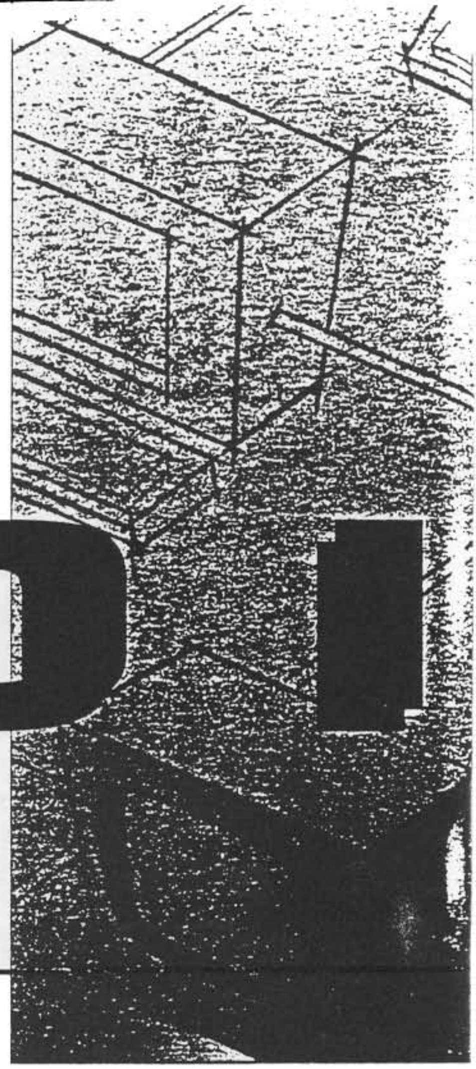
ON THE WAY TO FDDI



BRADFORD T. HARRISON

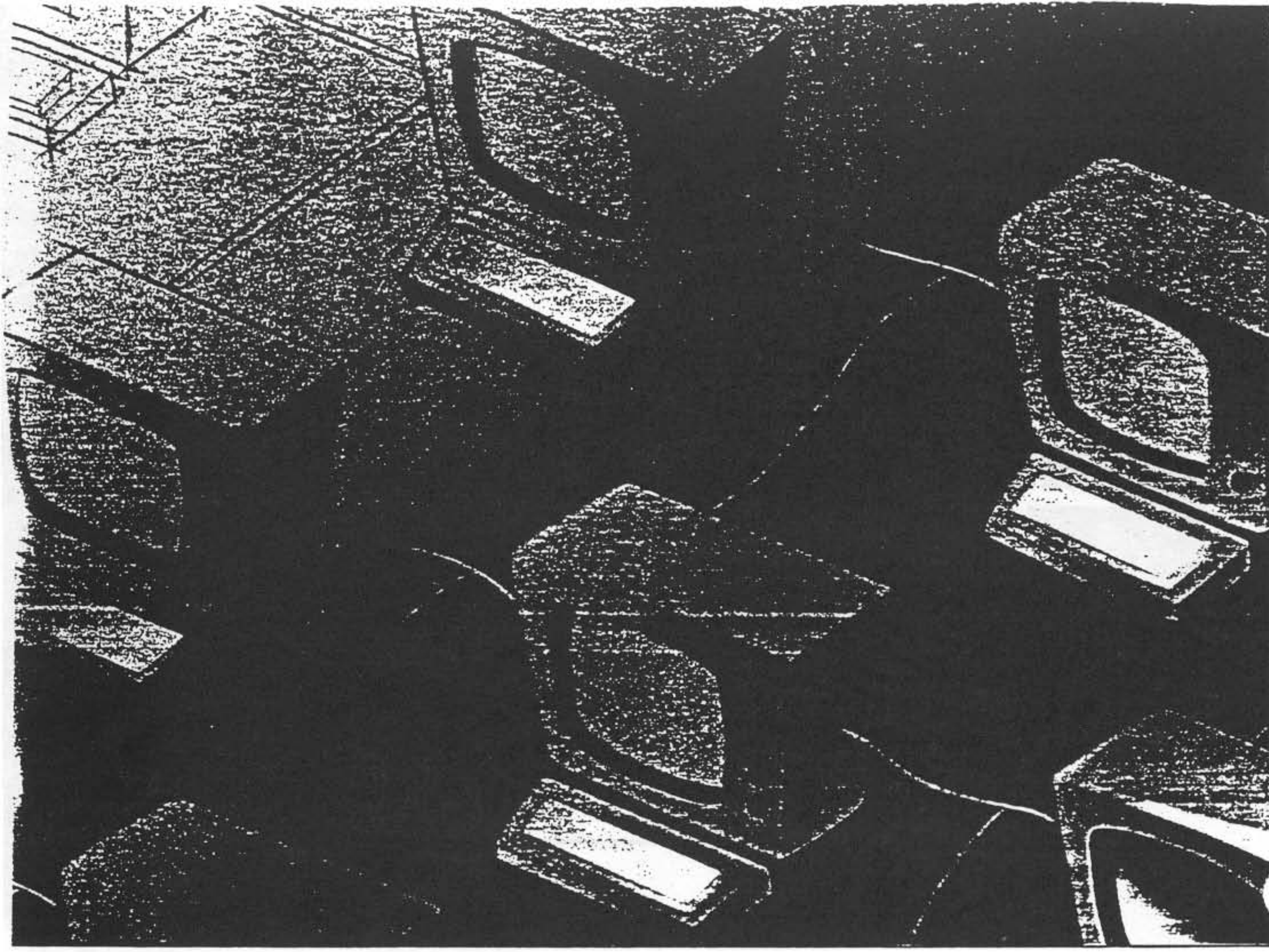
FDDI serves as a migration platform from older networking media to a new generation of high-speed, optical-based devices that will transform networks.

