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The 3Com Technical Journal

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3Com's Integrated Token Ring Solution
By Edgar Masri

3Com's Response to a Recent Request for Proposal for an Integrated Token Ring Solution

Implementing Mixed-Media Internetworking
By Jeffrey Weaver

To Bridge or to Route in Implementing Internetworking Using Different Physical LAN Types

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3TECH The 3Com Technical Journal

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Editor's Note

Star-Tek, Solutions, and Stackability

By Suzanne Dowling

Star-Tek's Innovative Token Ring Technology

In case you haven't heard, 3Com's acquisition of Star-Tek,™ Inc. (Northboro, Massachusetts) in February 1993 means good news for 3Com's Token Ring expertise and hub product lines. Star-Tek is an innovator in Token Ring technology and has developed robust physical layer active hubs, preemptive fault lock-out, and draft Token Ring remote monitoring (RMON) standard technologies. Its product line consists mainly of intelligent wiring hubs and network management software products. You'll find more about Star-Tek's major products in "New Products at a Glance" (see pages 18-19) and lots of detail about 3Com's Token Ring solutions in the lead feature article, "3Com's Integrated Token Ring Solution" (see page 2).

Token Ring Solutions

In Edgar Masri's article "3Com's Integrated Token Ring Solution," 3Com's Token Ring products are discussed as more than a broad set of products—they are an integrated Token Ring solution. And what better way to illustrate this than a real-life example—3Com's response to a recent request for proposal from an overseas public transportation agency. By showing how our products can be used to meet actual customer needs, the solutions described in this article can be a blueprint for network managers and planners who have heterogeneous networking requirements.

Mixed-Media Internetworking

In "Implementing Mixed-Media Internetworking" (see page 12), Jeff Weaver answers the question "Should you bridge or route in planning internetworking using different physical LAN types?" whether they are Ethernet, Token Ring, or FDDI networks. This is a detailed and practical view of the issues that should be considered when you plan to mix physically different LAN types.

Stackability

Are you confused by the terms hub, repeater, stack, "pileable," fixed-port, chassis-based, and stackable hubs? Then read Terry Lockyer's "Demonstrating Stackability with 3Com's LinkBuilder FMS Hub" (see page 22) which provides excellent definitions of these all too confusing terms. Terry also provides you with an overview of the LinkBuilder® FMS™ hub, 3Com's innovative, stackable solution for the Ethernet environment.

3Com pioneered the stackable hub market with its first-generation LinkBuilder 10BT/10BTi hubs as a result of customer feedback that highlighted the need for a hub solution combining the best of both fixed-port and chassis-based hub designs. Now, Terry shows how with the addition of its LinkBuilder FMS (Flexible Media Stack) second-generation product 3Com has confirmed its leadership in the design, development, and implementation of stackable hubs.

Tech Tips

As always, this issue is full of hands-on, practical tech tips—from understanding and managing Telnet connections to 3Com NETBuilder® bridge/routers, to remote-booting a TokenLink® III adapter, to a NetWare® 3.11 server using ODI (see pages 9-11).

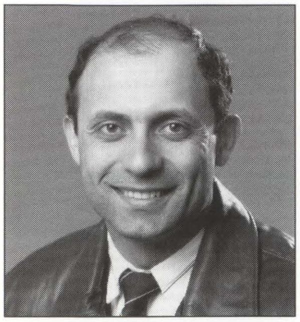
Data Compression and ANSI X3T9.5 Standards Update

We think you'll find the explanation of 3Com's data compression solution (see page 20) of interest—particularly those of you addressing the ever-growing issues around the effective bandwidth utilization and costs of wide area networks. A lot has been happening lately in the ANSI X3T9.5 committee—coverage of the FDDI standards group can be found on pages 26-27.

Don't Forget—*3TECH* is Free!

3TECH is free of charge and we ask only that you fill out the enclosed qualification card to continue receiving it. Even if you're already a subscriber to *3TECH*, we'd appreciate your filling out the qualification card and mailing it in. It's very important for us to have the most up-to-date information in our database.

Suzanne Dowling is managing editor of 3TECH. *Suzanne has also managed the newsletters* SNA Perspective *and* Network Management Perspective. *Before coming to 3Com in 1989, Suzanne worked at Communications Solutions, Inc. and SRI International in writing and editing positions. She received her B.A. from the University of California, Los Angeles and has M.A. degrees from the University of California, Berkeley and the University of California, Los Angeles.*



Edgar Masri is director of business development at 3Com Corporation. He is responsible for evaluating and managing new initiatives and business opportunities for 3Com and is currently focusing on the areas of ATM, 100-Mb Ethernet, network management, and Token Ring. He has over nine years experience in the computer communication and telecommunications industries and previously held engineering management positions at a Silicon valley start-up and at Rolm.

Edgar has a B.Sc. from Ecole Centrale de Paris in France, an M.S. in electrical engineering and computer science from the University of California at Berkeley, and an MBA from Stanford University.

3Com's Integrated Token Ring Solution

3Com's Response to a Recent Request for Proposal for an Integrated Token Ring Solution

By Edgar Masri

3Com, no newcomer to the Token Ring arena, introduced its first Token Ring product, the TokenLink adapter, in 1987. Since 1991 when the company announced its global data networking strategy—building networks as seamlessly as the telephone system—3Com has designed, developed, and distributed Token Ring products in every major product category. With products such as the TokenLink III network adapter, the NETBuilder II Token Ring bridge/router, and the LinkBuilder TR stackable hub, 3Com has created a complete Token Ring solution.

In this article, 3Com's Token Ring products are discussed as more than a broad set of products—they are an integrated Token Ring solution. And what better way to illustrate this integrated solution than a real-life example—3Com's response to a recent request for proposal (RFP) from an overseas public transportation agency. By showing how our products can be used to meet actual customer needs, the solution described in this article can be a blueprint for network managers and planners who have heterogeneous networking requirements.

Introduction

Since 1987, 3Com's Token Ring product offerings have evolved into an integrated Token Ring solution which is a key component of the company's global data networking strategy. This article describes how 3Com's Token Ring products complement each other in an RFP from an overseas public transportation agency. It also demonstrates that the benefits of 3Com's Ethernet solution—compatibility, simplicity, and reliability—are also part of 3Com's Token Ring solution.

The overseas agency wants a regional network that:

- Integrates existing Token Ring, Ethernet, and SNA® networks into a maximally interoperable environment
- Is easy to install, maintain, and manage
- Is consistently available for a full range of critical tasks

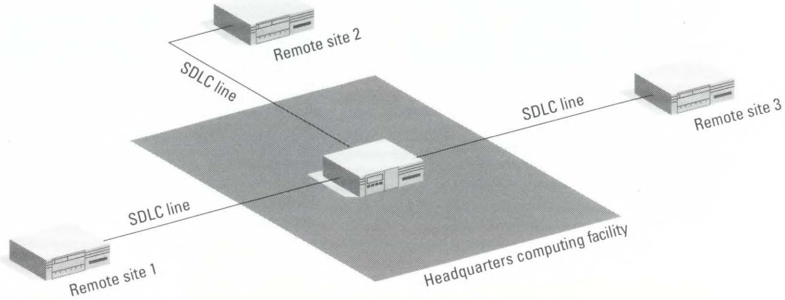
Transportation Agency—Background

The agency that submitted the RFP operates numerous bus and streetcar lines to provide public transportation services. The agency's computer operations are mainframe-based and it is a typical Big Blue, SNA-based networking shop. The agency also has a number of LANs that include several media and network types.

The agency has plans to expand its installed facilities and consolidate its networks into a regional network that includes network management. It has a heterogeneous networking environment (i.e., Ethernet, Token Ring, and SNA) distributed throughout its headquarters site and the metropolitan area and it anticipates the addition of several more LANs including at least one FDDI backbone network.

An overview of the agency's current data processing and communications facilities is shown in Figure 1.

Figure 1. Agency's Existing Network



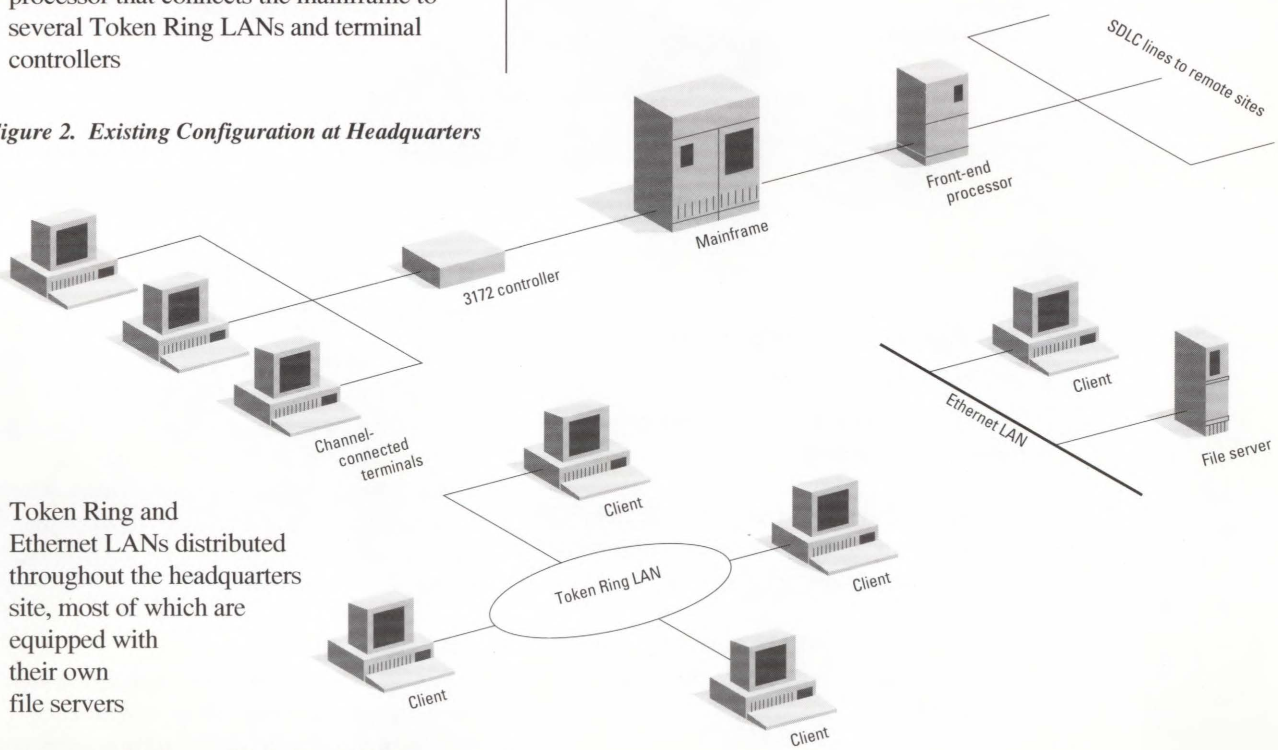
The Computing Environment

The systems located at headquarters (shown in Figure 2) include:

- A central computing facility consisting of a mainframe computer and a front-end processor that connects the mainframe to several Token Ring LANs and terminal controllers

In addition to the LANs, there are multiple terminals at remote sites that communicate with the headquarters mainframe/SNA network by 3274-type terminal controllers and SDLC leased lines. The typical configuration of a remote site is shown in Figure 3.

Figure 2. Existing Configuration at Headquarters

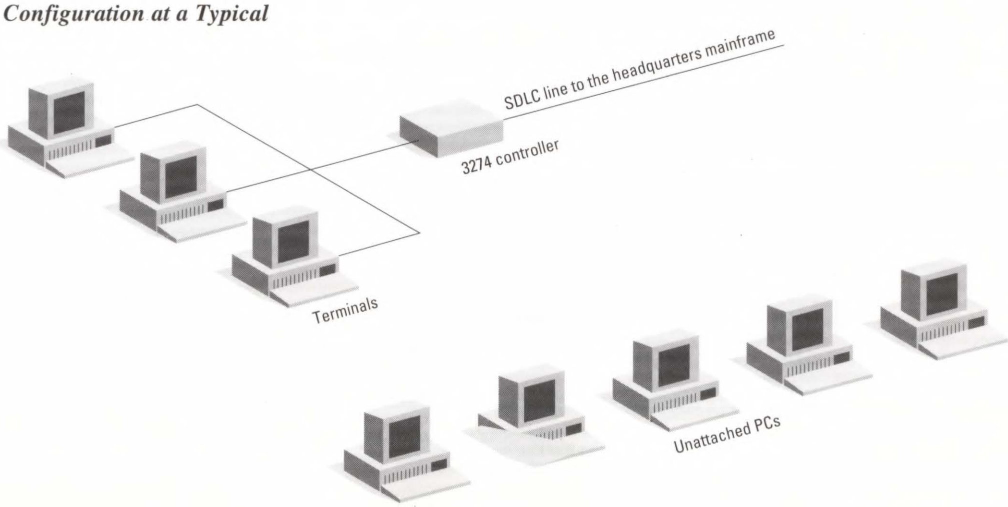


- Token Ring and Ethernet LANs distributed throughout the headquarters site, most of which are equipped with their own file servers

The agency also has multiple small Token Ring and Ethernet LANs dispersed throughout the city at remote locations. These remote sites are essentially identical and each contains one or more LANs. When there is more than one LAN, they are of the same media type—either Token Ring or Ethernet—and connected to one another via an appropriate internetworking device. However, these remote networks are isolated from the headquarters network.

