Migration Strategies for Token Ring Users

BY EDWARD RABINOVITCH

Using the comprehensive solutions presented in this article, Token Ring/SNA network managers can integrate mission-critical legacy traffic and new intranet, client/server, and other LAN-based applications with high-speed technologies.

TOKEN RING has always been a very stable, reliable technology for all parts of the network — from the edge to the core. However, one of the major reasons for this stability is that the applications for which Token Ring was designed — primarily mainframe-based applications — have a very predictable traffic flow. Token Ring networks conform to the 80/20 rule: 80 percent of the traffic generated in a workgroup stays within the workgroup, while only 20 percent of all traffic travels over the backbone. The architects of Token Ring envisioned a very predictable traffic pattern with higher-bandwidth rings assigned to mainframe links, or the core, and with lower-bandwidth rings relegated to endpoint devices at the edge of the network.

However, as network environments have evolved, established Token Ring shops may have compelling reasons to migrate to other technologies. The biggest determinants are Token Ring’s inability to handle network congestion, its inability to support next-generation business applications, and Ethernet’s high level of functionality. Also, a major migration decision may be due to decreasing Ethernet prices, which are widening the gap between the two technologies.

In recent years, there has been a shift in the nature of applications running over Token Ring networks. The move to client/server applications began the subtle alteration of traffic patterns in traditional Token Ring networks. Client-to-server communication involves much larger exchanges of data across the network. The deployment of client/server applications also started the proliferation of servers attached to the network. This combination of proliferating servers and more traffic began to introduce congestion points into the network. IS managers responded by trying to control traffic flow by centralizing server resources as much as possible.

More recently, Web-based applications have begun springing up at the periphery of Token Ring networks — and not always under the auspices of MIS. These applications have begun to have a profound impact on traffic loading in the network, putting local rings under traffic burdens that the architects of Token Ring never anticipated. TCP/IP Web applications have also spawned Web browser-based presentation techniques that will radically change the way information is accessed and presented in traditional mainframe-based environments.

In addition, the ever-growing variety of PC-based applications and productivity tools in the enterprise network has spurred the need to integrate not just PC- and host-based applications, but also the data residing on these platforms. New business applications require advanced functionality, such as integrating multimedia data from multiple hosts, servers, and workstations into a single screen view; or integrating server- and workstation-based files, databases, security systems and transactions.

However, SNA- and LAN-based enterprise networks have evolved separately through upgrade, acquisition and corporate mergers, resulting in different client platforms running different applications over a mix of SNA and non-SNA (TCP/IP, IPX/SPX, NetBIOS, Banyan VINES, and AppleTalk) LAN protocols. In some networks, SNA could be supported down to the client machines. In other cases, it was
of Layer 2 switching and Layer 3 routing is Layer 3 switching, a powerful combination should receive preferential treatment. Paths use the tag to identify traffic that switches and routers along the transmission marked with a priority value, subsequent queue outbound traffic. Once a packet is network switches and routers then use to their packets with a priority value, which packet classifier that identifies incoming Layer 3 switches and routers implement a CoS requires end-to-end implementation; lower-priority queues, and thus receive priority levels. Traffic in higher-priority networks — such as interactive voice and multimedia — take precedence over lower-priority multicast network flooding.

Although Token Ring technology was designed with token prioritization provisions, this function is rarely implemented. Therefore, Ethernet technology is becoming more popular for voice-over-IP and merged data and voice networks through the IEEE Class of Service (CoS) traffic prioritization 802.1p specification. CoS sets up eight traffic priority levels. Traffic in higher-priority queues — such as interactive voice and multimedia — take precedence over lower-priority queues, and thus receive lower delay and better performance. True CoS requires end-to-end implementation: Layer 3 switches and routers implement a packet classifier that identifies incoming traffic and prioritizes it. End stations mark their packets with a priority value, which network switches and routers then use to queue outbound traffic. Once a packet is marked with a priority value, subsequent switches and routers along the transmission path use the tag to identify traffic that should receive preferential treatment.

Another technology rising fast in popularity is Layer 3 switching, a powerful combination of Layer 2 switching and Layer 3 routing for Ethernet networks. Layer 3 switching.