WITH WINDOWS-INTENSIVE and multimedia applications coming online, high-speed LANs are becoming the norm. Network managers have many alternatives to consider when deciding the best way to achieve the necessary throughput rates. These alternatives include the many FDDI technologies combined with new and traditional Ethernet and Token Ring configurations.

The physical and data link layers of the ISO reference model — layers 1 and 2 respectively — are no place for proprietary technology. There are three fully specified standards competing at these layers: Ethernet (IEEE 802.3), Token Ring (IEEE 802.5) and FDDI (ANSI X3T9.5). Further standardization is occurring within the FDDI standard, and newer, faster optical standards are in the works. There is little room for products that do not tout compliance with at least one of the three established technologies.

FDDI is the standard of standards. It represents the paradigm of successful standards consensus, specification and implementation. Even more interesting is the fact that, even though it was developed for use with fiber optic cable, it is also finding widespread acceptance for use with shielded and unshielded twisted-pair (STP and UTP). FDDI, in addition to its role as the premier high-speed, multivendor interconnect LAN standard, is thus serving as a migration platform from older networking media to the new generation of high-speed, optical-based networking devices that will transform communications networks during the next decade. Chief among these is Synchronous Optical Network (SONET), which is specified to achieve speeds as high as 2.5 Gbps.

However, it is premature to pronounce the slower Ethernet and Token Ring technologies as dead. Most organizations will initially implement FDDI for high-speed backbones rather than as a technology to provide high-speed communications to individual desktops.



For several years, industry analysts have been recommending that organizations string fiber optic cable whenever they string any cable at all. Much of this "dark" fiber has lain dormant alongside thin and thick co-axial and TP cable for years, waiting for FDDI to mature. With the dramatic increase in support for FDDI during the past 2 years, much of this dark fiber has been brought into use, but many system administrators are waiting for the "break-even point." This is the point in time when it will cost about the same to use FDDI as it costs to use Token Ring and Ethernet.

Chipcom estimates that it costs about $1,000 to $1,400 per desktop to install FDDI, while costs for Ethernet and Token Ring are around $500. Other studies have placed the cost for companywide implementation of FDDI at about $5,000 per workstation. Network managers continue to string fiber — the cost of the actual media is insignificant compared to the cost of FDDI network interface cards (NIC) and concentrators. But neither the gradually dropping costs nor the need for greater throughput has propelled them into enterprisewide FDDI implementation.