At the remote sites, the agency plans to integrate the remote terminals into its regional network and eliminate the use of expensive SDLC links. To interconnect existing network and terminal cluster controllers, the agency plans connectivity between headquarters and the remote sites by providing WAN capabili-

Figure 3. Existing Configuration at a Typical Remote Site



ties at the remote sites. Figure 4 shows the proposed regional network.

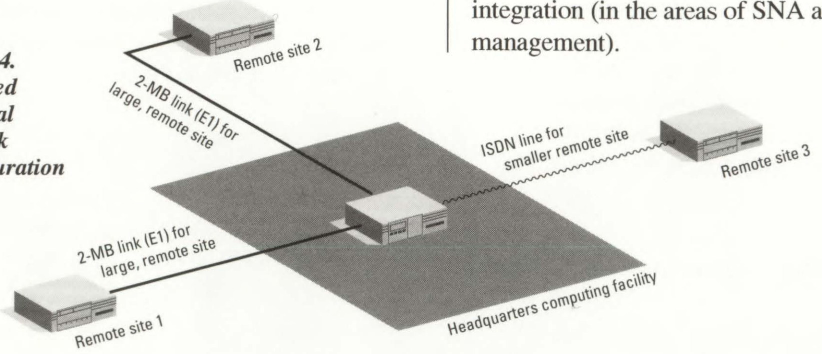


Figure 4. Proposed Regional Network Configuration

3Com's proposal specified unique benefits in compatibility (with TokenLink III adapters), simplicity (Boundary Routing™ solutions), and integration (in the areas of SNA and network management).

The Agency's Heterogeneous Network Requirements

The agency's RFP to 3Com included the following requirements:

- Adapters that support and are compliant with software applications (for the most part IBM® applications) running on its PCs
- Hubs that are SNMP-manageable, provide Ethernet and Token Ring support, and are cost-effective
- SNA integration that provides SNA and non-SNA traffic over the same WAN links (E1 and ISDN)
- Multiprotocol bridge/routers with appropriate peripherals to provide WAN connectivity (E1 at larger remote sites and ISDN for smaller remote sites)
- An open, UNIX®-based network management platform that includes an interface to IBM's NetView
- SNMP network management for all products managed from one network management station
- At the heart of the RFP was a deep interest in cost-effective, reliable, and standards-based solutions.

3Com's Integrated Response—Remote Site Solutions

3Com's response to the RFP addressed the technical benefits of providing unique, optimal approaches to the agency's heterogeneous networking requirements.

3Com's TokenLink III and EtherLink III Adapters

3Com responded to the agency's need for both compatibility and reliability at the PC level at remote sites by recommending TokenLink III network adapters to add users to existing Token Ring networks and to implement new Token Ring LANs. EtherLink® III network adapters were recommended for the Ethernet LANs.

IBM Compatibility

3Com's TokenLink III network adapters were recommended in Token Ring environments because they support and are truly compliant with IBM applications running on the agency's PCs. TokenLink III network adapters are implemented with the IBM TROPIC™ chip set so they are 100 percent IBM compatible. TokenLink III network adapters also include installation procedures that are familiar to those who have installed IBM devices.

Reliability

Reliability, another key item for the agency, is an important feature of TokenLink III network adapters. These adapters are built to last, have a lifetime warranty, and provide excellent value, an important consideration for a well-managed public agency.

Recommended 3Com Hubs at Remote Sites

3Com recommended LinkBuilder FMS stackable hubs to implement new Ethernet LANs. LinkBuilder TR stackable hubs were specified for new Token Ring LANs. LinkBuilder MSH™ hubs were recommended at the remote sites where the implementation of new LANs resulted in the creation of mixed-media environments.

3Com's Ethernet (LinkBuilder FMS) and Token Ring (LinkBuilder TR) hubs are SNMP-managed, a key requirement for the agency. The LinkBuilder TR (without management module) and TRi (with management module) hubs provide IBM compatibility in Token Ring environments. In addition, 3Com's stackable LinkBuilder FMS and LinkBuilder TR hubs are cost-effective and 3Com's chassis-based LinkBuilder MSH hub includes a number of innovative features such as special Token Ring facilities.

Innovative Features of LinkBuilder TR

LinkBuilder TR stackable hubs were specified to meet the needs of the agency's new Token Ring LANs. The LinkBuilder TR series, which is positioned as a solution for departmental LANs, branch offices, and remote sites, offers 16-lobe (i.e., node) ports per unit and supports both shielded and unshielded twisted-pair cabling. One LinkBuilder TRi (Model 1) can manage up to five LinkBuilder TR unmanaged stackable hubs. In addition, one LinkBuilder TRi (Model 2) can manage up to fifteen additional LinkBuilder TR units for a total of 256 users per ring.

By overcoming the limitations of fixed-port hubs and offering the functionality and fault-tolerance of chassis-based hubs, LinkBuilder TR stackable hubs offer extensibility, topological flexibility, and reliability, all of which adds up to an unparalleled price-performance ratio. LinkBuilder TRi provides complete, SNMP-compatible network management capabilities for itself and the stack.

LinkBuilder TR—Zero Delay Lockout

Because the agency wanted to minimize support costs and maintain high reliability at its remote sites, 3Com highlighted the zero delay lockout feature of LinkBuilder TR and emphasized that this feature is offered on both LinkBuilder TR (without management module) and the LinkBuilder TRi (with management module). Zero delay lockout is a unique, hard-error recovery feature that automatically isolates faulty nodes before they are inserted into the network, increasing uptime by preventing the failure of an entire ring.

Zero delay lockout prevents malfunctioning, misconfigured, or incorrect devices from impairing the network's integrity and wasting time while a faulty device is isolated. Two examples where zero delay lockout is beneficial are:

- A 16-megabit ring where a user plugs in a 4-megabit adapter or vice versa. This is a common occurrence that can take the whole ring down; with zero delay lockout this potential problem is detected before anything enters the ring.

- A user with an EGA card uses a similar kind of connector and plugs the EGA card into the ring. This, too, can take the whole ring down and can be prevented using the zero delay lockout feature.

As a result, zero delay lockout can dramatically increase the availability of Token Ring LANs while minimizing the time required for network administrators to solve the problems caused when inappropriate or malfunctioning devices are incorrectly inserted into the ring.

LinkBuilder TR—Phase-Locked Loop

The phase-locked loop feature of LinkBuilder TR was emphasized in 3Com's response to the RFP because of the customer's need for network integrity and cost-effectiveness. Phase-locked loop allows transmissions to run over a lower grade of cable for longer distances without retransmission problems that occur because packets are occasionally lost or garbled, or the network goes down. It thus makes networks more robust. In comparison to tank circuits (which are not able to sync up to a signal as reliably, degrade over time, and are temperature sensitive), there is no change over time with phase-locked loops and there is consistency.

With phase-locked loop retiming, the agency could use the more economical unshielded twisted-pair wiring most common in buildings and still achieve maximum distances of 200 meters at 16 Mbps. Phase-locked loops also simplify network design by eliminating complex distance limitation calculations. The cost of phase-locked loops has been reduced and the reliability increased by developing a custom ASIC chip.

Recommended SNMP Management at Remote Sites

LinkBuilder TR, LinkBuilder FMS, and LinkBuilder MSH are fully SNMP compatible and can be managed from a central network management station. In addition, LinkBuilder TR is the first stackable hub on the market to fully support the SNMP remote monitoring (RMON) management information base (MIB),

Abbreviations and Acronyms

ASIC
Application-specific integrated circuit

ATM
Asynchronous Transfer Mode

ISDN
Integrated Services Digital Network

LAN
Local area network

LinkBuilder FMS
LinkBuilder Flexible Media Stack

LinkBuilder MSH
LinkBuilder Multi-Services Hub

LinkBuilder TR
LinkBuilder Token Ring

Mbps
Megabits per second

MIB
Management information base

RFP
Request for proposal

RMON
Remote monitoring

SDLC
Synchronous Data Link Control

SNA
Systems Network Architecture

SNMP
Simple Network Management Protocol

WAN
Wide area network

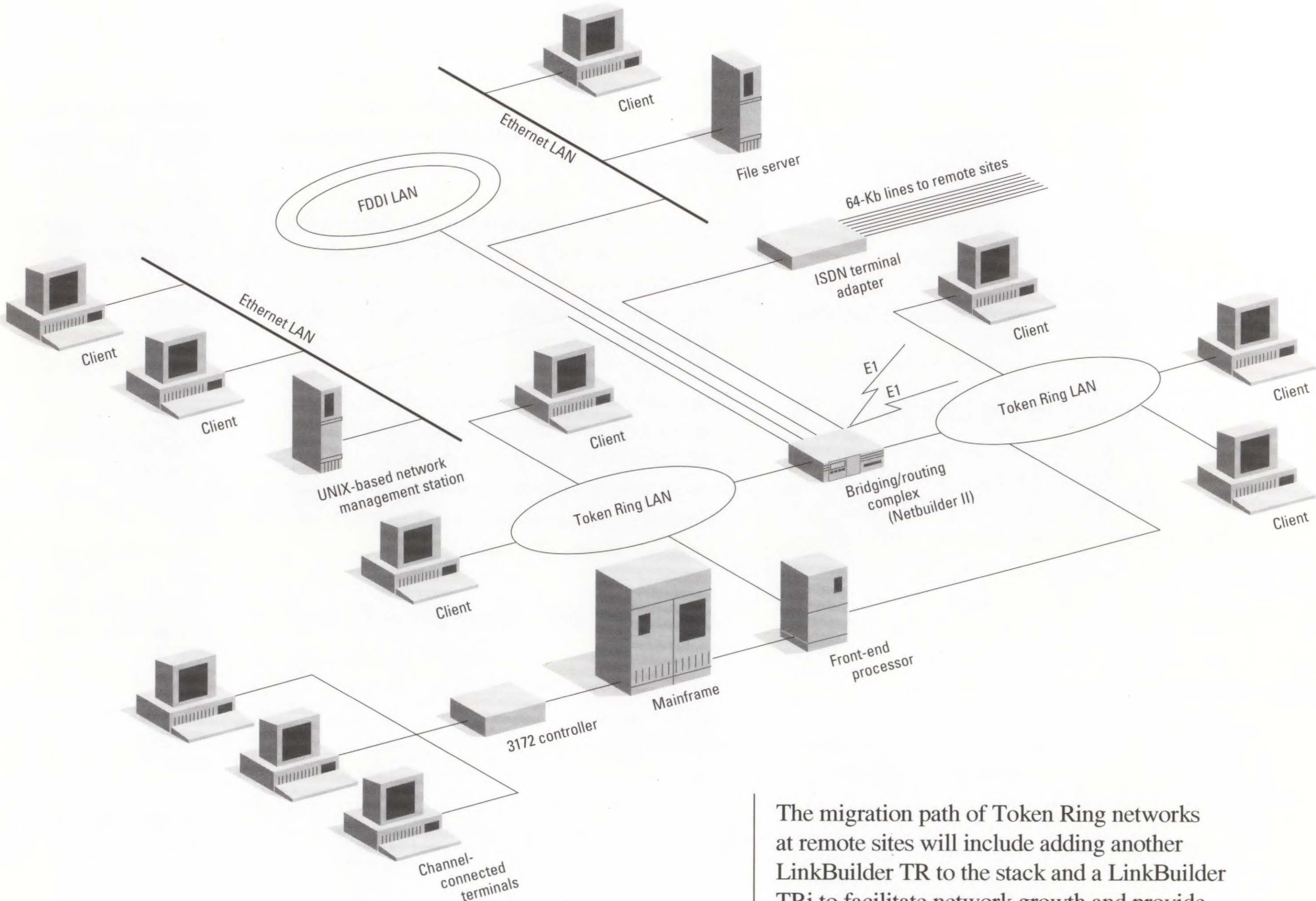


Figure 5. Proposed Headquarters Configuration

an SNMP standard for remote network monitoring and analysis. RMON will give the agency's network administrators the benefits of a network analyzer without the associated high costs.

Recommended Network Management at Remote Sites

3Com's recommendation for implementing new Token Ring networks at remote sites was based on a single LinkBuilder TR. As the agency's remote sites grow, they can use LinkBuilder TR with LinkWatch TR management software. This software allows the TokenLink III adapters that are attached to the hub to be managed directly from the network management station, even though the hub itself is transparent to the network management station. Combined with the zero delay lockout feature, this was all the management functionality these small Token Ring LANs initially needed.

The migration path of Token Ring networks at remote sites will include adding another LinkBuilder TR to the stack and a LinkBuilder TRi to facilitate network growth and provide full network management functionality.

Support for Mixed Ethernet/Token Ring Environments

3Com specified LinkBuilder MSH for remote sites where new media had been introduced because it provides support for both Ethernet and Token Ring LANs in a single hub. LinkBuilder MSH will allow the remote sites to implement multiple Ethernet and Token Ring LANs as necessary.

Innovative Features of LinkBuilder MSH

The LinkBuilder MSH chassis-based hub can include as many as eleven concentrator or internetworking modules. It features a high-performance backplane architecture that supports up to 2.6 gigabits per second of throughput. It also offers full bridging capabilities and dynamic card switching between backplane buses, as well as a separate network management bus. The LinkBuilder MSH hub is fully SNMP-compatible and includes SmartAgent™ network management capabilities. (For additional information on

SmartAgent, see the article "SmartAgent—Core Network Management Software on the New LinkBuilder FMS Hub," *3TECH*, Fall 1992.)

To provide high reliability at headquarters and the remote sites, the unique Token Ring architecture of LinkBuilder MSH was specified. This architecture utilizes on-board ASICs to ensure ring integrity and to build multiple multistation access units into logical rings. This avoids potentially crippling relay malfunctions that can occur in conventional Token Ring hub architectures in which relays are incorporated directly into hub backplanes.

