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ABSTRACT

This track of the 1993 CAUSE Conference presents eight papers on developments in computer network infrastructure and the challenges for those who plan for, implement, and manage it in colleges and universities. Papers include: (1) "Where Do We Go from Here: Summative Assessment of a Five-Year Strategic Plan for Linking and Integrating Information Resources" (Glenda F. Carter and others), which describes the telecommunications umbrella developed at Grambling State University (Louisiana); (2) "Wireless Communications--Come in Dick Tracy!" (Frank H. P. Pearce); (3) "Voice, Video & Data Backbone Network Project Implementation" (Bruce Longo and Barbara Robinson), which shares the experience of Monroe Community College (Rochester, New York) in implementing an integrated network environment; (4) "Some College/University Roles in the Transition to an Information Age Society" (Charles R. Blunt), which examines New York State's telecommunications development; (5) "Telecommunications + ISDN = Opportunity" (Arthur S. Gloster II and James L. Strom), which describes computer network implementation at California Polytechnic State University and Appalachian State University (Boone, North Carolina); (6) "Strategies for Recovering the Costs of the Campus Data Network" (Michael Hrybyk); (7) "NIC Knack Paddy Whack Give That Information a Home: Campus Wide Information Systems and Its Service Agent the Network Information Center (William Brand), which discusses computer network infrastructure using Arizona State University as an example; and (8) "The Electronic Kiosk: Interactive Multimedia Goes Enterprise-Wide" (John Wheat), which describes the University of Texas' new electronic information services. (Some papers contain references.) (JDD)

Managing Information Technology as a Catalyst of Change

Proceedings of the 1993 CAUSE Annual Conference

TRACK V

OPTIMIZING THE INFRASTRUCTURE

December 7-10
Sheraton on Harbor Island
San Diego, California

TRACK V

OPTIMIZING THE INFRASTRUCTURE

Coordinator: Kathleen M. Ciociola

As our need to be connected—to each other and the world—grows, networks proliferate and the clamor for new networking access grows. Tantalized with the possibilities for instantaneous communication and immediate access to vast sources of new information, staff, faculty, and students hold high expectations for the new order. However, while the potential held by the new infrastructure is immense, so are the challenges for those who plan for, implement, and manage it.

Where Do We Go From Here: Summative Assessment of a Five-Year Strategic Plan for Linking and Integrating Information Resources

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Abstract

This paper describes the implementation and the outcomes of Grambling State University's five-year strategic plan for linking and integrating its disjointed information resource systems under the umbrella of telecommunications. The range of services encompassed in the plan included energy management, surveillance and security, voice, data, and video communications, office automation, and administrative and instructional computing.

After a brief recap of the original plan, this paper sets forth the primary aspects of its implementation including technical implementation, integration of the technology into the workplace, and quality issues as related to human, physical, and capital resources. Also described are current and future directions for telecommunications as outgrowths of the successes and shortcomings of the original plan.

OVERVIEW

Emanating from senior management's realization that the attainment of virtually all of its institutional goals was dependent on an improved technological base, Grambling State University (GSU) set out several years ago to develop and implement a strategic master plan that would serve as the infrastructure for telecommunications, computing, information systems, surveillance, security and energy management. The vision for information resources at GSU was to:

- Establish telecommunications as the foundation for information;
- Embrace the philosophy of user-driven and distributed computing;
- Increase decentralization of access to information processing resources;
- Integrate network-based applications, such as voice, data, video, energy management, surveillance and security; and
- Accommodate new applications such as electronic mail, computer conferencing, bulletin boards, etc. (Lundy, 1986).

GSU is now in its fifth year of implementation of the strategic plan for information resources. After a brief recap of the original plan, this paper sets forth the primary aspects of its implementation. It includes discussions about the technical implementation, integration of technology into the workplace, and quality issues as related to human, physical, and capital resources. Further, the paper describes current and future directions for telecommunications as outgrowths of the successes and shortcomings of the original plan.

The theoretical model adopted as the foundation for the strategic plan was McKinsey's 7-S Framework. This planning paradigm has the appearance of an atom with seven factors, all beginning with the letter "S": (1) superordinate goals or shared values, (2) strategy, (3) structure, (4) systems, (5) staff, (6) skills, and (7) style (Peters & Waterman, 1982). Using the seven elements of the 7-S Framework, the university assessed current computing and communications resources and determined needs and desired outcomes. All goals and objectives were couched in this theoretical model.

