

## LAB TESTING SUMMARY REPORT

October 1998  
Report 231198

**DRAFT 2: 11-04-98**

Product Category:  
**Layer-3 Switches**

Vendor Tested:  
**Foundry  
Networks**

Product Tested:  
**BigIron 4000**



### Key findings and conclusions:

- The best price-performer, in both raw Layer-3 switching capacity and packet forwarding, among 7 Layer-3 switches recently tested by MierComm
- Supports IP and IPX routing—both implemented in hardware; AppleTalk routing also available
- Supports excellent Windows- and Web-based management applications

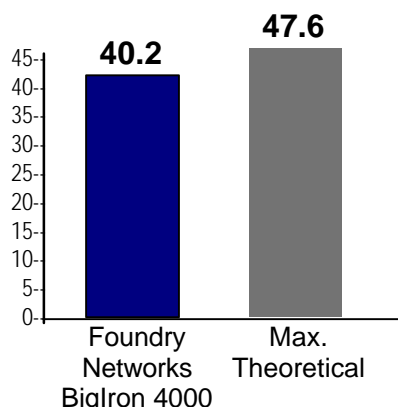
**F**oundry Networks' BigIron 4000 was lab-tested by Mier Communications using a methodology and test-bed that were developed especially for evaluating a new breed of Layer-3 switches that perform most routing tasks in hardware rather than software. These switches generally support custom ASICs (application-specific integrated circuits), originally developed for Layer-2 switches, to make them the basis for incredibly high-speed, high-capacity Layer-3 routing. The BigIron 4000 was tested with firmware 4.1.01. It received high marks for "Performance and Price Performance" and "Features and Functionality." The switch offers awesome power, delivering over 30 Gbps of raw, Layer-3 switching. It was also the best price-performer among the 7 Layer-3 switches recently evaluated by MierComm for a competitive evaluation published in *Business Communications Review* (October, 1998). BigIron 4000 is also rich with features, including good Layer-3 prioritization and filtering.

### Performance

The BigIron 4000, Foundry Networks' flagship product, is one of the Gigabit Ethernet market's top-performing products, and the vendor is

