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Networks Marketing

DECNIS 600 Performance

DECNIS 600 - the Performance Leader of Multiprotocol Routers

Document Number: NIPG-001-02 December, 1993

Abstract

The performance of multiprotocol routers is an important consideration when choosing from the many router products available today. Several important factors, such as definitions of speed and throughput, need to be considered when comparing the performance of router products from different vendors. Understanding these factors helps to ensure that the quoted performance of different vendors products can be compared on an equal basis. This document looks at these important factors and shows that Digital's DECNIS 600 router is the highest performing backbone router on the market today.

Scott Bradner of Harvard University conducts objective router performance tests that focus on speed and throughput measurements. At the Interop trade show in San Francisco in August 1993, Scott Bradner reported on test results for routers from over 45 vendors. This paper summarises a few key results from the Bradner tests, and describes how the DECNIS 600 router achieved the highest throughput performance recorded in those tests. This paper concludes with a discussion of the router performance issues that affect network stability and availability. Copies of Scott Bradner's Interop presentation are available over the Internet by anonymous ftp from:

hsdndev.harvard.edu in */pub/ndtl*

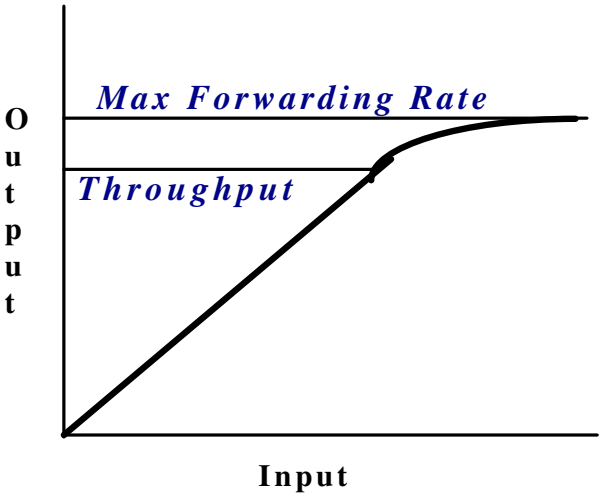
Using this information, you can review the comprehensive test results and evaluate directly the performance of the DECNIS 600 with other multiprotocol router products.

Introduction

The performance of multiprotocol routers is an important consideration when choosing a multiprotocol backbone router. The first metric to consider is speed or packet throughput. The second metric, which is often overlooked, is the router's ability to maintain network stability under all load conditions. Digital's DECNIS 600 router is the highest performing multiprotocol backbone router on the market today, according to these measures of performance.

Definitions of Throughput and Performance

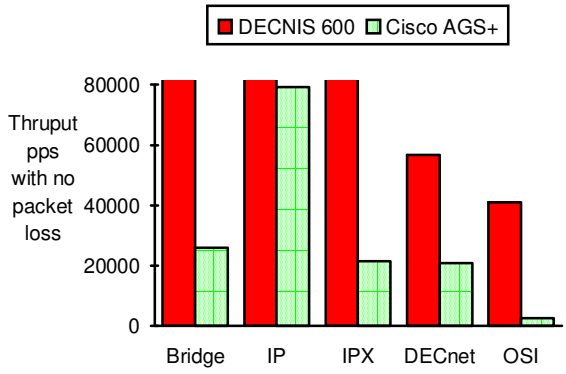
Before looking at router performance in detail, we first need to define the term "throughput" more specifically. The Internet Engineering Task Force (IETF) Benchmarking Methodology Working Group chaired by Scott Bradner has defined throughput in RFC 1242 as "the maximum data rate at which none of the offered frames are dropped by the device (router)". The most recent Bradner tests provide results according to this standard definition with no packet loss, and results for maximum forwarding rates with packet loss. The information presented in this document uses results according to the standard definition with no packet loss.



