MULTIPROTOCOL HIGHWAYS

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ABSTRACT

With DECnet, SNA, TCP/IP, OSI, IPX, AppleTalk, IS-IS, and OSPF all finding market share on today's networks, the network integrator's choice isn't which specific protocol to use, but how to effectively use them all. The products available from Digital Equipment Corp. are especially useful in the deployment of multiprotocol networks. Techniques such as tunneling can be used to implement multiprotocol networks without requiring immediate decisions about which routing protocols to use or whether to replace the dominant protocol in use on the network with multiple protocols. SNA, IBM's networking architecture, introduces some especially vexing problems for multiprotocol networking.

INTRODUCTION

Networking using multiple protocols has become a fact of life in today's enterprises. Over the past decade, dozens of LAN "islands" have popped up throughout organizations of all sizes and now they're being hooked together. Sometimes, as in the case of Digital Equipment Corp.'s VAXclusters, these LANs include minicomputers. But more often they are composed of UNIX workstations, Macintosh computers, or personal computers running DOS and sometimes OS/2. In addition, the IBM mainframe usually towers over all these smaller machines from some central point within the organization, demanding connectivity to the myriad of smaller processors throughout the company.

Backbones

Most organizations implement some sort of multiprotocol backbone to hook together the many different machines and subnetworks scattered throughout a single building, across a city, or around the world. The backbone concept scales well, since smaller backbones may be connected into a much larger network with a high-speed wide area backbone. FDDI is proving to be the preferred backbone connecting local Ethernet and Token Ring networks, while high-speed, digital T1 lines using Frame Relay technology are proving to be the most useful for WAN backbones. Slower X.25, 64Kbps and 56Kbps technologies continue to find implementation for wide area networking, but they cannot handle the high volumes of traffic that are becoming the norm on today's multiprotocol networks.

A simple multiprotocol wide-area T1 backbone connects just two sites and uses bridges to filter different packet types across the connection. Some bridge manufacturers are providing the greatest possible performance for this configuration by using techniques such as data compression. More complex multiprotocol backbone configurations include multiple routers and alternate paths through the network.

Multiprotocol networks, however, were not what most industry analysts and computer system managers were expecting 10 or even just 5 years ago. The "open" networking protocols being specified by the International Organization for Standardization (ISO), loosely referred to as the Open System Interconnection (OSI) protocols, were supposed to solve computer networking problems in the same way similar problems had been solved for the telecommunications industry by a variety of international organizations like the CCITT and Electronic Industries Association (EIA).

ISO has accomplished much, drafting and approving many international standards for open systems. But many large organizations have not been able to wait for the slow, cumbersome international standards process. These organizations—usually either governmental, academic, or research—have turned to the TCP/IP (Transmission Control Protocol /Internetwork Protocol) protocol suite for the open systems technologies they need to implement LANs and WANs that solve the multivendor communications problems they face. Standardized by the Internet Activities Board (IAB), researched by the IAB's Internet Research Task Force (IRTF) and specified and tested by the Internet Engineering Task Force (IETF), TCP/IP and its associated protocols have provided network managers—for the very first time—with access to a non-proprietary, fully standardized and tested, comprehensive base of "third party" communications products available on nearly every computing platform.

However, open systems is not defined by just TCP/IP or OSI, or even a combination of the two. Open systems is the ability to integrate any number of protocols and technologies. Open systems means flexibility, not rigid standardization. The almost overnight success of the many multiprotocol and multimedia bridging and routing vendors clearly indicates that the most successful standards-based products win support not because they do just one job well, but because they allow many different protocols and standards to work together to perform a variety of functions on the network. Further, they provide easy integration of future protocols and standards, which may be designed to perform functions that we cannot even imagine today. These future protocols could be proprietary and de facto, like DECnet Phase IV, Apple Computer's AppleTalk, IBM's Systems Network Architecture (SNA), and Novell's Internetwork Packet Exchange (IPX), or they could be non-proprietary like TCP/IP and OSI.

Integrated IS-IS

The Integrated Intermediate System-to-Intermediate System (Integrated IS-IS) routing protocol provides the best example of the drive toward flexibility in open networking. Developed by Digital in the mid-80's and submitted to ISO in 1987, IS-IS for OSI is specified in ISO International Standard 10589. Another version of IS-IS called Dual IS-IS has been specified by the IETF for routing both OSI and TCP/IP packet types over the same network backbone. It is specified in Request For Comments (RFC) 1195. RFCs are the official documents of the Internet community.

IS-IS, however, is being expanded to incorporate all protocol types, including AppleTalk and IPX. Digital is the driving force behind this Integrated IS-IS, but the routing protocol is finding acceptance within many other computer and networking companies.

