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ACUTA

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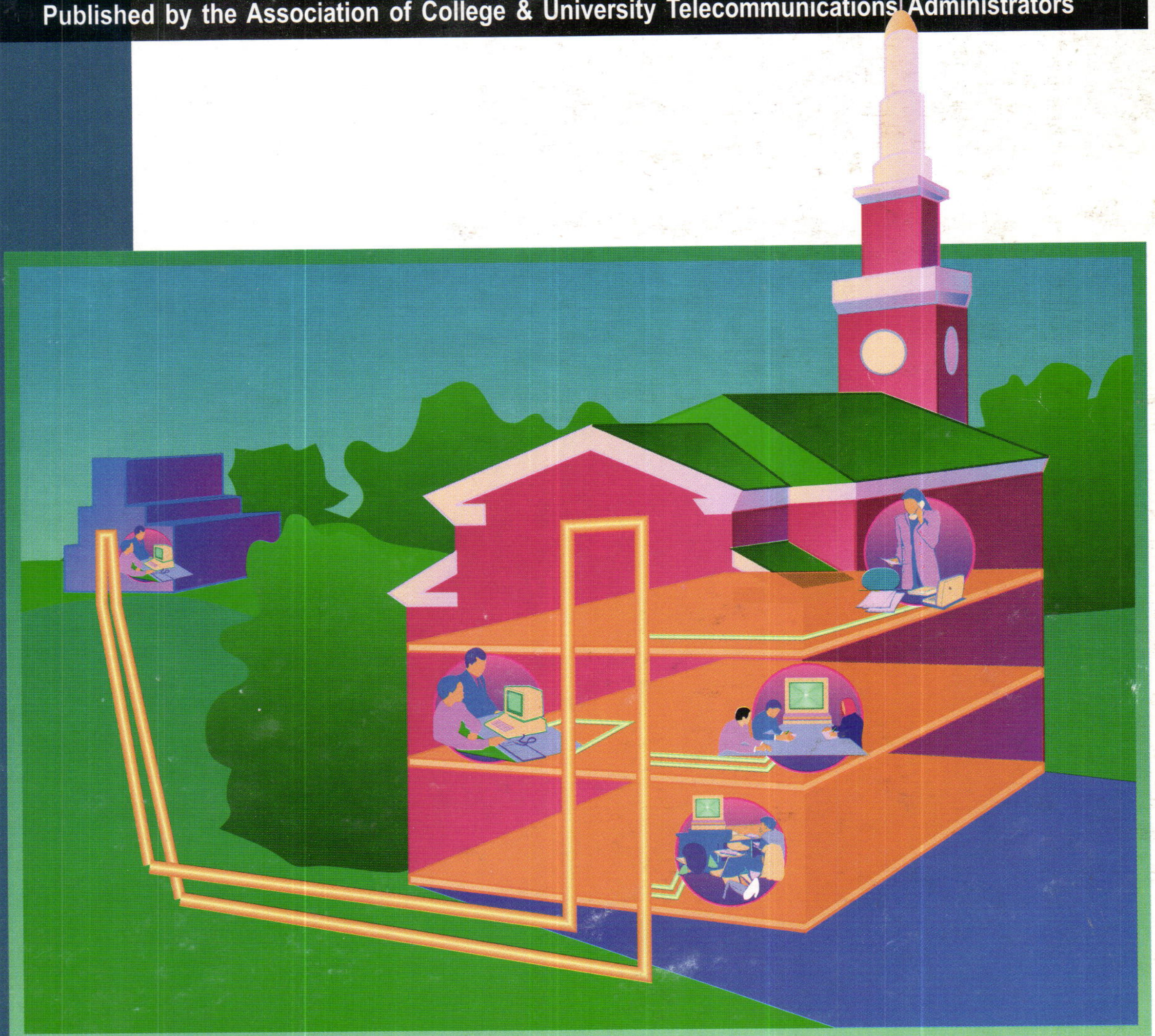
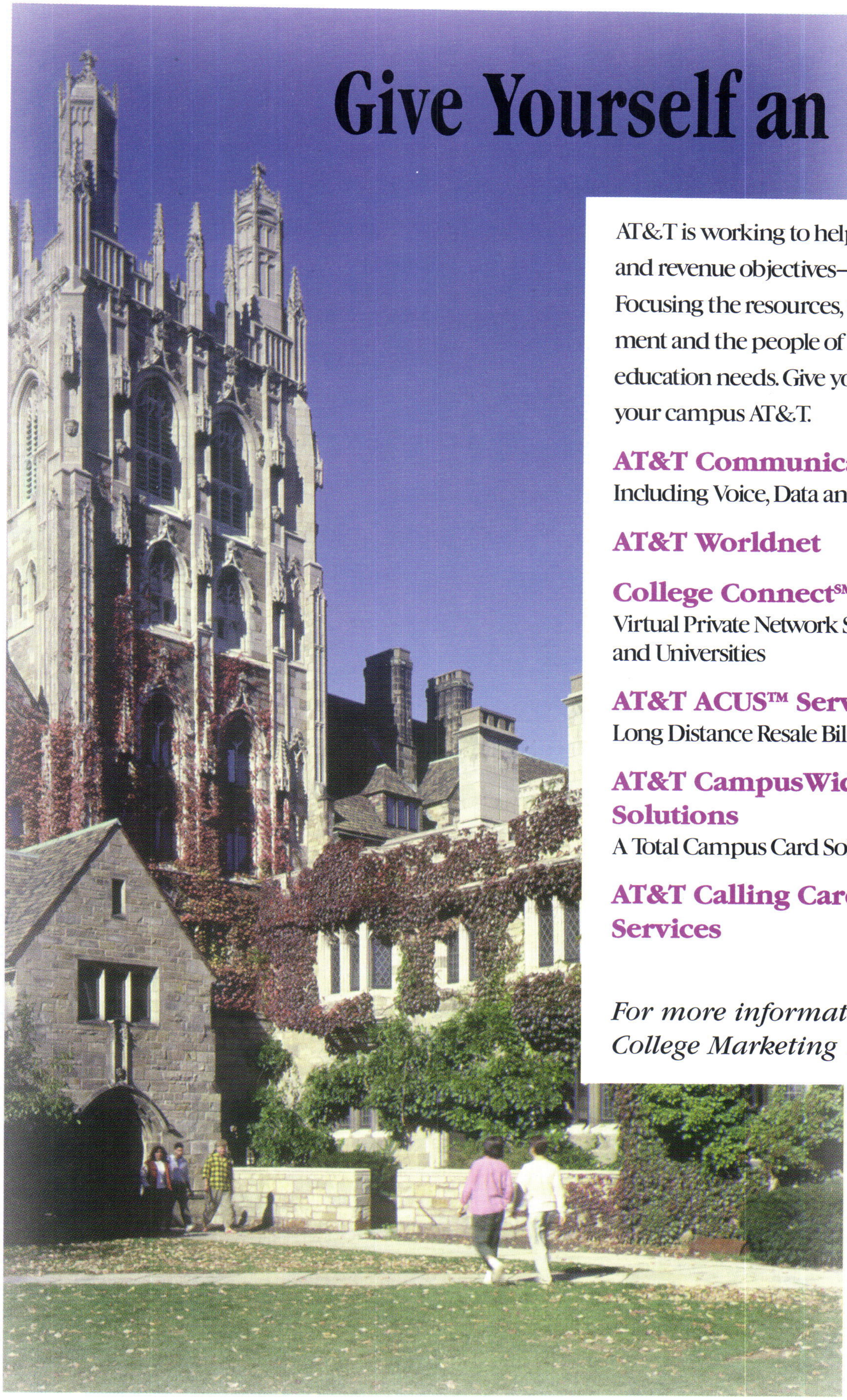


This Issue: Integrating Networks



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Welcome to the Journal

After months of planning, the *ACUTA Journal of Telecommunications in Higher Education* is at last a reality.

The ACUTA Board of Directors, Publications Committee, Editorial Review Board, and staff hope you find this publication of value as you strive to carry out your responsibilities more knowledgeably, efficiently, and effectively.

Topics for this and subsequent issues have been selected because of their importance to campus telecommunications, especially as they relate to the theme of each issue. For our premier issue, we chose Integrating Networks as our theme. Our Summer issue will focus on Financing Telecommunications/Student Services. For the Fall we will examine Technology in the Classroom. The Winter edition will consider Strategic Planning and Team Management.

May the time you spend reading this material be a good investment in your campus or your career, and may you continue to rely on ACUTA for the information that will lead to your success. Your comments and suggestions are always welcome.

"

We need to know, and we need to know quickly, how we can maximize our investments in voice and data switches, routers, and cable plant to achieve maximum performance, increased capacity, and full utilization of our resources to support our colleges' and universities' expanding needs. We see network integration as a solution, but we need information on how we economically and seamlessly get there from here.

—Jan Weller
University of Kansas
ACUTA Program Committee Chair

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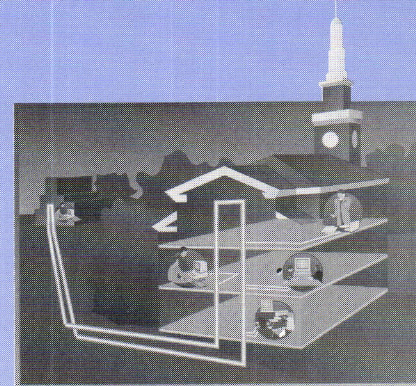
FOCUS
INTEGRATING NETWORKS



FEATURES


Page 12


Page 32


Page 35

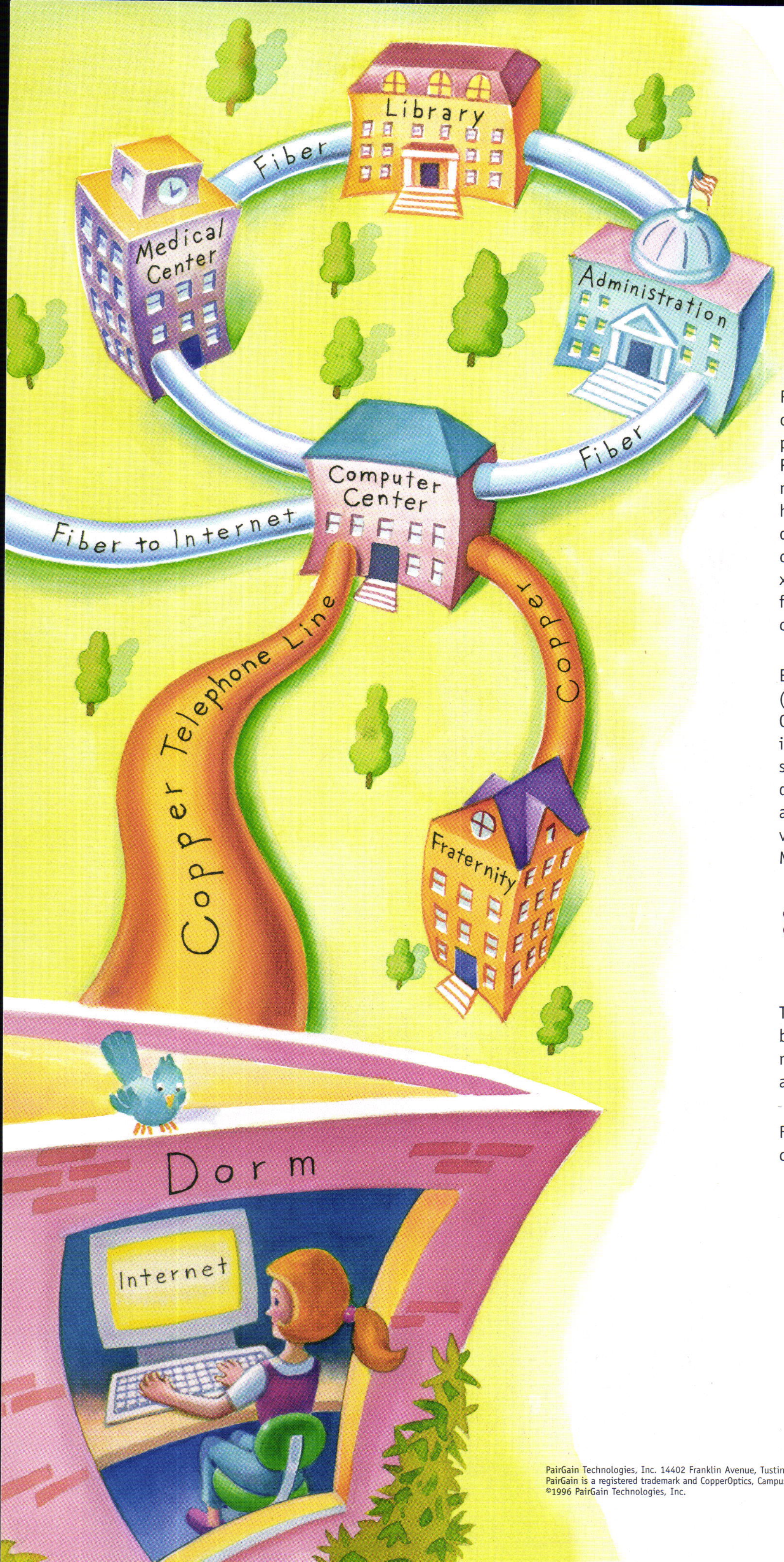
INTERVIEW


Page 44

CAMPUS PROFILE

BOOK REVIEW

COLUMNS



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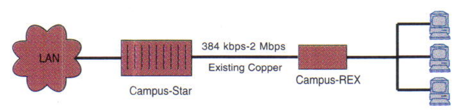

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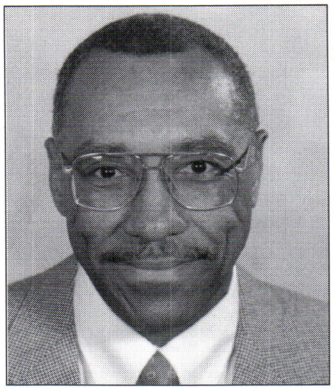

President's Message

Dr. James S. Cross
Michigan Technological University
ACUTA President, 1996–97

A Journal Is Born

One of the key objectives outlined in ACUTA's 1992 Strategic Plan was to forge ahead vigorously and purposely in exploring the need and value to the membership in publishing a quarterly *ACUTA Journal*. This inaugural issue represents a major milestone in the evolution of the Association. The vision of ACUTA Board members spanning the '90s becomes reality with the publication of this issue.

Our goal then and now is that the *ACUTA Journal* will serve as a communication forum to provide the core membership with educational and developmental opportunities. Through original articles and case studies submitted by members, vendors, and nontraditional sources such as faculty and practitioners in the field, the journal will provide information on current and emerging issues of importance to members as they pursue the mission of their institutions.

Strategic, tactical, and management issues addressed in the journal will be targeted to meet the needs of operational staff as well as key administrators. Technical, operational, legal, educational, regulatory, and practical applied content will be at the core of this publication.

"Integrating Networks in Higher Education" is a fitting theme for the inaugural issue of the *ACUTA Journal* since we are in the midst of a revolution in higher education—the most dramatic since the dawn of the Information Age. While economic, social, demographic, and related technology forces are contributing to this revolution, at center stage are networking innovations—digital TV, bandwidth bulk rate shaping, telecommuting, cellular phones, electronic mail, fax, Internet, Internet II, videoconferencing, multicasting, ISP providers, browsers, Java, computer telephony integration, virtual reality systems, and the virtual university.

Despite pagers, mobile computing, digital cellular phones, Java, DirecTV, webcasting, and everything else raining down digitized 1s and 0s at lightning speeds, knowledge continues to be the most valuable commodity in our institutions and in our personal lives. ACUTA must continuously provide a host of options for its members to stay abreast of new innovations—the tried and proven, the tried and failed, the new and different, the potholes to avoid, and the future stars. The *ACUTA Journal* affords

➤

the Association another avenue and means to present and convey information to the membership as an enabler to gain economies of scale, to build strong customer relationships, to support collaborative efforts, to visualize the future, to see what is changing, to let go of the "dogs" quicker, and to lock in sooner on the rising stars.

Thanks to all who believed in this dream and were willing to step outside of the now and the past and venture into that untraveled world where margins fade in making the *ACUTA Journal* a reality. As we approach the year 2000, there is no escaping the fact that the only constant in life and on campus today is change. The enormous changes in the capacities and capabilities of telecommunications technologies will present each of us with unique opportunities and challenges. Making the necessary institutional, organizational, and personal changes to assimilate these new developments will require many of us to develop new roles, new skills, and new ways of looking at the world, our campuses, and ourselves. The *ACUTA Journal* will serve not only as a value-added resource in developing these new skills, roles, and values, but also provide a means to facilitate moving quickly from one right choice to another.

To the ACUTA Board, Publications Committee, Journal Task Force, Editorial Board, Lexington staff, and those members whose efforts made the *ACUTA Journal* possible, thanks for a job well done. This is an accomplishment of which we can all be proud.

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ATM

It's All That Matters

by Curt Harler

You're not quite hitting the nail on the head if you think that ATM stands for Asynchronous Transfer Mode. It really stands for "All That Matters" in the telecommunications and data communications arena.

As you guide your network into the 21st century, ATM will be the basis for configuration both in local area networking (LANs) and in wide area networking (WANs). Any decision not predicated on ATM connectivity will come back to haunt you...or more likely, to haunt your successor in the job.

ATM allows the integration of voice, video and data over a single cable. The standard is so robust that you can actually run ATM over barbed wire (albeit for short distances), a feature that could give an edge to colleges in agricultural communities.

The change to ATM will come more rapidly in most colleges' LANs than in their WANs, mainly because a school has control over what it does in its campus LAN. In fact, many colleges, universities and teaching hospitals already are on the ATM bandwagon. Schools with multiple sites, or with community outreach education programs, will quickly be caught up in the need for ATM in their WANs. State schools, with their multiple locations and booming need for distance learning facilities, will look to ATM as their backbone.