Recommended Boundary Routing Solution

A key requirement in the agency's RFP is to provide connectivity between the remote sites and headquarters in order to establish a regional network. Such connectivity will be provided by either ISDN or E1 links, depending on the specific needs of each site.

3Com's NETBuilder Remote Control and NETBuilder II bridge/routers were the recommended devices to fill this need. They are capable of providing both E1 and ISDN support and are SNMP compatible for management from a central network management station. Of even more significance, however, is the fact that these NETBuilder products are the foundation of 3Com's Boundary Routing System Architecture which provides a way to simplify the role of the remote router when it is connected to a regional network. Because the remote device has only one WAN connection to communicate over, it decides only whether or not to forward a packet to a central (or headquarters) node, and does not need to keep and maintain routing tables for every router in the network.

In 3Com's response to the RFP, the Boundary Routing System Architecture is implemented with a NETBuilder II at headquarters (see Figure 5) and a NETBuilder Remote Control at the remote sites (see Figure 6). Remote NETBuilder configurations include a NETBuilder Remote Control for Boundary Routing at the remote site only (one LAN and one WAN port).

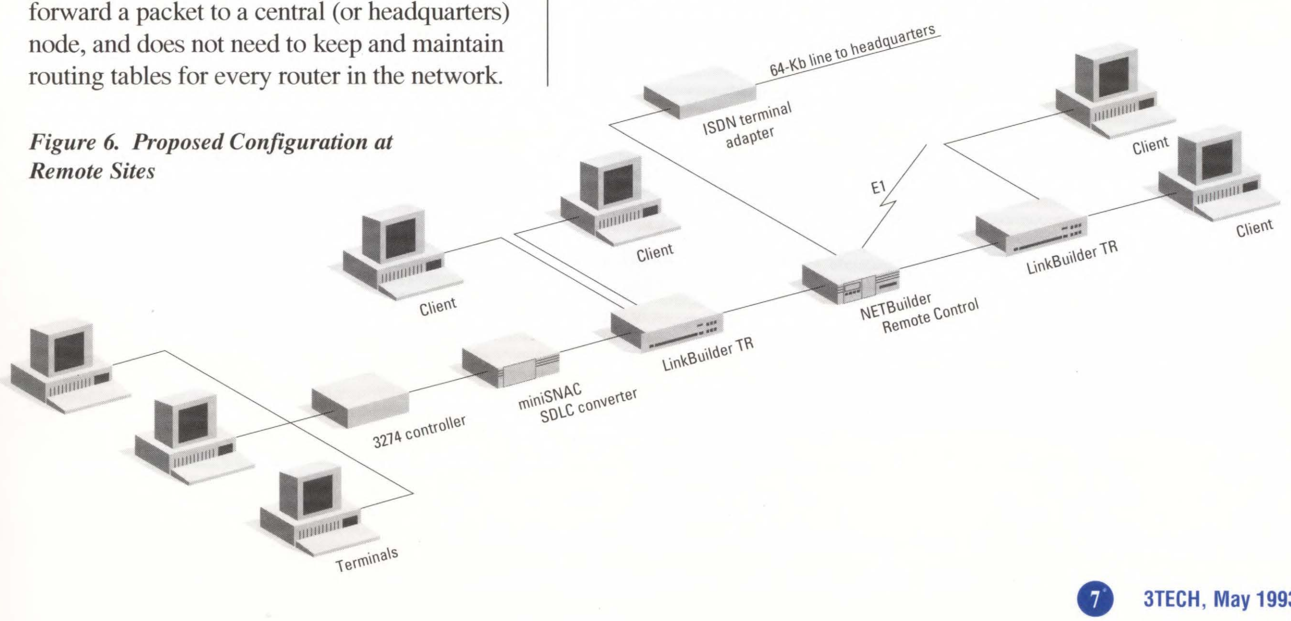
Boundary Routing saves time, effort, and money by minimizing the amount of configuration and maintenance required for WAN internetworking. The central (or headquarters) node is the only router that needs a complete set of routing tables and, because it is centrally located, it is close to the network management expertise needed to configure and maintain it. The transportation agency's regional network proved to be an ideal candidate for Boundary Routing because only a single active ISDN or E1 link was necessary between each remote node and the central bridging/routing facility at headquarters.

At remote sites, all that would be required to implement the architecture is simple software upgrades to existing NETBuilder systems to convert them to the appropriate NETBuilder Remote Boundary Routing configuration. In instances where an ISDN link to headquarters is required, these NETBuilders would be equipped with appropriate and widely available third-party ISDN terminal adapters to provide ISDN connectivity.

Recommended SNA Integration Solution

An important requirement of the RFP was to integrate the remote terminal clusters into

Figure 6. Proposed Configuration at Remote Sites



regional networks with Token Ring LANs at remote sites. 3Com offers this capability with SDLC conversion between the 3270-type cluster controller and the Token Ring LAN.

3Com's response specified the required SDLC conversion using a miniSNAC™ box produced by Sync Research,™ Inc. The miniSNAC interfaces with the cluster controller on one side and a LinkBuilder TR on the other (see Figure 6). This approach offers several important advantages. It ensures a high level of reliability through the local polling mechanism offered by the miniSNAC. In addition, it satisfies the key requirement of providing better utilization of remote links in a flexible way. There would be no need for remote links to be implemented in parallel for terminal clusters and LANs. And each remote site could be provided with a remote interface—either ISDN or E1—offering the bandwidth most suited to its needs. The miniSNAC also provides full NetView support of the remote terminal clusters.

"At the heart of the RFP was a deep interest in cost-effective, reliable, and standards-based solutions."

Recommendations for Headquarters

After a packet is transmitted from a remote site via the WAN link, it arrives at headquarters over an ISDN or an E1 line. If it travels via ISDN, it passes through the ISDN adapter that front-ends the NETBuilder II. If it travels over an E1 line, it goes directly into the E1 port on the NETBuilder II (and 3Com supports G.703). In the Boundary Routing System Architecture, this NETBuilder II is the only router in the system that contains a full set of routing tables for all the routers in the system, as well as the code that drives the entire system. Its central location makes it easy to administer.

At headquarters, 3Com's response to the RFP recommended new Ethernet LANs based on LinkBuilder FMS hubs, new Token Ring LANs based on LinkBuilder TR hubs, and new mixed-media LANs based on LinkBuilder MSH hubs. In addition, at headquarters, all these LANs were integrated into a single internetwork using one LinkBuilder 3GH hub, which was selected because of the need for an FDDI collapsed backbone solution.

For more information on Token Ring products, contact your local reseller or call 800-638-3266.

Recommended Headquarters Network Management Solutions

To put in place the requisite network management functionality at the agency's headquarters, 3Com specified an open, UNIX-based network management solution. A SunNet® Manager network management station will use SNMP to manage the agency's bridge/routers and chassis-based hubs and those hub stacks in which network management capabilities are required. To meet the agency requirement for a network management gateway between SNMP and NetView network management systems, 3Com recommended Bridgeway's EventIX,® a third-party software tool that runs on the UNIX-based network management station.

Conclusion

3Com offers the full range of products required to create a complete global data network. From TokenLink III adapters based on IBM's TROPIC chip set to SDLC conversion with NetView support, 3Com's offerings are fully IBM compatible. 3Com's unique Boundary Routing System Architecture is another excellent example of the kind of simplicity that characterizes the entire product line. Reliability is exemplified by the fault-tolerant capabilities of the LinkBuilder TR and LinkBuilder FMS stackable hubs, as well as the lifetime warranty that accompanies every TokenLink III adapter. Finally, the entire product line provides for standards-based network management and is fully SNMP compliant.

We've given you the 12,000-foot view of 3Com's Token Ring solutions. Look for more in-depth coverage in future issues of 3TECH *of some of the products briefly covered here, such as 3Com's LinkBuilder TR, LinkBuilder MSH, and Sync Research's SDLC converter.*

Tech Tips

Tech Tips has been developed to help you make your networks more efficient. We try to find the most meaningful technical tips from a variety of sources including Ask3Com,℠ 3Com's electronic information service (available on CompuServe®), which features technical articles, product and service information, patches, fixes, utilities, and a lively message section. Let me know how you like these tips—are they meeting your needs? I can be contacted via fax at 408-764-5001 or via the Internet at Suzanne_Dowling @3Mail.3Com.com.

Understanding and Managing Telnet Connections to 3Com NETBuilder Bridge/Routers

Problem:

Telnet is one way to access a 3Com NETBuilder bridge/router for configuration and management. (The other ways are Console Remote and via SNMP.)

During a Telnet connection, a TCP session is established between a peer (end station) and the NETBuilder bridge/router. While NETBuilder and NETBuilder II version 5.x and later software allow up to four simultaneous TCP sessions, older versions of NETBuilder software allow only one TCP session (and therefore one Telnet connection) at a time. If a peer does not terminate the TCP session correctly during the TCP disconnect (FIN, FIN-ACK, ACK) or via a TCP RESET, the NETBuilder bridge/router will not drop the Telnet session and will therefore reject future Telnet sessions.

Solution:

Managing Sessions

You can manage TCP sessions on the NETBuilder bridge/router using the -TCP menu option. Use the following steps to enable KeepAlive packets and set appropriate values to KeepAliveTime and KeepAliveLimit, which will close improperly terminated sessions.

1. Enable the TCP KeepAlive option on the NETBuilder bridge/router:

```
setd -tcp cont = keepalive
```

2. Set the KeepAliveTimer and KeepAliveLimit to appropriate values:

```
setd -tcp keepalivetime = 45
setd -tcp keepalivelimit = 5
```

The KeepAliveTime is the interval between KeepAlive packets. In this example, after five KeepAlive packets (at 45-second intervals) without a response, the NETBuilder bridge/router will drop the session.

Notes:

1. If the KeepAliveLimit is set to 0, the NETBuilder bridge/router does not drop the connection even if the peer fails.

2. A KeepAlive packet is a redundant TCP ACK sent to solicit a response from the peer. Refer to the *NETBuilder Bridge/Router Reference Guide* (P/N 09-0252-00), or the *NETBuilder Brouter Commands and Parameters Guide* (P/N 09-0239-00) for more information.

Closing Sessions

If you cannot access the NETBuilder bridge/router via Telnet because of hung TCP sessions, use a terminal directly attached to the NETBuilder console port, or use the Remote command from another NETBuilder bridge/router. To close the hung session(s) on the NETBuilder bridge/router, take the following steps:

1. Find out the TCP connection ID:

```
sh -tcp conn
```

The connection ID will be a six-digit number in the last column.

2. Manually terminate the TCP connection:

```
del -tcp conn <connection-id>
```

You should now be able to access the NETBuilder bridge/router using Telnet.

CardFacts Adapter Fax Service

CardFacts℠ is an interactive fax service for obtaining instructions and diagrams on the installation and configuration of 3Com adapters. CardFacts can be accessed from the U.S. or anywhere in the world if you have a touch-tone phone by calling 408-727-7021.

At your request, you will receive a menu of choices listed by product. Indicate your selection on your telephone keypad and the information will be sent to you by return fax. CardFacts is available 24 hours a day, seven days a week.

Note: If the TCP session is active but idle, the NETBuilder bridge/router will not time out the peer because the peer will be responding to the KeepAlive packets. To end this session, delete the TCP connection as shown above (del -tcp conn <connection-id>).

Remote-Booting a TokenLink III Adapter to a NetWare 3.11 Server Using ODI

Problem:

This tech tip explains how to remote-boot a 3Com TokenLink III adapter to a Novell® NetWare 3.11 server via ODI. Refer to the **NetWare 3.11 Installation Guide** ***for more information.***

Solution:

To complete this procedure, you will need the files RPLODI.COM and RPLFIX.COM, which are provided in the file DOSUP5.ZIP on the Novell forum on CompuServe. (Contact Novell for specific file names and downloading instructions.)

Server Setup

Include the following commands in your AUTOEXEC.NCF file:

LOAD TOKEN
BIND IPX TO TOKEN NET=nnn
(nnn=the network number you assign)
LOAD TOKENRPL
BIND TOKENRPL TO TOKEN

Workstation Setup

(Steps 1-5 create a boot image on the server.)

1. Create a NetWare bootable diskette for the workstation. The diskette should include:

COMMAND.COM
LSL.COM (provided with NetWare 3.11)
RPLODI.COM (provided by Novell)
TOKEN.COM (provided with NetWare 3.11)
IPXODI.COM (provided with NetWare 3.11)
NETX.COM (provided with NetWare 3.11)
AUTOEXEC.BAT

The AUTOEXEC.BAT file should match the following:

LSL.COM
RPLODI.COM
TOKEN.COM
IPXODI.COM
NETX.COM
F:
LOGIN username
(username=the user's login name)

2. Attach a workstation to the server and log in as SUPERVISOR.

3. Place the boot diskette you created in step 1 into drive A.

4. Go to the LOGIN directory. (You should currently be at the F drive.)

CD \LOGIN

If you type PROMPT=PG, your prompt should now be F:\LOGIN>.

5. Run the Novell DOSGEN utility (found on the Novell *WSGEN* disk):

F:\SYSTEM\DOSGEN

DOSGEN will copy the files on the boot diskette to a boot image file (NET$DOS.SYS) in SYS:LOGIN.

6. Copy the AUTOEXEC.BAT file from the boot diskette to SYS:LOGIN and to the default directory specified in the user's login script.