According to David Oran, Routing Standards Editor for ISO and a Digital employee, we are witnessing the same kind of industry-wide support for Integrated IS-IS that Frame Relay has found. We can even expect a forum to develop similar to the successful Frame Relay Forum that has proved so instrumental in the great success of Frame Relay technology.

ISO is now pretty much "out of the picture" as far as Integrated IS-IS is concerned, says Oran. "But that's not a negative comment," he adds. "It's like saying that IEEE is out of the Ethernet picture. They've done their work and moved on," he says.

"Keeping TCP/IP out of your backbone is really a moot point," Oran continues. "The whole issue has boiled down to managing a routing protocol—a single routing protocol." Oran says that reliability, the ability to implement useful network management tools, and performance all suffer with too many routing protocols. "You see protocol contention and the need to track too much routing information. It doesn't matter how many transport protocols you have; you want as few routing protocols as possible. Integrated IS-IS lets you use just one good one."

The integrated approach contrasts with the "ships in the night" approach, whereby a router implements at least two different routing protocols independently. The router's job is to make it look to the network as if one protocol is working behind the scenes, when in fact there may be several. Currently, the Open Shortest Path First (OSPF) Internet-standard routing protocol, which is replacing the older Routing Information Protocol (RIP), is the de facto standard recommended by the IAB for the Internet. But Integrated IS-IS is gaining fast, so it will likely exist as the other "ship" on many existing networks. The ultimate winner between these two routing protocols will likely be determined by the end of the decade.

Other important intradomain routing protocols include Cisco System's Interior Gateway Routing Protocol (IGRP) and Apple's AppleTalk Updated Routing Protocol (AURP). The interdomain protocol routing world, for extremely large networks, is still in the early stages of standardization but is fast becoming another important standards battle ground. IBM is keeping its SNA routing protocols out of the public domain, as it does with most of its SNA technology, but the third party is still finding ways to get useful SNA-based products onto the market.

According to Jeff Paine, a spokesman for Cisco, which has found great success with its IGRP standard, the company sees customers for Integrated IS-IS and OSPF coming from very two different sectors. "The demand for OSPF is in the academic and research worlds," he says. "Integrated IS-IS will be implemented on large corporate networks, especially those that are using a lot of DECnet."

Digital's Advantage-Networks

Integrated IS-IS is central to Digital's networking strategy. The company wants to integrate the enterprise, regardless of vendor and application mix. The protocol makeup of most networks is determined by the applications the network was constructed to address, and network administrators are reluctant to change what works simply because it is popular to move to open systems. Digital has been on the OSI bandwagon in a very big way ever since it announced DECnet/OSI (Phase V) in 1987, but the company also listens to its customers and is anxious to accommodate all protocol types.

Figure 1 shows how DEC is integrating DECnet Phase IV, OSI, and TCP/IP to yield DECnet/OSI, which is also known as DECnet Phase V and is now called Advantage-Networks. Integrated IS-IS plays the central role, since it is capable of routing all packet types.

Figure 2 shows the specific products Digital is using to integrate large networks. It also shows where they fit in terms of performance. In addition, Digital has struck deals with Cisco, Proteon, Stratacom, Vitalink Communications, and others to sell these companies' popular multiprotocol routers and high-performance Frame Relay products.

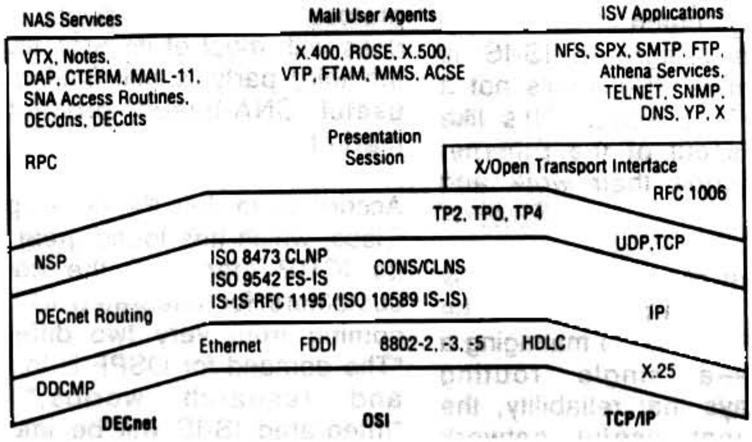

Figure 1. The layers of Digital's DECnet Phase V environment.

