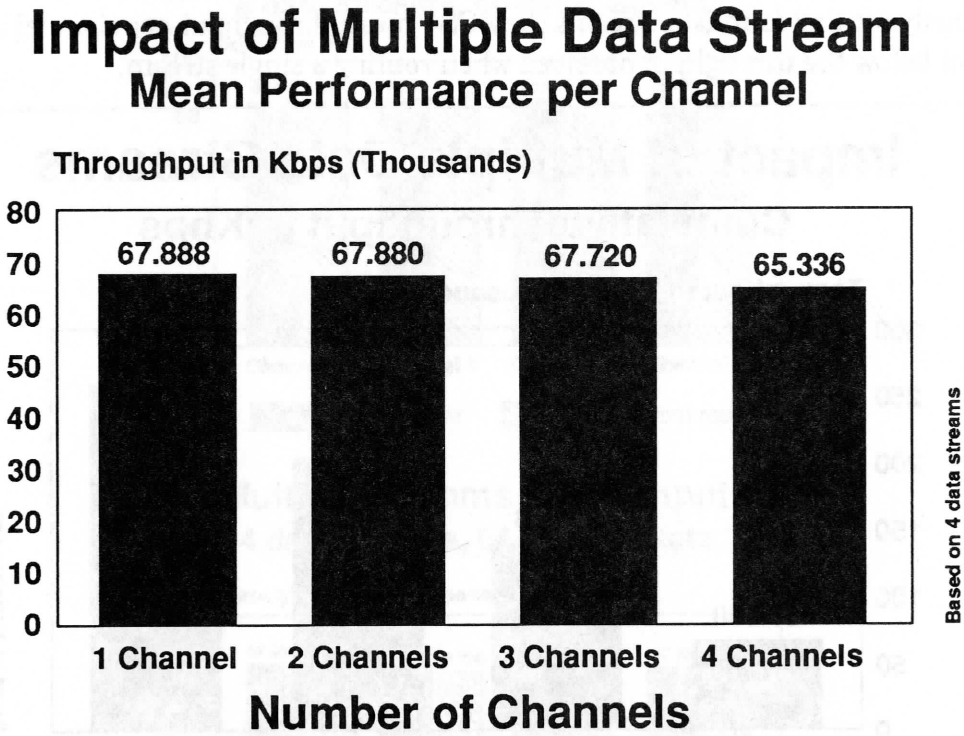


Figure 17. Aggregate throughput of the cisco AGS+ router routing 64-byte TCP/IP packets.