There are a lot of reasons to look at ATM. One of the most potent arguments for ATM is that it is scalable from 25 Mb/s in the LAN to gigabit speeds. The ATM Forum's Physical Layer Working Group has approved specifications for a wide range of speeds. These go from 25 Mb/s to 622 Mb/s in the private network and from T1/E1 to 155 Mb/s in the public switched network (see insert for more information on the Forum).

ATM is a standard form of cell relay, and as such has a lot in common with frame relay. Both are fast packet technologies, both have very little error correction overhead clogging up the pipe, and both have a host of standards to support the technology. CCITT, ANSI and Bellcore all are on the ATM bandwagon. ATM uses a standard 53-byte cell.

Long-term solution

"ATM is about the only strategic solution in the marketplace as a long-term technology," Peter Alexander of StrataCom declared at the ATM '96 conference. Is he preaching to the choir when he maintains that ATM is the best bottom-line answer to networking? "ATM can cover almost any kind of service and be carried over any type of media," he says, bolstering his argument.

Agrees IBM's Rick McGee, "ATM is the right play in the LAN and in the backbone." 3Com has announced an expanded ATM product family and other companies like Telecommunications Techniques, Tekelec, and RADCom are getting into the ATM test market with both feet.

Without a viable, widespread interest using a technology like ATM, there is no reason to put CPE test equipment on the market. These companies have seen the future and they spell it ATM.

Some of the places that already have bought into the ATM argument include schools ranging from The University of Miami's Rosentiel School of Marine and Atmospheric Science to the language program at the University of Cambridge in the UK. Both have hopped on the ATM bandwagon.

The University of Miami faced a near-future prospect of processing 50 to 100 GB of data daily for its Remote Sensing Laboratory (RSL). Longer term, terabytes (trillions of bytes) of data are anticipated. They installed DEC's Gigaswitch/ATM system to give the researchers the power to keep up with that amount of data. Starting with OC-3 bandwidth (155 Mb/s), the network is to scale to OC-12 (622 Mb/s) or higher before all is said and done.

"One of the biggest advantages of ATM is scalability, not simply the speed," says Peter Evans of the RSL. "You can scale the machine interface to the types of applications you're running and achieve a good application of dollars to the problem."

Cambridge University

Cambridge has installed a fiber optic ring to provide the infrastructure for an ATM network to enable interactive multimedia learning. "Use of ATM within Cambridge as a vehicle for campus-wide language learning is groundbreaking," says Dr. Edith Esch of Cambridge. "In enabling the integration of video, voice, data and videoconferencing among students, ATM is providing a high-speed backbone that could be utilized not only within Cambridge, but potentially between universities in the UK and Europe as well as in other parts of the world."

The network connects several remote sites across the 50 km campus area of Cambridge. Multimedia workstations linked to the net can present graphics, text, sound and full-motion video between faculty and students. While stand-alone multimedia terminals are common, Cambridge had a real challenge getting the features delivered over a network in real time. The answer was ATM service and technology, delivered by such companies as IBM, GEC-Marconi, and Ascom Timeplex.

While physically a ring, the network behaves logically as a mesh, interconnecting ATM switches and allowing traffic to be routed cell-by-cell using the ATM header. It minimized end-to-end delays by routing transfer traffic away from switches ensuring that only traffic originating from or destined for a site is routed via that site's switch.

Look for more schools to follow in the footsteps of a project initiated by the University of Illinois/ Chicago, the University of Pennsylvania, and the University of Maryland/College Park. They linked their computers via ATM to form a kind of "virtual supercomputer." More properly known as the National Scalable Cluster Project, it is funded by a two-year National Science Foundation grant and several business partners.

At each site, 155 Mb/s ATM is being used. Between universities, data will move at 45 Mb/s, or traditional T3 rates.

More advantages

Since everything is carried in cells and can be counted and accounted for in cells, that is a giant step toward truly usage-based fees, Alexander says.

"You can't wave a magic wand and the world will go to ATM," admits Jill Kaufman of IBM, speaking for the ATM Forum. But ATM's features will be a mighty powerful driver. "ATM equals flexibility," she says. "You can choose the speed you want for each client and have different speeds in different parts of the network."

ATM offers top-drawer performance, high bandwidth, and low latency. That makes it perfect for integration of voice, data and video. It is available now and deployment is growing.

ATM has the further advantage of providing bandwidth-on-demand. So bandwidth you need is available when you need it, while the bandwidth that you don't use but have subscribed for is available to someone else. This requires a change in how both ➤

ATM Forum

The best place to get information on ATM is from the ATM Forum. Their fax-on-demand service number is 415-688-4318; call, then follow the instructions. Two of the more likely documents an ACUTA member would want are #5007, the ATM Basics; and the Technical Committee contact information at #5017.

The ATM Forum's mailing address is 2570 West El Camino Real, Suite 304, Mountain View, CA 94040-1313. Regular phone number is 415-949-6700. To send a fax, dial 415-949-6705.

ATM Forum publishes a quarterly newsletter, "53 Bytes." To subscribe, contact the Forum at info@atm forum.com.

you and your telco look at service requirements. The phone system no longer has to be designed to meet maximum loads. Rather, it can be designed to meet some statistical average load. This gives an important economy of scale since the phone network itself suddenly becomes a sort of oversized statistical multiplexer. When an ATM network gets over-subscribed and becomes congested, it backs off slowly, using available bit rate technology (ABR technology). This is all part of ATM's bandwidth-on-demand feature.

All of the RBOCs are honing their ATM strategies. Ameritech, for example, has announced its ATM offering, noting that it

ATM is the only WAN technology that looks like a LAN. That means that you can take LAN-based equipment and put it in the carrier's central office (CO) and have the telco deliver those services to campus customers from the CO. This is a critical capability that would probably be attractive to smaller schools.

allows colleges to consolidate separate voice, video, image, and data networks, minimizing access line costs and support needs. Its flexible bandwidth lets traffic burst at rates higher than the circuit's subscribed rate. It is fairly secure because of its virtual-circuit addressing scheme. And, Ameritech says, it should not become obsolete.

WAN looks like LAN

ATM is the only WAN technology that looks like a LAN. That means that you can take LAN-based equipment and put it in the carrier's central office (CO) and have the telco deliver those services to campus customers from the CO. This is a critical capability that would probably be attractive to smaller schools. All of the faculty and student e-mail service could reside at the carrier's site and not on the college's real estate. The school's Lotus Notes server, data archiving service, and remote access connection could all be provided by the carrier from the CO. The economy of scale concept is further realized because each new service can be shared by multiple customers.

Video and imaging will be major drivers in ATM's growth. Duke University is using ATM to move images around. The radiology department was the major driver of the project. They are scattered among three buildings and regularly move images scaling up to 20 to 30 gigabytes. Duke decided to replace the shared Ethernet LAN with ATM switching.

It is fast. ATM lets radiologists move a standard X-ray image in less than a second, compared to the 30 to 40 seconds it took over the Ethernet network.

Individual institutions can make the move to ATM for a number of reasons. Doing away with routing is a typical one. "Down with routing; up with IP switching," says Kenneth K. Lee, President and CEO of Integrated Telecom Technology, Inc. of Gaithersburg, MD. IP switching based on ATM switching hardware is not new — Ipsilon of Palo Alto, CA, pioneered it and is working to make it a de facto standard. Lee says the business justification for ATM-based IP switching is so compelling for two simple reasons: performance and cost. "When compared to existing routers, ATM-based IP switching technology can provide a five-fold performance improvement per port at about one-fourth the cost," he says. This means the cost of routing a packet will be 20 times cheaper than today's technology (watch out Cisco).

In the WAN, ATM is being driven by the service providers. However, since the signing of the Telecommunications Act of 1996, the marketplace goes well beyond the RBOCs. Competitive access providers; cable TV companies; water, gas and electric utilities; and Internet access providers all are getting into the marketplace.

Albert Bender, President and CEO, NetEdge Systems, Inc., notes that communications and computing industries have been through a technology revolution once before recently, moving from vertically integrated mainframe-based systems to client/server multiprotocol shared LANs based upon routers. This took place in the mid-to-late 1980s and is still ongoing today. The transition was a tremendously painful activity for both universities and corporations. Initial installations failed and had to be replaced multiple times, sometimes wasting a lot of money. Many articles in the press questioned whether those dollars provided an effective return, he notes.

Regardless, those networks are in place, running today, and providing a valuable service, Bender notes. Today, he says, we are transitioning from multiprotocol routed networks to switched virtual networks systems that include integrated routing.

Kauffman says that applications which need a lot of bandwidth are good candidates for ATM, including client/server applications that are retrieving high volumes of information. Clients can have different speed interfaces to the network and can also have a different interface speed than the server.

Data services rather than voice will be the market battleground. This is because data is where the opportunity is. Data service is growing at 30 percent per year, while voice is only growing 3 percent a year. By the year 1998—just a year away—data will equal voice in the enterprise. Extrapolate this growth to the year 2005, and forecasters say that data will so exceed voice that your voice service will be given away for free to get your data business, Bender says.

While that may sound a bit like the 1960s claim that nuclear power would be so cheap that electric companies wouldn't bother to install meters at customer sites, his logic is sound. Data traffic will drive the market and voice will be an add-on. Today, companies like Micom promote boxes which give "free voice" over data circuits, but this is at slower speeds. Tomorrow's network will be high-speed broadband. With digital fiber optic lines, it is impossible to tell a data from a voice transmission—one reason why Sprint was so willing to slash its long distance prices at the end of the 1980s.

The upshot is that communications managers will have to change their thinking from pricing voice to pricing data, or at least total-package pricing.

Taking it slower

If you are shying away from a high-speed ATM network because of cost, consider the somewhat slower ATM/25. It's a bit like learning to ride a bike with training wheels before hopping on an 18-speed racer. ATM/25 offers a lower-cost system that can support video conferencing and other multi-media applications that typically would be found at a college or university. While ATM/25 is a good alternative to switched Ethernet or token ring networks that are about maxed-out, before you take the plunge be sure you can find the ATM applications you need someplace in the market before switching to ATM/25.

There is a group of 25 vendors who have formed The Desktop ATM/25 Alliance in San Francisco. It works to educate the market about the benefits of ATM at 25 Mb/s. Its charter is to make ATM/25 products open, accessible, and interoperable with other leading ATM vendors. This should provide an incentive for companies to develop and market ATM/25 products resulting in competitive prices, another good reason to migrate to ATM/25 at this time.

Big Blue announced an ATM workgroup switch priced at $495 per seat for 25 Mb/s ATM earlier in 1996. It's that kind of product pricing that IBM hopes will get the ATM ball rolling.

Today, Sprint claims the largest public ATM network. But other carriers are sprinting to catch up. Since there is no difference between ATM in the LAN or in the WAN, when ATM hits the public switched network in a big and broad-based fashion, these projections will become reality. Then everyone will agree that ATM is All That Matters.

Curt Harler, formerly editor-in-chief of COMMUNICATIONS NEWS and a well-known writer for such publications as COMMUNICATIONS INTERNATIONAL, RIS NEWS and BYTE, is a popular speaker and moderator for many telecommunications industry seminars and programs. His widely read articles are respected for their leadership and insight into end-user communications programs and operations, including network security, voice and data applications, videoconferencing, satellite, and international networking. Harler holds a B.S. from Pennsylvania State University, an M.S. from Ohio State, and a B.A. in journalism from Penn State.

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ATM Delivers Voice Data Video

by Walt Magnussen

Sharing voice, data, and video communications over the same network is the solution of the future, and Asynchronous Transfer Mode (ATM) is making this capability a reality.

For years, corporations and universities have had separate voice, data, and, if applicable, video offices: voice networks were managed by the Telecommunications Office; computing and its associated data communications service were the responsibility of the Management Information Systems (MIS) Office; if there was a video component, it was typically run by the Broadcast or Production Services Office.

Dr. Michael Pilant, Associate Director of Texas A & M University's Institute for Scientific Computation, uses the ATM network for file sharing.

While this has been the practice, it has been widely accepted that this model does not make a lot of sense because it lacks communications among these services. Quite often all three services are required at two locations, so sharing the resources would be more efficient.

Efforts to remedy this problem have led to the use of technologies that supported all three services. These include Time Division Multiplexing (TDM), Integrated Services Digital Networks (ISDN), and Frame Relay. Each of these technologies is an improvement over the alternative solution (not doing anything), but they also have their limitations.

The ATM Solution

Although ATM appears to be the "new kid on the block," it is a technology which has been under development for a number of years. The international standards group, the Consultative Committee on International Telegraphy and Telephony (CCITT)—now the International Telecommunications Union-Telecommunications Services Sector (ITU)—originally defined the network that would carry voice, data, and video as the Integrated Services Digital Network (ISDN). The original ISDN or narrowband ISDN was designed to be supported on existing telephone twisted pair wire. As a twisted pair technology, the bandwidth is limited to existing T1 speeds, or about 1.5 Mbps. Although this speed is sufficient for existing voice, data, and compressed video, it will fall short of meeting our future needs as demands upon the network increase.

To overcome the limitations of narrowband ISDN, the ITU went to work to define the Broadband Integrated Services Digital Network (B-ISDN). Although the definitions in 1988 were vague, they did describe the switching system that would support the future networks as Asynchronous Transfer Mode (ATM) switches that rapidly switched small cells of data and delivered them out on the Synchronous Optional Network (SONET). Converting all information to cells would allow a network to be designed that would be low in latency.

Most of the earlier packetized store-and-forward networks, such as the ITU X.25 networks, required an entire packet to be received and processed before it could be forwarded. If there were a number of hops (the number of nodes between a source and a destination) in a network, or if large distances had to be traveled, it would be impossible to build a network that would be responsive enough to support both voice and video applications.

Using SONET

The SONET network was selected as the initial physical layer (the first layer of the ISO/OSI reference model) of ATM for four reasons:

1. SONET has transmission speed definitions that are constant between the United States and international communications systems. Existing T1 and E1 compatibility issues were probably the driving factor behind this decision.

2. SONET was initially designed by the telephony section of the ITU and was already aggressively supported by many of the telephone companies and telecommunications manufacturers.

3. SONET uses fiber which is becoming the medium of choice for most communications systems, primarily because of error performance and bandwidth. It should eventually be commonplace either to the house or at least to the curb supporting a group of houses.

4. SONET interfaces support future speeds that range in multiple billions of bits per second transmission.

Implementation Issues

In June 1992, the ITU further defined components of the ATM. Sixteen recommendations were approved that became the foundation for future standards. Although this was the basis of ATM, it still left many implementation issues to be resolved.

Though the ITU was defining the basic components of the ATM, it did little to help define the types of equipment and applications that the end users would need to implement ATM. The ITU emphasized the public switched network, and did not address how to develop the private networks that must evolve to solve the more immediate needs of the end users.

Eight months earlier, in October 1991, NET corporation co-sponsored an ATM forum to address these issues. The forum included CPE and public network vendors, as well as end users. Although it is not a formal standards body, the forum is the leader in ATM direction.

Since its inception, the ATM Forum has grown rapidly both in size and importance. In early May 1993, there were 285 members in the Forum. This number has grown to more than 750 members today.

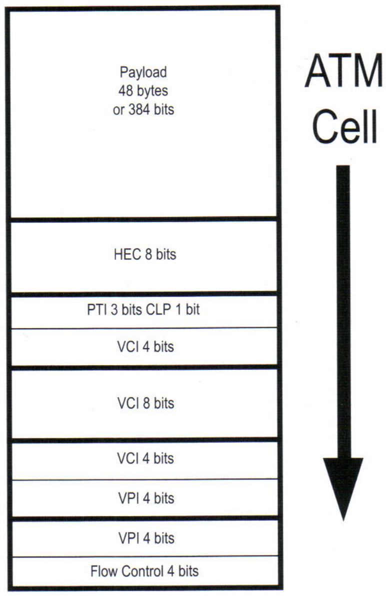
As defined by Newton, ATM is "a high bandwidth, low delay, packet-like switching and multiplexing technique." Originally developed as a wide area network (WAN) technology, ATM delivers voice, data, and video services in the local area through private LANs as well. The ATM network contains several service offerings designed to maximize the efficiency of the network despite the fact that voice, data, and video behave differently on networks and have widely different needs.

Cell vs. Packet

The foundation of the ATM network is the cell, which is a natural outgrowth of the packet developed earlier for delivering data services. The packet is a variable length enveloping system that contains addressing information, protocol specific information, the user's data (payload), and error detection information.

The disadvantage of the packet is that by using a variable length and performing an error check, it is necessary to allow the entire packet to arrive before it can be processed and forwarded. This adds latency to the network.

A secondary drawback is that the variable nature of the size of the packet makes it necessary for the communications device to support sufficient buffers to allow potentially large packets to be stored under high traffic conditions. In a high speed network, this could result in the requirement for terabytes (a million million bytes) of memory, which would significantly impact the cost of the network.



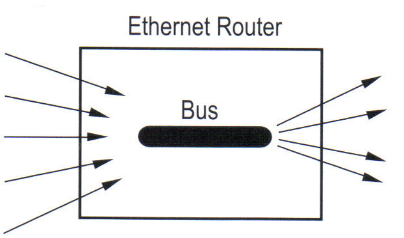
The cell, on the other hand, is a small, efficient packet-like unit that can be switched rapidly through the network. The ITU initially defined the ATM cell to be 53 bytes in length.

The cell contains a cell header which is five bytes and the payload which is 48 bytes. The header begins with the flow control bits that are to be defined once a flow control system is defined. (This process ➤

will be discussed later.) The next 8 bits contain the Virtual Path Identifier (VPI), which is established at call setup time and is used by the switches to route the call to the appropriate destination.

With an 8-bit VPI, a switch can support 256 virtual paths. Within each virtual path, virtual circuits can be defined. This is done by the Virtual Circuit Identifier, or VCI. Because the User-Network Interface (or UNI, the interface that connects end users' devices to an ATM switch) defines the VCI to be 16 bits, up to 65,536 circuits can be defined on each VPI. The VPI is the information that the network uses to route the cells. In that sense, it could be compared (although it is not a good comparison) to the IP address in TCP/IP networks. This 65,536 circuit limitation will be a factor that will have to be taken into consideration as ATM resolves the problems that are inherent in large, scaleable networks.

