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LAB TESTING SUMMARY REPORT

September 1998
Report 210998

FINAL DRAFT /W VENDOR EDITS

Product Category:

Gigabit Backbone Switches

Vendor Tested:

Foundry Networks

Product Tested:

BigIron 4000

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Key findings and conclusions:

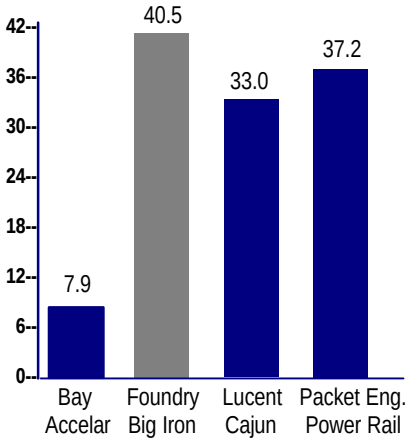
- **Rated "Best in Test" among 7 Gigabit backbone switches evaluated in the competition**
- **Superb performance and price performance**
- **Easy to install and configure**
- **High density—32 Gigabit Ethernet ports**

Foundry Networks' BigIron 4000 Gigabit backbone switch was lab-tested by Mier Communications in a competitive evaluation, the results of which appeared in the October 1998 issue of *Business Communications Review (BCR)*. The methodology and test bed used in this test were developed especially for evaluating Gigabit backbone switches supporting six or more Gigabit ports. Competitively, the BigIron 4000 was tested with software version 4.01. It fared best in the "Performance and Price Performance" and "Configuration" categories, in which the BigIron 4000 achieved top ratings. Furthermore, the switch received the BCR "Best in Test" rating, awarded by MierComms testing staff to the product that provided the best price, performance, features and functionality among all Gigabit backbone switches tested.

Performance

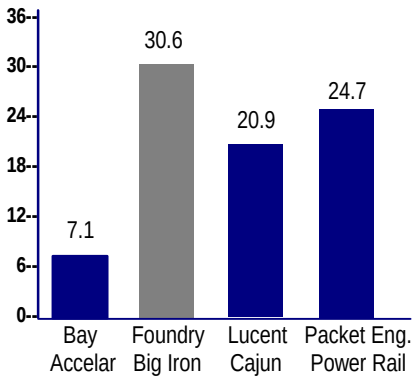
Foundry Networks' Gigabit backbone switch, aptly named BigIron, is a performance powerhouse. It demonstrated superb throughput—lab-tested at 30.6—which was the highest rate achieved by any of the

Packet-Forwarding Rates in Mpps*
(based on 64-byte IP packets)



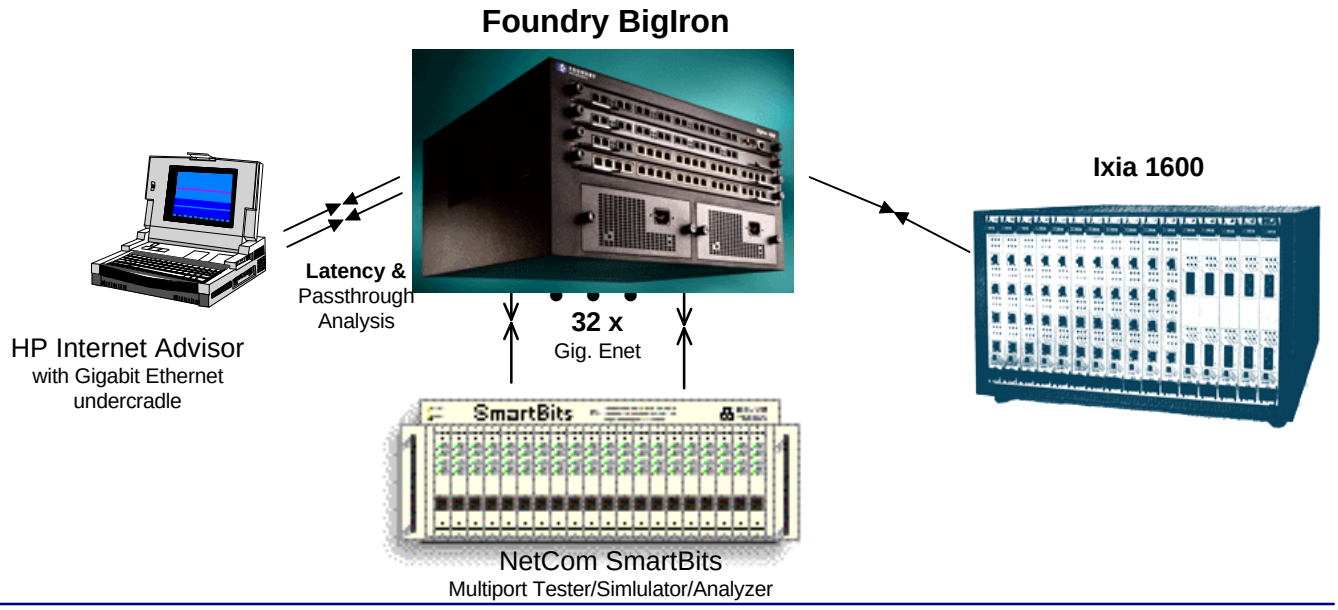
**Millions of packets per second*

Throughput in Gbps**
(based on 1,518-byte IP packets)