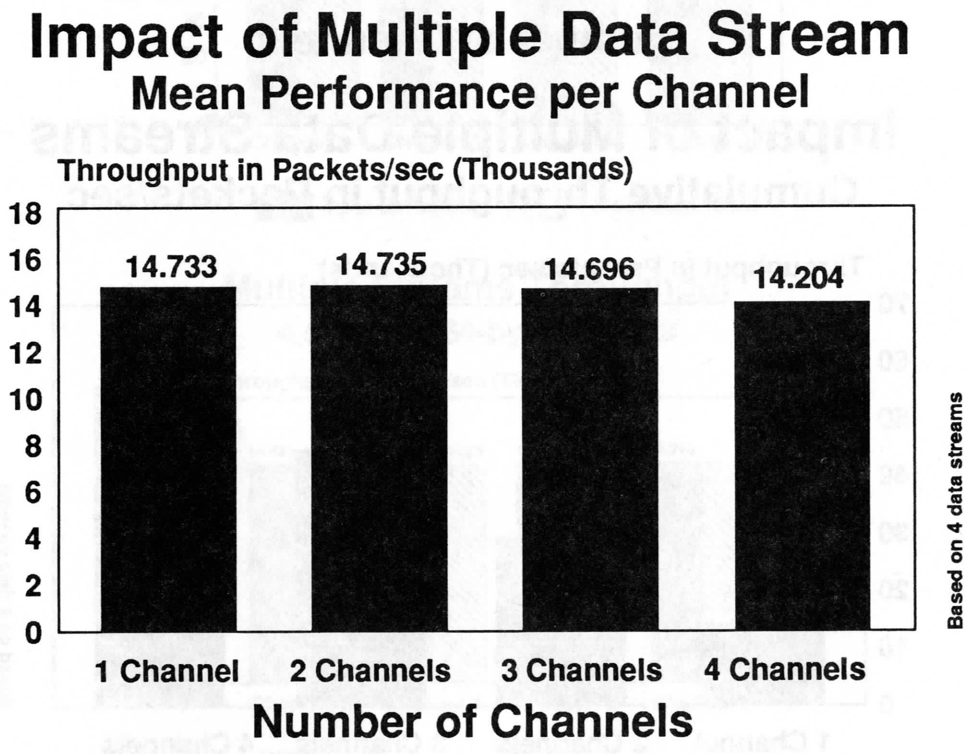


Figure 18. Mean throughput per channel of the cisco AGS+ using 64-byte TCP/IP packets.

Comparing cisco and Wellfleet Routers

Prior to performing these tests, LanQuest Labs performed a parallel set of tests for Infonetics Research Corporation using a Wellfleet Communications router. The results of these tests have been distributed as part of a report prepared by IRC. Although less extensive than the cisco tests, these data do provide some performance comparison points.

A parallel set of tests were performed on the cisco AGS+ and the results compared against the Wellfleet data. The tests used data streams of 64-byte packets using AppleTalk, DECnet IV, TCP/IP, Novell IPX, and learning bridge protocols. A sixth data stream combined packets from all five protocols. There were slight differences in the data streams used in the two tests. The cisco tests used AppleTalk Phase 2 while the Wellfleet tests used AppleTalk Phase 1. Also, there were slight differences between the two learning bridge protocols.

The results from the two tests are shown in Figures 19 and 20. The cisco router consistently out performed the Wellfleet router by margins ranging from a low of 4 percent (AppleTalk) to a high of 58 percent (IPX).