The primary goals developed to help achieve the desired linkage and integration of computing resources were as follows:

- Install an outside cable plant using fiber optic technology;
- Implement an integrated voice, data, and video local area network (LAN);
- Upgrade existing computing hardware and software by acquiring and linking (clustering) a VAX 8350 (upgraded to the VAX 9000) computer with other VAX computers ("Vax Family");
- Establish a Computer Information Center to develop and implement a training program in computer literacy for academic and administrative users. (Lundy & Carter, 1988 & 1989).

GSU's vision for the future was a totally integrated environment characterized as network-centered, workstation-based, server-enhanced, and software-integrated.

THE OUTCOMES

In general, the implementation of GSU's strategic plan for information resources has been a tremendous success. The technological environment on campus now is greatly improved over the environment that existed five years ago. But given the ever-evolving state of technology, there will always be room for expansion and improvement. Five years into formal implementation, the milestones point to documentable success. Below is a summary of the major achievements related to each of the four primary goals.

Goal 1: Implement Integrated Voice, Data, & Video LAN

GSU retained the consulting firm, Network Group, Inc., to assist in the design, procurement, and installation of the campus communications network. The system was designed to integrate all computing, telecommunications, and video transmission systems on the campus and was to use fiber optics as the transmission medium for all three elements of the network--voice, data, and video.

Although integration of voice, data, and video was achieved campus wide, it was not achieved using fiber optic technology as was originally planned. Instead, integration was attained by employing two different transmission media--twisted wire pairs and coaxial cable. The explanation for the change in transmission media is presented below in the discussion about the outside cable plant.

The integration of capabilities commenced with the acquisition of a new telephone system. Prior to 1984, GSU's voice communication was supplied by an antiquated cable plant and switch that was installed in the 1940's. This outdated technology greatly limited the university's ability to provide basic telephone services.

During the time span of 1981-83, a new cable plant was installed and a new telephone exchange building was constructed with funds appropriated by the Legislature (State Project No. 19-23-00-79-4). In 1984, GSU installed a four-node ROLM VLBX PBX system on campus. This system, which is housed in the Telephone Exchange Building where the cable plant is centralized, did not have data capability. Since the initial PBX installation, there have been some minor upgrades and one major addition--the installation of a fifth node to increase capacity and provide data access. The fifth node provided a 40 percent to 60 percent split between voice and data offerings. Even with these recent upgrades in place, the university is at capacity in terms of its ability to provide basic telephone service.

The modified telephone system did, however, set the stage for the initial integration of data with voice communication. The new ROLM telephone system provided the needed capability to connect data lines directly to ports in the telephone switch; thereby giving all users voice and data capabilities.

The campus ROLM telephone system supports serial RS-232 data transmission on a limited number of circuits. While this service is too expensive ($1111 per circuit) to be used as a campus-wide network and is less sophisticated (only one device can be used at a time) than the high speed Ethernet TCP/IP network, data transmission through the ROLM system represented a viable alternative to a full-fledged ethernet network node for users in remote locations not connected to the cable and in facilities that required few network connections.

In the ROLM system at GSU, data communication takes place between a ROLM Phone with data (at the user end) and a data termination interface (DTI) located at the host computer.

In the new network, all DTIs were relocated from the various host computers to a central location in the Telecommunications Central Office. Network terminal servers for both the administrative network and the academic network were located there and were connected to the DTIs. A user of the ROLM Phone with data dials into the campus network by connecting through the ROLM system to a terminal server in the Central Office. From that connection with the terminal server, the user can connect to any host computer or service on the network.

In addition to the telephone upgrades, accomplishing the integrated LAN with voice, data, and video required making some changes in the SMATV frequency spectrum plan for the campus SMATV broadband cable transmission system. This involved changing spaces for the exclusive use of different services on campus such as data networking, cable television, security video, and energy management. This needed to be done because the signal channels used for the television channels on the Grambling system conflicted with the data communications channel recommendations given in the Institute of Electrical and Electronic

Engineers (IEEE) Project 802.7 specification, "Broadband Local Area Network Recommended Practices". In order to purchase standardized. off-the-shelf data communications equipment to work with the campus SMATV system, the channel allocations for the SMATV system had to be changed.