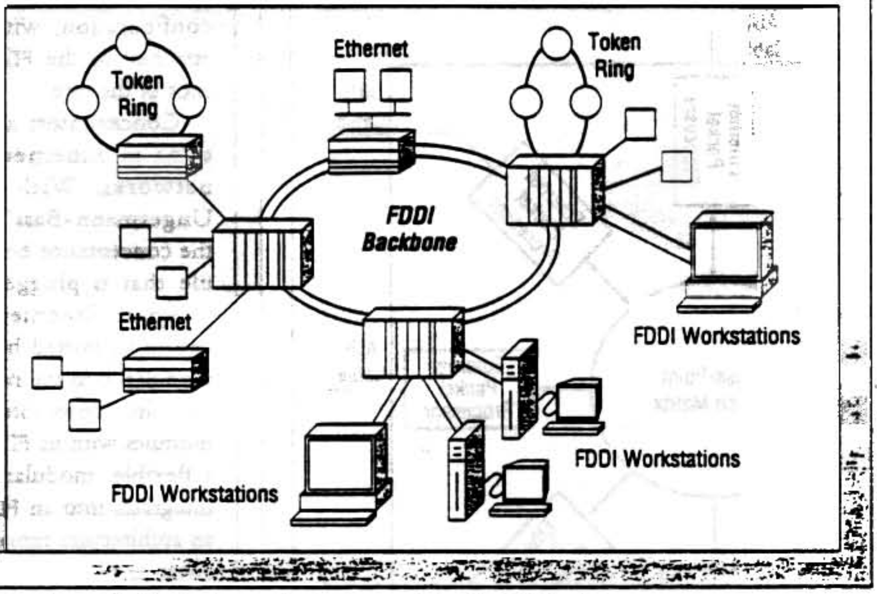
Copper And FDDI

Whether or not to implement fiber is further complicated by the fact that the ANSI X3T9.5 committee is establishing subsets to the FDDI standard for STP and UTP. This is an important technology that is now receiving belated attention, in large part because FDDI over fiber has not shown the rapid drop in cost that many anticipated. In fact, companies such as Cabletron Systems are actively recommending that customers string STP for initial implementation of FDDI.

FDDI over twisted-pair made its debut nearly 2 years ago when Chipcom and SynOptics Communications simultaneously announced that they had successfully achieved 100 Mbps on STP. At Interop '90, both companies proved the technology on the show floor. Less than a year later, Crescendo Communications announced that it had successfully implemented FDDI over UTP. Now this remarkable technology has been officially endorsed and is being actively pursued by the members of the Unshielded Twisted Pair Development Forum, whose members include Crescendo, AT&T Microelectronics, British Telecom, Fibronics, Hewlett-Packard and Ungermann-Bass.

The ANSI FDDI committee is expected to reach a decision by April on what is now being touted as "low-cost FDDI." The process is reminiscent of the 10Base-T standardization activity hosted by the IEEE 4 years ago. At that time, a large group of vendors was intent on pushing through an Ethernet over twisted-pair specification and several vendor proposals were under consideration. The IEEE, since it was dealing w[illegible] the already-established Ethernet technology, was able to quickly reach a decision,

Figure 1.



Copper-based technologies are being integrated with FDDI backbones.

formalize the standard and establish the playing field.

There will be at least two ANSI FDDI over TP standards specified as subsets to X3T9.5. One will be for Category 5 STP, a high-quality twisted-pair such as IBM's Type 1 and Type 2 cable, which IBM recommends for 16-Mbps Token Ring and other technologies requiring bit rates as high as 100 Mbps. The other will be for Category 3 UTP, which will be suitable over shorter distances — probably less than 100 meters — but which will include most grades of UTP currently installed. Final standardization for Category 3 will likely take considerably longer than Category 5 standardization.

But according to Bill Redman, LAN communications analyst at the Gartner Group, a market research company in Stamford, Connecticut, you should also be on the lookout for a possible Category 4 — or Level 4, as it is sometimes called — specification from ANSI.

"People have tended to classify unshielded twisted-pair as voice grade or data grade," says Redman. "But now we're getting away from that terminology. Both can carry data, but Level 4, which used to be considered data grade, is now referred to as super twisted-pair, while voice grade is now simply UTP." Category 4 would specify what is required to qualify as super twisted-pair, while Category 3 will draw the line for the lowest quality UTP that can handle the FDDI data rate.

"Unfortunately," adds Redman, "a lot of the installed base of UTP is unusable, because cable records are not up-to-date or the quality of the cable is poor." Redman estimates that 90 percent of the total installed base of twisted-pair wiring is unshielded. "It's a huge, exciting market," says Redman. "I am very encouraged about the prospects for FDDI over UTP."

Mario Mazzola, president and CEO of Crescendo, agrees that FDDI over UTP will be a huge and important market. "It's what the users have been waiting for," he declares. Statistics from Dataquest, a market research company in San Jose, California, support the observation, showing that, of all the cable installed in 1990 and 1991, UTP moved up from 34.7 percent in 1990 to 52.9 percent in 1991, while STP dropped from 63.2 percent to 44.2 percent during the same time frame.