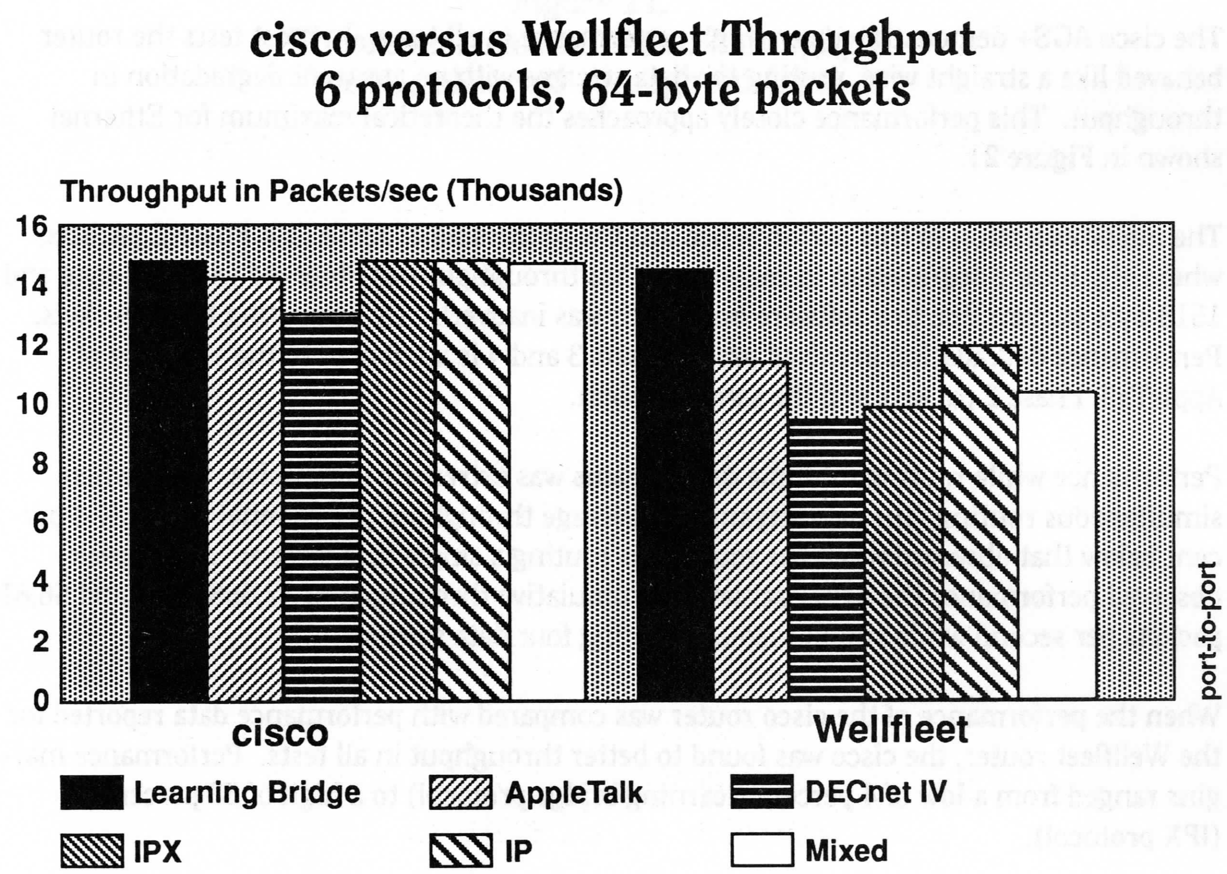


Figure 19. Performance of the cisco AGS+ and Wellfleet router/bridges.

PROTOCOL	cisco	Wellfleet
Learning Bridge	14,741	14,472
AppleTalk	14,472	11,343
DECnet IV	13,154	9,047
IPX	14,740	9,337
IP	14,741	12,158
Mixed	14,734	10,281

Figure 20.
A comparison of cisco and Wellfleet router performance in port-to-port mode, routing 64-byte packets. Throughput is shown in packets per second (pps).

Conclusions

The cisco AGS+ demonstrated very high performance in all tests. In most tests the router behaved like a straight wire, routing the data streams with no apparent degradation in throughput. This performance closely approaches the theoretical maximum for Ethernet shown in Figure 21.

The major exception to this performance was the processing of AppleTalk Phase 2 packets, where significant degradation in measured Kbps throughput was observed with 512-byte and 1518-byte packets due to a software bug which was inadvertantly truncating these packets. Performance degradation in mixed protocol sets 3 and 4 is attributed to the presence of AppleTalk Phase 2 packets and the same problem.

Performance while routing multiple data streams was extremely impressive. Even when simultaneous routing four data streams the average throughput per channel was only 4 percent below that observed when the router was routing a single data stream. At the peak observed performance the AGS+ achieved a cumulative throughput of 32,668 Kbps and 56,816 packets per second while simultaneously routing four data streams.

When the performance of the cisco router was compared with performance data reported for the Wellfleet router, the cisco was found to better throughput in all tests. Performance margins ranged from a low of 4 percent (learning bridge protocol) to a high of 58 percent (IPX protocol).

	PACKET SIZE		
	64	512	1518
Theoretical Maximum Throughput	14792	2347	812
Observed cisco Throughput			
AppleTalk Phase 2	14742	2278	804
CLNS	9271	2228	804
DECnet IV	13154	2277	805
TCP/IP	14742	2278	804
IPX	14741	2278	804
XNS	14742	2278	804

NOTE: Theoretical Maximum Throughput was calculated by:

10,000,00/(packet size * 8) + 64 (preamble) + 100 (interpacket gap)

Figure 21.
Theoretical maximum data throughput versus observed throughput (pps).