#### Packet-Forwarding Rates in Mpps\*

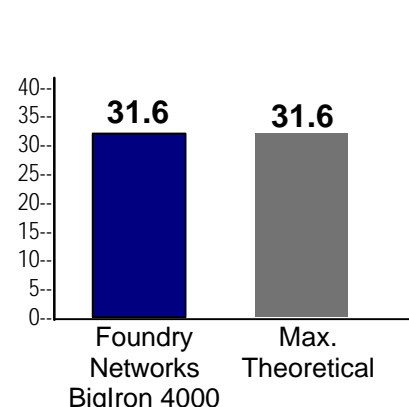
based on 64-byte IP packets



\*Millions of packets per second

#### Throughput in Gbps\*

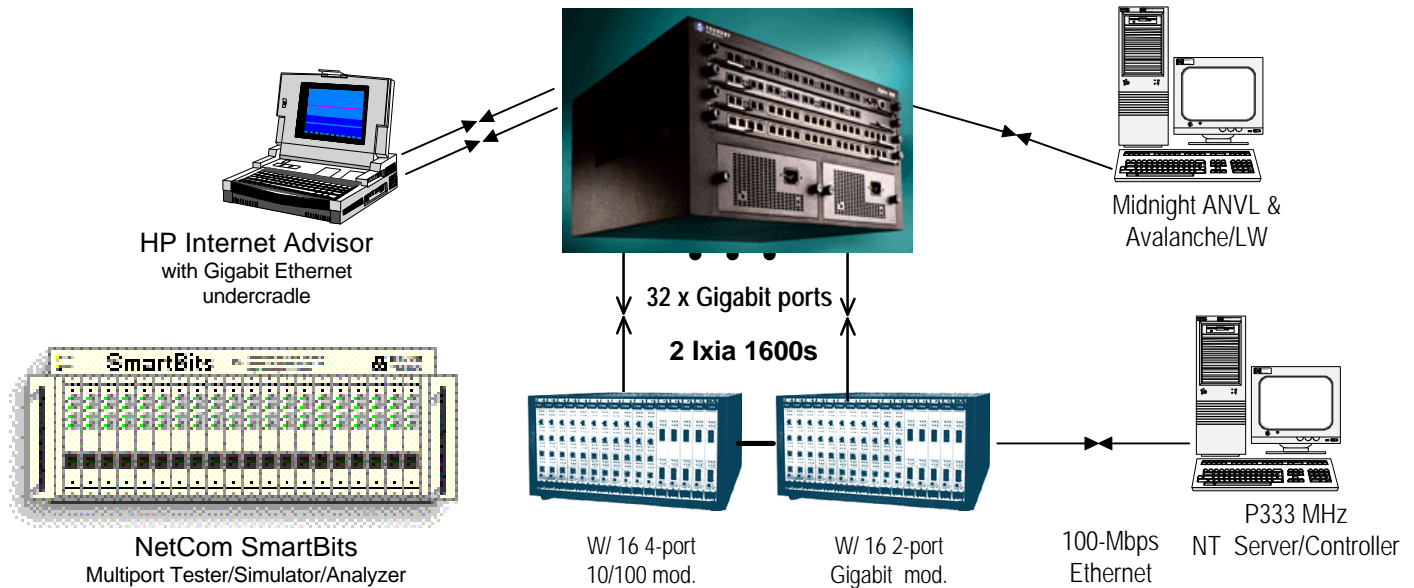
based on 1,518-byte IP packets



\*Gigabits per second

## Test Bed Set-up:

### Foundry Networks BigIron 4000



**About the testing...** Mier Communications and Ixia Communications developed performance test scripts for a traditional (back-to-back) paired port loading and a new “mesh” peak-load test, which uses a round-robin approach, combined with temporary overloading of various ports throughout the test. The mesh test also stresses the device’s buffering architecture, latency and jitter mechanisms. We also wrote scripts to test the prioritization of UDP over TCP. In these tests, 2 streams of traffic, one UDP and one TCP, were injected into separate input ports, all destined for the same output port, each stream at 75-percent line rate. The UDP packets were tagged and measured for throughput. The device under test was then configured to prioritize all UDP traffic. The destination port was then monitored for UDP packets received versus the TCP traffic. We determined the switch was prioritizing UDP flows if more tagged UDP packets made it through the second time. We also used 2 of Ixia Communications’ 16-slot traffic generators (the Ixia 1600), one configured with 16 4-port 10/100 modules and the other with 16 2-port Gigabit modules. This enabled us to concurrently load and test up to 64 10/100 ports and 32 Gigabit ports, as needed. Both Ixia systems were linked via 100 Mbps Ethernet to a P333 MHz NT server acting as a controller. This controller/server ran the Ixia/MierComm-developed test scripts. We also applied router conformance tests from using Midnight Networks’ Avalanche with Automated Networks Validation Library (ANVL). We used the ANVL, an automated software test tool for routing protocol compliance and interoperability, and the Avalanche/LW to simulate the existence of multiple network nodes and traffic flows. To verify throughput on Gigabit ports, we used NetCom Systems’ SmartBits test system, equipped with GX-1405 Gigabit cards, and Hewlett Packard’s HP J2901A LAN Internet Advisor with Gigabit Undercradle.

## Performance - continued

one that is making tremendous inroads into this new, but rapidly growing, segment. The BigIron 4000 is currently one of the top performers in the Layer-3 switching arena, and few products can come close to offering the power, and depth and breadth of features, this switch does.

We tested the BigIron 4000 with the maximum 32 Gigabit Ethernet ports, applying routable-IP loads on each Layer-3 port up to the port’s maximum, fully loaded capacity. Traffic was sent in both directions simultaneously. Switches that successfully processed all of the “offered load” in both directions, on all ports, were said to run at “wire speed,” which the BigIron 4000 did transferring 1,518-byte packets.

Overall, testing revealed that Layer-3 switches, including the BigIron 4000, deliver incredible routing throughputs, compared to “traditional” software-based routers. For example, while a typical router might deliver a maximum of 1 Mpps of packet forwarding (based on 64-byte IP packets), the BigIron delivered a maximum of 40.2 Mpps. The same holds true for throughput rates (based on 1,518-byte packets)—delivered at 31.6 Gbps. A “traditional” router cannot come close to this performance. In fact, only a couple of switches could even compete with the BigIron in performance. And, BigIron 4000 offers the added advantage of being the best price-performer among the switches tested.

## Performance - continued

Because Layer-3 switches are difficult to accurately compare simply on bottom-line list prices, we developed a price-performance ratio analysis to determine how the switches compare in terms of price per each Gbps of measured throughput supported, and per each millions of packets per second delivered.

