THE TOLLY GROUP

No. 6263 JUNE 1996

IBM Corporation

8272 Nways Token-Ring LAN Switch Model 108
Boosting Bandwidth with Token-Ring Switching

Test Summary

IBM Corporation commissioned The Tolly Group to evaluate the performance of the IBM 8272 Nways Token-Ring LAN Switch Model 108, and to demonstrate the benefits of token ring switching in real-world scenarios.

The test results demonstrate that the IBM 8272 switch delivers high throughput, extremely low latency regardless of frame size, and immunity to head-of-line blocking. The IBM 8272 can also deliver a dramatic improvement in aggregate throughput for campus LANs built around legacy two-port bridges that are migrated to token ring switching.

Test Highlights

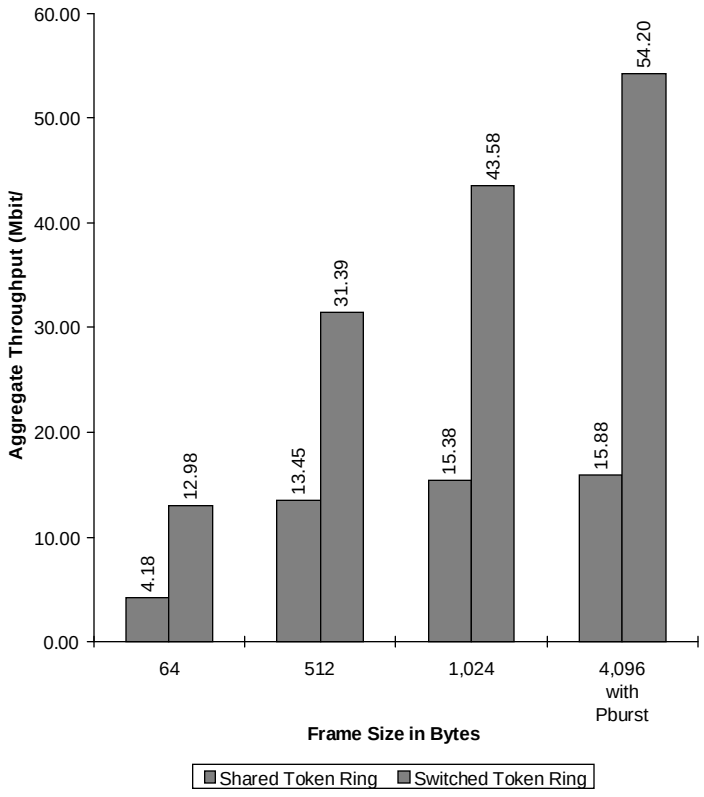
- Switch delivers over 250,000 frames per second with six pairs of ports simultaneously handling 28-byte frames with priority bits enabled.
- Switch delivers over 45,000 frames per second with 28-byte frames (single stream).
- Over 91,000 frames per second across a full-duplex, switch-to-switch link.
- Latency as low as 37 microseconds (28-byte frames).
- 54 Mbit/s aggregate throughput with four workgroups accessing four NetWare servers.

Test Results

Aggregate Performance Improvement

As figure 1 illustrates, replacing the traditional shared 16 Mbit/s backbone with the IBM 8272 switch dramatically increases aggregate throughput. With workgroups connected to the backbone ring via legacy two-port bridges, all client/server groups share the 16 Mbit/s of bandwidth. The servers are underutilized, and end-user performance suffers.

Aggregate Throughput (PERFORM3)
Shared vs Switched Token Ring Environments
(Four Concurrent Client/Server Streams)



Source: The Tolly Group, June 1996

Figure 1

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Frame Forwarding Across the Switch Backplane

IBM 8272 Nways Token Ring LAN Switch				
Frame Size (Bytes)	One Data Stream		Six Data Streams	
	Average Throughput per Stream (fps)	Average Throughput per Stream (Mbit/s)	Average Throughput per Stream (fps)	Average Throughput per Stream (Mbit/s)
28	37,296	8.354	not tested	not tested
28*	45,680	10.232	42,922	9.615
64	22,107	11.319	22,321	11.428
64*	24,749	12.672	24,752	12.673
512	3,721	15.241	3,721	15.242
1,024	1,906	15.614	1,906	15.614
3,972	498	15.824	498	15.824