Also, when the SMATV system was installed, all of the television signals were placed in channels other than those used for VHF television. This made a "cable ready" television or a converter necessary to receive any television signals. Seven of the cable television channels were moved into the broadcast channel 7 through 13 spectrum. This served two purposes; it freed the channels necessary for data communications to meet the IEEE standard, and; it allowed students without "cable ready" televisions or converters to receive at least the three major networks--PBS, the two local programming channels, and one independent channel (BET). Reception of the other six channels still require either a "cable ready" television or a converter.

This new frequency spectrum plan allowed for the installation of two data communications network allocations (each requiring 3 video channels). They are the academic communications network and the administrative communications network. Both networks are carried on the broadband SMATV system, but on different assigned channels. The frequency separation between transmit and receive signals for the data communications allocations is 192.25 MHz, as recommended in the IEEE 802.7 specification.

The two networks are interconnected using an intelligent bridge and gateway. The intelligent bridge allows authorized users on the academic network to access the resources on the administrative network but restricts certain users from bridging between the two networks and maintains an audit trail of all users working through the bridge. This prevents unauthorized access to the sensitive data stored on the administrative network.

A gateway for the AppleTalk local area network was installed and performs three major functions:

- The gateway provides connection between the AppleTalk network and the campus Ethernet network.
- The gateway translates between AppleTalk protocols and TCP/IP protocols.
- The gateway supports simultaneous terminal emulation on the Ethernet TCP/IP network by multiple Macintosh computers on the AppleTalk network. The Macintosh computers are able to access all network computers and services through the gateway.

Six broadband ethernet modems support the administrative network and seven support the academic network. Terminal servers are the principal devices providing user connection to the networks. The terminal servers allow multiple terminals, personal computers, or host computer ports to be connected to the networks.

The administrative network operates on a transmit frequency band of 35.75 MHz to 53.75 MHz and a receive frequency band of 228.0 to 246.0 MHz. This network allows users access to the services on the Digital Equipment Corporation VAX 9000 (which replaced the VAX 8350 and the VAX 11780), 2 VAX 4300, and the Library VAX 4300 computers located in the new Business/Computing Center Building.

The academic network operates on a transmit frequency band of 53.75 MHz to 71.75 MHz and a receive frequency band of 246.0 to 264.0 MHz. This network allows academic users (including students and faculty) access to any of the academic computer systems on campus. Both broadband ethernet networks were connected to the data ports on the ROLM telephone switch, so users in buildings not yet served by the networks can still access network services.

In the initial configuration, both networks provided ample terminal connection service with each network functioning as a large distributed data switch. Any user on either network with proper authorization may initiate a connection to any host computer on the network, and thereafter, communicate with that host computer as if the user were a dedicated terminal connected to that computer.

Another equally important aspect of the success in establishing an integrated network is the training of personnel. Included in the scope of work of the consulting firm, Network Group, Inc., was the task to train network technicians in theory and operations of the ethernet networks. The training prepared university technicians for both operational responsibility and maintenance of the network system. Specific aspects of the training included:

- Ethernet network operation theory and practice;
- Terminal Server setup and operation;
- Network Control Server setup and operation;
- Network security features and practices;
- Broadband Ethernet Modem theory and operation;
- Broadband Ethernet Network troubleshooting; and
- Data communications testing.

Goal 2: Install Outside Cable Plant with Fiber Optic Backbone

Installation of an outside cable plant provided the data and video link to the integrated network. As previously mentioned, the transmission medium of choice for this outside plant was fiber optics. However, circumstances necessitated that coaxial cable serve as the backbone of the outside cable plant instead of fiber optics.

The decision to forego fiber for the immediate future came about as a result of persistent student demand for cable television. Students wanted cable television **NOW!** They insisted that the university enter into a contract with a local cable company to provide the service. The university acceded to providing cable access in a more timely fashion, but would not concede to making the substantial expenditure of funds to provide cable television only. Students had to be convinced that their demands were shortsighted and that it was necessary for the university to acquire as much as possible for the dollars expended. At a minimum, video and data capabilities had to be purchased.