Foundry Networks' price performance is the best (that is, the lowest) compared to the other Layer-3 switches evaluated. The BigIron 4000 had a price per Gbps of throughput of only \$2,309 in a range from \$2,309 to \$8,639, and a low price of \$1,817 per Mpps delivered, in a range from \$1,817 up to \$10,439. The \$2,309 per Gbps of throughput is the only number below \$3,000 in the competition, and the \$1,817 per Mpps of packet-forwarding is the only price below \$2,000.

**Latency**—the time interval that begins when the end of the first bit of the input frame reaches the input port and ends when the start of the first bit of the frame is seen on the output port—was measured for short, 64-byte IP packets and long, 1,518-byte IP packets.

The measurements shown below represent an average of 3 tests, conducted with Gigabit Ethernet ports. They were performed with unicast packets at 50-percent loading. All of these metrics were observed without jitter.

Latency Measurements (µsec.) Gigabit Ports	
64-byte IP Packets	1,518-byte IP Packets
7.6	31.3

Latency metrics below 20 µsec. for 64-byte packets, and below 50 µsec. for 1,518-byte packets, are considered negligible.

**UDP/TCP Prioritization.** A distinguishing factor among Layer-3 switches is support for prioritization of UDP (user datagram protocol) traffic, commonly used in voice-over-IP (VoIP) products, over TCP (transmission control protocol), which is used for most routine data traffic. MierComm thinks this is a key feature for switches designed for enterprise applications that will deploy VoIP products. The BigIron 4000 did support this feature, as well as prioritizing Web-based HTTP traffic over FTP.

## Configuration

The BigIron 4000 scored an 84 out of a possible 100 points for "configuration," placing it about in the middle third of Layer-3 switches tested (scores ranged from 92 to 72).

The BigIron 4000 is housed in a 4-slot chassis; all 4 slots can be used for port modules. The total Gigabit port capacity is 32 ports (8 per module), while the total 10/100 ports supported is 88 (24 per module, plus 16 10/100 ports on a management module).

In addition to Gigabit Ethernet and 10/100, the switch supports 100BaseFx, 1000BaseSx, 1000BaseLx, and 1000BaseLH ports.

The total switch address capacity on the product we tested is 32K, but a 256K version is planned for delivery soon. Total RAM memory is 32 Mbytes of fixed DRAM. BigIron 4000 supports 2 Mbytes of fixed buffer memory, which is shared in a buffer pool.

Noteworthy is the fact that Foundry Networks supports a full line of Layer-2, Layer-3, and Layer-4 switches and, at the time we tested the BigIron 4000, the vendor was about to add a newer, bigger switch to the product line. Dubbed the BigIron 8000, this new product will offer double the capacity of the BigIron 4000 (to 64 Gigabit Ethernet ports) making it the biggest Layer-3 switch in the industry.

## Foundry Networks BigIron 4000: Key Features

Switch software tested	4.1.01
Configuration	4-slot chassis; all 4 slots accept port modules
Max. number Gigabit Ethernet ports	32 (8 per module)
Max. number 10/100 ports	88 (24 per module, plus 16 10/100 ports on management module)
Other supported interfaces	100BaseFx; Gig Sx, Lx, and LH
IP routing support	RIP, RIPv2, OSPF; multicast: IGMP, IGMP snooping, DVMRP, PIM, BGP-4, VRRP
Other Layer-3 protocol routing	IPX (in hardware) and AppleTalk (in software)
Supports Layer-3 (L3) protocol-based VLANs	Yes, based on IP, IPX, AppleTalk, DECnet and NetBios/Netbeui
Layer-2 (L2) switching and L3 routing on same/all ports simultaneously	Yes
L3 filtering, user-definable	IP, IPX address, TCP port number, well-known protocol type
Prioritization: no. of queues per port	4
Prioritization of UDP traffic over TCP; HTTP over FTP	Yes; both
Prioritization based on IP TOS field	No
Redundancy options	Power supply
Hot-swappable modules	Power supply, line cards (except mgmt.)
Windows-/Web-based management application, interface(s)	IronView (4.0), Windows-based (\$1,495); also embedded Web server
Cost of switch as tested (US list price); ports included in price	\$72,975; 32 Gigabit Ethernet ports

## Installation and Ease of Use

The BigIron 4000 received overall score of "86" in this area, placing it in the "middle third" of the 7 Layer-3 switches evaluated. Significantly, we were able to run Layer-2 bridging and Layer-3 routing simultaneously "out of the box" on this product.