7. Flag NET$DOS as Shareable in SYS:LOGIN.

FLAG NET$DOS.SYS S

8. If the user has DOS version 5.0 or higher, run the RPLFIX.COM utility, specifying the NET$DOS.SYS file which is found in the \LOGIN directory. For example, assuming F: points to the LOGIN directory, you would type:

RPLFIX F:NET$DOS.SYS

This modifies the boot image file for use with the correct DOS version.

9. If the user has a PC containing a bootable hard disk, disable the boot partition of the remote boot workstation's hard disk. To do this, run the token RPL program from the diskette provided with the adapter:

3CTOKRPL.EXE

Then remove all diskettes from the floppy drives and reboot the workstation.

The boot partition must be disabled for the remote boot process to work properly. If you want to re-enable it, simply run 3CTOKRPL again. The hard drive is not damaged by this utility and can still be used after the remote boot process is completed.

Protocols that are Bridged or Routed over a Point to Point Protocol-Configured Serial Line

Problem:

When you have a serial connection between two NETBuilder or NETBuilder II bridge/routers in a multiprotocol environment, there may be times when one or more protocols do not seem to be routing properly. This tech tip explains why this might happen and offers a suggestion to discover where the problem is located.

Solution:

Across a serial line, the Network Control Protocol (NCP) of the Point to Point Protocol (PPP) negotiates communication on a per-protocol basis. Only those protocols that are capable of being routed are negotiated. In order for NCP to negotiate a particular protocol, that protocol must be supported and enabled at both ends of the link.

The new NETBuilder version 6.0 SW/CP and SW/XW packages support routing of IP, OSI, XNS,® DECnet,® VINES,® and AppleTalk® using PPP. The SW/BP package supports routing of only IP, IPX, and XNS.

In the version 5.x family of NETBuilder software, the SW/NB4M-BREXT and SW/NBII-BREXT support routing of IP, OSI, XNS, DECnet, VINES, and AppleTalk using PPP. The SW/NB2M-BREXT software does not support VINES and AppleTalk because of memory limitations.

Because bridging is protocol independent, NCP negotiates a collective communication across a serial line for bridged traffic. All traffic not being routed or not capable of being routed (for example, LAT traffic) is transmitted as bridged traffic.

You can verify the status of the PPP link by entering the following command at the NETBuilder command prompt:

SHow -PPP status

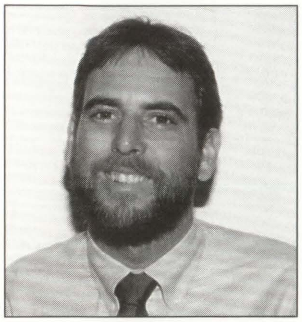
A matrix similar to the following appears. It shows whether NCP has properly negotiated communication of the bridged and routed protocols for each serial port configured for PPP.

```
                PPP Link Control Protocol Status

                      Path          LCP
                      1             LISTEN
                      2             LISTEN
                      3             OPEN
                      4             LISTEN

              PPP Network Control Protocol Status

Port  IP        OSI     XNS      DECNET  IPX     BRIDGE
1     LISTEN    LISTEN  LISTEN   LISTEN  LISTEN  LISTEN
2     LISTEN    LISTEN  LISTEN   LISTEN  LISTEN  LISTEN
3     OPEN      OPEN    REQUEST  LISTEN  LISTEN  LISTEN
4     REQUEST   OPEN    LISTEN   LISTEN  LISTEN  OPEN
```

Possible states are as follows:

LISTEN	Indicates idle mode. The port is listening for communication to begin.
OPEN	Negotiation between the two devices is complete.
REQSENT	A configuration request packet is sent. Negotiation is in progress between the two devices.
ACKCVD	An acknowledgement packet is received, but a configuration request packet is not received.
ACKSENT	A configuration request packet is received, for which an acknowledgement was sent.

Thanks to Cathy Anderson, Greg Caldwell, Bob Driver, Steve Lamb, Michael Zock, and Sandra Zock for their contributions to Tech Tips.



Jeffrey Weaver is currently a marketing engineer in 3Com's Network Systems Division and was previously a 3Com field systems engineer. He has worked for more than twelve years in the data communications industry, including four years with Dow Jones, Inc. and four years as a data communications manager for a large insurance company. Jeffrey received his engineering education from the United States Air Force where he worked as a space systems equipment specialist.

Implementing Mixed-Media Internetworking

To Bridge or to Route in Implementing Internetworking Using Different Physical LAN Types

By Jeffrey Weaver

In a marketplace that demands greater and greater access to and exchange of vital information, engineers are planning to internetwork all available computing resources from existing LANs. These mixed-media LANs typically include Ethernet, Token Ring, and, with increasing frequency, fiber distributed data interface (FDDI) networks. Interconnecting users and computing resources on each of these different networks requires a practical understanding of the issues that should be considered when mixing physically different LAN types.

This article takes a practical look at the major areas of concern engineers and network planners need to consider when deciding whether to implement bridging or routing in internetworks that use different physical LAN types (Ethernet, Token Ring, and FDDI). These issues include multicast to functional address mapping, source route versus transparent bridging, maximum transmission unit (MTU) size, and protocol translation.

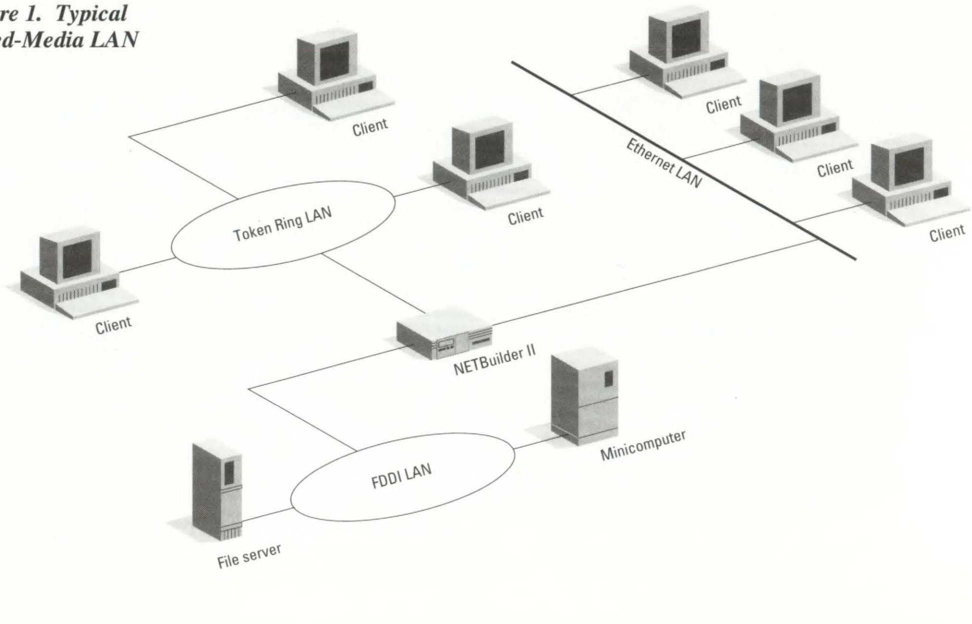
The information in this article will be useful to system engineers, network integrators, and customers who are responsible for network planning. This article should be especially useful to readers planning a migration of Ethernet or Token Ring LAN file servers to FDDI, as well as readers interested in providing connections between existing resources on established Ethernet and Token Ring networks.

Introduction

With the introduction of various network media options to the typical bridge/router, network planners have difficulty deciding which internetworking options to implement in their environment. There is a perceived advantage in sharing information from users on existing Ethernet and Token Ring networks and a very clear need to provide access to FDDI computing resources for these users. As the price of FDDI network adapters (such as 3Com's FDDILink™) has decreased, the logical growth step for many LANs is to migrate shared computing resources (file servers, print servers, database systems, etc.) to 100-Mb FDDI for enhanced performance.

A mixed-media bridge or router such as 3Com's LinkBuilder 3GH or NETBuilder II is the logical hardware device to provide users on Ethernet and Token Ring LANs with access to FDDI networks (see Figure 1). The primary

Figure 1. Typical Mixed-Media LAN



issues that remain for network planners are whether to implement bridging or routing between each attached network. To begin the discussion of mixed-media internetworking, let's look at the changing role of the media access control (MAC)-layer bridge and the network-layer router.

The Changing Role of the Bridge and the Router

A MAC-layer bridge is a device that operates at the ISO/OSI data link layer to connect local or remote networks. A bridge makes forwarding and filtering decisions based solely on the source and destination (MAC) information contained within each data frame—regardless of the higher level protocols within the frame. Bridged networks have historically been considered easy to install and manage because they create a single logical network for all the protocols that are present on each LAN—and a typical bridge installation requires little or no user configuration.

A router is a device that operates at the ISO/OSI network layer to connect local or remote networks. Unlike a bridge, a router makes packet forwarding decisions on a protocol-by-protocol basis. For those protocols being routed, forwarding decisions are based on the most efficient path between each network known to the router. It is important to note that protocols that do not contain network address information cannot be routed. A bridging solution must be used for these protocols.

Installation of a router has typically been considered more difficult than the installation of a bridge. The person installing the router must configure the network addresses for each attached network protocol by protocol, as well as enable the routing of each specific protocol. In many cases, several additional configuration steps (such as RIP, OSPF, etc.) may be necessary. By using separate network addresses for each attached network, administrators create separate fault isolation and network administration domains. This provides a relative degree of LAN administration autonomy and stops broadcast traffic from being sent between networks.

With the introduction of mixed-media internetworking, however, routing becomes the simpler solution while bridging becomes more complex. A router behaves as a native end station on each attached network and forwards data packets between different logical networks. It is much more difficult to create a single logical (bridged) network containing Ethernet, Token Ring, and FDDI than it is to install a router that acts as a native end station on each network and routes packets between what it knows (by the difference in network addresses) to be different LANs.

It is worth noting that, with few exceptions, end users attached to each LAN don't know whether the network administrator has implemented a bridging or a routing solution between networks. The connection to shared resources is handled differently by each device, but users are only aware that the resource is accessible.

Mixed-Media Bridging Issues

The sections that follow describe four issues that network planners should consider carefully before deciding on a bridging or routing solution: multicast to functional address mapping, source route versus transparent bridging, MTU size, and protocol translation. In almost every case, the complexity of finding a bridged solution for all protocols that may exist on a network can be easily overcome by the installation of a multiprotocol router.

In many cases, it may be necessary to install a multiprotocol bridge/router to route all protocols that contain network address information (e.g., IP, Novell's IPX, AppleTalk) while simultaneously bridging only those protocol types that contain no routing information (such as DEC® LAT® or NetBEUI®). Clearly, a multiprotocol bridge/router such as 3Com's NETBuilder II provides administrators with the most flexibility to match the correct solution to the network protocols being encountered.

Multicast to Functional Address Mapping

The first issue planners must consider when designing an internetwork that will incorporate Token Ring as well as Ethernet and/or FDDI LANs is the mapping of the Ethernet or FDDI multicast addresses to valid Token Ring functional addresses. Within an Ethernet, Token Ring, or FDDI frame, the least significant bit of the most significant byte of the destination address is set to 1 to identify the frame as a multicast address. An example of a typical multicast packet is a NetBEUI name resolution request (see Table 1).

Key Terms Used in this Article

Functional addresses
A method of specifying a group of end stations to be addressed by a single packet on Token Ring or FDDI networks.

Multicast addresses
A method of specifying a group of end stations to be addressed by a single packet on Ethernet and FDDI networks.

Source routing
Technology that runs within a network specifying that an end station discovers the proper route and uses that route.

Source route transparent bridging
Technology that allows source routed packets and transparent packets (an Ethernet packet that does not include the routing information field) to be forwarded simultaneously by a bridge.

Abbreviations and Acronyms

ANSI
American National Standards Institute

ARP
Address Resolution Protocol

FDDI
Fiber distributed data interface

IEEE
Institute of Electrical and Electronics Engineers

IP
Internet Protocol

ISO/OSI
International Standards Organization/Open Systems Interconnection

LAN
Local area network

LAT
Local Area Transport

MAC
Media access control

Mb
Megabit

MTU
Maximum transmission unit

NBP
NetBIOS Protocol

NetBIOS
Network Basic Input/Output System

OSPF
Open Shortest Path First

PDU
Protocol data unit

RIP
Routing Information Protocol

SNAP
Subnetwork Access Protocol

TCP/IP
Transmission Control Protocol/Internet Protocol

In Table 1, if a single bit identifies a destination address as a multicast address, millions of other addresses remain for defining specific, unique multicast addresses (2^{47}).

Table 1. NetBEUI "Name Resolution Request" Multicast Address

MAC address
03-00-00-00-00-01

The least significant bit of the most significant byte set to 1 indicates a multicast address

While the IEEE has standardized the global allocation of multicast addresses for Ethernet, FDDI, and Token Ring networks, a problem exists for most Token Ring hardware chip sets. This hardware limitation which generally exists on all Token Ring networks is worked around in practice through software techniques. Instead of using multicast addressing, Token Ring stations utilize a proprietary IBM standard (specified in the *IBM Token Ring Network Architecture Reference*) that uses functional addresses. Functional addresses are specified to be within the space described in the standard as locally defined, and are therefore limited to a total of 32 group addresses.

Translation Bridging
When installing a translation bridge between Ethernet or FDDI and Token Ring networks, network administrators must manually enter a mapping table on the bridge so that valid multicast packets are forwarded to valid functional addresses, and vice versa. Most bridge/routers (including 3Com's NETBuilder II) provide a default mapping for broadcast addresses of all 1s and all 0s. These default entries ensure that the core network remains operational while protocol-specific mapping issues can be resolved by network administrators.