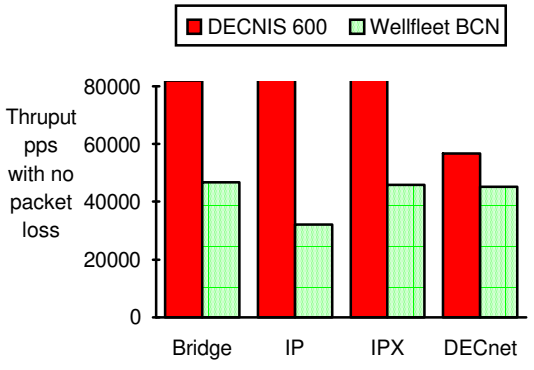
Many vendors promote the performance of their routers by citing packet forwarding rates much greater than the router's throughput as measured according to the standard, zero packet loss, definition. How is this possible? The router may indeed be forwarding packets at the higher rate, but it is also dropping packets at the same time, as illustrated in the figure opposite. Once packet loss begins, the performance of network applications is degraded as response time delays and additional network traffic result from error recovery procedures at the transport level. The additional error recovery further degrades the performance of the already overloaded routers. Packet loss in routers which are not designed correctly can also effect network stability, as we will discuss below.

Backbone Router Performance

To measure the overall capacity of a router, a performance test must stress the router with large data inputs on as many router ports as possible. Amongst the most stressful Bradner tests involved routers with 12 Ethernet ports. Uni-directional traffic inputs were applied to six input ports. Each input data stream contained packets destined for all six output ports. The aggregate throughput results for Digital's DECNIS 600 router, Cisco System's AGS+ router, and Wellfleet Communications' Backbone Concentrator Node for 64 byte packets are summarised below for bridging, TCP/IP, IPX, DECnet, and OSI routing.



System Performance, 64 Byte Packets (Source: Bradner 1993, e2e-6)



System Performance, 64 Byte Packets (Source: Bradner, 1993, e2e-6)

The results of this test demonstrate that Digital's DECNIS 600 router provides:

- *The highest system throughput of any router that participated in the Bradner tests, with consistently high performance for all protocols with no packet loss, including bridging and the routing of TCP/IP, IPX, DECnet and OSI CLNP protocols.*

- *Between two and three times the system performance of the Cisco AGS+ router for bridging, DECnet routing and IPX routing. For OSI routing, the DECNIS 600 router provides an order of magnitude greater performance than the Cisco AGS+ router.*

The DECNIS router's superior OSI routing performance is important in OSI networks, but also indicates the ability to deliver high performance when routing packets with complex, variable length headers. This capability will be important in maintaining TCP/IP routing performance when the TCP/IP protocol is enhanced to accommodate larger networks and address spaces.

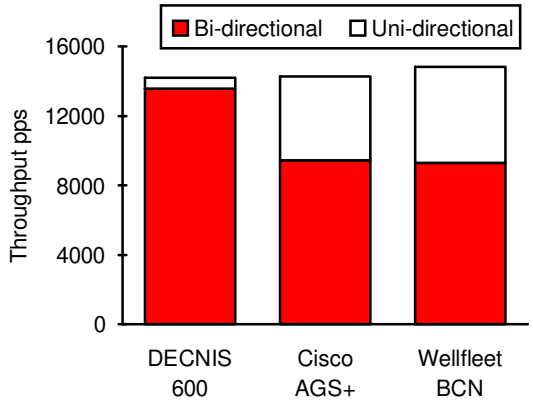
The DECNIS 600 router is based on a distributed processing architecture. Each interface card has its own processors and custom-designed silicon to accelerate the address recognition, routing decisions, and packet forwarding processes that govern overall router performance. This allows the DECNIS 600 router to deliver consistently high and scaleable performance.

As new interface cards are added to the DECNIS 600 router, performance increases proportionally up to the current 83,000 packet-per-second system capacity. Consistently high performance is maintained as new protocols are added to the network, and as information is routed between ports on the same DECNIS 600 interface card or between ports on different cards.