In addition, since extra lengths of UTP traditionally are pulled when phone wiring is installed in a new building, the copper infrastructure already exists in many buildings for 100 Mbps to the desktop.

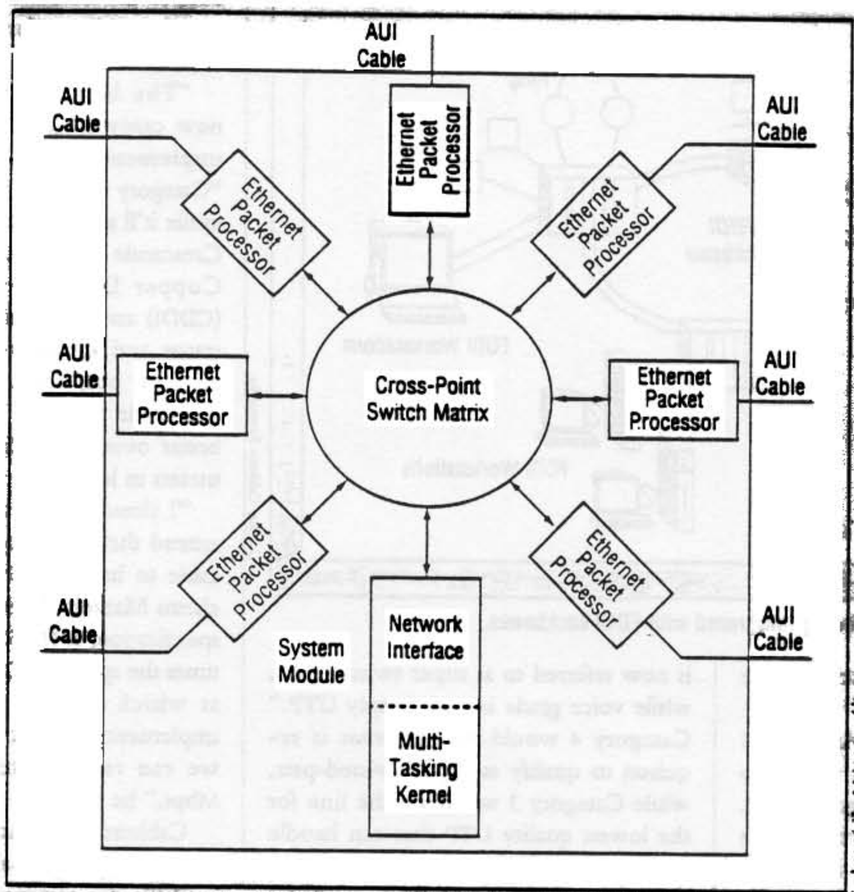
"The labor involved in installing new cable is the bulk of the cost of implementing FDDI," says Mazzola. "Category 5 FDDI is now implementable, while it'll still take time for Category 3." Crescendo calls its UTP technology the Copper Distributed Data Interface (CDDI) and is already selling a concentrator and an adapter for Sun Microsystems' bus, Sbus. CDDI meets FCC standards for class A applications or better over datagrade wiring up to 100 meters in length.

"I already know that we'll be able to extend the technology over Category 5 cable to handle SONET OC-3 speeds," claims Mazzola. The Optical Channel-3 specification, at 155.52 Mbps, or about 1.5 times the speed of FDDI, is the initial rate at which SONET is expected to be implemented. "But I'm confident that we can reach as high as 200 or 250 Mbps," he says.

Cabletron estimates that it will have ANSI-compliant Category 5 products available this summer. Motorola reports that only a single chip in its ANSI FDDI-compliant chipset will have to be changed to accommodate the new twisted-pair standards, so time-to-market will be minimal. Digital, which worked with Motorola when it developed the DEC FDDI chipset, is already supporting FDDI over STP in its DECconcentrator 500, using a transmission scheme jointly developed with Motorola, Advanced Micro Devices, Chipcom and SynOptics.

Interoperability among FDDI on fiber optic cable, UTP and STP will not be a problem. Digital and friends demonstrated interoperability of the group's STP transmission scheme with FDDI over fiber at Interop '91. In addition, interoperability tests are ongoing for the industry at Advanced Micro Device's Advanced Networking Test Center in Sunnyvale, California, as well as in a

Figure 2.