Of overall concern for network administrators should be the total number of multicast frame types on the Ethernet or FDDI network that need to be mapped to Token Ring functional addresses (see Table 2). Some protocols use many multicast addresses during normal operation, and it is possible that there will not be enough unique functional addresses available on the Token Ring network to support the required multicast mappings for each protocol.

Network Routing
Installation of a router between Token Ring networks and Ethernet or FDDI networks eliminates this concern. Since the router is acting as a native end station on the Token Ring network, it will receive and respond to those functional addresses that are specific to a Token Ring router (for each protocol type being routed). Since the router is also acting as a native end station on the Ethernet or FDDI networks, it will receive and respond to those multicast addresses that are specific to an Ethernet or FDDI router (for each protocol type being routed). Note that when a router is installed, no translation between multicast addresses and functional addresses is necessary. The router simply behaves as a native end station for each LAN type, using Token Ring functional addresses where appropriate and Ethernet or FDDI multicast addresses where appropriate.

Source Route and Transparent Bridging

The second area of concern that must be resolved when planning a mixed Token Ring, Ethernet, and FDDI network is whether the Token Ring end stations and internetworking devices (bridge/routers) are using source route bridging. Source routed end stations specify routing information within the data frames sent on to the network. Similar to identification of multicast addresses, a Token Ring (or FDDI) frame that contains source routing information is identified by the least significant bit of the most significant byte of the source address being set to 1.

Currently, source route bridging is standardized for Token Ring and FDDI networks, but most FDDI vendors have chosen not to implement source routing and have continued to use standard transparent addressing. There are currently no industry standards defining a method of bridging source routed Token Ring or FDDI frames to transparent IEEE networks (Ethernet or FDDI).

Table 2. Typical Multicast Address to Functional Address Mappings

	Functional Address	Multicast Address
Broadcast	03-00-ff-ff-ff-ff	ff-ff-ff-ff-ff-ff
Broadcast	ff-ff-ff-ff-ff-ff	ff-ff-ff-ff-ff-ff
NetBEUI	03-00-00-00-00-01	03-00-00-00-00-01

In other words, industry-standard bridges do not perform a gateway function between source routed Token Ring or FDDI networks and transparent Ethernet or FDDI networks. Token Ring frames received with the source address indicating that the frame contains source routing information are simply dropped by the transparent bridge. (Note that this gateway function has been accomplished in a proprietary manner by some bridge vendors, but in many circumstances installation of these devices may seriously affect the stability of an internetwork using industry-standard protocols and technologies.) Therefore, it is not practical to seek a bridged solution when attempting to internetwork source routed Token Ring or FDDI networks to transparent Ethernet or FDDI networks.

When connecting source routed Token Ring or FDDI networks with transparent Ethernet or FDDI networks, installation of a router is the only reliable solution. Once again, the router behaves as a native end station on each network, terminating the source routed domain and beginning the transparent domain—connecting two logical networks rather than trying to create a single logical network using both source route and transparent bridging.

Note: In many cases, Token Ring workstations using protocols that are not routable (DEC LAT, NetBEUI, etc.) issue both source routed frames and transparent frames.

For example, a Token Ring workstation may transmit a source routed request to a server located on an FDDI network and, when an answer is not received within a specified time, the workstation will issue the same request without including the source routing information (i.e., a transparent request).

While an industry-standard, mixed-media bridge may not forward the source route request from Token Ring to FDDI (or Ethernet), the bridge will forward the transparent frame and the connection can be completed. In almost every case, the Token Ring software drivers on the client device (which uses a nonroutable protocol) will issue transparent frames only or will issue both source routed frames and transparent frames (using the technique described above) and therefore can be successfully bridged between media.

Maximum Transmission Unit Size

A third area of concern for network planners building mixed-media internetworks is the difference in MTU size. MTU is defined as the maximum size of the data packet allowed on the LAN. The MTU size for Ethernet is 1,500 bytes, for FDDI 4,500 bytes, and for Token Ring 16,624 bytes (although in practice, vendors generally limit this to 4,500 bytes).

Key Internetworking Standards

IEEE 802	Overview and architecture
IEEE 802.1d	MAC bridges
IEEE 802.1i	MAC bridging in FDDI networks
IEEE 802.1h	Draft recommended practice, MAC bridging of version 2.0 in 802 networks
IEEE 802.5m	Source route transparent bridging
IAB RFC 1042	Transmission of IP over 802 networks
ANSI X3T9.5	FDDI standards (MAC, PHY, PMD, SMT)

Translation Bridging

If a mixed-media bridge is selected to provide the connections between Token Ring, FDDI, and Ethernet networks, all devices on each network must be configured to use a frame size of 1,500 bytes. The bridge has no ability to fragment frames when sending between media. Packets greater than 1,500 bytes will not be forwarded to Ethernet networks, and packets greater than 4,500 bytes will not be forwarded to FDDI networks.

Forcing end-station configurations on Token Ring and FDDI to use a maximum frame size of 1,500 bytes where possible will ensure forwarding of frames between networks. However, this configuration could be a great disadvantage if network administrators are attempting to optimize each LAN for peak performance.

For example, a customer who has migrated two file servers to FDDI may want to periodically back up each server to the other while continuing to serve clients on Ethernet or Token Ring. To optimize performance, the file server backup exchange should be done using 4,500-byte frames. However, if a bridge was used to connect the Ethernet users to FDDI, the servers would have to be configured to use a maximum frame size of only 1,500 bytes—slowing down the FDDI-to-FDDI communication.

Network Routing

Once again, the solution to this problem is the installation of a network-layer router. By behaving as an end system on each medium, the router will use the maximum frame size possible for each physical LAN type. Unlike a bridge, the router will fragment frames greater than 1,500 bytes received from Token Ring and FDDI networks and will forward multiple smaller frames as necessary. Note that packet fragmentation is accomplished on a protocol-by-protocol basis, and some protocols do not provide a fragmentation mechanism. These protocols typically determine the MTU size to use on a connection-by-connection basis and will adjust to the largest MTU supported across the routed internetwork connection.

Note: Some Ethernet-to-FDDI bridges (such as 3Com's Linkbuilder 3GH) provide a packet fragmentation feature specific to the TCP/IP protocol. This lets the bridge operate in a manner similar to a router—fragmenting large FDDI frames into multiple smaller Ethernet frames as necessary. The IP fragmentation feature is only for TCP/IP.

Protocol Translation

The fourth and last issue that must be considered when planning mixed-media internetworks is perhaps the area of most concern. Industry standards document the translation of Token Ring, Ethernet, and FDDI frames between mixed media by a translation bridge. These standards are specifically in the area of correctly formatting MAC-level addresses when bridging frames between networks to ensure compatible formats. Token Ring networks use one hardware addressing format (noncanonical) and Ethernet and FDDI networks use a different format (canonical). There is no way to determine which format a MAC-level address is in by simply looking at the packet itself, so the bridge must ensure that the format is correct based on the physical LAN type to which the frame is being forwarded. (For more information, see the article "FDDI Encapsulation and Translation Bridging," *3TECH*, Summer 1992).

When MAC-level address information is contained within a protocol data unit (PDU) such as a TCP/IP ARP reply, the issues regarding correct address formatting are not generally standardized. It happens that TCP/IP ARP is the only protocol-specific information a translation bridge is expected to translate into the correct format for each media type.

Industry standards specify that the hardware address returned within a TCP/IP ARP request or response always be in canonical order. This standardization ensures that end stations on Token Ring, Ethernet, and FDDI networks always know the specific order in which the hardware address is presented and therefore know how to correctly format the MAC-level destination address of a frame for delivery across the internetwork. This is a good example of why the IEEE 802 standard which specifies a common way of resolving addresses is so important to the industry.

Suggested Reading

"FDDI Encapsulation and Translation Bridging," Jeffrey Weaver. *3TECH* (Summer 1992).

Inside AppleTalk (second edition). Apple Computer Inc., Cupertino, California, 1990.

Local and Metropolitan Area Networks; Media Access Control Bridges. Institute of Electrical and Electronics Engineers Inc., 1991.

"Optimizing Network Performance with Token Ring Bridges," Bill Erdman. *3TECH* (Spring 1992).

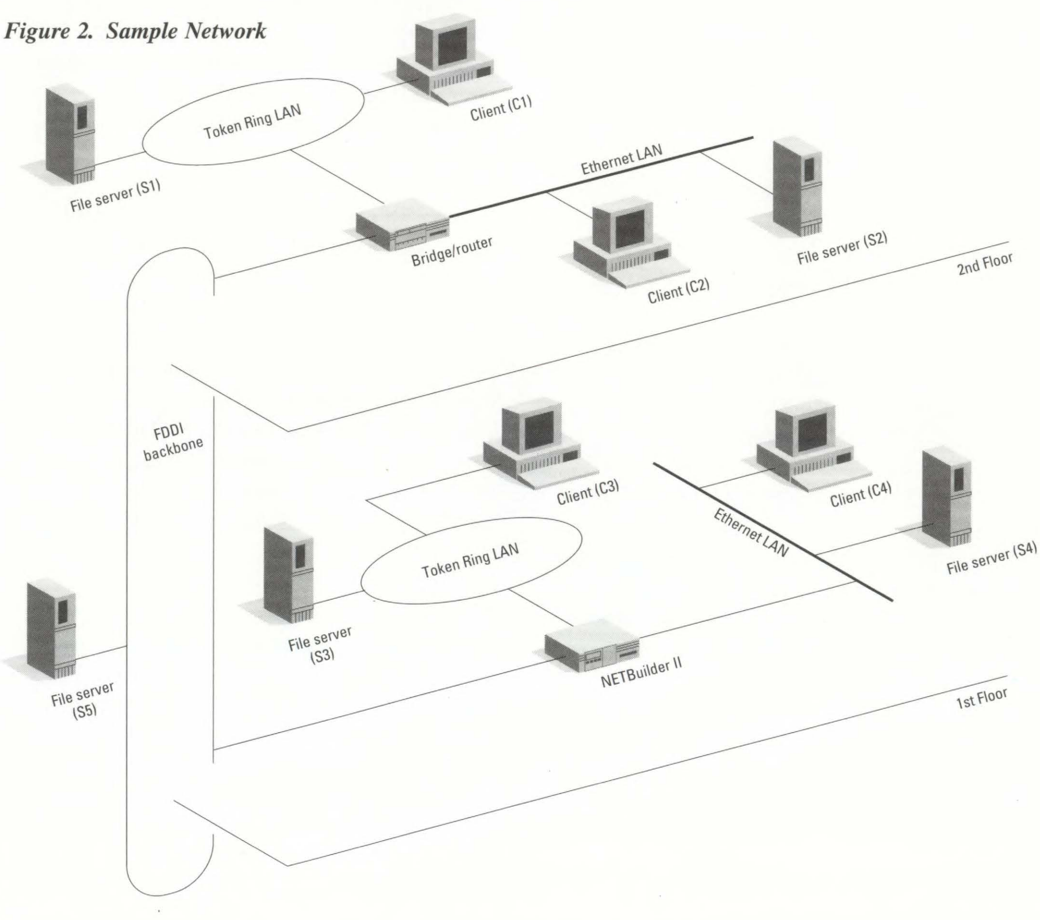
"Planning and Maintaining FDDI Networks," Dono van-Mierop. *3TECH* (Winter 1991).

"Token Ring Internetworking Concepts," Bill Erdman. *3TECH* (Fall 1992).

Understanding FDDI: Self-Study Guide. 3Com Corporation, Santa Clara, California (manual part number 8832-00).

"Understanding FDDI: Standards, Features, and Applications," Doug Sherman. *3TECH* (Winter 1992).

Figure 2. Sample Network



Protocol Translation Problems

When MAC-level address information is contained within other PDUs (such as a Novell IPX "get nearest server" request), the bridge does not alter the format of the MAC address information within the PDU. When the server replies to the client, the format of the destination address allows the frame to be successfully translated to Ethernet but, after translation from FDDI to Token Ring, the MAC address is in the wrong format and is therefore ignored by the original client.

The lack of industry standards specifying the format of MAC-level address information within most PDU types creates great uncertainty when attempting to determine whether a specific protocol type can be translation bridged between end stations on mixed media. By looking at Figure 2 and Table 3, network planners should be able to determine on a protocol-by-protocol basis whether the protocol can successfully be translated between end stations on each media type.

Table 3. Mixed-Media Protocol Matrix

End-System Protocol	(1) Similar Media, Different Backbone C1 to S3	C2 to S4	(2) Mixed Media through FDDI or through a Single Bridge/Router C1 to S2	C4 to S1	(3) Token Ring/Ethernet to FDDI C1 to S5	C2 to S5
	Bridged (4)	**Routed**	**Bridged** (4)	**Routed**	**Bridged** (4)	**Routed**
TCP/IP	Yes	Yes	Yes	Yes	Yes	Yes
IPX	Yes (5)	Yes	No	Yes	Yes (6)	Yes (5)
XNS	Yes	Yes	No	Yes	No	Yes
AppleTalk	Yes	Yes	No	Yes	No	Yes
NetBEUI	Yes	No	Yes	No	Yes	No
NetBIOS	Yes	No	Yes	No	Yes	No
NBP	Yes	No	No	No	No	No
DECnet	Yes	Yes	Yes	Yes	Yes	Yes
LAT	Yes	No	Yes	No	Yes	No
VINES IP	Yes	Yes	No	Yes	No	Yes
SNA	Yes	No	Yes	No	Yes	No
OSI	Yes	Yes	(Not tested)	Yes	Yes	Yes

Notes:

(1) Token Ring to Token Ring via an FDDI or Ethernet backbone; Ethernet to Ethernet via an FDDI or Token Ring backbone.