Figure 2 Narrowband Network



Once the cells have been formed, they are switched through the network at high speeds. Most existing data networks are routed or bridged, which are narrowband functions. The ATM network, on the other hand, is defined as a broadband network that normally interfaces better with a parallel process such as switching—which has many inputs and many outputs, all of which can carry traffic at the same moment in time.

In a narrowband communications device, there is typically a bus that is only capable of supporting one packet at a time (Figure 2). Higher speed communication devices increase the processor and bus speeds, but they still have the single simultaneous packet limitation even if they support many inputs and outputs.

Switching Services

One of the benefits of ATM is that it uses switching services. This is a requirement if the broadband component of B ISDN is to be met. As defined by Newton, broadband means "may carry numerous voice, data, and video channels simultaneously." Broadband in a WAN generally refers to speed (45 Mbps or faster).

Most ATM switches are described in terms of the Strowger switch, developed by Almon Strowger in 1891. With this system, the Virtual Path is used by the switch to route a cell through the system. As in Figure 3, a cell sent into port 3, with a path of 110, would be sent to the output port 1. The key to switching is that while one cell is routed through the switch into port 3, another cell can be submitted through any or all of the other input ports simultaneously. Hence, the broadband service delivery takes place.

Theoretically, a multistage nonblocking switch could be designed that could fill all output ports while at the same time receiving on all input ports.

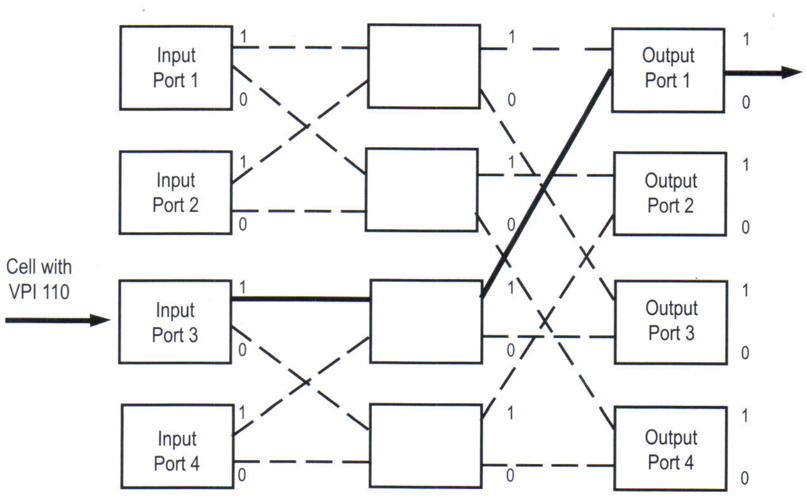
Physical Layer Alternatives

The ATM switches are to be connected to each other using high speed communications links. The initial plan as defined by the ITU is for these links to be carried on SONET links. The SONET is just one of the options for the physical layer of the ATM network.

As stated, one reason SONET was initially chosen was that it already has definitions that are in the gigabit (billion bit per second) range. In addition to the high bandwidth capacity, it is a standard that is accepted by the public telephone companies, both in the United States and internationally.

In the past, links between devices were connected in the United States using a T1 that ran at 1.544 Mbps and had 24 channels. The international counterpart was the E1 that ran at 2.048 Mbps and had 32 channels (only 30 are for information bearing, while the other two are reserved for signaling and control). This requires a gateway when connecting any service in the United States to another in any other country.

Figure 3 ATM Switch



Source: U. D. Black, *ATM: Foundation for Broadband Networks*, 1995

Table 1 SONET Transmission Rates

SONET (US)	SDH (Europe)	Data Rate
OC-1	N/A	51.84 Mbps
OC-3	STM/1	155.52 Mbps
OC-12	STM/4	622.08 Mbps
OC-48	STM/16	2.4883 Gbps

Although there are U.S. and international SONET standards, the transmission rates are common. The Optical Carrier (OC) signals are the U.S. standard, while the Synchronous Transfer Mode (STM) signals are the European counterpart. (Examples of the OC-n levels are shown in Table 1.)

At this time, OC-96, OC-192, and OC-248 have already been defined, and it appears that the transmission rates will continue until the physical limit of single mode fiber has been reached.

In addition to SONET, the ATM network can use existing DS-3 as well as DS-1 for the physical layer. However, there are some questions as to the efficiency of carrying ATM traffic on DS-1 circuits.

ATM runs at DS3 or better in the WAN. It is definitely not efficient at lower speeds. Nevertheless, lower speed inputs (for example, DS1) can be time division multiplexed through a device (such as an access multiplexer, a terminal multiplexer, or an edge switch) to build up a DS3/OC-1 rate.

Adaptation Layers

Another benefit of ATM is that it has the ability to adapt to the type of traffic it is carrying. Some services, such as video and voice, are connection oriented and use a constant bit rate (always 64 Kbps for voice unless compression is used).

Other services, such as local area networks, are connectionless and use a variable bit rate. For example, a LAN uses little bandwidth at 2:00 a.m. when, for the most part, only the router updates are occurring, but may require a great deal of bandwidth if five users on the LAN begin simultaneous file transfers. This type of traffic is referred to as "bursty."

Data communications systems, such as the permanent virtual circuits (PVCs) used in X.25, are connection oriented but still require a variable bit rate. Video is also con- ➤

nection oriented, but once connected it can use a constant bit rate. This bit rate can be negotiated during call setup time.

To support these different types of requirements, the ITU defined different ATM adaptation layers (AALs). These AALs are defined to support the differences between an application's requirements in connectionless systems (data) and connection-oriented systems (video and voice).

This very important characteristic of ATM allows the application to define a Quality of Service (QoS) that is guaranteed in the case of voice and video and uses an as-available QoS in the case of routed data services.

Perhaps the greatest advantage of ATM is that it will serve to carry information of any type (voice, data, video, image, and multimedia) with QoS being definable across a wide range of options.

Applications

While most other network architectures are out looking for the "killer app," ATM must continue to rely on a combination of applications to find its true place in the network world. The reality of ATM is that as a voice transport, video transport, or data-only transport, it is far less efficient than many other existing technologies. Only when these three can be combined will ATM fill an important niche.

Many existing time division multiplexing (TDM) networks are built on the premise that the voice traffic pays the bills and the video and data often ride "for free."

Each of these three networks and their relationship to ATM is an important discussion that must take place if both the limitations and capabilities of ATM are to be understood.

Voice

Voice traffic is the traditional corporate PBX-to-PBX traffic that is carried between sites. It can consist of voice telephone calls, fax transmissions, and modem traffic. Voice traffic has some inherent characteristics that make it less than efficient to carry:

- Voice circuits are often heavily utilized during normal business hours and idle during the off hours.
- Analog voice digitizes at 64 Kbps. Since there is typically little compression on voice circuits, it requires significant bandwidth to carry relatively little traffic.
- During a telephone conversation, only one party or the other is typically talking at any one time. As a result, the bandwidth of full duplex is consumed for what is in essence a half-duplex communication.

...as a voice transport, video transport, or data-only transport, ATM is far less efficient than many other existing technologies. Only when these three can be combined will ATM fill an important niche.

One ATM edge switch manufacturer is offering a device that turns voice traffic into ATM cells, and offers a high level of compression (16 to 1). To compensate for the half duplex nature of voice, the receive device generates a signal of background noise similar to the last sample received when there is no return signal actually being transmitted. This way, empty cells do not have to be transmitted.

Much of this technology is currently proprietary, but the ATM Forum has indicated that such functionality would be a part of the standards.

Video

The major applications for video in the higher education arena currently are centered around distance education. These systems use highly compressed video and voice due to the high cost of bandwidth over long distances.

Although this is a relatively new field, current systems are proving to be adequate for the time being. There is, however, a strong desire by the students and teachers for higher quality video.

Most of these distance education systems are closed systems that use point-to-point links. The disadvantage is that these systems cannot easily support learning outside of the boundaries of the network. ATM, once fully implemented, has the ability to get around these problems.

Using the higher bandwidth of SONET as transport, the ATM networks will have the ability to use JPEG and MPEG compression, providing video comparable to that of the digital satellite systems.

Furthermore, once the ATM services are deployed by the carriers, it will be possible to support these higher quality services even in a switched environment. Many of the ATM switch manufacturers can accomplish this today, but only in a proprietary fashion.

Data

There has been a lower volume of data traffic than voice traffic on the national networks since the networks began almost a century ago. The data volume, however, is growing at a much faster rate than the voice traffic and is expected to overtake voice as the leader by the turn of the century. This will severely stress the routed systems that we currently rely upon to support our LAN and Internet services.

A technological paradigm shift will be required to support speeds in the gigabit range, support millions of simultaneous users, and guarantee Quality of Service delivery. ATM, with its inherent capabilities, is the only technology that has the potential to deliver this type of traffic. Like the voice and video components of ATM, the data component must evolve more before it can fully meet these challenges.

ATM, as it was implemented in late 1996, does a great job of supporting data traffic in a bridged type fashion, as is common on many LANs. VLANs or Virtual LANs can be built today that allow high speed access across long distances in a way that the end user cannot distinguish between LAN and WAN access. (However, VLANs are not part of the WAN world. A campus VLAN employing ATM is still only a LAN.)

One example of a data application is access to the large database at Texas A & M University that is used for scheduling classroom and video conference facilities. A commercially available scheduling system is used by the staff to support this application.

Recently, with the creation of the Center for Distance Learning Research (CDLR), some members of the staff were moved to a remote building on campus. The existing campus Ethernet and FDDI backbone, although great for most applications, could not support the access speed needed for this application because of the number of router hops to cross the LAN.

The solution was to connect the server and the clients located on the opposite side of campus to an ATM switch through an ATM Network Interface Card (NIC) and place them on the same VLAN. This solution proved to be both cost effective and functional.

Obstacles

One problem with ATM is more of an Internet support issue than a LAN issue. The Internet is dependent upon TCP/IP which is a connectionless type protocol in which each router along the way simply grabs each data packet, looks at the IP source and destination, and makes a forwarding decision based on the content of the frame.

ATM is a switched system which, by definition, is connection-oriented. To get around this problem, the ATM Forum has released a standard referred to as Multiprotocol over ATM, or MPOA. With the Winter 1996 revision, the standard has been refined enough that many vendors are announcing MPOA implementations for early 1997.

At this writing, of the fourteen major ATM equipment manufacturers, three had announced MPOA planned offerings. The others were still relying upon LAN Emulation (LANE) or a proprietary solution.

Another current problem with ATM is the complication of configuration. Although ATM is well defined when connected to a public network, there is a great deal of potential confusion when connecting a number of switches in a campus environment to each other. ATM addresses must be created and connections established for services that require broadcast and multicast traffic.

The ATM Forum is also in the process of releasing a set of standards that should allow these configurations to be plug-and-play. For example, the Integrated Private Network-to-Network Interface or I-PNNI protocol is designed to integrate the routing information between ATM and non-ATM networks. I-PNNI and its precursor PNNI should allow what could be a difficult network to configure to be much more manageable.

Still more ATM problems include lack of full standardization, current lack of voice standards, lack of widespread availability, requirement for full equipment upgrade, and very high cost of both equipment and services.

Baseband vs. Broadband

There is currently much debate in the industry as to the ultimate wisdom of a cell-based switched network such as ATM. Critics cite recent developments in Ethernet switching, proposed gigabit Ethernets, and quality of service parameters within Ethernet or more accurately TCP/IP, such as the new RSVP protocol, as reasons to support baseband.

In spite of these potential enhancements to the existing baseband networks, there is little doubt that an ultimate conversion to a broadband network will be required to support voice, data, and video at the level that the Internet, or whatever it evolves into, will surely require.

At this time, ATM holds the most promise and, in spite of obstacles yet to be overcome, should be a large part of our future infrastructure. Add to that the speed at which the ATM Forum has been resolving issues presented to them and the conviction that the industry has been showing in implementing the resulting standards.

For these reasons, ATM should become an integral part of our daily lives in the very near future.

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CATEGORY 5

How Did We Get Here... Where Do We Go Next?

by Jim Serenbetz and Pete Lockhart

Is the reliable performance of cable important to your college or university's bottom line? According to a study commissioned by LeCroy, a high-end test and measurements equipment manufacturer, failures at the physical layer (structured cabling) account for an average loss of $250,000 per year per 100 users. This encompasses the wiring and its connections within an end-user's buiding and measures losses in user productivity, network manager effort, and business downtime. And the physical layer represents only about 10 percent of the cost of the overall network installation, which includes computers, software, structured cabling, and support. Fortunately for those responsible for cable infrastructure, a system of acceptablestandards exists that defines the expectations and limitations of cable and provides structure and direction for technological advances.

Looking Back: I thought wire was wire!

In 1989, Anixter began a dialog with colleges and universities about what seemed to be indiscernible differences in communications cabling construction. Some people were surprised to learn that all wire is not created equal.

At about the same time, a Texas company promised to make obsolete the coaxial cable and connectors we all had learned to love and hate. The computer electronics industry sat up and took notice. After all, we got great performance from our Ethernet transceivers and cabling—when they worked. Remember "Thicknet" and "Thinnet"? Words like "reflection," "terminator," and "vampire tap" would not disappear from our conversations until the arrival of robust and reliable 10 and 100Base-T LANs and "categorized" unshielded twisted pair cabling systems.

Anixter engineers, concerned that vendor hype would distort the facts for their counterparts in education, established that all cables are not created equal as they developed and published a "Cable Performance Levels" purchasing specification for communications cables. The specification was their attempt to create some measurement of electrical uniformity and performance assurance in the cable manufacturing process. Three years later EIA/TIA published the cabling standard that set the baseline for interoperability in structured cabling and provided a consistent platform to which networking devices could be built.

A System of Levels

Someone graduating from college today wouldn't know (or care) about Level 1 "POTS" cable, as it was called—Plain Old Telephone System or telephone voice-grade copper cable. Level 2 handled IBM mainframe and minicomputer terminal transmission, as well as some early slow-speed (1–2 Mbs) LAN technologies like Arcnet. Level 3 was designated as the minimum quality twisted-pair cable that would handle 10 Mbs Ethernet and 4/16 Mbs active Token Ring without errors at the desktop.

The seven years since the original Levels were defined have seen America being rewired, information transmission technologies advancing, and standards ratified. In 1992 a group of manufacturers marketed a copper version (CDDI) of an FDDI (Fiber Distributed Data Interface) transport system using thin coax and IBM Type 1 cabling products. In that same year, Anixter engineers authored a Level 5 purchasing guide for 100 Mbs over UTP (Unshielded Twisted Pair) and delivered it to cabling manufacturers for specification compliance. In 1993, ANSI ratified TP-PMD (twisted pair-physical media dependent) for FDDI over Category 5 UTP. Shortly after that, EIA/TIA signed the "568" standard document, followed immediately by TSB36, which adopted in total the "Levels" requirements set forth earlier, although EIA/TIA defined these levels as "categories." This same team of engineers worked with Underwriters Laboratories, Inc. to create the UL Level testing and follow-up program, which assured end-users that the manufacture of cables would fully meet these levels/categories programs, and would give them an independent yardstick for cable performance.

It wasn't until the birth and availability of affordable 100Base-T this past year that institutions and organizations saw a reason to enable 100 Mbs desktops, and then largely because it was an inexpensive and well-understood insurance policy. Manufacturers began producing Ethernet network interface cards (NICs) for PCs that could operate at either 10 Mbs or 100 Mbs, automatically sensing the network operating speed and adjusting themselves to match. For a little extra money, whether turned on or left dormant, dual speed 10/100 Mbs Ethernet NICs became a "no-brainer" for network managers. Fiber optics and FDDI remained in the campus backbone, and became the server superhighways and inter-closet infrastructures. In the five short years since Level 5 was introduced, the physical layer transport of the most forward-thinking planners has become "maxed out" in terms of the high-speed networking options of the near future!

Isn't Cat 5 enough?

Maybe you've heard someone remark, "I might give my users 100 Mbs at their desktops. It's inexpensive, and my support groups know Ethernet very well. I've also heard that intranets could be delivering some high-bandwidth 'enabled' applications soon."

This is not an uncommon statement these days. Few of us can conceive of the need for anything beyond 100 Mbs. For example, 155 Mbs ATM (Asynchronous Transfer Mode) is seen by many to be a technology in search of an application, but we should remember how much things can change in a five-year period. In 1991, an article in *PC Week* magazine reported an analyst's opinion on the newly introduced 486 processor: "Outside the niche of graphics and CAD applications, there's no need to have a 486 sitting on your desk..." Few mainstream applications existed to take advantage of the increased processing power. The article further observed: "Overall, the greatest impact of high-end 486s will probably be on applications that have not been computerized yet." An unwitting reference to WIN95? Could he have seen the Internet as more than just a scholarly and governmental vehicle to pass data back and forth?

Today, in the age of Pentiums, the chicken-and-egg routine continues. Processing power ultimately drives innovation in user applications, specifically media-rich and collaborative functions. These business and learning-enabled applications ultimately drive the need for more bandwidth. Transport technologies like switching and ATM will likely catch on as the economic and sociological benefits of multimedia, distance learning, and mediaconferencing are realized. When thinking about where applications will be in five years, remember the size of hard drives and modem speeds in 1991.

Hundredfold increases in performance and plummeting costs make these technology innovations solid drivers in today's corporate America and in educational circles.

If we consider that five years ago our high-end wiring choice was Category 5 cabling in the LAN and multimode fiber-optic systems in the backbone, when LAN speeds were 10, 16 and 100 Mbs, the "headroom" or additional capacity we built into our systems seemed more than adequate for the future.

This past year the ATM Forum put its seal of approval on 155 Mbs ATM to run on existing Category 5 systems, and the first interface products have just recently started to appear on the market. We may ask *what applications will require more than 100 or 155 Mbs at the desktop*; but a more visionary question is *will my Category "X" cabling system have enough additional "headroom" or TRUE electrical bandwidth to provide error-free transmission when I do need the extra throughput?*

A few issues need to be explored to answer this question satisfactorily. All high-speed LAN standards require compliance with generic cabling specifications *plus* many additional parameters that are defined only in the specifications and standards for the network interface products. These extra requirements define the actual electrical and digital signaling and usually *assume* a well-behaved and consistent cable and connectivity system. Figure A shows the relationship between cabling standards (center ellipse) and networking standards (outer ellipse) and demonstrates, unfortunately, that cabling requirements are just a subset of the overall requirements for a smooth-running network.