**Gigabits per second*

Test Bed Set-up



About the testing… The primary test system we used to apply and then to concurrently measure traffic load through the switches in this test was from NetCom Systems (Chatsworth, CA; www.netcomsystems.com). NetCom's Gigabit modules applied up to 40 Gbps of packet traffic to the high-end backbone switches in our lab-test environment, while simultaneously monitoring the switching capacity and throughput on a packet-by-packet basis. Measurements were verified using Gigabit test gear from Ixia Communications (Calabasas, CA; www.ixiacom.com). Using NetCom's SmartBits system and Ixia's 1600 we were able to measure: total throughput, latency and jitter, address capacity, and MAC learning rate. We also used Hewlett-Packard's (Palo Alto,CA; www.hp.com) Internet Advisor with Gigabit Ethernet under-cradle and pass-through analysis of traffic. All reported measurements of throughput, in Gbps, are based on traffic tests involving maximum-size, 1,518-byte packets. That's because throughput measurement using larger packets minimizes the amount of data-carrying bandwidth that's lost due to inter-frame gaps. These are the brief time lapses that must be allowed between sequentially transmitted packets in all Ethernet environments. A Gigabit Ethernet link that's filled with minimum-sized packets can really only transport about 760 Mbps (in each direction, because Gigabit Ethernet is full duplex), due to the many inter-frame gaps required. By using all larger 1,518-byte packets, a Gigabit link can then carry up to 986 Mbps of real data, which is much closer to the real maximum bandwidth of Gigabit Ethernet. All reported measurements of packet-forwarding rates are based on traffic tests involving minimum-size, 64-byte packets. Using small packets applies a maximum packet-delivery rate to the Gigabit switches, which actually is 1.488 Mpps for each Gigabit Ethernet access to, and egress from, the switch.

Performance - continued

switches in the competition. The BigIron 4000 also delivered an actual lab-measured packet-forwarding rate (based on 64-byte IP packets) of 40.5 Mpps—again, the highest rate achieved among all the switches tested. (In the first-page figure, we've shown how the BigIron compares to 3 other modular, multi-slot switches; the stackable switches that were evaluated are not shown.)

Price Performance Summary*

	Bay Accelar 1200	*Foundry BigIron 4000*	*Lucent Cajun P550*	*Packet Engines PowerRail*
$$ per Mpps**	$6,006	$1,828	$1,747	$2,348
$$ per Gbps***	$6,712	$2,344	$2,763	$3,542
System Price (U.S. list price)	$47,455	$74,000	$57,650	$87,335
Maximum number of Gigabit ports	12	32	24	25

**Based on an analysis of packet-forwarding rates and throughput relative to system pricing.*
***Based on measured packet-forwarding rate (64-byte IP packets).*
****Based on measured Gbps throughput (1,518-byte IP packets).*

The BigIron is also in the Winners' Circle in terms of price performance. Due to the tested switches' varied configurations, a comparative "per-port" price was not adequate. We, therefore, calculated the pricing based on "price per Mpps" and "price per Gbps" based on measurements actually performed in the MierComms laboratory during testing. With a price per Gbps of only $2,344, BigIron 4000 is the price performance leader among the multi-slot contenders. In

Performance - continued

the price per Mpps analysis, the BigIron 4000 comes out near the top with $1,828. (The best price performance number per Mpps was $1,747, which is only slightly less expensive.)

We should point out that, overall, pricing for the stackable switches in the evaluation was lower for both measurements, which was expected because they are smaller systems.

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. How the BigIron performed in these metrics, compared to other multi-slot Gigabit backbone switches, is shown in the table below. All measurements shown are in microseconds:

Latency Measurements* (µsec.)				
	Bay Acclear 1200	Foundry BigIron 4000	Lucent Cajun P550	Packet Engines PowerRail
64-byte IP packet	5.6	5.9	3.4	7.5
64-byte IP packet with load	6.9	6.1	3.4	7.4
1,518-byte IP packet	13.1	19.4	10.1	24.9
1,518-byte IP packet with load	35.6	19.8	10.2	25.0

**1 GB to 1 GB first-in/first-out (FIFO).*
All measurements based on an average of 3 tests.

Latencies within the ranges shown above for both 64-byte and 1,518-byte IP packets are generally considered negligible for Gigabit backbone switches. We observed all of these metrics with relatively no jitter.