(2) Ethernet to Token Ring via a single bridge/router or Ethernet to Token Ring via an FDDI backbone.

(3) A file server located on an FDDI backbone serving client workstations on Ethernet and/or Token Ring.

(4) Bridge solutions that work assume that the end-station protocols operate within the guidelines specified in this article—and end stations are not source routed when they traverse an Ethernet backbone.

(5) Ethernet and Token Ring workstations must not be configured with SNAP headers.

(6) An FDDI server must be configured with a SNAP header type.

Close examination of Table 3 will disclose that with a few exceptions (such as 3Com's NetBIOS Protocol), protocols that cannot be routed can be bridged between mixed media provided that the end-system protocols operate within the basic design limits outlined above.

Note: In general, protocols can be carried across a backbone network of a different physical LAN type as long as the end stations on each side of the communication are the same media and provided that the protocols operate within the guidelines mentioned above. Protocol-specific translation issues apply only when end stations are attempting to communicate with each other, either directly between media or across a backbone of similar or different physical LAN types.

Conclusion

In simple environments with one or two protocols, it is possible to implement a bridged solution by carefully examining each of the issues discussed and by ensuring that the protocol does not contain information within the PDU that does not operate correctly in a translation bridging environment.

When internetworking mixed-media LANs over remote links, the issues discussed in this article are exactly the same. Consider only the media and protocols used by the end stations on each physical LAN without regard to the media or technology used to interconnect the central and remote networks. Continue to use routing wherever possible and bridging only for protocols that are nonroutable.

It is safe to state that when mixed-media and multiple protocols are introduced to the network, routing becomes a simpler solution and bridging becomes more complex. For complex multiprotocol environments, install a multiprotocol bridge/router such as 3Com's NETBuilder II and enable routing for all protocols possible. Enable bridging only for those protocols that contain no network address information and therefore cannot be routed. To ensure compatibility, pay careful attention to each of the issues outlined above for each of the nonroutable protocols that will be bridged. As always, test the application carefully using production software before implementation.

Special thanks to Venkat Prasad, Gayle Ledgerwood, Rex Mann, Mick Seaman, and George Prodan, for their contributions to this article.

If you would like an expert opinion on the best way to internetwork your mixed-media LANs, contact your 3Com field systems engineer or call 800-638-3266.

For more information about the 3Com products mentioned in this article (FDDILink, LinkBuilder 3GH, and NETBuilder II), contact your local reseller or call 800-638-3266.

New Products at a Glance

Here's a quick view of new 3Com products, and their features and functions, that have shipped since the last issue of 3TECH, *in the period February through May 1993. Hope this helps you in your product evaluations.*

Bridges/Routers

NETBuilder II Version 6.0 Software

- Link-level data compression of up to 4:1 for bridging or routing at line speeds up to 64 kbps; Tinygram compression for Ethernet encapsulated 64-byte packets
- LLC2 tunneling and local termination
- X.25 gateway/connection service providing Telnet sessions via Packet Assembler/Disassembler between WAN hosts and remote terminals, or remote hosts and LAN terminals
- A DECnet Phase IV/V gateway for Phase IV to Phase V migration
- Integrated IS-IS allows IP and OSI traffic to share routing tables and the same bandwidth
- Policy routing (IP, IPX, and DECnet) to advertise or hide networks, routes, or services
- IP Security RFC 1108 operates to provide security on a per-port basis for multiple sensitivity-level combinations
- Multicast and broadcast throttling to control storms, reduce congestion, and increase reliability of the network
- BOOTP Helper for handling BOOT requests from other routers
- Requires 4 MB of private RAM, 2 MB of shared RAM, and a 2-MB disk drive

NETBuilder TR Remote Control

- A remote Token Ring LAN/WAN device which implements Boundary Routing System Architecture
- Routing decisions are made at a central router
- Eliminates remote administration
- Requires connection to a central NETBuilder II router running version 6.0 with Boundary Routing software
- Upgradable to NETBuilder Token Ring Remote Access or NETBuilder Remote with just a software change

NETBuilder TR Remote Access

- A full routing device with one Token Ring LAN and one WAN connection
- Conventional bridging and routing decisions are made at the remote site
- Supports industry-standard protocols
- Upgradable to NETBuilder Remote with just a software change

Adapters

TokenLink III EISA

- The only TROPIC™ chip set-based EISA adapter currently on the market
- A full 32-bit EISA bus
- 100 percent IBM compatible with a money-back guarantee
- RPL utility for easy driver downloading (which is unique among Token Ring adapters)
- On-board DB-9 and RJ-45 ports
- Fully SNMP-ready through LinkWatch™ Token Ring

Network Protocols

TCP with DPA Version 2.1

- Includes new Windows Sockets API, the standard application interface to TCP/IP

Terminal Servers

CS/2500 and CS/2600 Version 6.0 Software

- New support for the OSI International Standard-Virtual Terminal Protocol (IS/VTP) protocol
- Also supports TCP/IP, LAT, and TN3270
- Includes RBCS version 2.0 boot software

New 3Com Token Ring Products with the Star-Tek Acquisition

If you have IBM midrange, mainframe, or Token Ring LAN–based information systems, you can now look to 3Com to meet more of your networking needs. 3Com's acquisition in January 1993 of Star-Tek, Inc. expands 3Com's Token Ring expertise and hub product lines.

Star-Tek, located in Northboro, Massachusetts, is an innovator in Token Ring technology and has developed robust physical layer active hubs, preemptive fault lock-out, and draft Token Ring remote monitoring (RMON) standard technologies. Its product line consists mainly of intelligent wiring hubs and network management software (see "New Products at a Glance"). Star-Tek, which was founded in 1985, is now a wholly owned subsidiary of 3Com.

The full line of Star-Tek products is available now from 3Com. For more information, contact your local reseller or 3Com at 800-638-3266.

Hubs

LinkBuilder TR

- Can be used as an unmanaged hub or as an expansion unit for one of the managed (TRi) models
- Supports a maximum of 256 users per ring configured as 16 stackable hubs
- Allows a maximum of fifteen stackable hubs to be managed from one managed stackable hub (TRi)

LinkBuilder TRi

- Model 1—a managed hub that supports six hubs in a stack with SNMP and basic RMON management
- Model 2—a managed hub that supports sixteen hubs in a stack with SNMP and full RMON management

LinkBuilder TR/TRi

- Intelligent jitter cancellation removes jitter at all frequencies, allowing mixing of unshielded twisted-pair and shielded twisted-pair media
- Custom, per-port phase-locked loop ASICs extend distances over unshielded twisted-pair levels 4 and 5 to 660 feet
- Zero delay lockout and Distributed Recovery Intelligence isolate faults to protect the ring
- Basic and full RMON implementation—functions as a network analyzer in a hub; provides a complete error history of each port; alarms can be triggered when user-defined thresholds are exceeded

LinkBuilder Focus™

- Three chassis-based models—two-slot, five-slot, and five-slot with redundant power supplies
- Intelligent jitter cancellation removes jitter at all frequencies, allowing mixing of unshielded twisted-pair, shielded twisted-pair, and fiber media
- Custom, per-port phase-locked loop ASICs extend distances over unshielded twisted-pair to 660 feet
- Zero delay lockout and Distributed Recovery Intelligence isolate faults to protect the ring
- Full support for SNMP and RMON MIB standards
- The RMON management agent module includes a RISC processor

LinkBuilder FMS Fiber Hub (shipping late May 1993)

- A six-port fiber hub that integrates with coax and twisted-pair FMS hubs in a single stack
- Has an AUI port and transceiver module for coax or fiber backbone connection
- Full SNMP management to MIB II and 3Com extensions via a single module per stack, which can be added as needed and installed by users
- Can be upgraded to new management protocols via a software download
- Fully 10BASE-FL compliant

LinkBuilder MSH

- An eleven-slot, chassis-based hub that combines up to three interconnected Ethernet and five Token Ring workgroups, managed via a single module
- Has a passive, high-speed, slot-independent backplane
- Distributed Management Architecture and SmartAgent software for cost-effective SNMP management
- Phase-locked loop retiming and RingBuilder architecture increase reliability on Token Ring networks
- Distributed Repeater Architecture and LAN Security
- Designed to support FDDI and ATM in the future

Network Management

LinkWatch Token Ring (shipping June 1993)

- SNMP remote management agents for all TokenLink III adapters
- Provides PC hardware and software information, user information, traffic and error statistics, and remote adapter disabling
- Partial manageability (user information and error statistics only) for all IBM Token Ring adapters

Star-Tek Network Management 2.1 (STNM)

- One installation manages an entire ring of up to 260 nodes (the Token Ring-specified limit)
- Has an impact on node memory of less than 6 KB
- OS/2-based software that supports SNMP standards including the full RMON option of MIB II on both Token Ring and Ethernet LANs
- The flexible graphics interface is used to manage devices supporting SNMP

CardBoard– Bulletin Board System for 3Com Adapters

CardBoard℠ is a multiple-line bulletin board system that contains the latest drivers, patches, and fixes for 3Com adapter products, as well as technical articles from the 3Com technical support organization.

To access CardBoard, you need a terminal, a modem, and the communications software for dial-up. To reach CardBoard in the U.S. call 408-980-8204 and have your modem set up to 14400 baud, eight data bits, no parity, and one stop bit.

For more information on these products, call 800-638-3266.

Internetworking Solutions Seminar Scheduled

3Com is offering a high-end internetworking seminar in the spring of 1993 for people particularly concerned with LAN/WAN cost issues. The seminar focuses on today's networking solutions and challenges for the future. 3Com's innovative Boundary Routing System Architecture will also be presented. Seminars in May will be held in Atlanta, Chicago, Philadelphia, Dallas, and Toronto.

For more information, call 800-638-3266.

Q & A

3Com's Data Compression Maximizes WAN Throughput

NETBuilder family bridging and routing software (NETBuilder 6.0) has many new features to meet customer demand for a flexible range of solutions to connect remote sites, reduce WAN operating costs, enhance IBM connectivity, and improve control and performance of bridged and routed traffic. This Q & A concentrates on showing how the data compression feature of NETBuilder 6.0 is 3Com's answer to helping customers address ever-growing issues around effective WAN bandwidth utilization and costs.

Why is Data Compression So Important?

Data compression enhances effective throughput on serial lines by removing unnecessary bytes from packets before they are transmitted and replacing the removed bytes again on the other side of the link. Customers see increased throughput translated into reduced line usage, more available bandwidth for other communications data, and therefore optimum WAN utilization.

How Do Link and Tinygram Compression Work?

Link compression is performed by NETBuilder on all packets (header and data field) sent on a specified Point to Point Protocol (PPP) WAN link. The process uses a Lempel-Ziv (LZS) algorithm to find and replace repetitive patterns within a sample of packets with shorter length codes. As long as the sending and receiving ends of the WAN link are synchronized, they can build up a history buffer of codes to encode and decode the data stream. Each history buffer adapts as the patterns of repetition in the data stream change.

The types of compression ratios for WAN links depend largely on the data type and patterns in the data stream. Typical performance for link compression of a spreadsheet or graphics file at 64 kbps can produce an average compression ratio of 2:1 versus a ASCII text file that can produce around 4:1.

Note that 3Com adopted the LZS algorithm over other available data compression algorithms (for example, LZ2 or CCITT V.42bis recommendation). LZS offers better performance for several reasons:

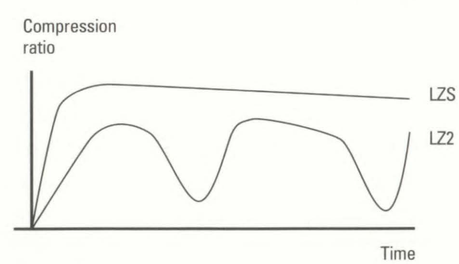
1. LZS uses a history buffer to store actual data from repetitive patterns; LZ2 keeps a dictionary of encoded information. Translating the encoded information during the decompression process for LZ2 often takes longer than substitution of actual data for LZS.

2. In LZ2, once the dictionary becomes saturated a flush operation must occur; this results in poor compression immediately afterwards. LZS does not experience this limitation.

3. LZS adapts more quickly to changing data patterns than LZ2.

For a comparison of LZS and LZ2 performance, see Figure 1.

Figure 1. Performance of LZ2 and LZS Data Compression Algorithms



Tinygram compression operates by suppressing the transmission of trailing nulls in Ethernet encapsulated packets before they are transmitted over a PPP WAN link. The receiving end of the WAN link re-creates the original packet by just adding the trailing nulls. Since the CPU cycles involved in stripping and adding these nulls is significantly less than the time it takes to transfer these nulls across a slow-speed line, the effective throughput is increased.

A typical use of Tinygram compression is for LAT traffic, where compression is very useful in reducing response time between LAT terminals.

When Should Data Compression be Used?

Since data compression performs additional processing on the contents of each packet, it is most effective when there are sufficient CPU cycles available to handle the additional processing without negatively impacting the rest of the activities in the system.

Using data compression on reliable PPP links running at speeds of 64 kbps or lower ensures NETBuilder users enhanced performance for WAN connectivity. LAN performance will very much depend on whether traffic is being bridged or routed, and whether the application is CPU-intensive and therefore competing with data compression.

The following guidelines suggest which NETBuilder configurations are best suited to providing efficient data compression:

1. For remote sites, NETBuilder Remote Access or NETBuilder Remote Control offer effective performance connecting one LAN to one WAN.