APPENDIX 1:

ROUTER CONFIGURATION FILES FOR TESTS

```
*******************************************************************
FOR IP:
*******************************************************************
uut-ip

!
no service config
!
!
!
!
!
!
!
!
!
!
!
interface Ethernet 0
ip address 131.108.165.66 255.255.255.0
no keepalive
!
interface Ethernet 1
ip address 131.108.165.66 255.255.255.0
no keepalive
!
interface Ethernet 2
no ip address
shutdown
!
interface Ethernet 3
no ip address
shutdown
!
interface Ethernet 4
```

```
no ip address
shutdown
!
interface Ethernet 5
no ip address
shutdown
!
interface Ethernet 6
no ip address
shutdown
!
interface Ethernet 7
no ip address
shutdown
!
interface Ethernet 8
no ip address
shutdown
!
interface Ethernet 9
no ip address
shutdown
!
interface Ethernet 10
no ip address
shutdown
!
interface Ethernet 11
no ip address
shutdown
!
!
!
!
!
!
!
!
!
!
ip name-server 255.255.255
hostname uut
```

```
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
******************************************************************
back-ip

!
no service config
!
!
!
!
!
!
!
!
!
!
interface Ethernet 0
ip address 131.108.165.4 255.255.255.0
no keepalive
!
interface Serial 0
no ip address
shutdown
!
interface Ethernet 1
ip address 131.108.167.77 255.255.255.0
```

```
shutdown
!
interface Serial 1
no ip address
shutdown
!
!
!
!
!
!
!
!
!
!
!
ip name-server 255.255.255
hostname back
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
```

****

FOR BRIDGING:

****

```
uut-bri


!
no service config
!
```

```
no ip routing
!
!
!
!
!
!
!
!
!
interface Ethernet 0
ip address 131.108.161.66 255.255.255.0
no ip route-cache
no keepalive
bridge-group 1
!
interface Ethernet 1
ip address 131.108.165.66 255.255.255.0
no ip route-cache
no keepalive
bridge-group 1
!
interface Ethernet 2
no ip address
shutdown
!
interface Ethernet 3
no ip address
shutdown
!
interface Ethernet 4
no ip address
shutdown
!
interface Ethernet 5
no ip address
shutdown
!
interface Ethernet 6
no ip address
shutdown
!
```

```
interface Ethernet 7
no ip address
shutdown
!
interface Ethernet 8
no ip address
shutdown
!
interface Ethernet 9
no ip address
shutdown
!
interface Ethernet 10
no ip address
shutdown
!
interface Ethernet 11
no ip address
shutdown
!
!
!
!
!
!
!
!
!
!
ip name-server 255.255.255
bridge 1 protocol dec
hostname uut
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
```

```
line vty 2
line vty 3
line vty 4
!
end
*********************************************************************
back-bri

!
no service config
!
no ip routing
!
!
!
!
!
!
!
!
!
interface Ethernet 0
ip address 131.108.165.4 255.255.255.0
no ip route-cache
no keepalive
!
interface Serial 0
no ip address
shutdown
!
interface Ethernet 1
ip address 131.108.167.77 255.255.255.0
no ip route-cache
no keepalive
!
interface Serial 1
no ip address
shutdown
!
!
!
```

```
!
!
!
!
!
!
!
!
ip name-server 255.255.255
bridge 1 protocol dec
hostname back
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
```

****

FOR DECnet

****

```
uut-dec

!
no service config
!
no ip routing
!
decnet routing 4.27
decnet node-type routing-iv
!
!
!
```

```
!
!
!
interface Ethernet 0
ip address 131.108.161.66 255.255.255.0
no ip route-cache
no keepalive
decnet cost 4
!
interface Ethernet 1
ip address 131.108.165.66 255.255.255.0
no ip route-cache
no keepalive
decnet cost 4
!
interface Ethernet 2
no ip address
shutdown
!
interface Ethernet 3
no ip address
shutdown
!
interface Ethernet 4
no ip address
shutdown
!
interface Ethernet 5
no ip address
shutdown
!
interface Ethernet 6
no ip address
shutdown
!
interface Ethernet 7
no ip address
shutdown
!
interface Ethernet 8
no ip address
shutdown
```

```
!
interface Ethernet 9
no ip address
shutdown
!
interface Ethernet 10
no ip address
shutdown
!
interface Ethernet 11
no ip address
shutdown
!
!
!
!
!
!
!
!
!
!
ip name-server 255.255.255
hostname uut
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
```