All high-speed standards need to conform to SNR (Signal-to-Noise Ratios) and maximum noise thresholds. But pair skew and propagation delay characteristics are important supplemental requirements for 100Base-T, 100Base-VG and for ATM above 100 MHz. Pair skew applies to technologies using multiple pairs for signaling. In essence, signals are divided between pairs and must be reassembled at the receiving end. If they arrive at different times, skewing of the signal occurs, resulting in transmission errors. Propagation delay, the time it takes for the signal to travel to the receiver, is a factor of the efficiency of the cable in moving the signal relative to the theoretical speed of electricity (light). Also known as the velocity of propagation, it is expressed as the percent of the speed of light represented by the cable's speed.

Network electronics manufacturers deal with electrical loss across cable distances by incorporating equalizers into their receivers. These equalizers attempt to amplify the received signal based on what they assume happened through attenuation or the electrical loss during transmission through the channel. This same received signal must also be identified within the noise picked up during its transmission and receipt, and in most cases a little bit of the noise is also reamplified. If this results in an incorrect representation of the original signal it is called a "bit error." Bit errors often lead to garbled information and/or retransmissions of the data.

As in the case of 155 Mbs ATM running on Cat 5 cable, anomalies can occur above the Cat 5 maximum signal frequency (in excess of 100 MHz and as far out as 200 MHz) that when seen by the equalizer are amplified as if they were part of the signal. This results in higher than acceptable bit errors and therefore corruption of the information. No additional headroom will help in this case. If the attenuation performance of the cable is not smooth, then the ATM signal will probably not be interpreted correctly even though the cable installation passes Cat 5 requirements below 100 MHz.

Figure A: Structured Cabling Standards Vs Network-Specific Standards

All high-speed networking standards require compliance with generic cabling standards plus some additional parameters.

Examples:

Supplemental Requirement	Network Standards
Signal to noise ratio requirements	All
Maximum noise thresholds	All
Self NEXT Noise (incl. above 100 MHz)	ATM
Pair skew	100BASE-T, 100VG
Total propagation delay of a cable link	100BASE-T, 100VG

To assure the operation of networks over installed cabling, both must be tested.

Aren't all Cat 5 cables standard?

Standards by definition are derived by consensus and often are open to interpretation. "Delay Skew" is an addendum to the ANSI/EIA/TIA-568-A specification (Category 5.1?? *or Cat 5-1997*) and requires another test be performed on the cable before it leaves the manufacturer. The TIA task group has elected *not* to have the cables that would comply with the new standard marked different from the other seven billion feet of four-pair cable already manufactured and currently installed in North America. The only way to know for sure if your cable meets this new requirement will be to get a copy of the actual product specification that the manufacturer used to make the exact cable that you purchased at *that* time. When was the last time you consulted the cable manufacturer's spec sheet? So, enhancements to cable can only be determined by looking at exactly what parameters the manufacturer has tested and guaranteed.

Performance is directly related to the chemical compounds used in the manufacture of cable. To date and largely because of a worldwide shortage of FEP (Fluorinated Ethylene-Propylene—Teflon, a registered trademark of DuPont, and Neoflon, a registered trademark of Daikin) from early 1994 on, there are more than 105 different electrical designs of plenum cables, including 15 high-end Cat 5 plenum designs and 33 standard and high-end non-plenum designs … all with varying electrical performance characteristics, yet still Cat 5-compliant.

In addition, a high-speed system must display Category 5 characteristics from input to output—in other words, across all connectors, cross-connects, patch panels and outlets. So assuming our Cat 5 cable tests out at 155 Mbs, we still must contend with the quality of the components and the installation. Some of the various plenum "flavors" that used different numbers of Polyolefin pairs mixed in with the FEP pairs to reduce the amount of FEP consumed, were very installer-friendly; others were not. This mixing of different materials can cause the propagation delay skew to exceed the 45 ns specified in the revised TIA-568 standard and has resulted in a recent addendum.

It's ironic that the original EIA/TIA-568 was signed in the summer of 1991 and *only* covered what essentially was 10Base-T electricals, or the then-current Category 3. Immediately after the standard was issued, the committee came out with TSB36 (Technical Systems Bulletin) for "Additional Cable Specifications for Twisted Pair Cables," which defined the new Category 3, 4, and 5 electrical performance requirements based on the Levels Program developed by the Chicago-based engineering staff of Anixter Inc. and the work done at NEMA (National Electrical Manufacturers Association) and ISO.

A TSB is *not* a standard but a preliminary look at what a standard might be as generated by the TIA working group. That is, if they publish such a standard, it might look like the TSB after the voting is done. So, a new standard can be approved then immediately made obsolete by the same working group. A rewrite of the 568 standard was signed into existence in October 1995 as ANSI/TIA/EIA-568-A, and ANSI formed a working group to explore the issue of delay skew, resulting in another change or addendum. Many standards are obsolete the day they are signed because they cover existing, implemented, and proven technologies that by design must be available from a number of different sources.

What's next?

We may see the promise (or opportunity) of deploying even higher speed technologies in the next five years as applications and processors address new creative and competitive business needs and continue to consume more and more of the available bandwidth. The Gigabit Ethernet Alliance has concluded that this technology will have a significant impact on cabling. It will push the limits. Regardless of product and installation quality, there will be no slack if implemented on the current Category 5 cabling.

> We may see the promise (or opportunity) of deploying even higher speed technologies in the next five years as applications and processors address new creative and competitive business needs and continue to consume more and more of the available bandwidth.

So while it seemed, a mere five years ago, that Cat 5 would be all that would ever be needed in the horizontal cable infrastructure, it appears that headroom and "structural return" concerns will open the books again with the help of a new "Levels 5–7" Program from Anixter. This timely Performance Assurance Program is based

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on a stringent purchasing specification that requires our suppliers to qualify their high-performance unshielded twisted pair products. (In order for any product to be acceptable to Anixter Inc., it must have been tested for compliance to the purchasing specification through a lot sampling procedure by the ASCL, Anixter Structured Cabling Laboratory, a certified-independent Lab connected to the Anixter Technology Center in Illinois.

This new purchasing specification sets guidelines for electrical bandwidth in excess of 100 MHz by reaching for a performance mark that has over twice the actual usable electrical bandwidth of the current Category 5. It also extends the data bandwidth to the 1.2 Gbs performance mark, making it useful in developing Gigabit Ethernet systems while incorporating less sophisticated encoding schemes than those required for conventional Cat 5 cabling.

The initial Levels Program continues to cover the performance requirement for existing Cat 5 cables. The more stringent requirements for what has been called High-End Cat 5 or Cat 5+ cables are referred to in the program as Level 6. And a new generation of recently launched products that meet the twice Cat 5 bandwidth requirement constitute Level 7. Figure B gives the basic requirements for these new performance Levels. Note that even the Level 5 is different from the standard Cat 5 in that it now must meet the more stringent requirements included in the international standard document ISO 11801. This standard allows cables meeting these requirements to be used globally. This new definition for cable performance creates a "super-set" of the original Category 5 requirements.

Not a bad achievement for copper technology in less than a decade! According to those engineers in Illinois, beyond this, it looks as if we'll have to use fiber optics.

As is usually the case, the implementation should fit the need. Colleges and universities in many ways are poised to take full advantage of the technology wave as education more than ever before becomes America's competitive advantage. Is your campus ready to deploy tomorrow's technological advances? Is your physical layer infrastructure up to the task? Thankfully, there are cost-effective, future-proofing solutions in high-end copper still in the works. And as we move into the world of lightwave communications over optical fiber, the same guiding principles of price, performance, and ease of installation and maintenance are at work in the engineering and standards committees of the industry.

Table 1

Anixter Purchasing Requirements for High Performance Structured Cabling Systems: Levels of Acceptable Cable Performance

100 OHM Performance Level	UTP Highest Test Freq. MHz	Electrical Bandwidth			Other Required Measurements
		MHz as ACR>10 dB FREQUENCY 24 AWG	MHz as ATTN<33 dB FREQUENCY 24 AWG	MHz as ACR>0 dB FREQUENCY 24 AWG	
5	200	100	200	160	ISO IMP – SRL <45 NS SKEW LCL MIN
6	350	150	200	200	ISO IMP – SRL <25 NS SKEW LCL MIN
7	350	200	230	300	ISO IMP – SRL <25 NS SKEW LCL MIN

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Telemanagement Software Systems and Service Bureaus: Critical Tools for Complex Networks

by Ray Horak

What are telemanagement systems? Where did they originate? How did they evolve? What is state-of-the-art? This article will consider these questions as we define the functional suite of this critical toolset in terms of the management of costs, assets, connectivity, processes, and security. We will profile premise-based and service bureau approaches, and at the conclusion provide a guide to vendor and system selection.

Telemanagement Origins

The concept of telecommunications management originated in much simpler times. In the years B.C. (before Carterphone), users had few choices. Long distance was the province of AT&T, with the rare exception of limited, short-haul long distance networks provided by GTE, Continental Telephone, and a few other independent telcos. Local service was provided by the local telco who also provided all CPE (Customer Premise Equipment), effectively on a rental basis—the CPE list was very short.

In time, the requirement developed for an individual or group to assume responsibility for controlling rising telecom costs. The costs of the network, of course, had to be balanced against its availability, i.e., *grade of service*. In a multisite PBX application, by way of example, this process of *network optimization* initially involved determining the number of WATS trunks of various bands which could be heavily utilized to lower costs, overflowing to DDD long distance during peak periods of usage. Local calling requirements had to be considered as well as the internal (station-to-station) traffic. Centrex, of course, was a CO-based option which developed in the early 1960s, providing very basic PBX-like features at attractive monthly rates.

During the late 1970s, analog PBXs were replaced with new digital versions. The level of network complexity increased as dedicated leased lines were added to the mix of network options. The range of equipment options also grew with the introduction of digital PBXs. Further, the Carterphone decision led to deregulation of CPE and the introduction of competition in 1968. About the same time, long distance was deregulated; MCI and others began to compete for voice and data business.

Complexity Sets In

While the process of telemanagement was very basic twenty years ago, contemporary telecom managers are faced with a wide array of vendor options for CPE; within each vendor's product line exist a staggering number of options for terminal equipment. IntereXchange Carrier (IXC) services are available from literally hundreds of carriers, resellers, and aggregators. IXC service alternatives include switched services, leased lines, Virtual Private Networks (VPNs), and ISDN.

Local Exchange Carrier (LEC) options exist in some areas and likely will soon be available nationwide; in fact, some organizations have gained regulatory approval to serve as their own LEC. IXC access can be secured directly from the IXC, through a Competitive Access Provider (CAP), or through the historical means of LEC access. In addition to the traditional wired alternatives, many organizations also support a number of wireless technologies including microwave and satellite access, pagers, cordless and cellular telephony, and, soon, PCS.

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Further, many *telecom* managers also are responsible at some level for data systems and networks. This responsibility may be limited to Wide Area Network (WAN) services, or it may include LANs and LAN internetworking. In the latter case, the range of MAN and WAN alternatives is expanded to include SMDS (Switched Multimegabit Services), Frame Relay, and ATM (Asynchronous Transfer Mode).

Finally, the typical telecom manager also is responsible for the management of transmission systems, including twisted pair, coax, microwave, satellite, infrared, and fiber optic facilities. Managing issues of physical connectivity is challenging enough on an intra-building basis; interbuilding/intracampus connectivity adds a significant degree of difficulty.

So what this means to me is?

The planning, design acquisition, implementation, and ongoing management of a large, complex, multivendor network is a staggering process. There are not enough employees on the staff, hours in the day, or dollars in the budget to accomplish the process on a manual basis. Computer software systems are essential not only to automate the many varied tasks, but also to improve the manner in which they are performed. The right software will provide professional analysts and managers with quick and easy access to both detail and summary data which will enhance the entire organization's ability to ensure optimum network performance.

Telemanagement Functions

Telemanagement systems can best be described in terms of the broad categories of functions they perform. Specifically, those functional management categories include Cost, Asset, Connectivity, Process, and Security. Taken together, these functions provide a full suite of administrative management solutions. Generally, these functions can be considered individually and are presented on a modular basis, with each module being tightly linked to other, related modules in order to yield a comprehensive suite of functionality.

• **Cost Management** addresses the identification management of all system and network costs. Together, these several system elements facilitate the capture, trending, analysis, reconciliation, allocation, and billing of all non-recurring, recurring, and usage-sensitive system and network costs.

Call Accounting entails the capture of call records from the SMDR (Station Message Detail Recording) port of the PBX. The call accounting buffer is then polled by the host computer for purposes of call cleaning, filtering, and processing. The call processing involves identification of originating and terminating stations and users, identification of target city and state, and costing according to carrier- and user-specific rating algorithms.

Cost Allocation software allows all costs to be applied to user-definable cost centers, which generally are of multiple levels. At the lowest level is the station user, with cost rollups perhaps being defined at the work group, project department, location, division, and total organization levels. The costs include toll, installation, repair, circuit, software feature, and miscellaneous charges, with each charge being generated by another software module. Both detail and summary reports can be important at all cost allocation levels.

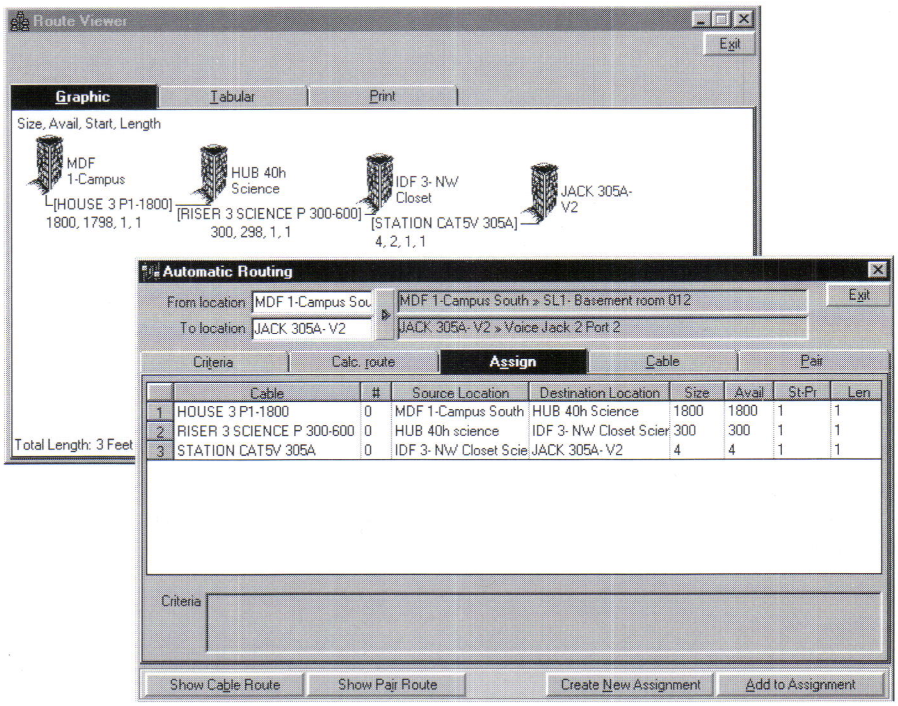
Bill Reconciliation is an optional feature, which still is unusual. Such software provides for rough comparison between carrier and vendor invoices and those created internally through the telemanagement system. Long distance carrier invoices may be compared in this fashion to call records generated by the PBX and captured and costed by the telemanagement system, with allowances made for slight differences in call timing. Similarly, circuit, installation, repair, and other charges and credits can be compared against those anticipated, with exception reports providing management the ability to challenge vendors as appropriate.

Billing software is essential if users are to be presented with invoices for payment, an especially important step if costs are to be recovered from students or contractors in a resale environment. The more substantial systems provide for flexibility in terms of bill format, which generally is similar to a telco invoice. Such systems also support creation of adjustment entries, aging of accounts receivable, generation of dunning notices, final bill write-off, and referral to collection agencies.

• **Asset Management** refers to the management of hard assets, i.e., Inventory Management. Such software should provide the capability to inventory entire systems, such as sealed KSUs (Key Service Units) in a small key system environment. More importantly, the system must be capable of managing any and all physical components of a system or network, including cabinets, line and trunk cards and ports, voice and data terminals, modems, channel banks, and so on.

The system must also be capable of managing logical components such as system software. Each system and each physical and logical component must be logged into inventory and vital information such as manufacturer serial number, warranty expiration, warehouse location, and other pertinent data recorded. As the inventory is assigned to active use through a work order, the inventory must be relieved, and the user, cost center, and physical installation location must be identified. As the component ages, its cost must be amortized according to the appropriate, user-definable amortization schedule until such time as the asset cost is recovered. As components fail and require repair, they must be tracked through the repair or retirement and salvage process and associated costs recorded.

• **Connectivity Management** involves management of both physical and logical connectivity of devices composing a network or subnetwork. Physical connectivity typically is defined in terms of the physical path which connects devices, with examples being twisted pair(s), coaxial cable, fiber optic cable, microwave dishes, and infrared transceivers. Logical connectivity commonly refers to the channel assignments of the devices as they communicate over a shared medium.