This concession made it possible for students to receive their greatly desired cable television in a timely fashion and afforded the university the opportunity to establish its networked system of communication using two transmission media, twisted wire pairs and coaxial cable, rather than the single fiber optic medium. Thus, coaxial cable, rather than fiber, became the backbone of the integrated network.

Goal 3: Upgrade Computing Hardware & Software and Create (Cluster) a VAX Family

Another important component in achieving integrated information resources was the clustering of the same types of processors or creating a "VAX Family" (VAX cluster). This clustering together of computer systems and/or devices allows for the sharing of disk resources by processors. Each processor can recognize the devices attached to other processors in a cluster group. Managing a cluster is easier and can be controlled from one designated processor within the cluster. If one processor is not available (down), the remaining clustered processors are still accessible to users. GSU's current VAX cluster includes:

1 VAX 9000 Computer System;
2 VAX 4300 Computer Systems;
11 Disk Drives;
3 Tape Drives; and
3 Line Printers.

Goal 4: Establish Computer Information Training Center

Recognizing that a state-of-the art technology environment is useless if customers do not or can not use the resources, the university developed a strategy to ensure greater use of the new technology. The strategy was education and training.

It was believed that a full-scale, intensive, and comprehensive effort had to be launched to increase the comfort level of faculty, staff, and students with new technology applications. As a result, it was proposed and Title III funds were secured to establish a computer information training center.

The Computer Information Center, (CIC) a component of the Information Resource Center, was established to aid in developing a computer-fluent population at GSU. Programs are designed to aid faculty, staff, administrators, and graduate students develop proficiency in the use of computers and the application of computer technology.

The Computer Information Center opened in very small quarters on September 15, 1988 and has evolved from a one-trainer, one-assistant, six-microcomputer, two-printer classroom to a spacious, sophisticated laboratory containing eight IBM PS/2 microcomputers, 13 DEC PCs, five Hewlett Packard laserjet printers, one Hewlett Packard Paintjet printer, one Hewlett Packard Paintjet XL300 printer, two IBM 4019 laser printers, one Epson FX-1050 dot matrix printer, one Epson LQ-1170 printer, a Macintosh IIcx scanner and laser printer, a full-page scanner, and a hand-held scanner. The Center also will maintain a twenty-station terminal lab with printers.

All instruction is provided in a "hands-on" environment with each participant assigned to a personal computer. The seminars and workshops are video taped and cataloged for future use and transmission on the university's television station. At its inception, the CIC offered four seminars. The number of offerings now exceeds twenty-five seminars including topics such as: Introduction to Microcomputers, DOS Commands, dBase III+, dBase IV, WordPerfect, WordPerfect for Windows, Desktop Publishing, Lotus 1-2-3, Microsoft Windows, Microsoft Word for Windows, Microsoft Excel, PrintMaster Plus, Printshop, Using Quattro Pro, Your PC-Inside and Out, and Harvard Graphics.

In addition to the seminars and workshops, the CIC provides various other services to its clientele. It serves as a resource base for users who need help with applications which may include installing and testing new software, performing demonstrations of the software, and setting up some hardware devices. In addition, microcomputing support is provided by assisting users in selecting software to fit individual needs as well as providing vendor and price listings for both software and hardware. Assistance is also provided for those who wish to establish micro-to-mainframe communications. Additionally, the CIC runs a "help desk". Individuals needing assistance call the "help desk". If possible, the problem is resolved over the telephone; if not, someone from the Center goes to the problem site to assess and resolve the problem.

The CIC has established its own library. The library houses multiple resource materials including guides to the latest computer technologies and techniques, various periodicals, reference texts, and audio and video tapes. The addition of a VCR and monitor created an alternative method of training for individuals unable to attend regularly scheduled seminars. All materials may be checked out for limited time periods.

Two of the more recent additions to the CIC have been the purchase of a Macintosh computer, laser printer and scanner specifically for desktop publishing purposes and the establishment of a demonstration local area network.

Since opening, the small CIC staff has trained well over 600 participants from various departments throughout the entire university and at least 100 others from the surrounding communities as a result of the Center's very popular Community Outreach Program. Outreach services have been provided to employees of various city, parish, and state offices and to area retirees.

The CIC is also quite popular with graduate students enrolled in the College of Education's doctoral program. Many graduate students spend considerable time in the Center preparing research papers and dissertations.