2. For central sites, there are a variety of options:

   - NETBuilder IIs using one to three WAN ports, minimal LAN routing, and typical office computing applications such as email, database retrieval, or file exchange between remote sites provide the best data compression performance.

   - For three to six WAN connections with minimal LAN traffic, NETBuilder II's data compression performance slightly degrades by around 10 percent but still provides better throughput compared to no compression.

   - With NETBuilders using one to two WAN ports, and mainly LAN ports for CPU-intensive traffic such as bridging, consider whether LAN throughput is more important. If so, dedicate a second NETBuilder platform to handle the WAN traffic, leaving the first to handle LAN traffic. Alternatively, if a one-box solution is required, turn off WAN compression and consider using modems with integrated data compression.

What is the Future of Data Compression?

Currently 3Com's link compression is a software implementation. Depending on the availability of more efficient hardware implementations, future NETBuilder platforms may have hardware-assisted data compression. While the algorithm is the most efficient proprietary solution offered today, should V.42bis performance improve 3Com could migrate to the CCITT V.42bis recommendation.

Thanks to Alison Seaman for her contribution to Q & A.

For more information on NETBuilder 6.0, contact your local reseller or call 3Com at 800-638-3266.

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Demonstrating Stackability with 3Com's LinkBuilder FMS Hub

Terry Lockyer is currently development manager in 3Com's Premises Distribution Division and, in this position, has been closely involved in the development of LinkBuilder FMS. Terry has worked for British Aerospace, Texas Instruments, Brown Boveri Kent, BICC Research and Engineering, and was a founding member of BICC Data Networks.

At BICC Research, Terry worked on the application of fiber optics to data networks, as well as early IEEE 802 Ethernet standardization. Terry has been a leading contributor to repeater standards as well as the FOIRL and fiber 10BASE-F standards and holds several patents in computer systems and networking.

Terry graduated from Loughborough University with an honors degree in electrical and electronic engineering.

An Overview of the LinkBuilder FMS Hub, 3Com's Innovative, Stackable Solution for the Ethernet Environment

By Terry Lockyer

Fixed-port hubs typically provide a good, inexpensive basis for LANs when they are first implemented. However, LANs tend to expand in size and, when they do, they often exceed the limitations imposed by the fixed-port hub design. Chassis-based hubs, on the other hand, offer greater expandability, more flexibility in terms of supported cabling options, and enhanced fault tolerance when compared to fixed-port designs. But they tend to be more expensive than fixed-port hubs on a per-port basis, particularly for smaller numbers of users. They also require a large up-front expenditure compared to fixed-port designs.

3Com pioneered the stackable hub market with its first-generation LinkBuilder 10BT/10BTi hubs as a result of customer feedback that highlighted the need for a hub solution combining the best of both fixed-port and chassis-based hub designs. Now, with the addition of its LinkBuilder FMS (Flexible Media Stack) second-generation product, 3Com has confirmed its leadership in the design, development, and implementation of stackable hubs.

This article considers some of the general characteristics of stackable hubs, reviews some technical issues involved in implementing them, and discusses in detail the LinkBuilder FMS hub, 3Com's innovative, stackable solution for the Ethernet environment. This article should prove especially valuable to network planners and managers responsible for establishing LANs that start small but will expand over time.

Introduction

Fixed-port hubs were the first type of hub available in the LAN marketplace and they were followed closely by modular, chassis-based models. As the name implies, fixed-port hubs provide a specific number of ports per box and are usually limited to support for a single physical medium such as thin coax. They also represent a single point of failure. Chassis-based designs, on the other hand, often accommodate multiple media types and their modular design offers considerable fault tolerance. But these advantages bring with them a relatively high entry cost for purchasing the chassis.

Advantages and Limitations of Chassis-Based Hubs

Chassis-based hubs accommodate a number of wiring concentrator modules and, optionally, a management module or internetworking modules all on the same backplane. This modular approach allows chassis-based hubs to support various cabling media within a single device.

The advantages of the chassis-based design include:

- The ability to expand the number of ports by adding modules
- The ability to support several LAN technologies within a single enclosure
- The ability to manage all modules with a single management module
- The ability to internetwork LAN functions in a central location
- The provision of power and cabling redundancy, and resulting fault tolerance, and advanced security features
- The ability to act as a single, logical repeater

The limitations of chassis-based designs include:

- Large, up-front expenditures. This is exacerbated by the need for chassis systems to have backplanes that support a number of internetworking and LAN technology options, which results in considerable expense being built in.

- Generally higher per-port costs, especially in small configurations.

- Typically, a major buying decision involves commitment to a single vendor. Chassis-based systems require an up-front commitment to a single vendor's solution for all networking components. (This is like buying a stereo system from a single manufacturer rather than picking and choosing separate components, based on their merits, from several manufacturers.) The lifetime of chassis-based network equipment will be somewhere between five and ten years. Selecting a vendor who will remain in the forefront of the technology across a number of internetworking and LAN technologies requires a considerable commitment.

- They can be difficult to set up and use.

- They are generally restricted to 19″ rack mounting so they are not suitable for small office environments and unstructured wiring configurations.

- Reconfiguration is limited by the chassis framework.

Advantages and Limitations of Fixed-Port Hubs

The advantages of fixed-port hub designs include:

- Low per-port and entry costs.

- Convenience—units are small, easy to set up, and can be mounted flexibly in a number of orientations.

- Capacity can be added in small, steady, and cost-effective increments.

The limitations of fixed-port hub designs include:

- A lack of modules within the box—each unit provides a fixed number of repeater ports.

- Usually, management is not an option—these hubs are either managed or they are not.

- The purchase of a totally new hub may be required if management is desired later.

- They usually accommodate a single cabling medium only, such as twisted-pair or thin coax cable.

- Each hub must be managed individually as a separate entity, which complicates LAN administration.

- They have limited expansion potential because each additional hub constitutes a separate logical repeater.

Both fixed-port and chassis-based hubs have been quickly accepted and are fixtures in the marketplace. Given the huge popularity of both, these two approaches to hub design could easily have remained the only two choices available indefinitely. Then 3Com began listening hard to what customers had to say about their hub needs.

3Com heard enough to realize that there was both a market gap and a technology gap in the hub market. Customers told 3Com they wanted:

- Manageability (control over the number of users)

- Upgradability (add management only when needed)

- Flexibility (mutiple cabling options)

- Expandability (seamlessly scalable as LANs grow)

- Cost-effectiveness (reduced cost per port)

- Aesthetics (reduced size and improved looks)

3Com responded to this customer feedback by introducing a new type of hub—the stackable hub—to fill the gaps with its first-generation LinkBuilder 10BT hub products designed for twisted-pair Ethernet LAN environments. This was followed by the second-generation

Key Terms Used in this Article

Chassis-based hub
Chassis-based hubs feature a number of wiring concentrator modules, management modules, or internetworking modules, all on the same backplane. This modular approach also allows them to support various cabling media within a single device.

Fixed-port hub
The first type of hub available in the LAN marketplace, followed by chassis-based models. Fixed-port hubs provide a specific number of ports per box, and are usually limited to a single physical medium such as thin coax. They also represent a single point of failure. Fixed-port hubs have set options and cannot be upgraded.

Hub
A generic industry name for multiport repeaters.

"Pileable" hub
A 3Com term meaning hubs that, however they are joined together, will always be separate repeaters. "Pileable" hubs can be thought of as multiple units piled together that are not one logical unit like a stackable hub.

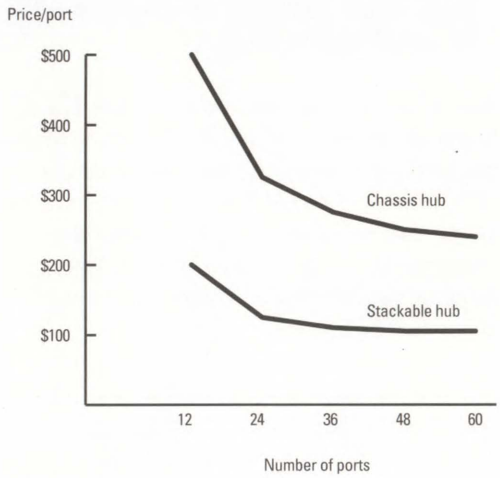
(continued on page 24)

LinkBuilder FMS hub which better integrates management functionality and mixed-media capabilities.

The Stackable Solution

3Com's stackable hub solution was based on a detailed analysis of the advantages and limitations just described. The goal was to provide the advantages of both fixed-port and chassis-based designs while minimizing the limitations of both. Customer input that played a major role in the development of stackable hubs included a strong desire for greater cost-effectiveness in terms of per-port costs, reduced size, and improved looks (see Figure 1).

Figure 1. Per-Port Costs—Chassis vs. Stackable Hubs



LinkBuilder FMS—A Stackable Ethernet Hub

One Single, Logical Repeater

The LinkBuilder FMS stackable hub allows one to four hub units to be included in a stack (a set of hubs that when joined together act as one repeater). Unlike competing hubs that are merely "pileable" (multiple units piled together that are not one logical unit), these units are connected together by means of a passive backplane extension to form a single, logical repeater (see Figure 2).

Multiple Cabling Options

Each hub supports a given cable medium—for example, thin coax, fiber, or twisted pair—in addition to the option of connecting to a thin or thick coax backbone and a fiber backbone. These media can be mixed within a given stack as necessary.

Network Management

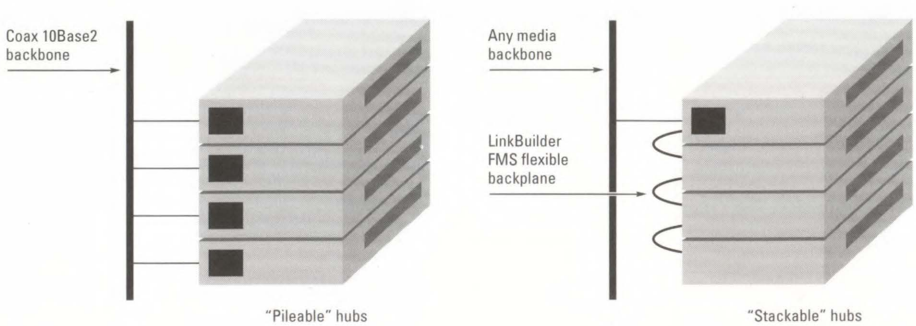
In-band and out-of-band Simple Network Management Protocol network management functionality can be added to a stack by customer installation of an optional management module. This is an easy and cost-effective solution because there is no need to buy another network management unit. Because a stack represents a single, logical entity, addition of a management module to any hub in the stack provides management functionality for the entire stack.

Enhanced network management capabilities are provided by the LinkBuilder FMS SmartAgent feature. SmartAgent enhances the manageability of the stack by providing special hardware and software support for certain statistics collection and analysis tasks, which also results in a reduced task load for the network management station. (For more information on the LinkBuilder FMS SmartAgent, see "SmartAgent—Core Network Management Software on the New LinkBuilder FMS Hub," *3TECH*, Fall 1992.)

Fault Tolerance

A single LinkBuilder FMS stack can provide up to 52 Ethernet ports, and each hub in the stack can continue to operate independently of other units being powered down. Failure in a single unit does not affect other hubs in the stack because each hub is equipped with its own power supply, cooling system, and repeater logic. Common backplane circuitry is supplied by each unit power-sharing in a redundant manner. In effect, the stack provides a degree of fault tolerance that is equal to or greater than that found in chassis-based systems.

Figure 2. The Single Logical Repeater



Key Terms Used in this Article (continued)

Repeater
An Ethernet device that is used to reconstitute the amplitude and timing of a packet when passing it from an input port to an output port. In a structured wiring system such as an unshielded twisted-pair network, it is usually in the form of a multiport hub which is used to expand the number of branches in a tree-type topology. A packet input on one port is repeated as output to all other ports. The function of a repeater is standardized by the IEEE 802.3 and ISO 8023 standards.

Stack
A set of hubs that when joined together act as one repeater.

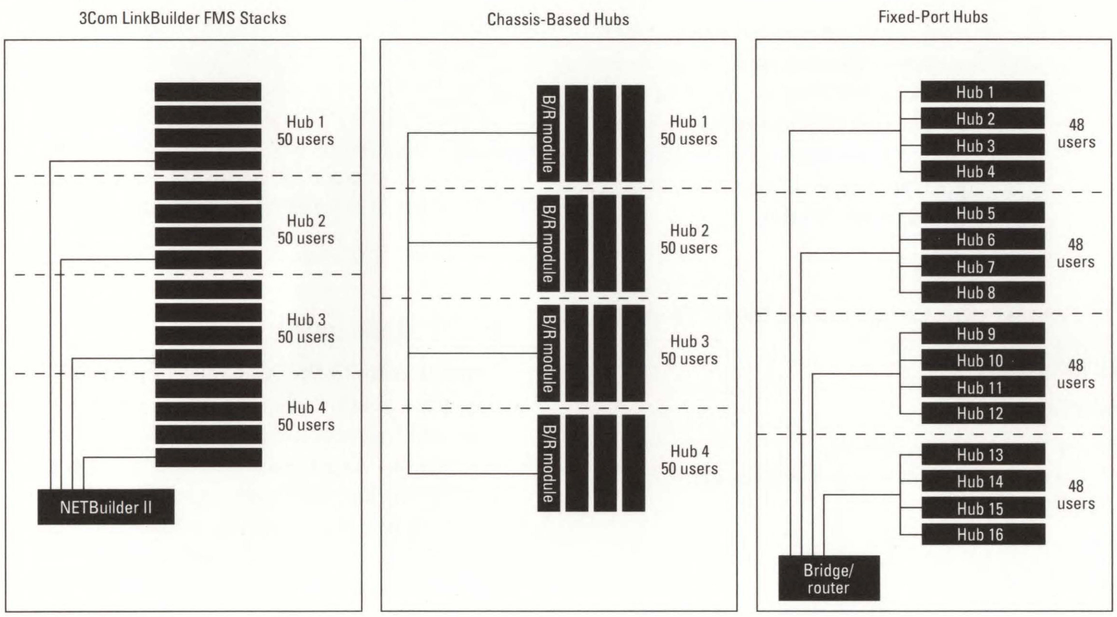
Stackable hub
A stackable hub has the advantages of both fixed-port and chassis-based designs with greater cost-effectiveness in terms of per-port costs.