Cable and Wire Management is an option of telemanagement systems of significance, although most systems are unremarkable in this regard. Given the tremendous investment of most organizations in cables and wires, it is critical that this asset be implemented, inventoried, and managed carefully throughout its life. For example, each cable and pair must be tracked from port through the MDF (Main Distribution Frame), the IDFs (Intermediate Distribution Frame) or patch panels, and the repeaters to the target jack and associated device and user. All attributes of the physical medium must be cataloged, including route length, pair color and gauge, category or level, bandwidth, application (voice/data/video) supported. This module should enable the user to trace connectivity from end to end, through all intermediate points of connection, with the search beginning at any point of the connection. The more substantial systems provide for automatic cable and pair assignment, in consideration of factors

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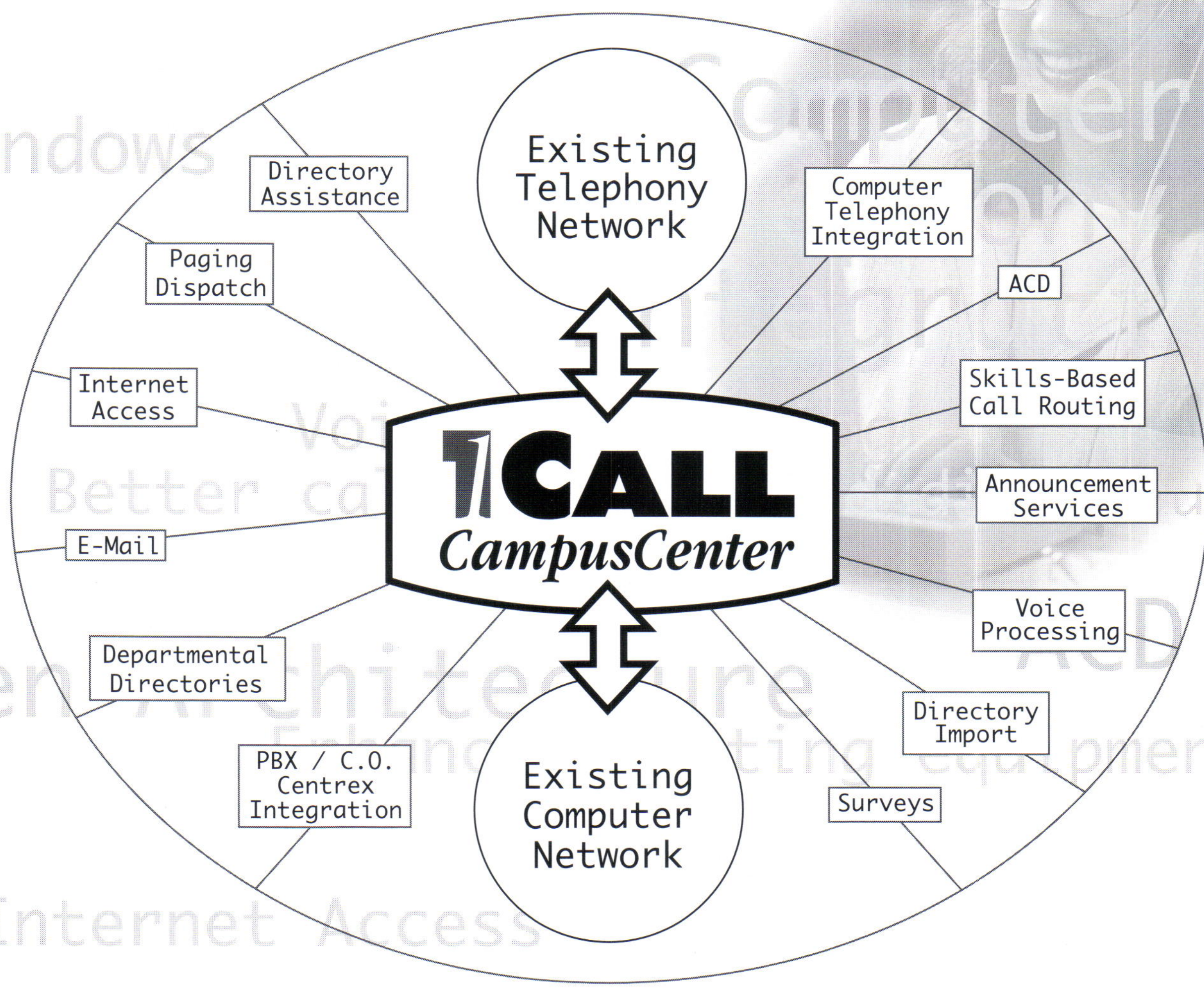

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such as application, route length, and number of points of intermediate connection. In LAN applications, high-capacity, multi-channel, shared media such as 10-Mbps Ethernet coax and 100-Mbps FDDI fiber are accommodated by only the most robust telemanagement systems.

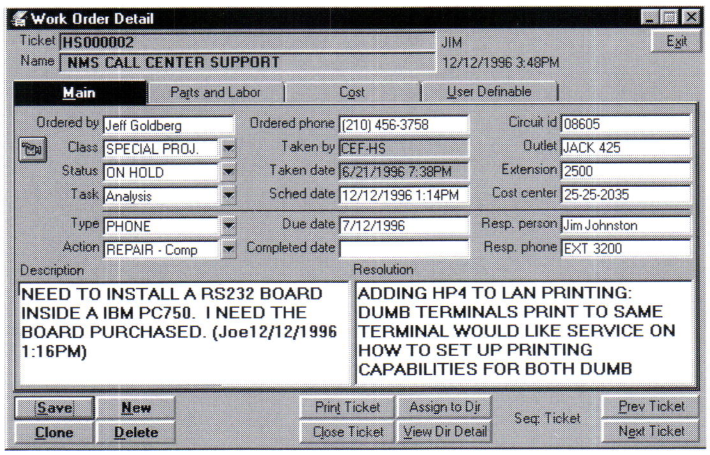
Circuit Management involves the inventory of circuits providing connectivity to the outside world. Trunks and trunk groups, lines, and channels must be cataloged and tracked in detail, including attributes such as direction, bandwidth, port termination, circuit ID, and monthly cost. Point-to-point and multipoint leased lines should both be supported.

• **Process Management** includes a number of modules that address the full range of processes which must be performed in order to effectively design and optimize the network, manage change and trouble, and allow console operators and users to find users and services within the organization.

Network Design and Optimization software assists in the initial process of designing the network for optimum performance, as well as making periodic adjustments in that design. Factors to be considered can include traffic levels and patterns, carrier costs, carrier options, and overflow options. Such software is provided by third parties, with the analysis typically being conducted based on summary traffic data provided via the Call Accounting module.

Traffic Analysis involves a set of reports driven by the Call Accounting module. Frequent review of such reports can assist in the identification of shifting traffic patterns, perhaps pointing to the consideration of FX (Foreign eXchange) lines. The more capable systems allow users to create traffic reports by terminating NPA, LATA, NNX, and user-definable groups of NNXs. Frequent traffic analysis also can point to obvious under- or over-trunking, poorly performing trunks or trunk groups, and "killer trunks," allowing the management team to address the problem before users bring it to their attention.

Work Order Management is at the very heart of any capable telemanagement system. If well designed, flexible, and easy to use, this module makes life a lot more pleasant for the telecom manager, given the highly dynamic environments which must be managed. The best Inventory Management system is absolutely useless unless service order activity can be accomplished and tracked effectively. Features to look for include automatic order number assignment, hot links to Inventory Management and other related modules, automatic personnel/vendor resource assignment in consideration of due date and workload, segmentation of projects into interrelated task-level assignments, terminal templates for assignment of soft key features, mass order capabilities at the project level through work order cloning or Class of Service (CoS), and jeopardy reporting.



Trouble Ticket Management is perhaps even more critical than is Work Order. The detection or reporting of a case of trouble requires immediate action to avoid inconveniencing the user; indeed, the entire organization can be brought to its collective communication knees unless the trouble is addressed quickly and resolved confidently. The more capable systems treat a trouble ticket as a special and separate event, rather than just another type of work order. Ideally, trouble codes point help desk staff to likely causes and resolutions. Hot links should be provided to inventory, as well as both internal and vendor personnel (by skill level) available for assignment or reassignment. Where multiple tasks are involved in order to effect resolution, the trouble ticket must be segmented and transmitted to the appropriate entities. Unless troubles are addressed immediately, they can cascade, eventually burying the unwary telecom manager in an avalanche of complaints.

Directory Management software usually is considered to be pretty routine—a commodity product. Don't be fooled; it's just not true. A truly capable directory system is highly flexible, adapting to the needs of the organization. Whether accessed by a console operator or a privileged user, the system must support searches by full or partial last name, hyphenated last name, and previous last name, as well as on a "sounds like" basis. Searches also should be supported by title, department, and location. Once the target listing is accessed, additional information should be available through secondary screens accessible only by level of privilege. Such information should include user status (e.g., out of town or on vacation), backup answering points, supervisor, and

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emergency contact names and numbers. User-definable fields should be provided to allow notation of information such as assigned parking space, calling card number, and building access code. Finally, console operators should be able to take messages and pass them (ideally, electronically) to the target user.

• **Security Management** cannot be ignored, although that often is the case. A solid system will provide for multiple levels of privilege for system access. While the system administrator should have full privilege, others require access to certain specific modules, screens, and data fields for purposes of inquiry and limited data entry. Completing this aspect of Security Management is the absolute requirement that the system include a very substantial audit mechanism in order that the system administrator be able to review all system activity. For example, it is essential that the capability exist to audit a work order or trouble ticket from initiation to completion to archive in order that each individual touching that order or ticket be identified and that full details of each action be recorded in sequence. Only through such an audit trail can the integrity of the processes be ensured.

Security Management also includes the very critical security of access to network resources. In this respect, toll fraud is the main risk. While toll fraud was the focus of a great deal of attention a few years ago, vigilance appears to have relaxed while the problem has grown steadily. Generally, toll fraud access is gained through a DISA port, which can also provide access to unprotected computer systems and associated databases. While the best protection is to totally eliminate DISA access, that is not always possible. The next best level of protection is to install port protection devices in the form of separate physical devices which literally will disable ports in the event of unusual activity such as repeated hacking attempts.

Many telemanagement vendors provide passive fraud detection capability through exception reporting. Based on user-definable thresholds, unusual inbound and outbound calling activity is recognized by the system, which alerts management through exception reports. Some of the more capable systems analyze activity on a near-realtime basis, alerting management via pager immediately on detection of an abnormal situation.

Service Bureaus: Outsourcing at Its Earliest

Service bureau was the first rendition of telemanagement. Although still limited largely to Call Accounting and Cost Allocation applications, directory reports and inventory reports usually are available. Some service bureaus also provide Traffic Analysis, Network Optimization, and Toll Fraud Reporting services. With call record data being polled from the central service bureau location where it subsequently is processed, service bureaus remove the user organization from the more mundane tasks of telecom management.

The downside is general lack of control, including lack of flexibility in report formatting and the inability to view reports on demand. Data is processed and reports are prepared on a batch basis, generally once a month, in what essentially is a CDR report factory. In short, service bureau is easy, painless, involves no capital outlay for computer equipment, and requires minimal staff involvement; however, it tends to be rigid and limited in functionality.

Telemanagement Software Systems

User organizations which actively manage the networked world generally prefer a hands-on, premise-based approach, in the form of a telemanagement software system. There are well over a hundred vendors that provide systems of decidedly limited capability, generally including Call Accounting, Cost Allocation (limited), Traffic Analysis, and Directory Management (limited).

A select few manufacturers of serious telemanagement systems provide a full range of functionality, have verifiable track records, are survivable, and are committed to servicing what they sell. Such systems are provided on a modular basis, with core modules such as Call Accounting, Cost Allocation, and Directory Management generally being installed first. Once the core database is built, Inventory, Work Order, and Trouble Management are usually phased in quickly, building on the same data core. Connectivity Management is usually the last module to be considered, as its implementation is much more troublesome unless applied to a new facility—inventorying a legacy cable and wire system is a time-consuming (and expensive) task.

Regardless of the order in which the modules are phased into operation, the ultimate effect should be a suite of tightly linked applications which rely on a single database, thereby providing a single point of data entry and ensuring that management of all costs, assets, and processes are fully synchronized.

Telemanagement Vendors: Operating Environment

Examination of telemanagement vendors and products invariably leads first to a consideration of operating environment. In this regard, there are three dimensions which must be considered: platform, operating system, and database management system.

• **Platform** basically boils down to mainframe, midrange, and PC, just as it has for the last ten years.

Variations on the theme include LANs, with client/server thrown in as an interesting twist.

Mainframe systems offer the advantages of tremendous processing power and storage capacity, and redundancy. Although they are very expensive, large organizations still make heavy use of them, and will continue to do so, in part because the systems and resident applications and databases are so tightly managed and secured. While it is virtually inconceivable that a user could justify the purchase of a mainframe on the basis of a telemanagement application, the MIS department often insists that the presence of the box dictates that the application run on it. Few telemanagement vendors remain active in this environment.

Midrange systems are largely a thing of the past in telemanagement, although a few vendors remain active.

PC systems are by far the most prevalent. The low cost of development and platform acquisition, coupled with increased performance and reliability, make PC-based systems a natural choice for many organizations. Additionally, Windows and Windows 95 Graphic User Interfaces (GUIs) are intuitive and widely popular applications interfaces—much more user-friendly than a mainframe "green screen."

PC-LAN and Client/Server software clearly has lately captured the majority of the telemanagement market. The combination of PC advantages, coupled with multi-user, multi-tasking capabilities, as well as significant storage and security advantages, combine to make this solution most attractive.

While telemanagement systems are designed for optimum performance on a specific platform, some vendors actively port their systems to multiple platforms.

• **Operating system** is tightly linked to computer platform considerations. Mainframe systems are limited to the IBM world; therefore choices are limited to MVS, VSE, and AIX (UNIX). Minicomputers generally are also limited to the IBM world, with the same choices of operating systems. The PC world is limited to IBM-compatible (read *DOS*), with Windows and Windows 95 interfaces. PC-LANs and client/server telemanagement systems are being developed largely to take advantage of the Windows NT environment, with some systems making use of the UNIX operating system. Very few telemanagement vendors have developed UNIX applications; in fact, the effort drove several of them out of business. Interest in UNIX telemanagement is generally limited to the college and university market and some elements of the government market.

• **Database architecture** is either hierarchical or relational. Relational Database Management Systems (RDBMSs) offer the advantage of flexibility, as virtually any data field can be associated with virtually any other—the possibilities are virtually endless. However, RDBMSs are processor-intensive; they tend to slow things down a bit. Frankly, this is not much of an issue for most applications, as CPU cycles are so cheap today and contemporary computers are plenty fast for most of us. As a practical matter, this makes an appreciable difference only in the performance of significance volumes of highly repetitive tasks such as call processing. Virtually all vendors make use of this hierarchical approach for call processing, linking the results to the RDBMS for integration with data from other applications and for subsequent reporting. The exception to this rule is the mainframe vendors, which prefer to avoid IBM's DB2.

• **Inputs and Outputs** While functions and features are impor-

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tant, it is also important to remember that the user deals directly not with processes, but with inputs and outputs. Regardless of the sophistication of system internals, its use can be cumbersome and ineffective unless data can be entered and extracted with a minimum of effort. The first consideration is the user interface, which should be effective and intuitive—Graphic User Interfaces (GUIs) such as Windows and Windows 95 are at the top of the list, while "green screens" are at the bottom.

Additionally, it is critical that data input be easily accomplished, as there is a lot of data entry involved in building the initial database. This step can be facilitated greatly if the vendor assists in population of the initial database via downloads from switch databases, as well as interfaces to personnel and other corporate databases.

In terms of outputs, all telemanagement systems will provide a number of standard reports. The more significant vendors also have provided a high level of report flexibility in the form of report generators which allow the creation of user-definable reports, both on demand and on a scheduled basis.

• **Switch Interfaces** The final critical measure of a telemanagement system is the relationship between it and the switch(es) it supports. It is preferable that the systems be interfaced so that two-way communications are possible. In that fashion, two databases can be synchronized and will remain so. Major problems arise when the database of the managed switch does not match that of the managing system.

How To Select a Telemanagement Vendor

Having established the nature of telemanagement and the need for it, and having explored several critical dimensions of such systems, here are a few key considerations of the acquisition process.

✔ *Functional Suite:* Make sure that the system provides the functions and features you require, both now and into the future.

✔ *Operating Environment:* The system should have been designed for and should operate effectively in the preferred environment, including computing platform, operating system, and database architecture. If possible, choose the operating environment best suited for your department's needs, which may or may not be the one preferred by the MIS/DP department.

✔ *User Interface:* Should be intuitive, offering ease of use and requiring minimal training.

✔ *Dimensions:* The system should fit your needs in terms of factors such as number of stations supported, single-site vs. multi-site, and number of simultaneous users. Allow for future growth and make sure the system is scalable—no quantum leaps in cost for modest increases in capability.

✔ *Reporting:* Ease and flexibility of reporting are absolutely critical. The system is of little use unless you can get to the data you need—quickly and in the correct format .

✔ *Track Record:* Look for vendors that have verifiable experience with similar clients of similar dimensions using the same applications with similar levels of intensity.

✔ *Survivability:* Make sure that the vendor and product life spans are at least as long as yours; also consider the quality of that life. Several vendors are currently in trouble, while others no longer actively enhance certain (mainframe and midrange) software. Ask the hard questions and verify the soft answers.

✔ *Creativity and Comfort:* Look for vendors that take a creative approach to software development, perhaps even customizing a feature or two in order to match your requirements most closely. Focus on vendors that are willing and anxious to develop a special relationship with you and your organization.

✔ *Support:* Make certain that documentation is complete and easy to use, and that training is available when and where you need it. Finally, make certain that technical and user support is available around the clock, both remotely and on-site. The technically superior system is worthless if supported poorly.

✔ *Cost:* It always comes down to price, doesn't it. (As a vendor, I always cringed when prospective clients immediately flipped to the price quote, which was on the last page of the painstakingly crafted and exquisitely bound 200+ page proposal.) Carefully consider all costs of the system throughout its life span, including costs of acquisition, customization, platform, operation (watch out for that mainframe alternative), and maintenance and enhancement.

About the Author: *Ray Horak is president of The Context Corporation, an independent consultancy headquartered in Mt. Vernon, WA. Context consults at the strategic and tactical levels with end users, carriers and manufacturers. He is the author of* Communications Systems & Networks, *published by M&T Books and reviewed on page 31 of this journal. Ray has been a frequent speaker at ACUTA events, and is a member of the Editorial Advisory Board of* The Journal of Telecommunications in Higher Education. *He can be reached at ray@contextcrp.com.*

Appreciation is expressed to The Angeles Group for providing accompanying illustrations.