****

back-dec

```
!
no service config
!
no ip routing
!
decnet routing 4.77
decnet node-type routing-iv
!
!
!
!
!
!
interface Ethernet 0
ip address 131.108.165.4 255.255.255.0
no ip route-cache
no keepalive
decnet cost 4
!
interface Serial 0
no ip address
shutdown
!
interface Ethernet 1
ip address 131.108.167.77 255.255.255.0
no ip route-cache
no keepalive
!
interface Serial 1
no ip address
shutdown
!
!
!
!
!
!
!
!
!
!
```

```
!
ip name-server 255.255.255
hostname back
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
```

****

FOR Appletalk

****

```
uut-apple

!
no service config
!
no ip routing
!
appletalk routing
!
!
!
!
!
!
!
interface Ethernet 0
ip address 131.108.161.66 255.255.255.0
no ip route-cache
no keepalive
appletalk cable-range 676-676 676.128
```

```
appletalk zone speedy
!
interface Ethernet 1
ip address 131.108.165.66 255.255.255.0
no ip route-cache
no keepalive
appletalk cable-range 677-677 676.128
appletalk zone speedy
!
interface Ethernet 2
no ip address
shutdown
!
interface Ethernet 3
no ip address
shutdown
!
interface Ethernet 4
no ip address
shutdown
!
interface Ethernet 5
no ip address
shutdown
!
interface Ethernet 6
no ip address
shutdown
!
interface Ethernet 7
no ip address
shutdown
!
interface Ethernet 8
no ip address
shutdown
!
interface Ethernet 9
no ip address
shutdown
!
interface Ethernet 10
```

```
no ip address
shutdown
!
interface Ethernet 11
no ip address
shutdown
!
!
!
!
!
!
!
!
!
!
ip name-server 255.255.255
hostname uut
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
*********************************************************************
back-apple


!
no service config
!
no ip routing
!
```

```
appletalk routing
!
!
!
!
!
!
!
interface Ethernet 0
ip address 131.108.165.4 255.255.255.0
no ip route-cache
no keepalive
appletalk cable-range 677-677 677.129
no appletalk zone
appletalk zone speedy
!
interface Serial 0
no ip address
shutdown
!
interface Ethernet 1
ip address 131.108.167.77 255.255.255.0
no ip route-cache
no keepalive
!
interface Serial 1
no ip address
shutdown
!
!
!
!
!
!
!
!
!
!
!
ip name-server 255.255.255
hostname back
!
```

```
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
```

****

FOR XNS

****

```
uut-xns


!
no service config
!
no ip routing
!
xns routing AA00.0400.1B10
xns maximum-paths 1
!
!
!
!
!
!
interface Ethernet 0
ip address 131.108.161.66 255.255.255.0
no ip route-cache
no keepalive
xns network 1164
!
interface Ethernet 1
ip address 131.108.165.66 255.255.255.0
no ip route-cache
```

```
no keepalive
xns network 1165
!
interface Ethernet 2
no ip address
shutdown
!
interface Ethernet 3
no ip address
shutdown
!
interface Ethernet 4
no ip address
shutdown
!
interface Ethernet 5
no ip address
shutdown
!
interface Ethernet 6
no ip address
shutdown
!
interface Ethernet 7
no ip address
shutdown
!
interface Ethernet 8
no ip address
shutdown
!
interface Ethernet 9
no ip address
shutdown
!
interface Ethernet 10
no ip address
shutdown
!
interface Ethernet 11
no ip address
shutdown
```

```
!
!
!
!
!
!
!
!
!
!
ip name-server 255.255.255
hostname uut
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
*********************************************************************
back-xns


!
no service config
!
no ip routing
!
xns routing AA00.0400.4D10
xns maximum-paths 1
!
!
!
!
```

```
!
!
interface Ethernet 0
ip address 131.108.165.4 255.255.255.0
no ip route-cache
no keepalive
xns network 1165
!
interface Serial 0
no ip address
shutdown
!
interface Ethernet 1
ip address 131.108.167.77 255.255.255.0
no ip route-cache
no keepalive
xns network 91
!
interface Serial 1
no ip address
shutdown
!
!
!
!
!
!
!
!
!
!
!
ip name-server 255.255.255
hostname back
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
```

```
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
```