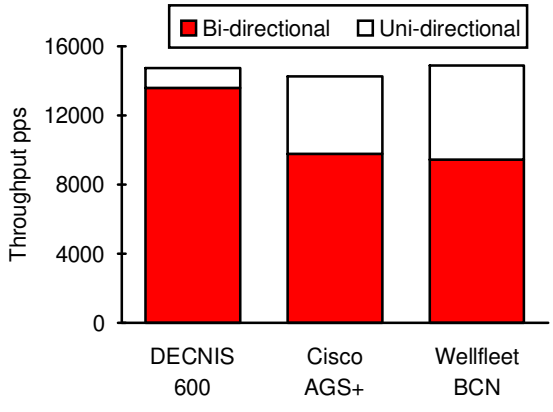
Performance in Real Life Networks

The system performance tests described above loaded the routers with data streams in one direction only and the routers tested did not have to deal with the substantial level of network control or management traffic present in real networks. The DECNIS 600 router is designed to provide a greater performance advantage in more complex, real life networks than demonstrated in the simplified environment of laboratory performance tests. In fact, the *DECNIS 600 router provides leading performance when routing or bridging realistic bi-directional traffic.*

Although no bi-directional data is available for the latest Bradner tests, the following charts show the bi-directional test results announced in October 1992 for bridging and IP routing for 64 byte packets. The router throughput for unidirectional and bi-directional traffic flows are shown in each case.

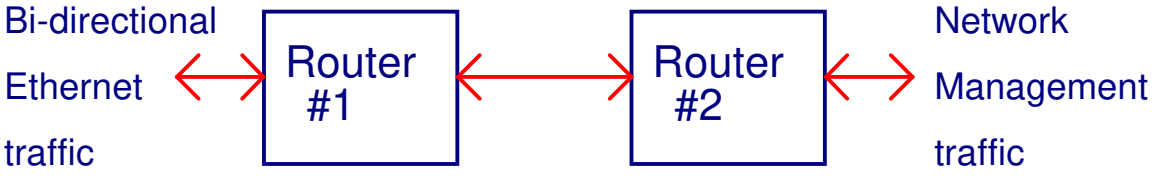


Bridge Throughput, 64 byte packets
(Source: Bradner,1992,e2e-1tb,e2e-1b)



IP Throughput, 64 byte packets
(Source: Bradner,1992, e2e-1tb, e2e-1b)

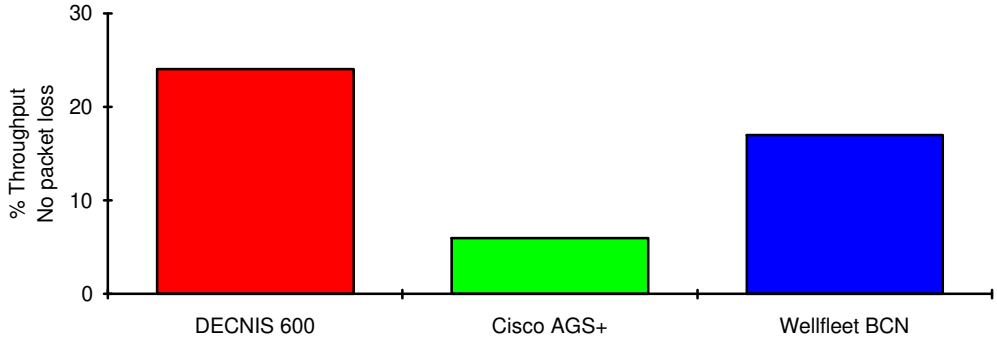
These tests show that even in simple, two-port, router configurations there can be significant differences in router performance. With uni-directional traffic flows, all three routers achieved throughput close to the theoretical limit of 14,880 packets-per-second. When more realistic bi-directional traffic was introduced, the DECNIS 600 router achieved significantly better bridging and IP routing throughput than the Cisco AGS+ and the Wellfleet Backbone Node routers.



The DECNIS 600 router achieves this leading bi-directional performance by using two Ethernet transceiver chips on each Ethernet port. The use of one transceiver for transmitting and the other for receiving eliminates the performance degradation that would be caused by the latency time for one chip to shift from transmit to receive mode. This is one example of the design features that gives the DECNIS 600 router a performance advantage in real world network conditions.