* Priority Bits Enabled

Source: The Tolly Group, June 1996

Figure 2

When the bridges and backbone are replaced with the IBM 8272, the power of the servers is unleashed and end-user performance increases. Even with frame sizes as small as 512 bytes, performance breaks through the 16 Mbit/s ceiling to yield 31 Mbit/s of aggregate throughput. As frame sizes increase, aggregate throughput increases significantly. With the backbone bottleneck removed, each client/server workgroup can achieve close to 14 Mbit/s of application throughput. (Only twelve clients were used in these tests. Adding more clients would yield throughput at near wire-speed).

Even in lightly loaded networks, switches can improve application performance. By eliminating high-latency, low-performance bridges, application response times can be significantly reduced. For example, when the IBM 8272 replaced the traditional bridged network on the test bed, a NetWare 4.1 login ran 17% faster, and downloading a cc:Mail attachment was 23% faster.

The results indicate that network managers who fail to migrate traditional shared backbones to token ring switching are often failing to realize the full processing potential of expensive servers, and missing an opportunity to improve significantly end-user performance.

Raw frame processing

The IBM 8272 delivers impressive frame-processing power with a variety of frame sizes, as figure 2 illustrates. Even with a single data stream of smaller 28-byte frames, the switch can process over 37,000 frames per second (fps). With larger frame sizes, the throughput of a single data stream is near wire speed.

Prioritizing traffic

Figure 2 also shows that the IBM 8272 can deliver even higher throughput when traffic is prioritized by setting priority bits in the frame control field of an LLC frame. With the priority bits set on every other frame, tests conducted with 28- and 64-byte frames showed higher throughput when processing both priority and non-priority traffic than when the switch processed non-priority traffic only.

Performance Scalability

With six pairs of ports simultaneously handling 28-byte frames, the IBM switch processed over 250,000 fps, with average throughput of nearly 43,000 fps per data stream.

Figure 2 shows that performance is equally scalable with larger frame sizes as well.

PERFORMANCE IN MBIT/S

The IBM 8272 delivers average throughput per data stream of nearly 16 Mbit/s with frame sizes of 512 bytes and larger, as one can see in figure 2. The device effectively runs at wire speed, and again, there is no performance degradation even when six streams of traffic traverse the switch.

LATENCY

The architecture of the IBM 8272 introduces extremely low latency to frames traversing the switch. As figure 3 illustrates, the latency remains below 148 microseconds regardless of frame size.

PORT CONGESTION

If a switch is designed to buffer frames on the input port, then traffic for a congested port will sit in the queue and block subsequent frames destined for uncongested ports. This condition is known as head-of-line blocking, since a frame at the head of the line may block subsequent frames in the queue. The Tolly Group confirmed that the IBM 8272 is immune to head-of-line blocking.

FULL DUPLEX

Testing also verified the 8272's full-duplex capabilities as a switch-to-switch link. The 8272 processed over 91,000 fps when The Tolly Group sent 28-byte frames in both directions simultaneously across a full-duplex link. This equates to about 20 Mbit/s of throughput across the link. In tests with 64-byte frames bi-directionally traversing the link, the IBM 8272 processed over 48,000 fps, which translates into nearly 25 Mbit/s of throughput across the link.

Note: Frame processing test results were extracted from The Tolly Group's 1996 Industry Study: Token Ring Switching (doc. # 6251). For a copy of the report, visit The Tolly Group's web site at http://www.tolly.com.

TEST METHODOLOGY

APPLICATIONS TESTING

The Tolly Group used PERFORM3, a Novell benchmarking utility, to generate traffic between the servers and the workgroup clients. Throughput was measured by connecting a Network General Expert Sniffer token ring analyzer to each workgroup token ring and measuring the cumulative bytes in a thirty-second sample. All measurements were converted into Mbit/s and reported as such. Each test was conducted three times, and the results were averaged.