If there is a shortcoming of the Center, it lies in its staffing. In spite of the vastly expanded services, staffing has increased from the original one trainer and one graduate assistant to two trainers and one graduate assistant. Given the quantity and quality of service rendered by this Center, the staffing is sorely lacking; and unfortunately, resource projections do not indicate any immediate relief in this regard.

FUTURE DIRECTIONS

Though much has been accomplished, as the outcomes have shown, the constantly evolving state of technology requires that information resources be upgraded continuously if the university is to maintain its competitive edge. Thus, future directions are already being charted and strategies developed. Short-term objectives include:

(1) Installing and outside cable plant using fiber optic technology to interface with the inside coaxial system;
(2) Upgrading existing computing software to take advantage of mainframe speed and flexibility;
(3) Expanding the university's computer fluency program to include mainframe training;
(4) Developing electronic classrooms in all academic building;
(5) Expanding the telephone system to accommodate the increasing demand for on-campus housing; and
(6) Implementing energy management and surveillance and security systems.

Each of these objectives is discussed in more detail below.

Transfer to Fiber Optic Technology

As noted earlier, Grambling State's original strategic plan for information resources called for a system with fiber optics as the backbone. However, persistent student demand for immediate access to cable television resulted in a decision being made to forego fiber as the first choice transmission medium and to use coaxial cable instead. As predicted, the utility of coaxial cable has been compromised greatly due to it lack of durability; its difficulty to maintain; and its vulnerability to damage during work on campus construction projects. The goal now is to install an outside cable plant using fiber optic technology to interface with the inside coaxial cable system. This technology is an industry-standard solution for an organization that needs flexible, high performance networks that will increase productivity for entering, transferring, retrieving, and updating information.

More than 10,500 linear feet of fiber will be installed to complete the first phase of the campus distribution system. In Phase I, the fiber will be installed in all major academic and administrative buildings currently linked by coaxial cable. The fiber will be installed using single and multi-mode fibers with built-in redundancy capability to prevent interruptions in service to network users.

In Phase II, fiber will be installed in the residence halls and new structures. This phase will allow the use of fiber electronic technology and devices to integrate with existing broadband technology creating an easy transition for network users.

At the completion of Phases I and II, the network will have full capability to operate with the university's existing 802.3 Broadband Ethernet Network and will accommodate current projections for future expansion.

The fiber network will be able to share software and hardware resources, preventing the duplication of resources throughout the university. Fiber optic technology will allow the university to interface with national and international networks and realize the full benefits of increased speed. The fiber network allows remote log in that provides the ability to access any computer on the network from any campus location; provides remote command execution, giving users the ability to submit jobs at one site for execution at another site; provides closed-circuit high-speed transmission; and, provides the capability to transmit large volumes of data in experimental laboratories in a classroom setting.

A major factor involved in moving to a fiber optic transmission medium is the installation of a **conduit system**. As recommended by Network Group Inc., the university will begin to develop and install a campus-wide system of telecommunications conduits. A small system of conduits and manholes already exits. The system of conduits and manholes will provide: (1) an installation path for a dedicated fiber optic cable link between Woodson Hall (location of the Head End of the SMATV system) and the Security Building, (2) an installation path for telephone cable plant expansion, and (3) will serve as a backbone for future expansion and installation of telephone and data communications cables.

Upgrade Existing Computing Software

In the near future, GSU plans to upgrade existing computing software to take advantage of mainframe speed and flexibility. Toward this end, GSU will explore data base management systems to achieve full data base integration. Data base management systems allow multiple users to access and share common data; thereby providing a better fit between administrative applications and the software chosen to perform the various functions.

If the university is to meet the demands of an information society, GSU must put in place a fully-integrated Relational Data Base Management System (RDBMS) software packet to manage its academic and administrative information. This software will integrate all aspects of enrollment management, records management, student accounts, fiscal management, academic affairs, office automation, and planning and decision making functions. The Relational Data Base Management System, 4GL, and related tools will enhance the university's capabilities by:

- Improving decision making,
- Increasing production and integrity of information,
- Reducing data redundancy,
- Reducing application development time,
- Enhancing the management of budget/planning units, and
- Increasing end-user participation.

Expand Computer Fluency Programs

Another of Grambling's short-range goals is to expand the university's computer fluency program to include mainframe training. The new information technologies and the creation of a LAN imply that all students, faculty, and staff should acquire certain computing skills. GSU will expand its computer fluency programs to address the increasing need for training.