Courtesy Kalpana Inc.

True routing at the data link layer — exemplified by Kalpana's Etherswitch — has only recently become available. Shown here is the Etherswitch architecture.

program hosted by the University of New Hampshire.

Redman points out, however, that it will not be as easy as many vendors claim. "We're all watching closely as the players test their technologies over greater and greater distances."

Light And Dark

The migration to optical networks for most organizations likely will entail mixing fiber optic backbones with copper media and older Ethernet and Token Ring technologies. The next several years will bring technology that pushes bit rates across copper to the limit and provides Ethernet and Token Ring data link packet bridging and switching speeds that keep these standards viable. In this way, the lower cost technologies will remain competitive even in the face of dropping costs for optical-based networking devices.

Figure 1 shows how copper-based technologies are being integrated with FDDI backbones. The FDDI standard defines three "entities" that can be attached to the fiber optic ring:

1. Single-attachment stations (SAS).
2. Dual-attachment stations (DAS).
3. Concentrators.

The SAS connects to only the primary ring, yielding a low-cost implementation. The DAS connects to both the primary and secondary (backup) rings for a more expensive but redundant configuration.

FDDI concentrators have DAS ports for connection to the ring as well as DAS and SAS ports to connect other devices into the ring, including ad[illegible] concentrators. When concentrators are cascaded, it is usually in a hierarchical tree configuration, with the concentrator attached to the FDDI backbone at the root of the tree.

Concentrators also support connections to Ethernet and Token Ring networks. With products such as Ungermann-Bass' Access/One hub the concentrator becomes a single module that is plugged into the hub to integrate Ethernet and Token Ring traffic, supported by other Access/One modules, into the ring. The Access/One hub also allows integration of 10Base-T modules with its FDDI module, yielding a flexible, modular 10Base-T hub that integrates into an FDDI backbone using an architecture remarkably similar to the twisted-pair/fiber combination that established SynOptics several years ago. The difference now is that these are fully standards-compliant products available in easily expandable configurations that can be upgraded to newer technologi[illegible]

Most of the other networking companies, such as Advanced Computer Communications, Cabletron, Chipcom, Network Resources, Network Systems, Proteon, SynOptics and 3Com, are taking the modular approach as well, making the migration path from low-speed copper to high-speed copper to fiber optics as inexpensive and flexible as possible.

Manufacturers of NICs are also exhibiting the modular, upgradable approach to implementing FDDI. For example, Codenoll Technology, which introduced the first commercial Fiber Optic Ethernet interface in 1982, implements a daughterboard architecture on its adapter cards that allows upgrades in the field. Similarly, Raylan is selling Ethernet and Token Ring fiber optic NICs that compete pricewise at the upper end of the 10Base-T Ethernet NIC price spectrum. These allow organizations to implement fiber optic cable now while continuing to use existing LAN tec[illegible]gies until the break-even point, w[illegible] will become cost-effective to switch over to optical technologies for good. All that will then be required are upgrades to adapters already in use.

Transmission speed from device to device is not the only consideration when increasing throughput across the LAN. Many have heard the story of the network manager who, under pressure from his boss to speed access to a server on a certain floor of a building, throws out the Ethernet backbone between floors and puts in an expensive, high-speed FDDI backbone, only to discover zero improvement. The problem turns out to be that the Ethernet subnetworks on each floor need to be properly segmented to reduce collisions.

If we assume that the problem is at the physical and data link layers of the network, a lot can be accomplished by changing how sub-LANs are configured and managed. These solutions range from using the new breed of low-cost 10Base-T hubs to moving to different data link bridging, routing and switching technologies.

Ethernet networks that use co-axial cable are rapidly being incorporated with 10Base-T Ethernet networks using structured wiring hubs. 10Base-T uses UTP to connect individual nodes to a hub, while thin and thick Ethernet lengths support multiple nodes with a bus topology. 10Base-T hubs are connected hierarchically, resulting in strongly structured wiring topologies that are easy to troubleshoot and manage. Bottlenecks can easily be detected and eliminated by adding more layers to the hierarchy.

The success of topologies using these hierarchically arranged stars has caused many industry observers to predict that traditional thin and thick co-axial cable will find limited use in the future. Thick and thin co-axial cable still have the advantage, however, of transmission over greater distances without a repeater, as well as the bus topology. Many companies make 10Base-T hubs. These companies include Cabletron, David Systems, Gandalf Systems, Hughes LAN Systems, Network Resources, SynOptics, Ungermann-Bass and 3Com.