### Ethernet and Token Ring Implementation Considerations

#### Cabling

Both Ethernet and Token Ring topologies support copper and fiber media. However, most new LAN installations commonly use Category 5 twisted-pair copper wire for Ethernet and/or Token Ring, so cabling is not a major migration issue. However, while most new LAN installations commonly use Category 5 twisted-pair copper wire for Ethernet and/or Token Ring, cabling can become an issue if it is not compatible. For example, if a Token Ring network is wired with IBM Type 1 cabling, to migrate workstations to an Ethernet network, each workstation must be installed with a balun (balancer/unbalancer) for impedance conversion.

#### Frame Sizes

Ethernet packet frames range from 64 bytes to 1.5Kbytes. Token Ring packet frames currently scale up to a 17.8Kbytes on 16Mbps rings; no minimum frame size is specified.

When Token Ring and Ethernet LANs are interconnected, the difference in the supported frame sizes may require segmenting Token Ring frames going to the Ethernet LAN. In this case, the maximum frame size for the entire network must be reduced to the Ethernet maximum. This is dependent on the higher-level protocol being transported by the LAN: for example, TCP/IP can be segmented; LLC2 transporting SNA cannot.

The advent of IEEE 802.3z Gbabit Ethernet has changed some of the original Ethernet parameters, however. With Gbabit Ethernet, the standard minimum Ethernet 64-byte frame size is too small to ensure the detection of a collision over a network of reasonable distance.

Therefore, the carrier signal that determines how long the sending station keeps access to the media for transmitting has been extended to 512 bytes. This effectively results in a very large inter-packet gap overhead for a minimum-sized (64-byte) packet. To improve this obvious inefficiency, a method called “packet bursting” allows the sending station to continue to transmit up to 8192 bytes of data each time it captures access. While this new method lessens the frame size gap, network managers may still need to adjust the Token Ring frame size to match the Ethernet frame size.

#### Network Management

The first Remote Monitoring (RMON) standard published in November 1991, RFC 1271, specifically focused on Ethernet. In 1993, the RMON Working Group expanded the standard with Token Ring extensions in RFC 1513. RMON provides MAC-layer statistics, events, and alarms, as well as packet capturing and filtering for protocol analysis. Due to high customer demand and interest, RMON became an integrated standard in December 1994 and was assigned the new RFC number 1757. RMON now allows network managers to collect information from Ethernet and/or Token Ring segments both for network troubleshooting and performance management.

The information in the RMON groups includes groups 1 to 9 for Ethernet information: (1) Statistics, (2) History, (3) Alarm, (4) Hosts, (5) Host Top N, (6) Matrix, (7) Filter, (8) Capture, and (9) Event. Group 10, Token Ring, contains Token Ring-specific items such as source route frame counts.

The definition of RMON compliance is somewhat vague. To be RMON-compliant for Ethernet, a vendor must support at least one RMON group between 1 and 9. However, RMON compliance for Token Ring — support for RMON group 10 — includes information for all nine Ethernet groups, leaving a lot of room for vendor-specific interpretations of RMON-compliance terms.
Figure 1: Token Ring Backbone Migration Strategies

Stage 0
Token Ring-based network

Drivers of change to high speed:
- High cost of Token Ring
- Lack of functionality and futures
- New applications
- Lack of support
- Converged networks

Rings connected via bridging

End users

Users/LANs segmented via switching

Stage 1
Switched Token Ring and high-speed network

Servers fully standard

- Only one translational device in network
- Add Ethernet clients anywhere
- Token Ring to Token Ring across high-speed backbone at wire-speed
- Full connectivity

Stage 2
Switched Ethernet/Token Ring and high-speed network

- High-speed backbone
- High-speed servers
- Layer 3 Ethernet functionality
- Full connectivity

Stage 3
ATM-based network with Ethernet LANs

Switching

Cell-based backbone

Frame-based backbone

Gigabit Ethernet/Fast Ethernet-based network with Ethernet LANs
developed to solve the problem of legacy LAN bottlenecks, brings unrivaled intranet performance and multimedia application support to enterprise networks. Layer 3 switches feature IP routing embedded in leading edge ASICs. Combining IP routing at Layer 3 with non-blocking Layer 2 switching, these switches can forward mainstream traffic at wire speeds, leaving legacy routers free to handle other protocols.

What other major factors influence the decision to migrate?