Initial set up involves assigning an IP address through the system console and then using the Windows-based or Web-based GUI for the rest of the procedure. Initial set up took about 15 minutes, which is about average for a Layer-3 switch. Modification of configuration parameters is easily accomplished through the GUI or the CLI by placing a "no" in front of an existing command.

Hardcopy documentation, shipped with the switch, was well-organized and accurate. Online documentation (delivered on CD-ROM) was planned at the time we tested, and is generally available now.

## Management and Administration

The BigIron 4000 is managed through Foundry Networks' IronView, version 4.0.0.0, which is a Windows-based application. A Web-based version, which operates on any frame-based browser, is also available. Overall, the IronView management application is one of the best we've seen. Real-time statistics are updated at 15-second intervals on the Web-based application, while a real-time graphic display of statistics is available through the Windows version, with polling available at 1- to 20-second intervals (user settable). Port settings are made via a drop down list, which is invoked by a mouse click. Per-port statistics can be graphed from a main table through the Windows application.

## Hits and Misses

### HITS

- Best price-performer among 7 Layer-3 switches tested
- Excellent GUI-based, Windows- and Web-based management, which includes Layer-3 routing configuration
- Good Layer-3 prioritization, including prioritization up to Layer 4
- Extensive user-definable Layer-3 filtering by IP/IPX address, TCP port number, and well-known protocol type
- Wire-speed performer switching 1,518-byte IP packets (31.6 Gbps)
- IP and IPX routing implemented in hardware; AppleTalk routing available
- Supports Layer-2 bridging and routing “out of the box” simultaneously
- Extensive support for Layer-3 functions on the IronView GUI, including RIP, OSPF, DVMRP, BGP-4, VRRP, PIM, IP, IPX, and AppleTalk
- Supports a very fast reboot time
- 90-day technical support with purchase

### MISSES

- Limited 10/100 port density (maximum 88 ports) compared to other systems tested
- Does not sustain wire-speed performance passing 64-byte IP traffic
- Limited redundancy (power supply only)

## Conclusions

Foundry Networks' BigIron 4000 offers a huge amount of power—31.6 Gbps of throughput and 40.2 Mpps of packet forwarding—and is the best price-performer among 7 Layer-3 switches evaluated by MierComm recently. The BigIron 4000 is also feature rich, supporting good Layer-3 prioritization, filtering, and IP and IPX routing that is implemented in hardware. Its excellent Windows- and Web-based management application tops off a truly excellent Layer-3 switch. Users looking for power and performance at a good price will find the BigIron 4000 an excellent prospect.

## Standardized Rating (100-point scale)

Category	Weighting	Score
Configuration (1)	10%	84
Installation and Ease of Use (2)	10%	86
Features/Functionality (3)	25%	88
Management and Administration (4)	25%	83
Performance (5)	30%	89
<b>The Bottom Line</b>		<b>86</b>

1. Includes configuration flexibility, port density, switch capacity, aspects of modularity; scalability, expandability, redundancy and resilience options.
2. Installation time; appropriateness of default settings; console set-up and install of management software; effectiveness of documentation and on-line help.
3. Includes ability to simultaneously switch and route on the same ports, ability to prioritize L3 over L2 traffic, to prioritize FTP ver HTTP traffic, prioritize based on IP TOS, other routing protocols and routing-control protocols supported, VLAN and filtering capabilities based on L3 criteria.
4. Effectiveness of management software, Web interface and/or the console/ command-line interfaces for configuration, monitoring status, activity, report logs, traps, alerts, etc.
5. Criteria include switch stability and reliability; IP throughput and percentage of maximum offered load that is successfully routed; meshed (round robin) L3 packet throughput; price performance; latency; and other throughput metrics and measurements; see “Performance” section in the main text for additional information.

## Meets Expectations

Foundry Networks' BigIron 4000 received top ratings in the "Performance and Price Performance," "Features and Functionality," and "Installation and Ease of Use" categories when compared to leading Layer-3 switches tested by Mier Communications for a competition sponsored by *Business Communications Review*. It supports one of the highest Gigabit port densities (32 ports) and delivers wire-speed performance (based on maximum-sized, 1,518-byte packets). Results are published in an October, 1998 article in *BCR*.



In the unanimous opinion of the testers, Foundry Networks' BigIron 4000 fully meets the expectations and requirements of the target user community for which it was designed and is hereby presented the "NetWORKS As Advertised" award.



**BigIron 4000**



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