Grambling State's computer fluency module is designed to serve faculty, staff, administrators, and graduate students. The major objectives of the computer-fluency module are to help the user demonstrate an understanding of:

(1) Capabilities, applications and implications of computer technology;
(2) Computer systems including software development, design, and operation of hardware;
(3) Use of computers in problem solving and model simulation; and
(4) Use of specialized computer software such as word processing, electronic spreadsheets, data management, and statistical packages for interactive computer applications.

The computer fluency program will be enhanced to meet the needs of those persons requiring training and additional support on the PCs as well as training on the mainframe. The Computer Information Center also will expand its computer fluency program to include the students of the university as well. This portion of the training program will consist of broadcasting the videotapes of the microcomputer seminars over the airwaves of the university's television station. Eventually, the Computer Information Center and the computer fluency program will impact the entire Grambling State family.

Develop Electronic Classrooms

An increased emphasis will be placed on developing electronic classrooms in all academic buildings. Establishment of full function educational telecommunications service units in support of the university's instructional and research program is the intent of this objective. The term "education" telecommunications is used here to describe the programs and services within the video area that operate primarily in support of instruction and public service.

The "electronic classroom" concept at GSU is the application of technical solutions to the classroom environment for the purpose of increasing the availability and enhancing the presentation of instructional material. Instructors must be provided access to an array of instructional media, including but not limited to, all varieties of video tape recorders/players, laser disc players, video floppy disc players, 16mm film transoptic projectors, slide transoptic projectors, cd-rom file servers, and all forms of interactive video systems. Thus, GSU seeks to facilitate the development of instructional material, custom designed and integrated with the instructor's normal teaching techniques. The electronic classroom concept centers around the development of an integrated information system in an option-laden environment which would compliment and improve modern teaching methodologies. This system will feature a video/audio switch housed in a control room along with a wide variety of source machines and terminal equipment. The control room will serve as a central distribution point for a multi-media delivery system to classrooms equipped with monitors, local inputs, and control panels providing the instructor with full-function control of source machines and communication with the control room. In its initial design, the system will have the capacity to serve up to five classrooms, multiple source machines, and provide access to satellite facilities and cable systems and audio/video teleconferencing. Instructors will be provided full-function control of multiple source machines simultaneously and instructional material may be custom designed and scheduled for presentation. Classrooms will be equipped with an adequately sized monitor with respect to the number of students, a control panel with remote capabilities, telephone access to the control room, LAN access, and capabilities for local input. Some of the classrooms will be designed specifically and equipped for distant learning applications.

Expand the Telephone System

Another emphasis of the new planning cycle for information resources will be on expanding the telephone system to accommodate the increasing demand for on-campus housing and to service new buildings scheduled to come online.

The minor upgrades that have occurred since 1984 and the more recent installation of a fifth node have served as temporary solutions to serious capacity challenges. Currently, the university population is utilizing all 2750 of its available station lines. The university, at this time, cannot provide telephone service to four new dormitories currently under construction--two of which are expected to go online in January 1994.

If the university is to meet the demand for basic telephone service, a new ROLM 9751 Model 50 node needs to be added to the current five-node system. The model 50 will support up to 1100 additional lines and provide the needed capacity to expand service to the new buildings. Acquiring the model 50 will make available ROLM's 9750 series of telecommunications products and will position the university to take full advantage of technological advances not available in the 9000 series. The installation of the 9750 node also will allow the university to install a Voice Response Unit (VRU) to work in conjunction with the VAX 9000 mainframe computer. The VRU will facilitate the automated distribution of selected information via the telephone. Students will be able to call into the system from any touch-tone telephone, enter their social security number, and retrieve selected information stored on the VAX computer. The VRU will provide an excellent avenue for students to obtain the status of their financial aid and can be used in a telephone registration system.

In addition to the new node, the university needs to expand the phone-mail, voice-messaging system. Students should be allowed to subscribe to phone-mail on a per-semester basis. Since voice-messaging is password controlled, the student would not have to reside on campus to take advantage of this technology. Multiple phone-mail boxes can be assigned to a single extension. A voice-messaging system for students will greatly enhance students' ability to communicate with parents, friends, and university personnel.