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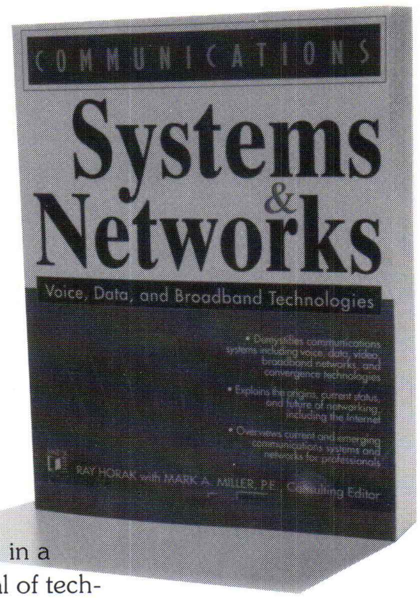
Book Review



Communications Systems & Networks: Voice, Data, and Broadband Technologies

Author: Ray Horak with Mark A. Miller

M&T Books, 1997: 486 pages

by Terry Robb

Trite but true: ACUTA members are confronted by rapid technological change. We are increasingly uneasy (not yet to the point of panic) about Internet phone calls and the potential impact on long distance resale revenues. We see dial-up Internet subscribers choking our voice switches with long holding times. We know that ATM can transport voice, data, and video, but we're not sure how that transport "convergence" will ultimately transform our voice network and organization. Those of us who are predominantly voice administrators must be vigilant to change and seek to maintain some level of expertise in all telecommunications technologies.

In the face of these challenges, *Communications Systems and Networks* provides an excellent educational resource. It is rare to find a technical telecommunications book that is both comprehensive and written in a clear, concise, and interesting way. Horak, a consultant and frequent ACUTA speaker, avoids the turgid and acronym-laden style common to many technical books. Instead, he describes telecommunications technologies in light of actual and potential applications, including discussions of cost, advantages, and disadvantages.

This is a book you can safely recommend to your non-telecom boss and colleagues, and even an entry-level telecom employee. Horak skillfully ties together voice, data, video, and image technologies with both the novice and experienced professional in mind. For the novice, he explains basic technology concepts and transmission fundamentals. Beyond the basics are chapters dedicated to voice and messaging systems, the Internet, and public switched telephone, public data, local area, broadband, wireless, and video/multimedia networks.

In addition to describing the technology, he includes chapters on convergence and regulation. The concept of "Information Superhighway" provides a much ballyhooed example of convergence. Horak jokingly refers to the "Super-*hypeway*." Then, in a departure atypical of technical books, he illustrates his point with a historical allusion: In 1829 New York Governor Martin Van Buren wrote a letter to President Andrew Jackson complaining about the new railroad and asking Jackson to preserve the canal system to save jobs and preserve national security.

Horak also cites numerous modern examples of convergence. Who would have guessed ten years ago that CATV companies would be itching to provide 10 Mbps Ethernet service or even switched voice?

Convergence frequently depends on changes in the regulatory environment. Horak first places regulation in context by briefly reviewing the historical development for regulation. In the remainder of this chapter, he tackles the topical 1996 Telecommunications Act by describing universal service, interconnection, local number portability, rates and tariffs, among other issues. The Internet, in particular, exemplifies technological convergence and its impact on regulation. No longer a data-only network, the Internet carries voice telephone calls and even low quality video. Internet telephony has even sparked a protest by the America's Carriers Telecommunications Association (ACTA), who point out that Internet telephony users do not pay access charges, and therefore don't contribute to the Universal Service Fund.

I thoroughly enjoyed this book, and even learned from it. I strongly recommend *Communications Systems and Networks* for your professional library. It is available at most major book stores or can be ordered at www.amazon.com. ISBN 1-55851-485-6

Terry Robb is Director of Telecommunications at University of Missouri-Columbia. He serves on ACUTA's Publications Committee and is the author of an ACUTA monograph.

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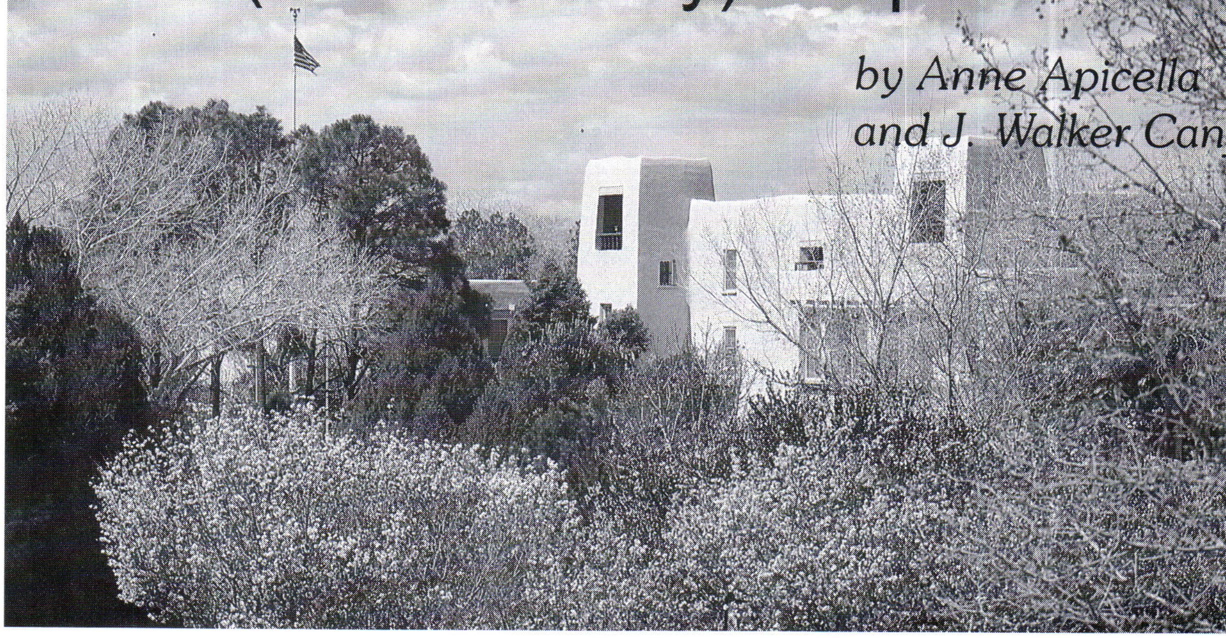
How to Migrate to a Client/Server Telemanagement System in Three (Not-So-Easy) Steps



by Anne Apicella and J. Walker Canfield

Sometimes change is thrust upon us—ready or not. At the University of New Mexico Telecommunications division, we occasionally entertained the idea of replacing our aging telemanagement system and had been watching the changes in server and database technology. But we never seriously looked around until we learned that support for our current system was being dropped by the vendor at the end of 1995.

Unexpectedly forced to replace our telemanagement system, we ultimately abandoned our comfortable server-based system to migrate to the latest client/server technology. With endless research, countless phone calls to other sites, and twelve billing cycles behind us, we are happy to announce that we made the correct decision.

Our circumstances forced us to drastically shorten the selection process. To make our vendor-imposed deadline, we divided the upgrade process into three simple steps: 1. Identify our needs. 2. Involve and motivate staff. 3. Examine the options.

1. Identify our needs

The UNM Telecommunications division supports a dynamic communications environment with over 17,000 working stations, 800+ trunks, and 35 off-campus OPX or T-1 sites. We operate multiple NEC NEAX 2400 IMS, ICS, NEAX 2000 IVS PBXs, integrated E911, and a Centigram Voicememo II voice processing system. We were operating under a telemanagement system that was server-based, running in AIX (UNIX) on an IBM RS6000 520H and a simple network of VT100 terminals or personal computers running VT100 emulation. The database was completely proprietary and had a crude report-writing interface. We were able to produce trouble tickets, work orders, long distance billing, limited inventory management, on-line directory for our campus operators, relational tables for long distance authorization codes, and limited management reports. Some of us were using a personal computer for word processing and other functions and a VT100 terminal for systems management. Some desktops were very crowded.

System Requirements

Computer technology is almost doubling in capacity every year and we wanted to capitalize on some of the advances. However, we also didn't want to get caught up in the technology du jour. We needed reliable technology that could be implemented quickly and still take advantage of the trend toward more open, user-friendly applications. We primarily wanted the new system to:

- include a "windows-type" user-friendly interface
- use a *nonproprietary,* SQL-compliant, relational database
- run over our network with TCP/IP
- operate with our existing IBM RS6000 server
- provide us with a way to verify system integrity

We learned the hard way that completely proprietary systems can leave you stranded. The more open the database, the more you can verify data integrity and monitor system backups. New network and database technology is much more open and allows many users to integrate accounting, 911, voicemail and PBX management into one package. New users can also take advantage of newer data protection, backup and verification techniques or even import and export data between the database and a Web page.

2. Involve and motivate your staff

We conducted exhaustive interviews with end-users. What was important to each person? Which features of the present system worked well and which were cumbersome? We asked for hands-on demonstration and testing of candidate software, then invited people throughout the department to participate. As a result of a high-level of individual participation, our internal staff were instrumental in selecting the system they felt best met their needs. This meant they were dedicated to making the project a success, and were strongly motivated to move forward.

3. Examine your options

Establishing specific criteria helped weed out several products, and the field of potential vendors ➤

Table 1: A Comparison of Server-Based and Client/Server-Based Systems

Specification	Typical Server Based System	Typical Client/Server System
Adaptability	Significant programming and cost to customize	More easily customized
Data Accessibility	Proprietary, closed	Open, SQL compliant
Development Language	CoBOL or similar 3rd generation language	"C" or 4th generation language
Ease Of Learning	Structured and easy to follow	Easy for users familiar with "Windows" interface
File Structure	Flat File or early relational database model	Relational database
Functionality & Integration	Most desired features supported; not all integrated	Most desired features supported with integration
Interfaces to other campus technologies like e-mail & WEB	Usually not supported	Often standard
Look and Feel	Functional	Functional, intuitive, colorful
Menu Movement	Rigid & hierarchical; time lost moving between applications	Fluid & dynamic; easy to jump between applications; tool bar makes frequently used items easily accessible
Network Bandwidth Required	Very little required	Greater depending on configuration, number of clients
On-line Help	Not typically supported	Cuts learning curve
RAM Requirements - Client	Not applicable (work session run on server)	Typically the same requirements as Windows (8 to 16 MB)
RAM Requirements - Server	Based on number of simultaneous sessions	Typically requires less since most applications run on the client
Report Tools/Report Flexibility	More difficult to use, limited access to data	Easier to use; full SQL capability; more flexible
Roots of Systems	Many rooted in mainframe applications developed in 1980s	More intuitive design
Typical File Server	UNIX & VMS	UNIX, Novell, Windows NT
Typical User Interface	Character Based	GUI
Typical Work Station	Terminal or Terminal Emulation	Windows PC or Macintosh

was split into two very distinct categories: server-based systems and client/server-based systems.

The server-based classification includes a broad range of systems and is based on technology dating back to the mid-1980s. Since this technology predates the desktop processor, it is character-based and relies on the server to perform all the application processing. Many of these systems evolved from or still are mainframe applications.

The client/server-based server takes advantage of more recent technology by using the desktop computer to do some of the processing. Frequently the desktop client (a PC or Macintosh) does most of the processing while the server simply manages the database. Most clients connect to the server with TCP/IP over existing networks.

Table 1 summarizes some of the differences that we see between the two technologies.

After comparing the two systems we were impressed with the advantages of a client/server architecture. The newer architecture followed the overall trend towards full integration of information systems on campus, and the open relational database interacts better with existing campus systems without expensive modifications. Although it wasn't required, the new system also allowed us to migrate to Windows NT on the client side, improving security and still giving our users a familiar interface. After looking at all the advantages, we had one basic concern: Could our existing infrastructure handle the new system? We were pleased to discover that our aging RS6000 520H could handle the new workload more easily than it handled X Windows and we were able to use our existing ethernet cable. With those two concerns resolved, we determined that client/server was the right technology for our telemanagement needs.

Our Selection

Our selection criteria were weighted very heavily toward system features and capabilities (standard and optional), quality of the vendor's implementation plan, and ongoing support and maintenance. Only 25 percent of selection was based on cost.

Several vendors offered attractive telemanagement packages. After we reviewed bid responses, viewed product demonstrations, and talked with customer references, we selected Compco's MySoft integrated client/server telemanagement system as the best match for our needs. We began planning the implementation in December 1995.

We had originally intended to run both systems concurrently for six months to ensure that we were getting at least the same level of support from the new system, and we were a little concerned about the possibility of overtaxing our server. We never had to face that problem. In January 1996, just one week after exporting the old database to simple flat files with the reporting software, the server crashed and the proprietary, redundant database backups failed. Without any support from the old system, we were forced to rely on the new, untested system. We were running trouble ticket and work order processing and directory service in January 1996 from the new telemanagement system and processed our first long distance billing in March.

Conclusion

Although we would not recommend the "by-the-seat-of-the-pants" system implementation we experienced, it did have its advantages. We had very little time to worry about being on the leading edge of the client/server technology. We didn't have the luxury of carefully defining and planning each small detail of the implementation—or the "paralysis by analysis" this can create.

In the year since we implemented the new telemanagement system, we have concentrated on reestablishing our core functions (trouble ticket, work order, operator on-line directory, and long distance billing) and getting our users comfortable with Windows, the enhanced user interface capabilities, and the awesome power of a true relational database. Now, as we move forward into uncharted territory, we anticipate major improvements such as automating our inventory tracking, cable records, and improved system management.

Anne Apicella has been with the University of New Mexico for seven years, serving presently as Associate Director of Telecommunications. She is a member of ACUTA's Program Committee and a frequent contributor to the newsletter and the ACUTA Listserve.

Walker Canfield presently serves as the Telemanagement System Administrator at the UNM Telecommunications Department. He has been with the University for almost five years, managing the Telemanagement system, their Local Area Network, and associated databases.

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Cabling the Integrated Network:
Hard Facts and Soft Issues

by Frank Peri

The fully integrated network that seamlessly carries voice, data, and video is the "Holy Grail" of communications for the next millennium. New technologies—the Internet, multimedia, interactive distance learning, virtual reality—have end users racing to connect to what will soon become the GAN-Galactic Area Network. This "Big Picture" thinking is an important contribution of the visionaries who provide momentum to change. But many end users will be derailed because they fail to see the little picture.

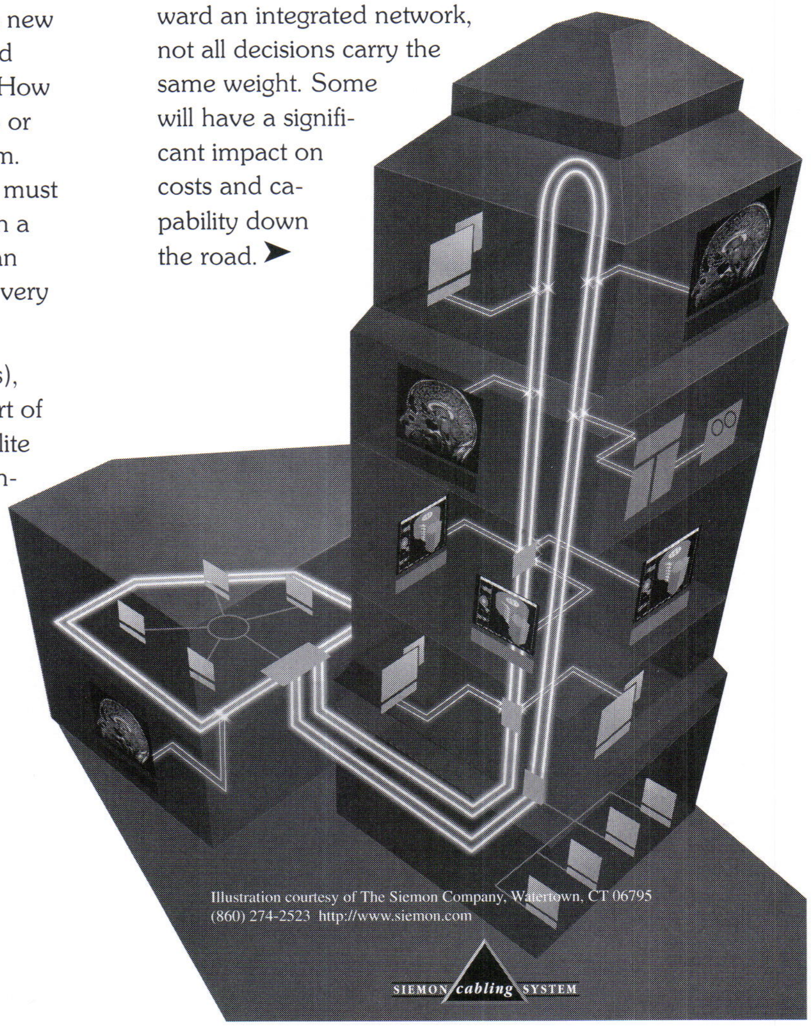
Specifically, consider the plug or jack opening in your work area outlet. That little 1/2" by 1/2" aperture is the window to the universe, where all the new technologies, dazzling applications, and unlimited communication possibilities will begin and end. How quickly and reliably information is transmitted to or from that opening is the job of the cabling system. Whether it's voice, data, or video, digital signals must be transmitted reliably at incredible speeds down a slim piece of wire not much thicker than a human hair, and the last 100 meters to the desktop are very critical.

Obviously, the NICs (network interface cards), hubs, routers, and switches are an important part of the integrated network, as are ISDN, ATM, satellite networks, and frame relay, but these are not controlled by the end user. These are developed and built by vendors with well designed, highly engineered systems and technologies with very tight specifications. End users rent time or access, buy parts or lease equipment, but they don't control the underlying technology —until information arrives at their doorstep. That's when the hand-off takes place and the cabling infrastructure must carry the ball.