Head-of-line blocking was also analyzed. This test determines frame loss between two ports when a stream of traffic is sent from one port to a second, uncongested port, while the source port is simultaneously sending traffic to a congested port. We observed no blocking on the BigIron.

Interoperability. BigIron was connected with 2 other vendors' Gigabit backone switches—the Extreme Networks Summit1 and Lucent's P550 Cajun Switch. It demonstrated that it could pass full Gigabit-rate traffic in both directions while connected to these reference switches.

Configuration

The BigIron achieved a high rating—a 90 out of 100 points—for its configuration. Supporting 88 100BaseT ports and 32 Gigabit Ethernet ports, it had the largest number of Gigabit ports among the switches tested in the Gigabit backbone category, although the 88 10/100 port density was a bit limited compared to other multi-slot systems. It offers flexibility through its modular design that includes 4 slots for 10/100 or Gigabit port modules. Scalability is achieved through a distributed switching architecture. In addition to 1000Sx ports, Gigabit 1000Lx ports are supported for longer distance transmissions.

In addition to the BigIron 4000, Foundry Networks offers a well-integrated Gigabit product line, including Layer 2, 3, and 4 switches and routers.

Installation and Ease of Use

The BigIron is set up via attached console. After IP address assignment, the switch is managed via a Web or SNMP GUI. Initial set up took about 5 minutes to complete. Subsequent modifications to the switch configuration were easily made "on the fly" through the Web or SNMP GUI or a command-line interface. An image of the system and a private MIB are provided on floppy diskettes.

Management and Administration

Management is through Foundry's IronView, v. 4.0 Windows-based application, which we rated a 7 out of 10 points for overall effectiveness. The lack of a 10/100 management port and a clickable image were the most noticeable deficiencies. Otherwise, management was basically good.

Foundry Networks BigIron 4000: Comparison of Key Features*

FEATURES	Bay Networks Accelar 1200	Foundry BigIron 4000	Lucent Cajun P550	Packet Engines PowerRail 5200
Switch software tested	1.1.1	4.01	1.0.17	1.10
Maximum number of Gigabit Ethernet ports	12	32	24	25
10/100 support	16-port 10/100 module replaces 2-port Gig module; up to 96 10/100 ports	24-port 10/100 module replaces 8-port Gig. Module; up to 88 10/100 ports	20-port 10/100 module replaces 4-port Gig. Module; up to 120 10/100 ports	20-port 10/100 module replaces 2-port Gig. Module; up to 240 10/100 ports
Integral 10/100 port for management	No	Yes	Yes	No, but mgm't mod. has 1 Gig. Sx port)
Configuration flexibility and modularity	8-slot chassis, 2 for control (redun.); 6 for Gig. or 10/100 mod.	4-slot chassis—all used for Gig. or 10/100 modules	7-slot chassis; 1st slot for control; 6 slots for Gig. or 10/100 mod.	14-slot chassis; 2 for control; 12 for Gig. or 10/100 modules
1000BaseLx support**	Yes	Yes	Yes	Yes
MAC address table capacity	24,000/switch	32,000/switch	16,000/switch	16,000/port; 400,000+/switch
Gigabit Ethernet trunking or hot-standy redundancy of Gigabit Ethernet links	Trunking planned; redundant Gig. Link switchover in under one second	Trunking up to 4 ports/group; switchover in under one second	Trunking up to 8 ports/group; switchover in under one second	Trunking planned; redundant Gig. Links switchover in under one second
Auto-negotiation on the Gigabit ports	Yes; on by default	Yes; off by default	No	Yes; on by default
Pause frame flow control	Obeys/issues	Obeys/issues	Obeys/issues	Obeys/issues
Port mirroring (roving and/or port monitor)	Yes	Yes	Yes	Planned; 9/98
Type of VLANs supported	Port- and/or L3	Port- and/or L3	Port- and/or MAC-	Port and/or L3
Per-port broadcast/ multicast control	No	No, but settable on switch-wide basis	On 10/100 ports, but not Gigabit ports	No; planned
Prioritization, queues. Quality of Service (Qos)	2 per port queues; not now 802.1p-based	Maps 802.1p levels onto 4 priority hardware queues	Maps 802.1p levels into 2 per-port queues	Full 802.1p support; 8 per-port priority levels
Filtering per port, user-definable	Yes (including by MAC and IP address)	None for Layer 2 switching	Yes (by MAC address); additional filtering w/ L3	Yes; up to 8 filters per port
Layer 3 (routing) support	IP included; IPX planned for 12/98	Included; IP (RIP, OSPF) and IPX; AppleTalk, BGP4, VRRP, IGMP, DVMRP and PIM	IP; different hardware modules req. IPX plnd.	IP, IPX and AppleTalk included in price
Windows/Web-based management, applications	Windows (95, NT) applications incl; Web interface also	Windows NT app. for $1,495; Web interface	Windows NT app. for $2,450; Web interface	Java- and SNMP-based Windows (95, NT) GUI (included)
Cost of switch as tested (list price)	$47,455	$74,000 for L2 switching; routing software extra	$57,650 configured for L2 switching only	$87,335