Implement Energy Management and Surveillance and Security Systems

Although outlined in the original strategic plan for information resources, not much has been done to install university-wide energy management and surveillance and security systems. These projects are, however, still in the plans for the future.

The energy management system is intended to allow centralized data collection and control of energy-consuming devices such as chillers, water heaters, furnaces, and lighting systems throughout the university campus. The data collection and control is to take place using dedicated channels on the SMATV system. The design phase of the energy management system is not complete at this time. It is expected that the design will be completed in 1994.

The surveillance and security system has been designed. Currently proposed is a dedicated fiber optic link to security. The security surveillance video system will provide video signals to the SMATV System Head End in Woodson Hall from surveillance cameras located throughout the campus. In order for the video to be viewed by the security personnel, it must be transmitted from Woodson Hall to the Security Building.

A dedicated fiber optic cable system will be installed to carry the video signals between Woodson Hall and the Security Building. Dedicated facilities are used rather than channels on the SMATV system, as using the SMATV system would allow anyone on campus to view the security video channel. Such a system would not be conducive to good security, as a viewer could tell when a particular camera was not being used and time his actions accordingly.

Cost Estimates

Below is an estimate of the total costs of the network equipment and services to be acquired in future years. The costs noted are estimates only; the system will be acquired under the state bid system and actual network equipment and service costs will vary. The estimates are:

• Network Equipment	$140,285
• Test Equipment	23,325
• Conduit System	66,700
• Security Surveillance System	24,150
Per Surveillance Site	4,800
• Telephone Cable Plant Addition	38,850
• Year 2 Cost Totals (excluding energy management system)	$389,310

CONCLUSION

Given sufficient resources--human, physical, and financial--GSU should be able to cultivate a technological environment second to none in the state of Louisiana. Successful attainment of the six goals proffered for the next five years is certain to move the university closer to its ultimate goal of **creating and achieving excellence in all programs and activities**.

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Wireless Communications - Come in Dick Tracy!

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ABSTRACT

Articles on wireless communications have hit the press in a big way with reports of a fabulous future enabling people to communicate with anyone, anywhere, anytime using any media. Have all our wiring problems now been solved? Do we no longer need to worry about having to install that "expensive" fibre-optics and copper infrastructure? Is the Dick Tracy wrist-watch around the corner?

The University of Toronto's Computing and Communications (UTCC) Division has been monitoring the development of wireless technologies and services over the last two years to determine how these recent developments relate to the University's campus network plan. The physical infrastructure that was chosen to support the long-term goal of integrating voice, data, image, and video on our campus network was, not surprisingly in 1991, identified to be a fibre-optic and copper-based wiring system. In 1993 is this still the right choice?

This paper will introduce the novice to the wireless "lingo", describe some of the various types of wireless communications technologies and services, discuss issues related to the use of wireless, identify opportunities for the deployment of wireless technologies in an institutional setting, and explain what we chose to do about wireless and why. Additionally, predictions for future services based on wireless technologies will be made.

1. Introduction

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This paper will introduce the novice to the wireless "lingo", describe some of the various types of wireless communications technologies and services, discuss issues related to the use of wireless, identify opportunities for the deployment of wireless technologies in an institutional setting, and explain what we chose to do about wireless and why. Additionally, predictions for future services based on wireless technologies will be made.

2. Wireless "Lingo"

The following basic terms are explained for reference purposes.

Spectrum Allocation: Refers to the allocation of radio-frequencies to provide specific wireless services. For example in Canada, the new cordless digital telephone technology will operate in the 944 to 952 MHz frequency range.

Infrared: Infrared enables information to be transmitted through the air using very high frequencies (3 x 10 power 14 Hz). Many VCR and TV remote controls use this technology. Infrared signals behave like visible light and the signals can not penetrate solid objects. Line of site must be maintained in order for communications to take place effectively. The Federal Communications Commission (FCC) does not regulate infrared signals.

Spread Spectrum: Spread spectrum enables information to be transmitted through the air using radio frequencies. The information is spread over many frequencies making the message difficult to jam, and difficult to intercept and decode. Products using spread spectrum do not need to be licensed by the FCC although their use is regulated to prevent interference problems.

Narrowband Microwave: Narrowband microwave is another way in which information is transmitted over the air using radio frequencies. Narrowband microwave products must be licensed by the FCC.