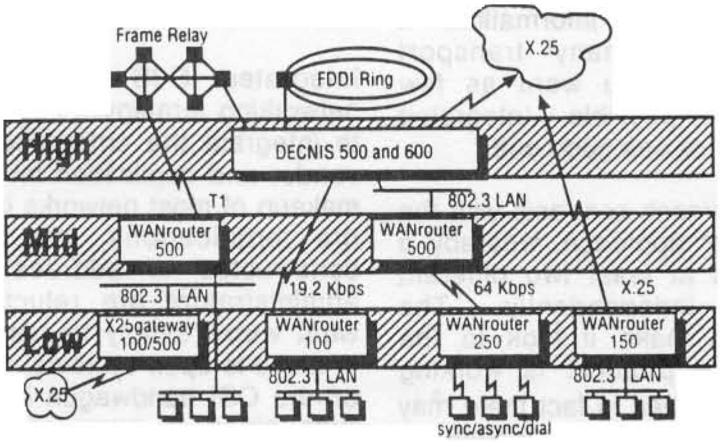

Figure 2. Digital's routers.

The DEC Network Integration Server (DECNIS) 500 and 600 are the key products in Digital's family of new-generation backbone network servers. They combine the functions of a multiprotocol router, local and remote bridging and X.25 packet switching into a single hardware platform. The DECNIS family is based on Integrated IS-IS. The products feature modularity and expandability, allowing customers to mix and match local- and wide-area network interface modules as needed. The DEC WANrouters are also based on Integrated IS-IS and are defined by Digital as access routers used by remote sites and branch offices.

Digital is committed to providing multiprotocol routing and bridging that support most industry-standard LAN and WAN technologies, including Ethernet, FDDI, Token Ring, Frame Relay, X.25 and the High Speed Serial Interface (HSSI).

According to Digital, it occupies a "unique and enviable" position among networking product vendors. Digital engineers and managers sit on 120 standards committees worldwide, with chairpersonships of groups in charge of network layers, security protocols, and network implementation issues. Internationally, Digital participates in the activities of

ISO, COS, OSInet, OSIcom, EurOSInet, and other organizations.

But the TCP/IP world remains strong, and many industry analysts still regard OSI as somewhere between the drawing board and actual implementation. OSI has not really even been tested yet in the real world, while TCP/IP technologies such as (Routing Information Protocol) RIP and OSPF have been thoroughly tested and are available in many products from many vendors. In addition, AppleTalk and Novell's IPX (the foundation of NetWare) continue to find enhancement by Apple and Novell, and third parties continue to flock into the Apple and NetWare folds.

Network Protocol Architectures

The obvious drawback to multiprotocol networking is that it can become awesomely complicated. But it can be simplified by restricting where multiprotocol networking occurs within the larger network architecture.

A single host or desktop machine can communicate using multiple transport protocols using technologies such as X/Open Transport Interface (XTI), AT&T's Transport Layer Interface (TLI), NetWare Loadable Modules (NLMs), or dual protocol stacks. Since individual client nodes are communicating using multiple transport protocols, this type of multiprotocol networking is the most sophisticated. Routers that connect subnetworks of these machines to a backbone must be able to route multiple transport protocol types between LANs and WANs. The big advantage to this architecture is, of course, that a single machine can communicate with many different types of machines across many different types of networks.

At the other extreme is use of a single transport and routing protocol network-wide. Unlikely as this may sound, some organizations have standardized on TCP/IP, using it on machines ranging from PC's and Macs to large mainframes and minis from Digital, IBM, and Unisys.

You can also restrict multiprotocol use to backbone applications, isolating individual LANs from the multiprotocol environment. This is a more common configuration and has many advantages, chief among which is LAN autonomy and reliability. The big disadvantage is that clients on these networks can access servers on other subnetworks that do not speak their protocol type only if some sort of protocol conversion occurs, normally with a gateway-type product. Gateways are still in widespread use, especially to connect IBM networks to the rest of the world, but they are clumsy and inefficient devices that add great overhead to the network.

Tunneling

Support for technologies like Integrated IS-IS is sounding the death knell for gateway-type products, but that death will not occur any time soon. Clients on LANs must be protocol-multilingual to efficiently access the wide variety of servers available to them within their own enterprises as well as across larger public networks. Of course, requiring multiprotocol support for most desktop machines is not practical today, but you still want to provide them with wide-area connectivity to other LANs with the same protocol type across network backbones. This can be done with a popular technology called tunneling (also known as encapsulation).

Protocol tunneling is used to simplify multiprotocol networking. It allows network administrators to keep their various protocol environments isolated from one another yet provide wide area connectivity among similar environments across a single backbone. Most protocol types can be tunneled, whether they are tunneled or doing the tunneling themselves.

With tunneling, LAN packets—AppleTalk, for example—are encapsulated within packets of the protocol type in use on the network backbone. They are routed to their destination using the routing protocol of the protocol type on the backbone, usually either TCP/IP or DECnet.

Because of the complexities of IBM's SNA environments and the difficulties in including SNA in multiprotocol routing products, companies such as Cisco offers SNA tunneling across multiprotocol networks that include TCP/IP (see Figure 3). In environments where a 56Kbps line has been used to connect remote IBM environments, Cisco's SDLC tunneling software enables IBM mainframe front-end processors (FEPs) and cluster controllers to communicate across a T1 line along with other multiprotocol traffic, without network managers having to worry about routing SNA using proprietary IBM routing protocols.