The test bed for baseline testing consisted of four 16 Mbit/s token ring workgroups with three clients each. Four NetWare servers (two NetWare 3.12 and two NetWare 4.1)

IBM Corp.
8272 Nways Token-Ring LAN Switch
Model 108

THE TOLLY GROUP CERTIFIED UP TO SPEC

Performance and Functionality

IBM Corp.
8272 Nways Token-Ring LAN Switch
Model 108
Product Specifications*

LAN ports:
- 8 Token Ring, twisted pair (UTP/STP) ports for shared or dedicated LAN segments
- Support for 1,790 active MAC address per port

Data rate:
- 4 or 16 Mbit/s (half-duplex)
- 32 Mbit/s (full-duplex)

Configuration and Management tools:
- Direct (VT-100-compatible terminal) or remote (modem) management, Telnet
- Supports SNMP-compliant applications such as NetView for Windows, NetView for AIX, and HP OpenView
- Address filters
- Virtual switch support
- TokenPipe
- BOOTP/TFTP TokenProbe

Notable features:
- Source-route switching
- Automatic sensing and automatic configuration of connection types
- Adaptive cut-through

Universal Feature Slot and Cards: optional, field-installable Universal Feature Cards (UFCs) provide additional connections.
Available immediately:
- 4-Port Token-Ring UTP/STP
- 2-Port Token-Ring Fiber

Available in the future:
- 1-Port FDDI (DAS multimode fiber)
- 1-Port FDDI (SAS multimode fiber)
- 1-Port FDDI (SAS UTP)
- 1-Port ATM (155 Mbit/s SONET)
- Ethernet Bridge UFC

**Vendor-supplied information not verified by The Tolly Group*

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Single Frame Latency

IBM 8272 Nways Token Ring LAN Switch					
	28-Byte Frames	64-Byte Frames	512-Byte Frames	1,024-Byte Frames	3,972-Byte Frames
Latency (µsec)	37.33	54.83	146.83	147.33	146.83

Source: The Tolly Group, June 1996

Figure 3

resided on one backbone 16 Mbit/s token ring. Each workgroup accessed its own NetWare server on the backbone segment. Workgroup LANs were connected to the server LAN by two-port IBM source route bridges (IBM Model 50Z or 70 PCs running the IBM Local Token Ring Bridge/DOS program, version 1.00). Each bridge was equipped with two IBM 16/4 Token Ring Adapter IIs using IBM Token Ring MLID version 1.27 drivers.

The source route bridges were removed from the test bed, and the workgroup MAUs were directly attached to the IBM 8272 switch (see figure 4). The four servers were each given their own port on the switch, and the switch's backplane provided connectivity between the four workgroups and their respective servers.

The switch remained in adaptive cut-through mode throughout the switched token ring tests. For the shared token ring tests, source route bridging was enabled in the NetWare servers (ROUTE.NLM) and the clients (ROUTE.COM). Source route bridging was turned off for the switched token ring tests by removing "ROUTE" from both the client and server configurations.

All servers were 90 or 133 MHz Pentiums with PCI 16/4 token ring adapters. Client PCs were a mix of 486 & Pentium class PCs with PCI, EISA, and ISA buses. Clients used 16/4 token ring adapters from different manufacturers. To connect to the servers, clients used the following NetWare drivers:

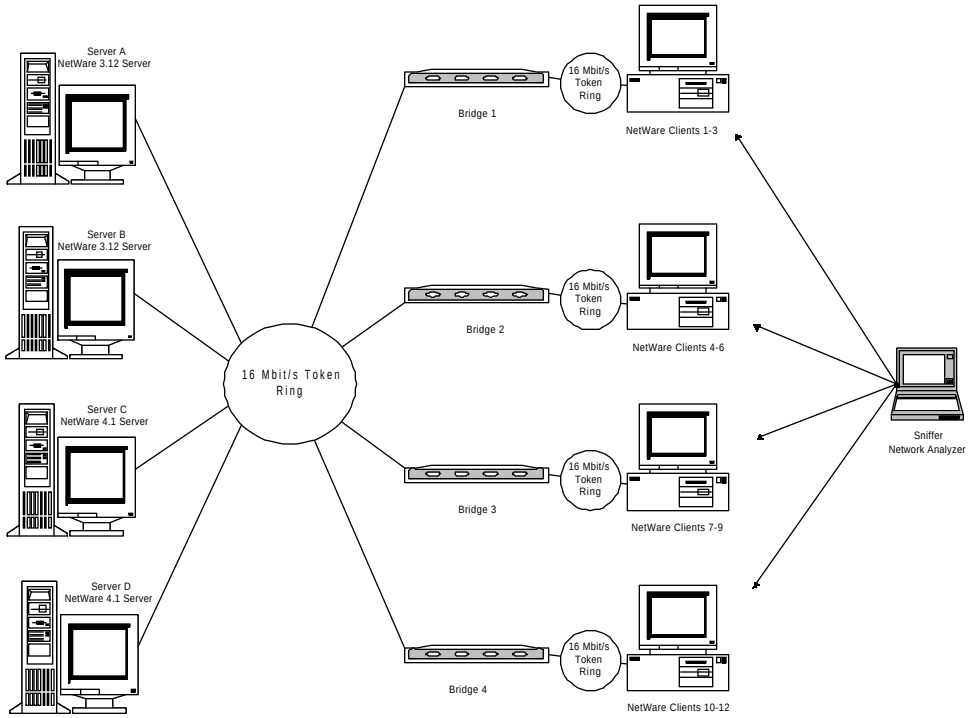
- Link Support Layer (LSL) version 2.14
- IPX/SPX Protocol version 2.12
- NetWare Source Routing Driver version 2.00
- NetWare Virtual Loadable Module (VLM) version 1.10

Latency and FPS Testing

To evaluate the fps performance of the IBM switch, Wandel & Goltermann Domino LAN analyzers generated frames on each of six input ports on the switch (see figure 5). A Domino LAN was also used to measure the frame rate on the six output ports. The frame generation rate was measured using the no-frame-loss method (1 to 2% margin of error). A Domino LAN on the output ports measured the frame generation rates, and the traffic level was increased until the transmit limits of the generators were reached or until the frame generation rate on the input LANs exceeded the measured throughput rate of the output LAN by 2%. Each test was conducted three times, and the results were averaged.

For frame priority tests, up to 12 Domino LAN analyzers generated traffic through the switch. Bits 5, 6 & 7 in the frame control field of an LLC frame can be used to assign a priority to frames, and can control how frames are handled by a switch with multiple queues. To each port under test, one frame generator transmitted priority frames with the control bits set to decimal 5, while another frame generator generated non-priority frames with the control bits set to the default value of zero. The frame generation rate was measured using the no frame-loss method (1 to 2% margin of error).

Application Testing on a Switched Token Ring Network



Source: The Tolly Group, June 1996 *Figure 4*

For latency tests, an Azure LAN Pharoah with dual token ring analyzers was connected to an input and output ring. A single frame was transmitted from the input port to the output port. The LAN Pharoah time-stamped the frame on the sending and receiving rings. The frame latency was calculated from the delta between the time stamps.