****

FOR IPX

****

```
uut-ipx


!
no service config
!
no ip routing
!
novell routing AA00.0400.1B10
!
!
!
!
!
!
!
interface Ethernet 0
ip address 131.108.161.66 255.255.255.0
no ip route-cache
no keepalive
novell network 1164
!
interface Ethernet 1
ip address 131.108.165.66 255.255.255.0
no ip route-cache
no keepalive
novell network 1165
!
interface Ethernet 2
no ip address
shutdown
!
```

```
interface Ethernet 3
no ip address
shutdown
!
interface Ethernet 4
no ip address
shutdown
!
interface Ethernet 5
no ip address
shutdown
!
interface Ethernet 6
no ip address
shutdown
!
interface Ethernet 7
no ip address
shutdown
!
interface Ethernet 8
no ip address
shutdown
!
interface Ethernet 9
no ip address
shutdown
!
interface Ethernet 10
no ip address
shutdown
!
interface Ethernet 11
no ip address
shutdown
!
!
!
!
!
!
!
```

```
!
!
!
ip name-server 255.255.255
hostname uut
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
```

****

back-ipx

```
!
no service config
!
no ip routing
!
novell routing AA00.0400.4D10
!
!
!
!
!
!
!
interface Ethernet 0
ip address 131.108.165.4 255.255.255.0
no ip route-cache
no keepalive
novell network 1165
```

```
!
interface Serial 0
no ip address
shutdown
!
interface Ethernet 1
ip address 131.108.167.77 255.255.255.0
no ip route-cache
no keepalive
novell network 5B
!
interface Serial 1
no ip address
shutdown
!
!
!
!
!
!
!
!
!
!
!
ip name-server 255.255.255
hostname back
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
```

```
**********************************************************************
FOR CLNS
**********************************************************************
uut-clns


!
no service config
!
no ip routing
!
!
!
!
clns NET 49.0008.3976
clns routing
!
!
!
interface Ethernet 0
ip address 131.108.161.66 255.255.255.0
no ip route-cache
no keepalive
clns enable
!
interface Ethernet 1
ip address 131.108.165.66 255.255.255.0
no ip route-cache
no keepalive
clns enable
!
interface Ethernet 2
no ip address
shutdown
!
interface Ethernet 3
no ip address
shutdown
!
interface Ethernet 4
no ip address
shutdown
```

```
!
interface Ethernet 5
no ip address
shutdown
!
interface Ethernet 6
no ip address
shutdown
!
interface Ethernet 7
no ip address
shutdown
!
interface Ethernet 8
no ip address
shutdown
!
interface Ethernet 9
no ip address
shutdown
!
interface Ethernet 10
no ip address
shutdown
!
interface Ethernet 11
no ip address
shutdown
!
!
!
!
!
!
!
!
!
!
ip name-server 255.255.255
hostname uut
!
line vty 04
```

```
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
***********************************************************************
back-clns


!
no service config
!
no ip routing
!
!
!
clns NET 49.0008.1234
clns routing
!
!
!
!
interface Ethernet 0
ip address 131.108.165.4 255.255.255.0
no ip route-cache
no keepalive
clns enable
!
interface Serial 0
no ip address
shutdown
!
interface Ethernet 1
ip address 131.108.167.77 255.255.255.0
```

```
no ip route-cache
no keepalive
!
interface Serial 1
no ip address
shutdown
!
!
!
!
!
!
!
!
!
!
!
ip name-server 255.255.255
hostname back
!
line vty 04
login
!
line con 0
exec-timeout 0 0
transport preferred none
line aux 0
line vty 0
line vty 1
line vty 2
line vty 3
line vty 4
!
end
```