Bridging and routing at the data link layer is also used to improve network performance and manageability. With transparent bridging and routing, end nodes know nothing about how the frames they send will cross the network. Bridges build tables of which nodes are on which side, and pass or block frames accordingly. Transparent bridges may also implement the spanning tree algorithm, as specified by the IEEE 802.1 committee, to automatically configure an optimal path for the frame through the network without the possibility of frames traveling in endless loops around the LAN.

Other technologies, such as source routing transparent (SRT), support both transparent routing and end-node involvement in frame routing. When the end node is involved, it specifies the route the frame is to travel through the network in the frame header, and the routing devices route it through the LAN accordingly. If that information does not exist, the routing is handled transparently by the internetworking d... Though IBM designed and first implemented source routing for Token Ring, the IEEE 802 committee is standardizing it, and companies such as CrossComm and Netronix are active in promoting it.

Digital has found great success with its DEChub 90, DECbridge 90, DECserver 90 and DECrepeater 90 Ethernet products. The bridge, repeater and server (terminal) modules plug into the hubs and support co-axial and twisted-pair connections. Multiple hubs can be connected with co-axial cable.

True routing at the data link layer — that is, receiving a frame at one port and routing it out one of several other ports — has only recently become available. This so-called packet-switching (really frame switching) is becoming a popular technology and is being championed by companies such as Kalpana.

The Kalpana Etherswitch architecture appears in Figure 2. The Etherswitch consists of three main components: system module, Ethernet packet processors (EPP) and cross-point switch matrix. At power-up, the system module learns the location of each end node and sets up an address table on each EPP. Once the address tables are made, all future frames are directly switched by the EPPs through the cross-point switch matrix. Each EPP module contains 512 KB of RAM to hold up to 256 Ethernet addresses. Additional memory can hold up to 1,500 addresses.

Though the Etherswitch supports Ethernet only, other network types can be interfaced to the device using frame translation outside the device. But "FDDI is very limited, in our view," says Larry Blair, vice president of marketing at Kalpana. "The key to increasing network performance is in massively subnetting the network." This involves structured wiring topologies and heavy use of bridges, switches and routers. Kalpana regards its greatest competition as coming from the network layer router manufacturers, such as Cisco Systems, Wellfleet, and from FDDI itself.

"FDDI will have a stunted growth,

says Blair. "Token-passing schemes are inherently limited, because it's difficult to subdivide the network. And routers are too expensive."

Blair is not alone in his unflagging endorsement of Ethernet. Other companies, such as Allied Telesis and Xircom, continue to build thriving businesses on the standard, while Digital is only now reluctantly acknowledging the existence of Token Ring.

But Bill Clark, FDDI product manager at Cabletron, is not so wholehearted in his endorsement of the Kalpana technology. "Even giving every workstation a full, switched 10 Mbps won't be enough for the multimedia applications we're just now beginning to see," he says. "For that, you need FDDI's 100 Mbps. It always comes down to bandwidth."

THE DECISIONS ARE DIFFICULT but not impossible. Even if the wrong decisions are made, the nice thing about the lowest networking layers is that they are so standardized. Network managers are always provided with a migration path if they stick with standards. And it is virtually impossible to network yourself into a corner if the devices are ANSI- or IEEE-compliant.

Would you like to see more articles on this topic? Circle on reader card: Yes 417 No 418

Companies Mentioned

Advanced Computer Communications
720 Santa Barbara St.
Santa Barbara, CA 93101
(805) 963-9431
CIRCLE 486 ON READER CARD

Advanced Micro Devices Inc.
P.O. Box 3453
Sunnyvale, CA 94088
(408) 970-9700
CIRCLE 487 ON READER CARD

Allied Telesis
575 E. Middlefield Rd.
Mountain View, CA 94043
(415) 964-2771
CIRCLE 488 ON READER CARD

British Telecom
2560 N. 1st St.
San Jose, CA 95131
(408) 922-0250
CIRCLE 489 ON READER CARD

Cabletron Systems Inc.
35 Industrial Way
Rochester, NH 03867
(603) 332-9400
CIRCLE 407 ON READER CARD

Chipcom Corp.
118 Turnpike Rd.
Southborough, MA 01772
(508) 460-8900
CIRCLE 437 ON READER CARD