- Token Ring technology is complex and there is an increasing lack of trained support personnel.
- Ethernet and Fast Ethernet network equipment prices are much lower than those for Token Ring equipment.
- Ethernet provides additional future-proof scalability; existing and emerging high-speed technologies seamlessly integrate Ethernet, while Token Ring support is questionable in many cases. For example, FDDI (100Mbps), Fast Ethernet (100Mbps), ATM (155+ Mbps), and Gigabit Ethernet (1000Mbps) are all available now with strong commitment for future products.
- There is very limited long-term commitment to high-speed Token Ring.

**MIGRATION SCENARIOS: A STEP-BY-STEP APPROACH**

Network managers can follow many paths for Token Ring-to-Ethernet migration, depending on their specific requirements.

The following migration phases represent typical steps for large, bridged Token Ring networks. See Figure 1.

Established Token Ring shops may have compelling reasons to migrate to other technologies... Token Ring’s inability to handle network congestion, its inability to support next-generation business applications, and Ethernet’s high level of functionality.

To reduce network disruption, maintenance headaches, and the risks and cost of migration, each phase leverages existing hardware and software to secure the smoothest migration path. It’s important to note that each customer environment is unique and may require special design considerations for the intermediate steps.

**Phase 1: Replace Backbone Bridges with Token Ring Switches**

As a Token Ring network becomes saturated with network traffic, IS managers can replace multiport backbone bridges in the data center with Token Ring switches to boost capacity where needed. Token Ring switching transparently replaces existing bridging solutions in addition to simplifying adds, moves, and changes. Each port on the switch represents its own ring, which can communicate with other switched rings without external bridging or routing — that is, each port becomes an internetworked LAN.

There are some important capability limitations to consider when implementing Token Ring switches, however. Some Token Ring switches support source-route bridging only and will not pass transparent packets; other switches that support transparent bridging can pass source-routed frames. But a network with dual backbones and multiple Token Ring interface coupler (TIC) attachments configured with identical MAC addresses — a common redundancy scheme in Token Ring environments — will not function as expected unless a source-route bridge sits between the TIC attachment and the rest of the network. By using a true source-route transparent (SRT) switch that can forward both source-route and transparent packets, network managers can improve throughput while maintaining compatibility with their current environment.

However, because it just hastens the overload on the 16Mbps Token Ring backbone, Token Ring switching can only be considered a preliminary step to full Ethernet migration. But since Token Ring technology is not going to disappear overnight, IS managers must find a higher-bandwidth alternative for the network core.
Phase 2: Replace Token Ring Backbone with Higher-Speed Technologies

As user populations and bandwidth requirement increase, the campus/building backbone in the data center becomes the obvious candidate for upgrading to high-speed technologies. Currently, IS managers can choose from three high-speed technologies to replace their Token Ring backbones: FDDI, ATM and Fast Ethernet. Each technology has its advantages and disadvantages. While either ATM or FDDI might be the right choice for some customers, for pragmatic reasons the market trend today is migration to Fast Ethernet and Gigabit Ethernet technologies. It is important to remember, however, that the choice is not an either/or situation.

In Figure 2, the FDDI uplink capability in the Token Ring switch connects Token Ring workgroups to a high-speed FDDI backbone. The FDDI switches can translate LLC, IP, and IPX frames without the need for a router as a translational bridge. However, there is no source-route-transparent bridging support with this solution. The solution allows for the FDDI attachment of shared resources to minimize hops and maximize availability, but not for direct Ethernet workstation-to-Token Ring workstation communication.

In Figure 3, dual-homed ATM servers — servers installed with both ATM and Token Ring server network interface cards (NICs) — allow users to share resources without the need for translational bridging. Using ATM as a transport, both Token Ring and Ethernet data travel on the same fiber cable. There are no compatibility issues with this solution because Token Ring and Ethernet users reside on separate emulated LANs (ELANs); the ATM servers can be members of both ELANs. As in the FDDI solution, source-route-transparent bridging is not supported, so direct Ethernet workstation-to-Token Ring workstation communication (or “translation”) is not available. An ATM router is required for translation between Token Ring and Ethernet emulated LANs.

Why is Fast Ethernet the more attractive alternative? For several reasons:

- The technology itself is rapidly becoming more mature and robust; as deployment accelerates, more and more vendors are developing products that support Fast Ethernet, ultimately leading to richer functionality and lower prices.
- Fast Ethernet is less costly to implement than either FDDI or ATM.
- Fast Ethernet is much simpler to configure and administer than ATM or FDDI, and there are more network personnel with Ethernet experience than with FDDI or ATM experience.
- Fast Ethernet is a natural bridge to Ethernet networks, promoting easier coexistence in companies where both types of networks are in place.
- Ethernet is a highly scalable technology (from Ethernet to Fast Ethernet to Gigabit Ethernet) and provides an easy migration path to ATM, which many companies have selected for their infrastructure over the long term.
- Gigabit Ethernet, now available, is capable of delivering 1000Mbps throughput, making it the fastest of the three backbone technologies.