FDDI Performance

The Bradner results for TCP/IP routing of 64 byte packets between two FDDI networks show throughput figures for each router measured according to the standard zero packet loss definition. These throughput figures are expressed as a percentage of the maximum FDDI throughput of approximately 186,000 pps in the following table.



System Performance, 64 Byte Packets
Source: Bradner 1993, f2f.br, f2f.ip

The results show that the *DECNIS 600 router delivered four times the FDDI throughput with no packet loss than the Cisco router and over 40% more than the Wellfleet router.* The DECNIS 600 throughput figure of 24% in the above table equates to over 33,000 pps between FDDIs *with no packet loss* using 64 byte packets.

Network Stability

The second metric of router performance which is equally important is the behaviour of the router when the throughput limit is reached. This behaviour can effect the stability of the network and thus the network availability.

As well as transmitting data packets generated by network applications, routers must handle network control and management packets. Network control packets are exchanged between routers in the network, for example to establish and maintain bridging topologies and to establish and maintain routing tables.

It is essential that routers process network control messages under all traffic conditions. If network control messages are dropped by a router, other routers in the network may conclude that the first router (or links to it) has failed. This may cause a network reconfiguration, during which parts of the network will be unavailable. The network may experience periods of instability, with reconfigurations occurring regularly as the overloaded router(s) periodically fail to process network control and management messages correctly.

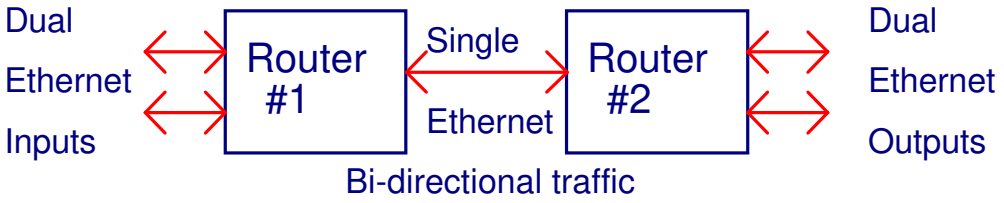
As the performance results summarised above show, traffic levels exceeding a router's throughput threshold can occur in many networks, especially those with FDDI LANs. For example, most of the routers tested reached their throughput (zero packet loss) limit at traffic levels corresponding to only a few percent of FDDI utilisation. Under these overload conditions, if the router drops network control packets, instead of recoverable application data packets, then network instability can occur.

The DECNIS 600 router is designed to always process network control messages, and therefore to maintain network stability and availability under all network load or overload conditions. Some of the design features of the DECNIS 600 router that deliver this robust performance include:

- Bridge filtering at 100% of Ethernet and near 100% FDDI rates
- Custom hardware on each interface card to trap routing protocol packets

- Separate queues which prioritise and guarantee the processing of control and management packets over data packets.

The Bradner tests included configurations in which routers were deliberately forced to drop packets. The test results show that the DECNIS 600 router always maintained the stability of the network. One of the most stressful configurations for testing routers during overload is shown in the following diagram.



Overload Test Configuration (Source: Bradner 1993, e2eve-2)

The test was conducted with a pair of DECNIS 600 routers with bi-directional data streams at the full Ethernet rate applied to both input ports on Router #1. Because only a single Ethernet path exists between the routers, only half of the total input traffic could possibly be forwarded to Router #2. When bridging and routing 64 byte packets, the DECNIS 600 routers delivered 14766 pps to the output ports, almost the theoretical maximum of 50% of the input packets. The DECNIS 600 was the only router tested in this configuration.

Conclusion

Digital strongly supports efforts throughout the industry to provide customers with more complete information regarding the performance of multiprotocol routers. This includes support for organisations, such as the IETF's Benchmarking Methodology Working Group, that are developing test procedures and standards for measuring the performance of routers and internetworks. As more comprehensive tests are developed to evaluate router throughput and stability in complex loading conditions, Digital believes that the DECNIS 600 router will further demonstrate its performance leadership.

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