In the Novell world, Interconnections provides IPX tunnelling across DECnet backbones. Interconnection's DECnet/IPX Portal is installed on a VAX/VMS system at each NetWare location and works by encapsulating NetWare IPX packets inside DECnet packets. Cisco and Wellfleet multiprotocol routers also route IPX packets, but these devices are considerably more expensive, and the routing protocol issues still have not been resolved.

Dealing With SNA

IBM itself tunnels SNA within other protocols in its new line of multiprotocol routers. According to IBM, this is the result of customer demand that SNA be consolidated with other protocols on the network. In addition, companies such as Computer Communications are providing just the opposite approach and encapsulating IP with SNA to connect UNIX LANs across SNA networks.

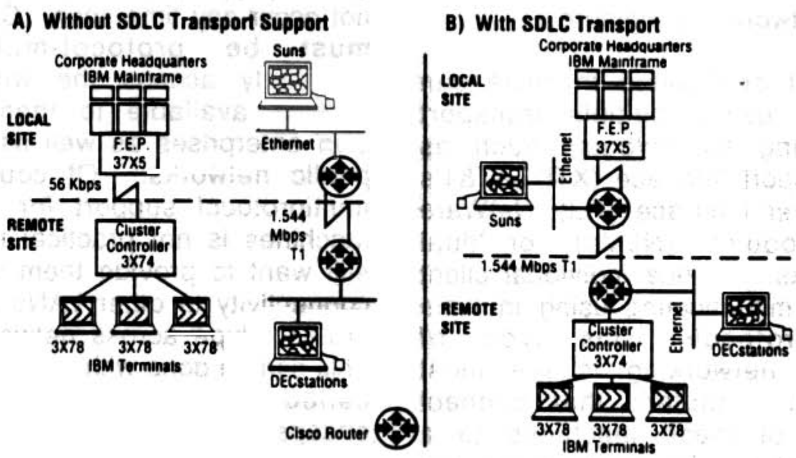

Figure 3. Tunneling SDLC across a TCP/IP backbone.

In the AppleTalk world, several companies provide tunneling across TCP/IP and DECnet backbones, including Cayman Systems and Shiva. The Cayman GatorBox uses RIP to propagate routing information to other IP routers and hosts and, if configured to accept RIP packets, periodically updates its gateway table with routing information provided by other IP routers.

SNA poses big problems in terms of integration into the rest of the network. SNA is clearly a de facto standard and IBM clearly is continuing to improve and support it. Although products that support SNA along with other protocols are becoming available from a growing number of vendors, SNA still pretty much lives in the glass house, and a traditional gateway type product is usually required to connect SNA environments to the multiprotocol world.

The IBM environment is very hierarchical. With the proliferation of PCs and LANs, IBM has begun to move its networking strategy toward a more distributed architecture. But the change will necessarily be gradual, since the IBM networking environment is so complex. The multiprotocol bridging and routing companies are similarly taking a very gradual approach to integrating SNA with the rest of the enterprise, so many of the solutions emerging today are aimed at specific applications rather than any kind of comprehensive support for SNA. This contrasts sharply with the support for DECnet Phase IV, since DECnet was engineered from the beginning for peer-to-peer nonhierarchial distributed networking, and Digital has always made DECnet specifications available to the third party.

McDATA is at the heart of the SNA-to-multiprotocol integration issue, since it is one of the few multiprotocol network interconnect companies coming from the IBM side of things. It recently began shipping a terminal server that combines SNA with LAT, supporting both IBM 3270 and VT terminal types. The company just introduced an SNA-to-Ethernet multiprotocol gateway technology to open the SNA environment in several new ways.

According to Brian Witt, Group Product Manager at McDATA, there are two primary obstacles to implementing SNA in the multiprotocol world. "There are business and technical obstacles," he says. "IBM doesn't release its routing specifications, so you have to reverse engineer. This is an expensive procedure that adds a lot to the R and D budget." Witt adds that the Cisco approach—tunneling SDLC across the wide area—is sound, and provides a good intermediate step until third party SNA routing products mature.

SUMMARY

Routing SNA with Integrated IS-IS will be a huge technical challenge, and some wonder whether it can even be done. Meanwhile, traditional gateways continue to provide the required connectivity to the IBM environment, while Digital and others continue to push hard to connect all other network types openly and easily. Far from standardizing on any single protocol, computer networking technology, like other types of computer technology, is proving a mixed bag. Those companies that are the most successful in the global computer environment will be those that can design architectures capable of incorporating both de facto and de jure standards flexibly and at a reasonable cost.