**TR-in-FE Backbone Technology Solution**

Obviously, it is not trivial to mix packets from Token Ring and Fast Ethernet. While bridging and routing are viable solutions, they are processing-intensive and result in higher equipment and administrative maintenance costs and slower performance.
As part of its overall strategy for integrating LAN technologies — including Token Ring, Ethernet, Fast Ethernet, FDDI and ATM — in IBM networks, 3Com has developed a technology based on the upcoming VLAN tagging IEEE 802.1Q standard — Token Ring-in-Fast Ethernet (TR-in-FE). TR-in-FE technology simply tunnels Token Ring frames through Fast Ethernet frames. Rather than taking all the information from one type of packet and translating it to another format as bridges or routers do, TR-in-FE takes in a Token Ring frame and repackages it with Fast Ethernet addressing. Information moves through the core of the network at 100Mbps wire speed and on to the TR-in-FE module at the destination switch, which strips off the Fast Ethernet addressing information and forwards the packet to the Token Ring server or desktop. By eliminating the translation step, the process becomes much faster than either bridging or routing, and packets can speed through the Fast Ethernet backbone switch to alleviate congestion.

Since TR-in-FE is based on the IEEE 802.1Q industry standard, it ensures long-term investment protection. For the user, this approach is significantly more beneficial, cost-effective, and easy to implement than the inefficient, proprietary techniques used by some networking vendors. As shown in Figure 4, the technology was designed to move easily into an existing network through low-cost TR-in-FE plug-in modules. Any Fast Ethernet switches can provide Token Ring users with aggregation and access to Fast Ethernet-attached servers. In addition, 3Com has also developed an enhanced driver for its Token Ring-in-Fast Ethernet server NICs that understands the 802.1Q Token Ring format, which allows NetWare- and Windows NT-based file servers to connect to a 100Mbps pipe. The same file server can also support standard Ethernet clients via a second Fast Ethernet NIC using standard Ethernet drivers. This dual-NIC approach offers Token Ring customers a reliable and inexpensive migration solution.

Like the FDDI and ATM solutions, the dual switch TR-in-FE solution does not support source-route bridging for direct Token Ring-to-Ethernet workstation user communication. However, adding a router as a source-route translational gateway (SRTG) enables true Token Ring and Ethernet interconnectivity, as shown in Figure 5.

A virtual port (VPort) must be defined to interconnect the two LANs to provide a logical attachment to the VLAN on the back-bone, specifying the port and virtual LAN (VLAN) ID to attach to. Router protocols or functions that specify the VPort will be logically attached to the VLAN.

Transmitted frames will be TR-in-FE encapsulated, while frames belonging to the VLAN are decoded before moving to the higher layers. With this solution, multiple VPorts can be created to attach to multiple VLANs and multiple VLANs can be supported from the same port.

As a source route translational gateway, the router allows stations X and Y (Figure 5) to communicate using NetBIOS or SNA protocols. The router translates the source-routed frames on the TR-in-FE VLAN to transparent frames on the Ethernet LAN. Stations X and Z could also be configured as Data Link Switching (DLSw) or APPN end stations attached to the TR-in-FE LAN. Note that since the TR-in-FE VLAN appears to be a source-routed LAN, correct source settings such as ring number, route discovery, and so forth, must be configured for a Token Ring interface.

Phase 3: Connecting Workgroups Directly to the Fast Ethernet Backbone

With congestion at the core of the network alleviated, IS managers can employ the same TR-in-FE technology to improve throughput for high-demand workgroups or to connect high-performance servers or mainframes directly to the Fast Ethernet backbone. Adding a Token Ring switch at the floor level, for example, improves performance on the local ring by removing server traffic, and hands the server 100Mbps to 200Mbps of dedicated bandwidth.