**Comparisons shown are for modular multi-slot chassis systems. The evaluation also included "stackable" systems, which are not represented in this comparison table.*

Hits and Misses

HITS

- A top performer in all measurements
- Among the leaders in price performance
- Supports a 30.6 Gbps throughput—among the highest of products evaluated
- Superb packet-forwarding at 40.5 Mpps (with 64-byte IP packets)
- A good set of features, including 4 priority hardware queues
- 1000Lx and 1000Sx on Gigabit modules
- The highest Gigabit-port density (32 ports) among the switches tested
- Special built-in features for limiting broadcast/multicast floods
- A physically compact switch that doesn't take up excessive space or power
- Gigabit Ethernet trunking for up to 4 ports per group
- Port- and Layer 3-protocol-based VLANs
- Supports MAC-level address locking

MISSES

- No 10/100 management port
- No filtering for Layer 2 switching
- Limited 10/100 port density compared to other multi-slot switches tested
- No "Quick Start" guide; electronic documentation not available (planned)

Conclusions

The Foundry Networks BigIron 4000 was rated "Best in Test" by the MierComms testing staff during its evaluation of Gigabit backbone switches. The switch is an excellent performer and price performer, receiving a score of 94 out of a possible 100 points in that category.

For end users in the market for a big, incredibly fast switch, Foundry's BigIron 4000 is an excellent choice. It is easily installed and configured and rich with features.

Standardized Rating (100-point scale)

Category	Wt.	Bay	Foundry	Lucent	Packet Engines
Configuration (1)	10%	85	90	91	92
Installation & Ease of Use (2)	5%	80	88	90	84
Features (3)	25%	86	82	90	87
Management & Administration (4)	30%	85	83	74	80
Performance (5)	30%	72	94	86	89
Bottom Line		**81**	**87**	**84**	**86**

1. Includes configuration flexibility, port density, switch capacity, aspects of modularity (including GBIC support); diversity of interfaces supported (including 1000BaseLx); scalability, expandability, scope of other Gigabit Ethernet products offered by vendor.
2. Installation time and level of difficulty (for deployment as a Layer-2 switch), including ability to work "out of the box"; appropriateness of default settings; console set-up and installation of management software; effectiveness of documentation and on-line help.
3. Includes trunking of Gigabit and 10/100 ports; pause frame-based flow control (full duplex, per 802.3x); MAC address table capacity; port mirroring; VLAN capabilities; Layer-3 routing support (whether included or via optional software); redundancy features; MAC-based security; and other capabilities.
4. Effectiveness of management software and the console/command-line interfaces for monitoring status, activity, report logs, traps, alerts, data export, etc.
5. Criteria include switch stability and reliability; ability to handle up to full load on all ports without packet loss; responsiveness of management interface under load; interoperability with three "reference" backbone Gigabit Ethernet switches; ability of Gigabit interface to operate at extended distances without errors; and other throughput metrics.

Meets Expectations

Foundry Networks' BigIron 4000 Gigabit backbone switch offers excellent performance and one of the best price performances among 7 competing products tested. It also offers an impressive set of features, including more advanced ones, such as support for 1000BaseLx, in addition to 1000BaseSx, MAC-address locking, and port mirroring, among others. The BigIron received the "Best in Test" award, among all Gigabit backone switches tested in a recent *Business Communications Review* article, published in September, 1998.

In the unanimous opinion of the testers, Foundry Networks' BigIron Gigabit backbone switch fully meets the expectations and requirements of the target user community for which is was designed and is hereby presented the "Net**WORKS** As Advertised" Award.

BigIron 4000

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About MIER Communications Product Testing Services…

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Founded in 1988 by Edwin E. Mier, formerly managing editor of *Data Communications* magazine and a practicing network consultant for 20 years, the company has pioneered the comparative assessment of networking hardware and software, having developed methodologies for testing products from ATM switches to network operating systems. MIER Communications' private test services include competitive product analyses, as well as individual product evaluations. Products submitted for review are typically evaluated under the "Net**WORKS** As Advertised" program, in which networking-related products must endure a comprehensive, independent assessment of the products' usability and performance. Products that meet the appropriate criteria and performance levels receive the "Net**WORKS** As Advertised" award and MierComms Labs' testimonial endorsement.

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