Cabling must be properly done. Unfortunately, many communications and network managers think cabling is either too low tech, devoid of the glamour of the Big Picture, or too confusing and complex. These managers would do well to assign responsibility for cabling to someone who recognizes that it is high tech and that properly specifying it is a cost-effective necessity. A well designed cabling infrastructure may not eliminate all your headaches, but a poorly designed one can easily create a crisis.

With the many complex choices facing communications and network managers and professionals, why is cabling so important? Consider two very good reasons:

1. Cabling decisions are long term. As you move toward an integrated network, not all decisions carry the same weight. Some will have a significant impact on costs and capability down the road. ➤



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Cabling is one of those. The cabling system you choose today will become either a very valuable asset or a costly liability. Since the cable plant is imbedded infrastructure, one of the most valuable assets you can build is a barrier to obsolescence. Obsolete cable means recabling, and that is costly. Changing cable systems every time you move to a higher speed, higher bandwidth network would be like changing the wiring in your home to accommodate higher wattage light bulbs. You just wouldn't do it. Cabling must support current and next generation networks.

2. Cabling technology is advancing rapidly. ISDN, ATM, Gigabit Ethernet, Internet voice, networking software, and an array of other new products and technologies continue to provide excitement at trade shows and conferences. But advancements in cabling technology, in particular copper cabling, are worthy of headlines as well. What was considered impossible just a few years ago has now become commonplace, and researchers still haven't discovered the edge of the performance envelope for copper cable. Cable systems underpin the integrated network. Those responsible for cabling decisions must stay informed on what is now available to take advantage of the latest technologies that will "futureproof" their cable plant for next generation networks. No one wants to recable because the very best cable technology wasn't used.

Discussions with a variety of end users, including institutions of higher education and other experts in the cabling industry, have identified three critical areas in building a cable plant capable of supporting integrated networks for the long term (15 years and beyond):

1. Structured Cabling System (SCS)
2. Cable selection
3. Cable plant documentation and management

Whether you're dealing with a new network or implementing a migration plan for an existing one, the following guidelines should help you save money by avoiding unnecessary expense.

Barrier to Obsolescence

Software	1 year
PCs and Servers	5 years
Mainframe	5–7 years
Cabling System	15+ years
Building Structure	50 years

Structured Cabling System

A Structured Cabling System (SCS) is fundamentally a strategy for how to design and lay out a foundation for the integrated network. There may be many definitions for an integrated network, but there is surprisingly uniform agreement about what constitutes an SCS, which is sometimes referred to as "universal wiring."

Structured cabling is a low maintenance, flexible system for moving information to any work area in the network reliably, efficiently, and with enough growth margin to support future needs and applications. Its benefits include:

- Communications with any device, anywhere, anytime.
- Speedy deployment of new technologies to meet user needs. Considerable savings and competitive gains result from having the capability to rapidly implement new technology. (Just because these savings can't be tracked on a cost sheet doesn't mean they don't impact the bottom line.)
- Open systems to support a wide variety of voice, data, video, and multimedia network applications, regardless of equipment vendor or network protocol.
- Long and reliable life span to support next generation networks.

SCS is a design strategy for a valuable asset that is inherently long term. There is a higher initial cost for SCS, but expensive recabling is avoided. Any apparent savings from not installing an SCS at the outset will quickly dissolve when only a few work areas must be recabled.

The SCS design or architecture consists of cabling each work area outlet from a central telecommunications closet. This is known as "home-run" cabling or star topology. The predominant cable type is plenum rated, four pair unshielded twisted pair (UTP) for horizontal runs and multimedia fiber for the backbones. A plenum rating means that cable can be installed in open areas above the ceiling where low flame spread and low smoke properties are required. Always put in more cabling than you think you'll need. Fifty percent more than current needs should provide sufficient growth margin in most cases. However, twice the amount of cabling above current needs is a popular design choice.

The main subsystems of an SCS are:

- Work area outlet
- Horizontal cabling
- Intermediate distribution frame/ telecommunications closet
- Riser backbone cabling
- Main distribution frame
- Campus backbone cabling

Each subsystem must be carefully designed, engineered, and installed, but horizontal cabling deserves particular attention.

Cable Selection

The integrated network does not necessarily mean that the same transmission media must be used for each link. For horizontal runs, copper cable is still the preferred media. Although the copper or fiber to the desk debate will continue, many believe copper will remain the mainstream technology for cabling to the desktop or work area for a long time to come for the following reasons:

• The combination of high performance insulating materials, cable engineering technology and improved connectors extends the transmission performance of copper. 622 mbps has been demonstrated and prototype capability of one gigabit per second Ethernet has been developed. New electrical encoding schemes have moved copper cable into what was once the exclusive domain of fiber optics. The performance limits available from copper cabling are still undetermined.

• Copper to the desk will continue to be cost effective vs. fiber because it represents the largest installed base. Hardware manufacturers know this and will continue to invest in and develop copper based electronic systems because of high demand and volume. Costs will be lower for copper based systems because of volume. This also means the high costs of a quantum leap to fiber for horizontal cable can be avoided, or, at a minimum, postponed until maximum value has been realized from the installed base of copper.

Reliance on industry standards for horizontal cabling selection can be extremely useful as a baseline, but standards alone are not the whole story. Industry standards define only minimum threshold levels of performance, and represent the least common denominator. "Getting by with the least" does not represent a strategy for the future. The benefits of specifying and installing cable which exceeds industry standards are substantial. Cabling is a long term asset. As illustrated, cabling will outlive all other components of the network. Studies suggest that the incremental cost of installing premium cable compared to generic cable that simply meets the standard is less than 1 percent of the cost of a network project, making selection of the best cable available more than justifiable.

This is especially true of Category 5 (Cat 5) cable, as specified in the almost universally adopted Telecommunications Industries Association/Electronics Industries Association Standard TIA/EIA 568A. The Cat 5 rating means that the cable and connectors, in a star wiring configuration, will support encoding schemes up to 100 megahertz per second, delivering 100 megabits per second for ➤

Sources for more information on cabling

Education and Training

Cabling Business Institute
Association of Cabling Professionals (ACP)
12035 Shiloh Road
Dallas, Texas 75228
(214) 328-1717

"Cabling the Workplace"
May 12–15, 1997
Atlantic City, New Jersey
For details: (214) 328-1717

Building Industries Consulting Services International (BICSI)
10500 University Center Drive, Ste. 100
Tampa, Florida 33612
(800) 242-7405

Standards and Specifications

Engineering Specification
Enhanced Margin CAT 5 Plenum Cable
Available from
Association of Cabling Professionals
Administrative Office
Jacksonville, Florida
(904) 645-6018

or from the author at:
Communications Design Corporation
14150 Riverside Avenue
Kennedyville, Maryland 21645-3312
(410) 348-2110

Telecommunications Building Wiring Standard

TIA/EIA 568A
Telecommunications Industries Association/
Electronics Industries Association
Available from:
Global Engineering Documents
Englewood, Colorado
(800) 854-7179

a distance of 100 meters. This level of performance has been achieved because of a superior thermoplastic insulation, widely recognized as Teflon® FEP made by DuPont.

Unfortunately, because of their inherently slow process, industry standards have not been able to keep up with the rate of technology improvements in Cat 5 cable. Today, new cable designs and connector technology have pushed performance even further. Simply specifying Category 5 cable in today's environment does not assure that you will be getting the highest level of performance.

Not all Cat 5 cable is the same. A wide range of performance is available depending on cable design and insulation type. During last year's temporary shortage of Teflon® FEP, cable manufacturers switched to lower performance, substitute insulating materials and alternative cable designs to meet minimum specifications. At the time, these options were necessary. Today, caution is the word. The long term stability of these materials has not been demonstrated, whereas Teflon® FEP will not change over time. Expansions at DuPont have given the cable industry a major increase of supply for 1997 so superior cable in which all four pairs are insulated 100 percent with Teflon® FEP is available. This is the cable system to specify.

Most of the major cable manufacturers produce ordinary Cat 5 cable which meets minimum standards and a higher performance version called "Enhanced Margin Cat 5" which offers more headroom for future growth. (See inset to obtain a copy of the engineering specification for Enhanced Margin Cat 5 Plenum Cable.) These cables offer superior performance and are generally available at a small premium over generic Cat 5 cable. Peace of mind and the advantages of futureproofing may be worth the higher price. Savings could be short-lived with lower performance cable.

Cable Documentation and Management

Document your cable plant because you can't manage what you can't find. Some users spend hundreds of thousands of dollars installing high performance cable but fail to record its location. Fortunately, new easy-to-use software tools are available to document, display, and manage network cabling. Many of the new releases have interfaces to link cable management with network management. This provides the physical connectivity information to help trace and troubleshoot problems on the network and also aid in disaster recovery. The better systems will also avoid unnecessary maintenance expense and provide for future growth.

If cable plant is your responsibility, superior long-term performance and flexibility should be your goals. You can increase your chances of success if you design a structured cabling system, install the best Cat 5 cable you can buy, and document and manage your cable plant. Making well-informed, carefully considered decisions early in the process is good advice.

Frank Peri is President of Communications Design Corporation. CDC provides consulting for structured cabling systems and specializes in the design and installation of voice and data cabling systems.

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Interview:

Robert Collet talks about Telephony on the Internet

A regular feature of the ACUTA Journal will be an interview with an expert on some aspect of technology that significantly impacts campus telecommunications. For our first interview, Robert Collet, Vice President and General Manager, Data Services and Network Systems, Teleglobe International, and President and Chairman of the Commercial Internet Exchange Carriers Association, spoke with Dave Barta, Manager of Communication Services at the University of Oregon and a member of ACUTA's Publications Committee.

DB: At your recent ACUTA seminar presentation you said the U.S. was the only country with flat-rate billing for local service and that would have to change. While this is obvious and logical from the viewpoint of an ISP, a LEC, or even an Internet user, there is still a large segment of our population that doesn't use the phone for Internet access and will find this a very distasteful change. Maybe enough to make it politically distasteful. Not to mention the impact on business budgets. How do you expect these two needs to be accommodated and when?

RC: The interesting thing is now the FCC has issued a notice of proposed rulemaking (NPRM) on access charges and, recently, on Universal Service. And actually there are three NPRMs, the third one being for interconnection. As you know, the Telecom Act of 1996 focused on opening up the local loop to competition and letting the BOCs enter the long distance market. For that to happen something had to be done about the underlying cost structure. It's fairly irrational now because there's a complicated web of cross subsidies and charges that have built up over the last 50-75 years. Untangling all of that is a pretty big deal. There are all kinds of subsidies in there. First you've got the Universal Service Fund. Within a particular geographic area all local calls are charged the same so there's geographic rate averaging. When long distance companies interconnect with the LECs, there's a transfer payment for access. So for the long distance companies to properly interconnect with the LECs, prices have to come down to cost for it all to make sense.

DB: The playing field has to be levelled.

RC: Exactly. Part of that potentially has to be the elimination of flat rate. You might have seen recently what happened when AOL announced its flat rate pricing. Their network melted down and they asked customers to moderate use. Clearly flat rate was a problem for AOL. Netcom is also eliminating its all-you-can-eat plan. It's possible the same may be true for telephony. It wasn't a problem when it was just switched voice. You can only talk so much; but now that you've got computers in homes, one could argue it's relatively easy to dial up a connection and keep it open.

DB: Given that this whole discussion of flat-rate pricing is going on, it was surprising to see AOL go to flat rate pricing.

RC: I was very surprised too.

DB: Do you think that will hasten the elimination of flat-rate pricing?

RC: I think across ISPs you will see the trend continue and see flat rate pricing go away. At the telephony level it's harder to do and there are regulatory issues involved. AOL's experience may provide some fuel to the fire at the FCC.

AOL's experience is probably a good argument for the RBOCs to say we've got to do something to ➤

make sure people don't abuse the system. I was at a meeting with somebody from AOL. They have folks who program their PCs to check their mail every 9.9 seconds and that keeps the connection open. The local exchange has got to be usage based.

DB: How long do you think it will take for that to take place?

RC: I'd say about two years.

DB: One description I've heard of the future of telephony is of a system with various quality choices, priced accordingly. For example, you might use basic grade Internet service for e-mail or poor quality telephony, use RSVP to reserve bandwidth for relatively reliable voice or limited quality video, or use switched services for guaranteed bandwidth. What do you think of this scenario?

RC: Not a chance unless the traffic stays on net. The Internet is so complex right now that being able to do RSVP across a chain of five networks, for example, is going to be an administrative and operational nightmare that just won't happen.

If it's on net, it's within your realm of control. That's why you see guys like Global 1 and Internet MCI working in concert building these global backbones so they can keep as much traffic on net as possible, and provide their customers a reasonable quality of service. Building a global backbone like they're doing is one way. Another way is to do it in partnership with a limited number of ISPs. That's TeleGlobe's strategy. By interconnecting our Internet service with others, we're going to have a family, and we will eventually work out how to do RSVP among this limited family. I'd refer to that as on net. If I'm going to retrieve a file from several links down the chain, it's going to be virtually impossible to get RSVP and quality of service working across that. I've spent a lot of years in operations: It's tough enough to get a 64 Kbps circuit switched call properly billed. It's going to be unbelievable to try to do it on a packet basis.

DB: A colleague recently sent me a quote from UUNet saying that with the present growth of the Internet, and not even counting adding video to the equation, they could see having to increase the size of some parts of their backbone 1000 times and were speculating on how difficult that will be to do. The tagline was, "If you're not frightened, you don't understand."

RC: It is a frightening scenario but that attracts a lot of people to try and solve the problem. In that environment there are two constraints: bandwidth and router/switch capacity.

DB: OC192 routers don't exist.

RC: Yet. The good news is there are several vendors working to solve that problem. It's a huge opportunity. One could argue that Cisco has done a great job providing the equipment the industry needs now; but as it scales higher and higher, the paradigm of building Internet nodes with multiple routers interconnected by LAN switches can only go so far. You need something like a telephone switch where you just add a card every time you add a new link. Somebody out there is working on that architecture, so I think when the market needs the capability somebody will show up with the box. And it will be more than one or two players. The real constraint is in the transmission and OC192 can move a lot. There are forces at work who see the opportunity and are working to fill the need. But even if you have OC192 links and Terrabit routers, it's still going to be an operational impossibility to try and do RSVP across a network of networks. But it may not be necessary if each network has sufficient capacity, and that's probably the best way to do it.

DB: If the market shakes out to only a few large networks, would it be possible to scale RSVP to work across a few networks?

RC: That's sort of the TeleGlobe approach—to have a family of ISPs across the world and fashion VPN capability within that family. But that would be within a very controlled environment where everybody in the family agrees to the rules, where revenue is being shared, and everything is well defined. But, for example, there are four ISPs in the Washington, DC, area all competing with each other. It may be hard to have these four interconnect with each other and provision and operate an RSVP service.

DB: When we talk about evolving Internet telephone from computer to computer on-net to phone-to-phone on-net then to on-net phone to off-net phone, the logical conclusion is a complete melding of the existing Public Switched Network (PSN) and Internet packet networks. First of all, is this really a logical conclusion?

RC: That's a very logical conclusion. The signalling in a circuit switched network—Signalling System 7—is a packet based network, so there is some affinity between those two. And this whole International Information Infrastructure that we're all supposed to be working toward is really an integration of the PSN with the existing and future Internet.

DB: What will the future network be?

RC: At the IP level it's going to be IP Version 6, and the differences

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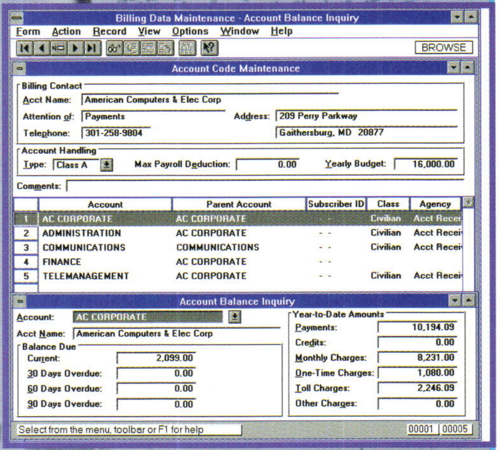

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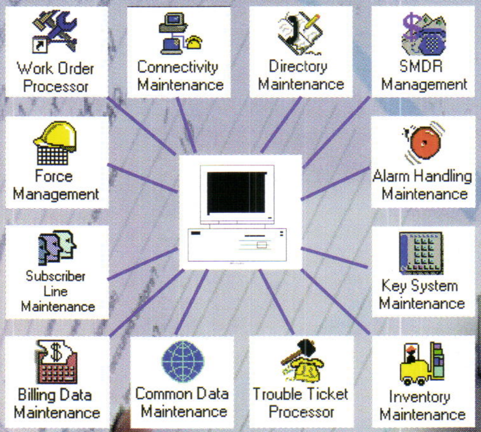

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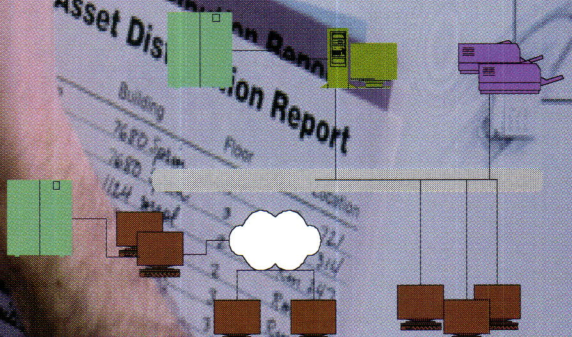

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between IP4 and IP6 are profound. IP4 has some address space limitations. It's hard to support mobility. Security is not inherent in the protocol. Those things are accommodated and engineered for in IP6, so we'll see good mobile capability, good security, no addressing problems, and improved ability to carry streams of data. Right now you have TCP/IP which is trying to assure delivery across the Internet and sometimes requires redelivery of a packet. With streaming, it's okay to lose one or two packets so it becomes more optimized for things like voice and video. You'll see RSVP easier to implement in an IP6 network than in an IP4 network.