As shown in Figure 6, adding a Token Ring switch at the floor level can also split 50- to 80-user rings into much smaller rings, each with fewer users. A single downlink to the high-speed backbone provides all workgroup rings with high throughput access to mainframes and server farms. This solution produces three key benefits:

- It reduces the impact of heavy users on other users. Each user enjoys improved performance while the existing network workgroup infrastructure is preserved.
- Network managers can segregate older 4Mbps Token Ring end stations from 16Mbps Token Ring end stations.
- With a simple reconfiguration, users with 16Mbps capability get a four-to-one bandwidth increase, while the investment in 4Mbps adapters remains intact.

Phase 4: Replacing End Station NICs

The previous steps laid the ground work for the final migration step — replacing network interface cards in Token Ring end stations. Because of this gradual approach, the cabling plant can also be converted in parallel, allowing each customer to select the most appropriate migration path for replacing NICs on as many workstations as needed.

Phase 5: Extending Connectivity to the Mainframe

To support next-generation business applications a seamless access to mainframe resources is often required. Figure 7 describes a cost-effective, integrated, end-to-end solution that incorporates advanced SNA/APPN services and Web-based mainframe data access.

The integrated data center connectivity solution consists of BusTech Inc.’s NetShuttle family of plug-and-play, intranet-to-mainframe connectivity products, installed with 3Com’s high-performance NICs, running Microsoft SNA Server or IBM Communications Server/NT gateway software. The complementary component technologies used in the integrated solution include TCP/IP Passthrough, PU Controller LAN-to-SNA gateways, advanced SNA/APPN functionality, TN3270(E) access to host-based data, and Web browser access to host-based data. The solution
seamlessly integrates traditional IBM-oriented data centers with any type of existing or next-generation network:

- TCP/IP-centric intranets
- SNA-capable intranets
- extranets
- multiprotocol, SNA-only or APPN-based networks

As shown in Figure 7, the NetShuttle high-performance communications controllers let network managers tie Ethernet, Token Ring, FDDI, Fast Ethernet, and ATM networks supporting SNA, TCP/IP, and IPX traffic directly to the mainframe without requiring additional, expensive front-end processors. NetShuttle communications controllers offload traditional mainframe channel-attachment processing tasks such as routing table updates and compression duties, preserving valuable mainframe performance for more important tasks. This solution can be implemented across a high-speed switched network infrastructure without the added overhead of high-priced, low-performance routers.

NetShuttle controllers support both Enterprise System Connection (ESCON) and parallel channel connections, as well as Token Ring, ATM, FDDI, Ethernet, and Fast Ethernet LAN connections. Embedded TR-in-FE technology provides 16Mbps Token Ring customers with a migration path to higher-speed bandwidth, and makes migration from Token Ring to Ethernet transparent to the network. NetShuttle integrates seamlessly within a network of Layer 2 and Layer 3 switches and routers.

Phase 6: Migrating Enterprise WAN Networks Using DLSw

Multiprotocol routers with Data Link Switching (DLSw) functionality have interconnected dissimilar protocols over the WAN for years. IBM originally introduced the encapsulation technique, and in March 1993, it was adopted by the Internet Engineering Task Force (IETF) as RFC 1434, and enhanced and superseded by RFC 1795 in April 1995.

Because of the high timing sensitivity of SNA sessions, DLSw is the only dependable technique for transporting SNA over IP networks. DLSw routers reduce the likelihood of timeouts by providing local polling and logical local termination of the data link, often called “spoofing.” By keeping the acknowledgment local, routers also reduce the amount of traffic traversing the wide area link. Additional DLSw advantages include the ability to route around link failure, support for an extended source-route bridging hop count, and Net-BIOS name caching, which greatly reduces NetBIOS broadcasts.

DLSw Version 2 (RFC 2166) was developed in 1997 to address scalability and improve connection setup time. Among other major benefits, DLSw V2 reduces WAN backbone traffic and TCP overhead, and increases the number of supported connections.

CONCLUSION

The comprehensive Token Ring migration solutions presented here can help Token Ring/SNA network managers integrate mission-critical legacy traffic and new intranet, client/server, and other LAN-based applications with ever-growing high-speed technologies. The strategy builds on the existing legacy infrastructure and allows customers to migrate according to their own timetable and budget.

REFERENCES


A physicist by training, Eddie Rabinovitch has more than 20 years of experience in information technology and data communications. He is currently senior network design consultant at 3Com’s Large Enterprise Design Center. Eddie has published more than 90 papers in technical and trade publications and is a frequent speaker at conferences.

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