Port congestion tests

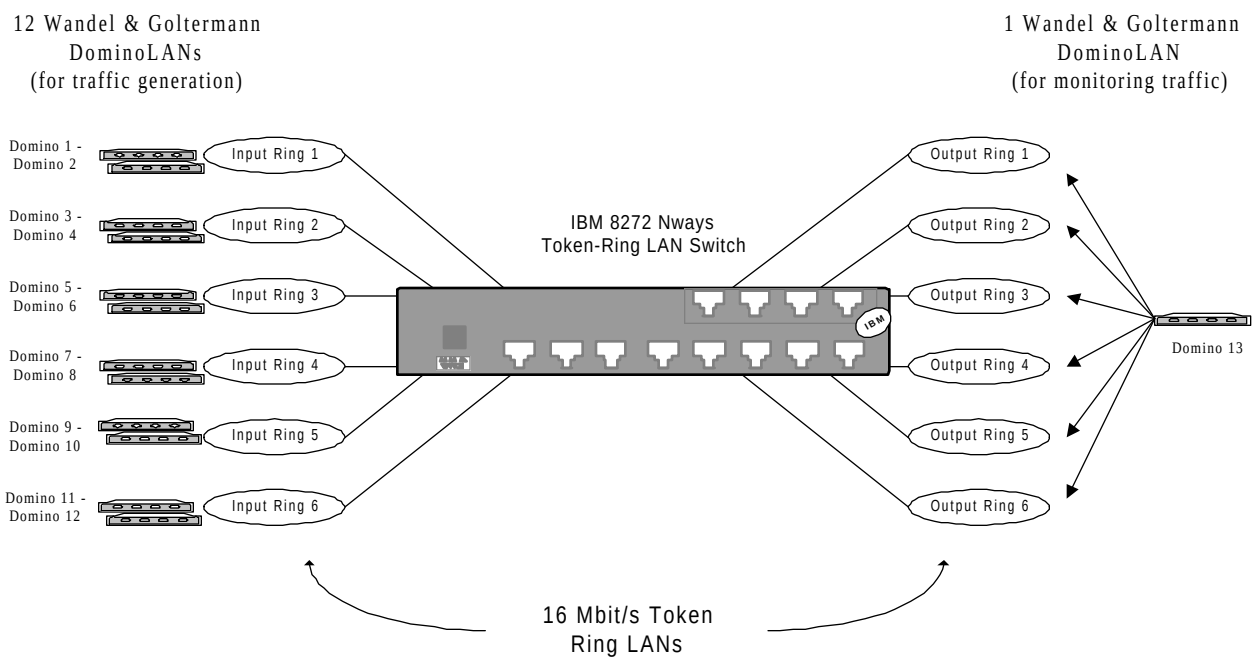
To test head-of-line blocking, The Tolly Group used four Domino LAN analyzers attached to an input port of the switch to generate equal amounts of traffic to two output ports. Another Domino LAN generated traffic on one of the output rings to add more congestion to the port. If the traffic level on the other output ring did not decrease or cease altogether, then port blocking did not occur. The test was conducted twice for verification.

Full-Duplex tests

For full-duplex testing, an additional four-port module was added to the switch using the Universal Feature Slot of the IBM 8272. Two virtual LANs were created by configuring six of the switch ports to operate in one domain, and the remaining six ports to operate in a second domain. A standard Category 5 UTP cable connected a port in Domain One to a port in Domain Two. The 8272 automatically detected the connection and configured a full-duplex link between the domains.

Four Domino LAN analyzers were attached to two ports in each domain to generate traffic across the full-duplex link to the other domain. This resulted in four data streams, two in each direction, crossing the full-duplex connection. The two destination ports in each domain were both equipped with a Domino LAN analyzer to measure the frame generation rate across the full-duplex link. Frame generation rates were calculated using the no-frame-loss method described earlier.

Latency and FPS Testing



Source: The Tolly Group, June 1996

Figure 5

About The Tolly Group

The Tolly Group provides strategic consulting, independent testing, and industry analysis. It offers a full range of services designed to furnish both vendor and end-user communities with authoritative, unbiased information. *Fortune* 1,000 companies look to The Tolly Group for vendor-independent assessments of critical corporate technologies. Leading manufacturers of computer and communications products engage The Tolly Group to test both pre-production and production equipment.

The Tolly Group is recognized worldwide for its expertise in assessing leading-edge technologies including networking, multimedia, and messaging. By combining engineering-caliber test methodologies with informed interpretation, The Tolly Group consistently delivers meaningful analyses of technology solutions. The Tolly Group has published more than 100 product evaluations, network design features and columns in the industry's most prestigious publications.

Kevin Tolly is President and CEO of The Tolly Group. He is a leading industry analyst and is responsible for guiding the technology decisions of major vendor and end-user organizations. In his consulting work, Tolly has designed enterprise-wide networks for government agencies, banks, retailers, and manufacturers.

For more information on The Tolly Group's services, visit our World Wide Web site at ***http://www.tolly.com,*** email to info@tolly.com, call 800-933-1699 or 908-528-3300, or fax 908-528-1888.

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Tolly Group doc. 6263 rev. 30May96