DB: Looking at this big network with IP6 and a whole change of landscape from the standpoint of Joe telephone user who's used to a regular telephone number and is used to the phone absolutely always working when he picks it up. It seems like there are whole slew of sociological issues and issues of reliability that have to be addressed for this vision to take place. And I presume that will work, but what is the timing and will those issues get dealt with?

RC: Well, I don't think the circuit switched network is going away; I think there will be an integration and coexistence of both. There are applications like telephony that work well in a circuit switched world and others that work in a packet world. But right now in the voice world you're dealing with one standard of quality, and as the market becomes competitive you'll see emerging various levels of quality and price. Will dialtone always be there in the future? I think so. We'll just see more and more choices.

DB: Here's a selfish question from a voice service provider at a University who makes a significant portion of my revenue from reselling long distance service to students living in dormitories—and this is pretty common.

RC: I used to work at Sprint where we were doing this, but even when you had a customer there would be a big MCI sign right outside the campus encouraging dialaround. If you're depending on long distance revenue to fund other activities, you might need to watch it closely because long distance rates probably have a ways to drop and your only other alternative would be to take a piece of the action out of local charges, which may be viable if it becomes a usage sensitive arrangement.

DB: It sounds like we're going to see a shift from traditional circuit switched service to people doing it another way. When voice starts going over the Internet, somebody's going to have to pay. I think at most universities the Internet has been a cost center while long distance has been a profit center. That's going to have to change as the profit goes out of the profit center and has to move over to the cost center. How are we going to price this?

RC: What you just described is very similar to experiences being felt by government and large corporations, and where there's a need somebody usually moves to fill it. So with regard to measuring use on individuals or departments over a broadband connection, you will see some capability to track how much people use and charge them for it.

DB: Will there be some evolution in the ability to count packets?

RC: Sure, it's already happening. I know one for sure, but I'm sure there are more firms entering this market and offering services or products of that type to help operators such as yourselves account for what people use. It's happening already so that's a good news story.

DB: I recently read an article that

said the argument against measuring usage is that the technology of the Internet is evolving so rapidly that it's very difficult for administrative structures and charging structures to keep up with the technology. Do you think it is?

RC: What I would refer to would be a box that you would have in-house which would account for how people are using the access to the Internet. One could argue that's a fairly crude and simple thing, but it may be an adequate rough approximation for a variety of cases. What I think will happen in the long run is usage being charged at the application level. Your classic problem in Internet infrastructure is your University connects into your ISP and most of your traffic is across the street. That's a cost of X; but if your traffic is going to Singapore, for example, there's an enormous cost and the Internet has no boundaries. It's postalized. There's a need to charge for microtransactions and make micropayments and you have micromerchants and I think that's what Cybercash is all about. You're going to see more and more applications utilizing some kind of electronic transaction capability so they can charge people for use. Today most Web sites are free, but pretty soon… Cybercash is built so you can charge people a penny or five cents for accessing a Web page, so that is do-able. Doing it at the RSVP level on telnet sessions and e-mail messages and so forth is really really hard; but doing it at the applications level is do-able and scalable, and the revenue from that gets plowed into supporting connectivity. It's a good feedback loop.

If I want to open a Web and the most I can charge somebody is one cent per page, now I'll have the ability to do that. That's basically the model that a company in France built on over the last ten years—the service provider was the one collecting and settling the money at the applications level. It became an enormous catalyst for the growth of the online community in France, and there's no reason the same thing can't be applied over the Internet infrastructure. Overall I'm quite optimistic.

DB: So you understand and you're not frightened.

RC: I understand the gravity of the problems we're facing; but I'm not too frightened because there are solutions being developed from the bottom of the protocol stack to the top, and I'm reasonably confident that they'll reasonably work.

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Campus Profile

BYU: Striving for Excellence in Telecom Services

Mark A. Philbrick, BYU Photographer

by Ferrell Mallory and Jack Boden

Brigham Young University has made a major effort to upgrade its voice and data telecommunications infrastructure and to expand student and faculty access to information resources. The project, a 10-year work still in progress, includes providing Internet access from outside contractors and several other steps that may be a bit unusual in the academic world but are paying off for the University community.

As the result of its telecommunications improvement effort, BYU received the ACUTA Institutional Excellence in Telecommunications Award in 1994. The effort began with installation of a new telephone system that included a new wiring plant capable of serving campus voice and data needs. That phase of the project was followed by the development of a campus-wide, packet-based Ethernet network.

Since receiving the ACUTA award, BYU has been steadily working on projects to upgrade the speed and capacity of data communications and the quality of services in both telephone and data telecommunication services.

"The goal has always been to have BYU on the leading edge of telecommunications technology, but not necessarily on the 'bleeding' edge," says Ferrell Mallory, director of BYU Telecommunications Service (TCS).

FDDI Over ATM

During the past four years, BYU has increased data speed and capacity by installing a Fiber Distributed Data Interface (FDDI) backbone, which included FDDI and CDDI concentrators. The backbone provided 100-Mbs service to University Computing Services (UCS) data servers and between all campus routers.

While BYU knew that Asynchronous Transfer Mode (ATM) was out there, ATM was not a proven technology in 1994 when the University's effort to increase speed and capacity began. Instead, ATM appeared to be on the "bleeding" edge of technology, with standards that had not been settled or defined enough. On the other hand, FDDI had proven standards at that time, which is why FDDI was chosen for BYU's backbone. However, BYU is presently experimenting with future uses of ATM within its expanding network.

Fiber to Housing Units

As part of the efforts to provide easier student access to data communications, TCS planned and executed a major project to install fiber optic cable to all on-campus student housing units. Since the project began in September 1996, Americom Technologies of Salt Lake City has been contracted by BYU to lay 23.9 miles of single and multimode fiber optic cable to 111 student housing buildings. The original $704,000 price tag on this project will increase when fiber is run to the remaining 31 buildings. For now, hubs have been installed and activated in 26 buildings with the rest of the locations to become operational as demand for data services increases.

Since the decision was made to run fiber to all the housing units, BYU school officials decided to expand the concept of data services to include computer labs in each of the housing units, not just to the individual bedrooms. The idea is to fill the gap for students who do not own a PC by providing a small bank of campus-owned computers in their housing units for access to the Internet and campus networks.

Hardware resources will come from the hundreds of 486 computers in the regular campus computer labs that will be replaced by Pentium 100s in the near future. Technical support for wiring and hubs in the labs will come from TCS.

Outsourcing Internet Service

Until March 1996, BYU's primary access to the Internet for on- and off-campus locations was through remote access via modem pools on the PBX and a NetBlazer.

In Spring 1996, BYU had 1,800 NetBlazer accounts, which were increasing by up to 300 per day in the busy season. It became obvious that Internet demand would soon exceed NetBlazer capacity.

Indicators that BYU was running into an Internet access problem included limited availability of equipment and CO lines, lack of support staff, and high costs for the maintenance of the NetBlazer equipment. All of this pointed to the need for change. Outsourcing the service appeared to be the most logical choice.

Leading the way to find an acceptable Internet Service Provider (ISP) was the University Computing Services (UCS). UCS pre-selected several ISPs and prepared the request for proposal (RFP) which was sent out to find the most economical and practical solution.

As a matter of convenience, the search was turned over to the BYU Purchasing Department, which slowed down the process. Eventually, two ISPs were contracted for a one-year period—beginning with the Fall 1996 semester—to provide Internet service to off-campus users only.

The ISPs agreed to contract with students so they would pay the ISP directly for service and support. They also agreed to pay BYU to sign up each user and to pick up the cost of installing T1 frame relay access to BYU.

In return, TCS and UCS agreed to advertise the ISP services, sign up users, provide on-campus technical support, and create an intranet Web page as a more convenient means for students to sign up for the ISP services. Although all of the contract's details were not immediately worked out, outsourcing Internet service proved to be successful: BYU staff levels have been maintained; the NetBlazer lines to the Internet have been reduced by 50 percent; more than 1,400 students use the ISP; and 75 departmental accounts have moved from the NetBlazer to the ISP. But even with this reduction of NetBlazer services, plans to decommission the NetBlazer in 1997 will have to be postponed. Until then, the NetBlazers will still be used as a resource for Internet access by students living in campus housing units who do not have Ethernet connections as well as by faculty and staff members living off campus.

In addition to outsourcing Internet Service, the Y-Net infrastructure was upgraded to include Switched Ethernet Ports. This upgrade also improved bandwidth by reducing the size of collision domains and providing dedicated 10-Mbs service to many servers cam-

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pus wide. Today, three NetBlazer computers, 52 modems, and 20 DCM connections are available to students, faculty, and staff for remote access to the campus networks.

A router provided by WestNet was upgraded from a Cisco AGS+ router to a Cisco 7000 router. The larger, faster router is used to move packets of information from on- and off-campus computers through the campus computer network. By August 1996, all of the four smaller and older routers on campus were replaced with Cisco 7000s or 7513s.

Telemanagement Software

Included in BYU's upgrade of its telecommunications infrastructure, as well as access to the Internet, is the development of its own "homegrown" Telecommunication Information Management System (TIMS). The TIMS software database application, which uses the Informix database manager, now includes inventory tracking, system component documentation, cable capacity, usage and assignment, work order budget ability, a customer billing feature, and the ability to record software moves, adds, and changes (MACs) as well as physical telecommunication MACs. It allows employees to access the program simultaneously to perform data entry on work orders, technician task completion, employee file management, and technical MACs.

Music on Hold

Although many of the network upgrades were global in scope, some of the actions taken to improve the system were smaller, yet just as rewarding. In February 1996, music started to play again for telephone callers placed on hold. Music-on-Hold had been discontinued earlier by an administrator who found certain commercials on the local radio station used as a source of music to be offensive. After surveying the campus community on the need for Music-on-Hold and the type of music to play, and then obtaining approval from the campus leadership, Music-on-Hold was again heard on the BYU telephone system; this time, it was classical instrumental provided by TCS's own CD players. The response from the campus community has been overwhelmingly supportive of this modest effort, which includes licensing by the American Society of Composers, Authors, and Publishers (ASCAP).

TCS Supports Amateur Radio Club

Another support service provided by TCS is sponsoring BYU's Amateur Radio Club. With 60 dues-paying members, this club has taught the basics of Ham radio skills to hundreds of faculty, staff, and students over the past 10 years. Under the direction of Wayne Voorheis, telephone services manager and club advisor, members have earned FCC licenses and gained the respect of campus leaders who regularly call on club members to assist the University Police in campus surveillance operations and in emergency response services

ROLM Phone Upgrades

Proprietary ROLM telephones, used extensively throughout the campus, were upgraded during 1996. During the upgrade period, Telecommunication Facilities (TCF) and Telephone Consultation Center (TCC) replaced more than 9,000 Rolm Telephone sets on campus, including models 120, 240, and 400 Rolm telephones with the newer 6XX series Rolm telephones. Even phones in on-campus student housing were upgraded to the newer sets.

In addition to lowering maintenance costs, the new telephones provided two key benefits: First, the new telephones have a display window that features automatic number identification (ANI), giving the telephone number of off-campus callers and showing the name and extension of on-campus callers. This feature has relieved much of the telephone harassment problems formerly experienced by campus residents.

The second benefit of the new telephones is the ease with which new features can be added, such as data communications, headset adapters, button expansion modules, and an analog equipment adapter that eliminates the need for a separate analog line for modems and fax machines.

Also during 1996, TCC and TCF expanded the PhoneMail system with the addition of a fifth, sixth, and seventh node. As an indication of the steady growth of this service to the campus community, the number of PhoneMail users increased from 5,300 in August 1995 to 5,700 a year later. The number of phone mail messages processed during the same period exceeded 12 million, up from slightly more than 9 million during the previous school year.

Video Conferencing

TCS has also been instrumental in adding video conferencing to the telecommunications services available at BYU. A PictureTel unit was purchased by TCS in April 1994, primarily for professional training of TCS employees and other campus personnel. Due to limited space, TCS could only provide limited video conferencing services to the University faculty and staff. However, frequent uses included students interviewing with prospective employers or faculty members located across the country at various locations. It was also used for meetings between campus faculty and their students who worked in internships off campus.

In June 1996, the PictureTel unit was relocated to the BYU School of Management where it is used to teach students about video conferencing in the world of business and to serve other campus video conferencing needs.

Data Network

In addition to the work on Y-Net mentioned above, BYU established a data network primarily for student academic use. This is an offshoot of Y-Net called LabNet. Unlike Y-Net, which allows selected individuals access to academic and administrative files, LabNet allows access only to the Internet and campus academic (laboratory) networks. Administrative networks that contain sensitive information about grades and payrolls are not available to users of LabNet. LabNet eventually will be accessible from all student housing areas and through modems from off-campus locations.

Infrastructure Expansion

The purchase of a building that belonged to nearby Utah Valley State College (UVSC) created a need to provide campus voice/data capabilities to this building. This required the extension of copper and fiber cables across Canyon Road, a main off-campus thoroughfare. Opening a trench to install cable would have been not only expensive but also disruptive to the students as well as the vehicle traffic on Canyon Road. Such an effort would also have involved approval from the city fathers, construction fees, and untold other problems.

TCS found a contractor who had the technology to do underground, directional boring with conduit installation. The contractor placed 1,950 feet of conduit, copper cable, and fiber optic cable with minimal disruption to student activities and no interference with vehicular traffic.

With the completion of services to the UVSC building, a means was also provided to supply direct connectivity for campus voice and data services to the Senior Missionary Training Center (SMTC), located in a newly obtained building also across the street from the main BYU campus. In the past, the SMTC operated on a telephone system independent of BYU's system.

The cable for this service— an additional 400 feet of both copper and fiber—was placed as an extension of the facilities at UVSC. As a result of this project, the MTC main office and the SMTC have direct connectivity at reduced cost.

Making the Grade

BYU submitted its application for the ACUTA Institutional Excellence Award after installing a state-of-the-art 13,000 port ROLM 9750 Computerized Branch Exchange (CBX) with 9004 software in December 1987. This system came with PhoneMail, data switching, and a 96-port modem pool. In 1990, the CBX was upgraded to a 9751 switch, using the more advanced 9005 software. In 1994 the new PBX was handling 10,480 telephone extensions, an increase of about 6,000 extensions over the old AT&T Dimension system previously used on campus.

Now the University supports more than 10,800 telephone extensions. Due to significant construction and remodeling projects currently underway on campus, the number of telephone extensions will again experience a significant increase. With some increase in cabinets and cards, the Rolm PBX should easily handle this additional load.

On the data side, BYU's campus-wide packet-based Ethernet network managed 4,064 ports by 1994, an increase of almost 3,500 ports since 1984. Two years later, the number of managed data ports has nearly doubled to almost 7,000.

BYU Tomorrow

BYU's "leading-vs-bleeding" edge approach to change may become a little less clear in the years ahead. A newly appointed President, Dr. Merrill J. Bateman, is encouraging the expansion of technology at BYU.

Inaugurated as BYU's 11th president in April, 1996, President Bateman has stated that helping all students—both on and off campus—have access to the information super highway is one of his visions of the future.

With newer and bigger projects looming on the telecommunications horizon, President Bateman's influence is already being felt by TCS.

Ferrell Mallory has been the director of Telecommunications Services since 1978. Jack Boden joined his staff in 1994 as office manager and administrative assistant.

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From the Executive Director

Jeri A. Semer, CAE

This first issue of the *Journal of Telecommunications in Higher Education* is the culmination of years of visionary thinking, planning, and preparation by ACUTA members, volunteer leaders, friends of the association and the professional staff. I would like to share with you some of the history that brought us to this point, resulting in an important new information source for ACUTA members and the higher education community.

During the strategic planning process of 1992-93, the idea of an "ACUTA Magazine" first surfaced. The association's leaders felt that there would soon be a need for information in more depth and on a wider array of topics than the *ACUTA News* and monograph series allowed. In a profession that is experiencing an explosion of information, ACUTA members identified a need for a magazine targeted specifically to the needs of telecommunications professionals in higher education.

When the Strategic Plan was reviewed and updated by the Board of Directors in July, 1995, this concept was refined and given a high priority. The Publications Committee was charged to develop a proposal and business plan for an ACUTA Journal. Through wide distribution of the Journal, the important role of telecom in supporting the mission of higher education—and the professionalism of ACUTA members—would be more widely recognized.

The Publications Committee worked for nearly a year researching, developing, and refining their proposal, determining that no existing publication specifically addressed telecom in higher education. A survey of members found overwhelming support for this new publication: a Journal with a practical orientation, consisting primarily of articles focused on telecom management and the application of telecom technology in higher education. Information of a more academic nature would also be welcomed when appropriate and relevant. Ideally, the Journal would consist of a combination of case studies and informational articles authored by members, consultants, faculty, and industry representatives.

While a majority of members expressed a desire for the Journal to be in printed format, some also wanted an electronic version. The committee will be engaged in an ongoing study of what form the electronic version will take. For now, the ACUTA World Wide Web site will contain a table of contents for each issue and brief abstracts of the major articles.

Articles are reviewed by an Editorial Board consisting of highly respected experts in telecommunications and higher education. The Publications Committee retains overall responsibility for direction of the publication, selects the Editorial Board members, and sets the editorial calendar. These hard working volunteers have devoted hours to conceptualizing and planning the Journal with the support of Editor-in-Chief Pat Scott, who is responsible for seeking authors, final writing and editing, and the graphic appearance of the Journal.

We extend an enthusiastic *Thank You* to the advertisers who have put their trust in the Journal sight unseen. Many advertisers are Corporate Affiliate members of ACUTA, who participate in so many ways in the association. There are also several new companies, and we welcome you as new members of ACUTA's extended family. We appreciate your support, and are committed to making the Journal a high quality product that will be worthy of your continued participation for many years to come.

To all who identified a need and envisioned a solution, we thank you for your time and expertise. In a world where professional demands are making time an increasingly valuable and scarce commodity, we are most fortunate to have a dedicated cadre of members and staff who have worked as a team to create this Journal. We expect some of our most exciting articles will be contributed by you, our members, who are willing to share your stories. (You need not be an accomplished author—we will gladly work with you.) As this publication evolves to meet the changing needs of ACUTA members, we will always be grateful to those who created the foundation that made it possible.

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