Enhanced Performance and Manageability
As shown in Figure 3, stackable hubs offer performance and management advantages over both chassis-based and fixed-port alternatives. Four LinkBuilder FMS stacks are connected to a NETBuilder II bridge/router creating four segments to enhance performance and manageability. The chassis-based hubs with bridge/router modules would be less cost-effective and more difficult to manage for this same network. Lastly, the fixed-port solution for this network would produce sixteen repeaters, increasing traffic and complicating network management. In addition, ports would have to be devoted to backbone links rather than users.

gap shrinkage. This is the gap of time allowed between successive back-to-back packets. Increasing the number of repeaters can cause this gap to shrink as packets travel across the network causing back-to-back packets to merge to the point that they cannot be successfully received. Requiring a topology to go beyond this limit will require packets to be stored and forwarded as in a bridge.

The four-repeater-hop rule limits the topology that can be safely constructed in a tree configuration. If the hubs are of a fixed configuration type so that they can only be expanded by being cascaded in series, the four-repeater-hop

Figure 3. 3Com Linkbuilder FMS vs. Chassis-Based and Fixed Port Hubs



The Four-Repeater-Hop Rule
Central to the success of the stackable hub concept in the Ethernet environment is the fact that the entire stack consists of a single logical repeater rather than four separate repeaters. This feature eliminates a major constraint imposed by the so-called four-repeater-hop limit inherent in the Ethernet standard's access method.

The four-repeater-hop rule provides a simple and safe configuration for an Ethernet network. The rule allows four repeaters to be included within a single end-to-end path without worrying about phenomena such as interpacket

rule can rapidly be exceeded, imposing harsh constraints on LAN growth. Expandable hubs can help to increase this limit and allow safe network configurations to be constructed.

Conclusion

Having pioneered the stackable hub market, 3Com continues to lead the way with its second-generation LinkBuilder FMS stackable hub solution. This product incorporates the essential features of any true stackable hub solution: expandability, simple management upgradability, accommodation of multiple cabling media, fault tolerance, and per-port cost-effectiveness.

For more information on 3Com stackable hub products, contact your local reseller or call 800-638-3266.

Tech Briefs

This department gives you hot technical tidbits about standards activities and industry happenings—all of which can impact your network today and in the future. In this issue, you get a few "sound bytes" on some technical happenings of late with 3Com—our new relationship with Sync Research, frame relay certification, and some FDDI standards activities. Your feedback on this department would be appreciated. Please fax us your comments on its value to you (408-764-5001, attention Suzanne Dowling).

Frame Relay Certifications For NETBuilder

Frame relay certifications are now in place from five major telecommunications companies for 3Com's NETBuilder product (see Table 1). This information is particularly important if you are selling frame relay solutions to customers who prefer using a major frame relay vendor.

Table 1. Frame Relay Certifications for NETBuilder

- **AT&T Interspan**
- **CompuServe**
- **Northern Telecom DataSPAN**
  Willing to certify either remotely or in conjunction with local offices.
- **Sprint**
- **Wiltel WilPAK**
  Wiltel is reference selling NETBuilder from 350 sites!

In future issues of *3TECH*, frame relay certifications for the NETBuilder II and NETBuilder Token Ring products will be listed. Also, the smaller vendors that the products have been certified with will be listed. If you have done such a certification and wish the information to appear in a future issue, contact Tom Dietrich.

For more information on frame relay certifications, contact Tom Dietrich at 408-764-5874.

3Com and Sync Research Target the SNA Marketplace

3Com and Sync Research recently announced a marketing agreement through which 3Com will recommend Sync's SDLC (Synchronous Data Link Control) to LLC2 (Logical Link Control 2) conversion products as part of its SNA internetworking solution. 3Com will leverage the partnership with Sync Research to fulfill the second stage of its three-stage SNA strategy to help customers integrate SNA and multiprotocol LANs.

3Com is currently reference-selling Sync Research's SDLC-LCC conversion products called SNAC.™ With this relationship, 3Com can offer its customers one-stop shopping for their SNA-LAN internetwork needs.

The conversion products, called the SNAC family, are a line of SDLC to LLC converters. They allow front-end processors to connect directly to a Token Ring network and move SNA traffic across bridged or routed WANs. The traditional method has been to use multiple SDLC lines between front-end processors. SNAC eliminates the cost of those lines, and any upgrades to the front-end processors as the need for lines increases. SNAC will provide 3Com with NetView and SNMP management, three platforms for high- and low-end price/performance value, and technology from an industry leader in SNA products.

For more information, call 800-326-3266.

FDDI Standards Update

Introduction to the X3T9.5 Committee
The fiber distributed data interface (FDDI) standard was developed by ANSI's X3T9.5 committee. All the significant vendors in local area networking have developed products based on four documents developed by this committee: media access control (MAC), physical layer (PHY), physical media dependent (PMD), and station management (SMT). These four documents were completed by the X3T9.5 committee over the past two years, and have also been adopted as international (ISO) standards.

The X3T9.5 committee continues to meet every two months. It is focusing on cost reduction and additional services. This tech brief presents the status of the cost reduction activities. Additional activities (e.g., isochronous services) will be discussed in upcoming issues.

FDDI Cost Reduction Issues
Cost reduction is approached by standardizing alternatives to the most expensive component of FDDI, fiber-optic PMD. Two alternatives currently being pursued are lower cost fiber and twisted-pair wiring. Both are a direct replacement for PMD and do not impact the other parts of the standard (PHY, MAC, and SMT). 3Com's innovative FDDILink adapter

can take advantage of the lower cost alternative by replacing a small printed circuit "slice."

The low-cost fiber PMD reduces the cost by relaxing the power requirements of the optical transmitter and by defining a more compact connector. The lower power transceiver restricts the distance of the wiring to 500 meters (which is enough in most local environments) and typically lowers the cost. The compact connector is not only less expensive, but it saves precious space on the boards. The low-cost fiber PMD standard has just successfully completed the X3T9.5 letter ballot and is now in public review.

TP-PMD Subcommittee Issues

The FDDI TP-PMD subcommittee is the industry pioneer in the area of running data at 100 Mbps to distances of 100 meters over unshielded twisted-pair wiring. This was thought to be impossible until the subcommittee was established two years ago. This subcommittee had a series of fundamental discussions on topics that, among other things, influenced other standards activities (e.g., 100-Mbps Ethernet, ATM, etc.). Topics discussed have included:

- Cabling systems: category 5 "data grade" vs. category 3 "voice grade"
- Encoding schemes: NRZI, PR-4 vs. MLT-3
- Equalization: predistortion vs. post-compensation
- Scrambling
- Emission requirements: FCC Class A vs. Class B
- Susceptibility to external noise
- Number of pairs in the twisted-pair bundle, and termination of the unused pairs

TP-PMD Subcommittee—February 1993 Meeting

The decisions made by the subcommittee were complicated by the trade-offs between the various issues—for example, the transmission voltage. The higher the transmission voltage, the stronger the emission; the lower the transmission voltage, the more susceptible it is to noise. The subcommittee decided during its Februrary, 1993 meeting to set the transmission voltage to 2.0 volts, a level that seems to find the right balance between emission and susceptibility to noise.

Major technical issues were resolved at this same meeting with the decision on transmission voltage. The remaining work on the TP-PMD standard is to complete editing all the documents, hopefully by August, 1993. Implementation of the standard by vendors can proceed as of February, 1993, however, with minimum risk of major changes.

Looking to the Future

The TP-PMD standard addresses only category 5 wiring, a superior grade that is becoming popular but that has been deployed for only about two years. The same subcommittee is starting to work on PMD for category 3 wiring (plain telephone wire). AT&T® and IBM are actively working on two different high tech solutions: CAP-32 and QPR-4, respectively. Both companies will report on progress with their prototypes at the June meeting.

For more information on FDDI standards, contact Dono van-Mierop at 408-764-5930.

3Com Quick Technical Resource List

Product Information
800-638-3266; from outside the U.S.and Canada, call the nearest 3Com office.

Techical Support
800-876-3266, press option 1; from outside the U.S. and Canada, call the nearest 3Com office.

Service Contract Help Line
800-876-3266, press option 3, then dial a three-digit extension:
- Ask3Com user ID-password: 603
- Authorized service centers: 922
- Maintenance agreements:
  Southcentral-Northeast: 604
  Southwest: 600
  West: 601

Consultant Relations
800-638-3266, press option 2

Training and Indpendent Study Courses
800-876-3266, press option 7. Fax: 408-764-7290. From outside the U.S. and Canada, call the nearest 3Com office.

Ask3Com Information Service on CompuServe
800-848-8199; outside the U.S. and Canada, call the nearest CompuServe office.

User Groups
408-764-6802

3Wizard Program
408-764-6764 or contact Education Services at 800-876-3266, press option 7.

3TECH *Journal*
800-638-3266, select option 4, ext.5898; or call 408-764-5898

3INFO

3Com Training and Information Resources

New CD-ROM Product Offers Multivendor Networking Information

A new multivendor CD-ROM product provides technical users with a single-source solution for network hardware and software information. 3Com, along with more than 37 top industry vendors, has provided documentation to Computer Library to create Support on Site™ for Networks. This comprehensive, easy-to-use source of over 39,000 vendor documents also includes contributions from Novell, Microsoft, Banyan, IBM, SynOptics,® Lotus,® Cabletron Systems,® Madge Networks,® Proteon,® SMC, and WordPerfect.®

Support on Site for Networks lets subscribers search its vast database in seconds using keywords, word strings, or fields provided by a template. It features a cross-product search capability which makes it easy to isolate problems when several products are involved. Documents in the collection include manuals, installation guides, board-level diagrams, configuration and error messages, technical bulletins, compatibility reports, troubleshooting guides, books, and newsletters.

Typical "how tos" provided by Support on Site for Networks include:

- How to get a printer to attach to a queue when installing NetWare for the Macintosh®
- How to find the latest server drivers to install a 3Com EtherLink 16 adapter (3C507) in a NetWare 3.11 server
- How to configure a 3Com NETBuilder II to route TCP/IP and IPX
- How to find what is causing excessive network traffic in a multiconcentrator SynOptics installation
- How to understand an "OS/2 Error 69" message on a LAN Manager workstation
- How to implement TCP/IP on a Banyan VINES network
- How to determine which procedures Microsoft recommends for debugging Windows® printing problems on a NetWare LAN

The system requirements for Support on Site for Networks are:

- An IBM PC/AT,® PS/2,® or other fully compatible computer
- MS-DOS® 3.3 or higher
- 1 MB of RAM
- A minimum of 640 KB of free hard disk space
- A CD-ROM drive installed
- MS-DOS CD-ROM Extensions versions 2.1 or higher

Subscribers to the service receive monthly updates. The annual subscription price is US$1,495 for a stand-alone, single-user copy, and US$4,995 for up to five concurrent users on a network. 3Com customers who order Support on Site for Networks by July 31, 1993 will receive a thirteen-month subscription for the twelve-month price.

To order, call Computer Library at 800-827-7889, extension 515. Outside the United States, call 212-503-4400, extension 515.

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Introduction to Bridging and Routing • 3CS-011

A comprehensive introduction to internetworking, covering the basics of networks and internetworks, bridging technology, bridging versus routing, and transport systems.

Network Architectures, Standards, and Protocols • 3CS-330

A systematic introduction to the major networking industry data communication standards and protocols supported by the 3Com product line. Standards and protocols include ISO/OSI, CCITT recommendation X.25, ISDN, TCP/IP, Ethernet IEEE 802.3, Token Ring IEEE 802.5, IBM's SNA, and DEC's DNA.

Introduction to SNMP • 3CS-350

Explore the architecture and governing principles of the Simple Network Management Protocol, as well as Structure of Management Information and Management Information Base.

Understanding TCP/IP • 3CS-340A

Expand your understanding of addressing, subnetting, protocol layering, and routing of the Transmission Control Protocol/Internet Protocol with this in-depth course and reference.

Understanding FDDI • 3CS-360

Basic and advanced concepts in FDDI networking are covered down to the engineering level in this definitive study course.

Thanks to Barbara Bjornstad for her contribution to 3INFO.

Training Information

If you would like to order a course catalog, or if you have questions on scheduling, course content, prerequisites, or 3Com's 3Wizard® program, call 800-876-3Com, wait for the automated greeting, then press option 7, and select 1.

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Upcoming Events

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ICA COMNET Dallas '93
Dallas, Texas
214-233-3889

May 25–27
NetWorld Europe '93
Frankfurt, Germany
(49) 89 678 210

May 17–20
INET '93
San Francisco, California
(Eric Benhamou, chair)
415-390-0317

June 2–4
NUI Conference (Novell Users)
San Jose, California
408-764-6228

August 23–27
INTEROP Fall '93
San Francisco, California
800-INTEROP, extension 2502

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