Cisco Systems Inc.
1525 O'Brien Dr.
Menlo Park, CA 94025
(415) 326-1941
CIRCLE 490 ON READER CARD

Codenoll Technology Corp.
1086 N. Broadway
Yonkers, NY 10701
(914) 965-6300
CIRCLE 499 ON READER CARD

Concord Communications Inc.
753 Forest St.
Marlborough, MA 01752
(508) 460-4646
CIRCLE 504 ON READER CARD

Crescendo Communications
710 Lakeway Dr.
Sunnyvale, CA 94086
(408) 732-5942
CIRCLE 500 ON READER CARD

CrossComm Corp.
140 Locke Dr., Ste. C
Marlboro, MA 01752
(508) 481-4060
CIRCLE 459 ON READER CARD

Datability Inc.
1 Palmer Terrace
Carlstadt, NJ 07072
(201) 438-2400
CIRCLE 475 ON READER CARD

David Systems Inc.
701 E. Evelyn Ave.
Sunnyvale, CA 94088
(408) 720-8000
CIRCLE 501 ON READER CARD

Fibronics Int'l Inc.
25 Communications Way
Hyannis, MA 02601
(508) 778-0700
CIRCLE 481 ON READER CARD

FTP Software Inc.
338 Main St.
Wakefield, MA 01880
(617) 246-0900
CIRCLE 476 ON READER CARD

Gandalf Systems Inc.
9 N. Olney Ave.
Cherry Hill, NJ 08003
(609) 424-9400
CIRCLE 468 ON READER CARD

Hughes LAN Systems
1225 Charleston Rd.
Mountain View, CA 94043
(415) 966-7300
CIRCLE 444 ON READER CARD

Kalpana Inc.
125 Nicholson Ln.
San Jose, CA 95134
(408) 428-1150
CIRCLE 482 ON READER CARD

Motorola Inc.
1301 E. Algonquin Rd.
Schaumburg, IL 60196
(708) 576-5518
CIRCLE 493 ON READER CARD

Netronix
1372 N. McDowell Blvd.
Peteluma, CA 94954
(707) 762-2703
CIRCLE 502 ON READER CARD

Network Research Corp.
2380 N. Rose Ave.
Oxnard, CA 93030
(805) 485-2700
CIRCLE 508 ON READER CARD

Network Resources Corp.
736 S. Hill View Dr.
Milpitas, CA 95035
(408) 263-8100
CIRCLE 494 ON READER CARD

Network Systems Corp.
7600 Boone Ave. N.
Minneapolis, MN 55428
(612) 424-4888
CIRCLE 496 ON READER CARD

Novell Inc.
122 E. 1700 S.
Provo, UT 84606
(801) 379-5900
CIRCLE 477 ON READER CARD

Process Software Corp.
959 Concord St.
Framingham, MA 01701
(508) 879-6994
CIRCLE 426 ON READER CARD

Proteon Inc.
2 Technology Dr.
Westborough, MA 01581
(508) 898-2800
CIRCLE 435 ON READER CARD

Raylan Corp.
120 Independence Dr.
Menlo Park, CA 94025
(415) 324-5000
CIRCLE 503 ON READER CARD

SynOptics Communications Inc.
4401 Great America Pkwy.
Santa Clara, CA 95052
(408) 988-2400
CIRCLE 495 ON READER CARD

TGV Inc.
603 Mission St.
Santa Cruz, CA 95060
(408) 427-4366
CIRCLE 478 ON READER CARD

Ungermann-Bass Inc.
3990 Freedom Cir.
Santa Clara, CA 95054
(408) 496-0111
CIRCLE 497 ON READER CARD

Wellfleet Communications Inc.
15 Crosby Dr.
Bedford, MA 01730
(617) 275-2400
CIRCLE 498 ON READER CARD

The Wollongong Group Inc.
1129 San Antonio Rd.
Palo Alto, CA 94303
(415) 962-7200
CIRCLE 509 ON READER CARD

Xircom Inc.
26025 Mureau Rd.
Calabasas, CA 91302
(818) 878-7600
CIRCLE 458 ON READER CARD

Xyplex Inc.
330 Codman Hill Rd.
Boxborough, MA 01719
(508) 264-9900
CIRCLE 479 ON READER CARD

3Com Corp.
5400 Bayfront Plaza
Santa Clara, CA 95052
(408) 764-5000
CIRCLE 480 ON READER CARD