Digital Cordless Telephone (DCT): This is a specification of a personal communications device, the telephone, for use in second generation systems. Some of the air interface standards that are being used or considered for various implementations of DCT are DECT (Digital European Cordless Telephone), CT-2 (cordless telephone, second generation), and CT-3 (cordless telephone, third generation).

Channel Access Standards: This refers to the method in which a wireless device accesses the shared wireless communications channel. Some of the standards that are being used or considered are FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access), and CDMA (Code Division Multiple Access).

Mobility: There may be some confusion over this term. People use "mobile" in different ways. A system may provide mobility in that a person can communicate with this system from various locations (e.g., home, work, shopping mall, etc.). A system may also provide mobility by allowing a person to communicate with this system while literally in motion. The speed at which a person is in movement greatly affects the ability of a given wireless technology to support reliable communications. For example, cellular telephone technology was designed to provide service to a user while traveling at high speeds in a vehicle. Other wireless services may not provide this capability.

Personal Communications System (PCS): PCS is a concept that has many definitions. A reasonable definition is as follows:

Definition: A personal communications system is one which provides universal accessibility to a wide range of voice, messaging, and geographic positioning services, to individuals at home, work, remote locations, or in-transit on a premise [building], local, national, and international basis[1].

Perhaps hidden in this definition is the supplementary concept that a user is assigned a unique, personal identifier that may be used to reach the user irrespective of the user's location. Note that this definition does not refer to how a PCS system is implemented. In particular, it does not mention whether wired or wireless technologies would be part of the system. However, it is clear that wireless technologies have to be part of the system in order to provide the mobile capability for the user. It may be less obvious that wired technologies will still be a big part of providing the PCS infrastructure.

3. What are Some of the Wireless Technologies and Services?

There are a significant number of wireless technologies and services available today. Satellite, cellular, and paging services are available from carriers, although, perhaps not at the "right cost". Private facilities may be constructed using satellite, microwave, and wireless versions of PABX (Private Automatic Branch eXchange), point-to-point modems and LAN (Local Area Network) interfaces.

The variety and quantity of carrier services and products (existing or proposed) are greater in the U.S. and Europe than in Canada. Some of the products that have been developed in the U.S. and Europe may not be usable in Canada, or vice-versa, because they operate in an unsuitable section of the available frequency spectrum. The U.S. and Europe are investing considerable amounts of money and time into wireless R&D, standards, and lobbying (spectrum, licensing) efforts. The Canadian efforts are modest by comparison.

The following existing technologies and services have potential relevance to our University.

Satellite: Many communication services that we use everyday, including cable television and the telephone system, make extensive use of satellite technologies. The use of satellite technologies for private (non-carrier) applications is becoming more pervasive. Examples can be found in the trucking industry (messaging and dispatch), the financial sector (bank branch office connectivity), and education (reception and transmission of educational programs).

Satellite technology has been continuously improved over the years to deal with system limitations, overcrowding of orbiting space, the cost factor, etc. This has resulted in a multitude of services and a diversity of hardware. For example, there are two types of satellite dishes in common use (C-band, Ku-band) and a third type is in the experimental stage (Ka-band). All of these use different segments of the frequency spectrum and have different physical characteristics such as the size of the dish and the power level for transmission. Satellites now come in many flavours such as LEO (Low Earth Orbiting), VLEO (Very Low Earth Orbiting), and GEO (Geosynchronous Earth Orbiting).

1 Dr. K. Murthy, "Personal Communication Systems and Services", IEEE International Conference on Selected Topics in Wireless Communications, June 24-26, 1992.

Microwave: Microwave has long been used, primarily by carriers for long-distance applications. The clutter of the spectrum, wide-spread availability of satellite bandwidth, interference from C-band satellites, and the reliability of optical fibre has slowed the deployment of this technology for traditional applications. A niche market still exists for the local trunking of cellular voice traffic, but the main new applications that have been developed are for short-hop LAN traffic and "private" high-bandwidth (DS1, DS3) communications in intercampus situations.

Cellular: Cellular telephone services have been around for some time and are becoming more affordable. There are plans to upgrade the existing cellular networks from analogue to digital technology to improve the service quality and capacity. DCT may encroach on the market for cellular and other personal wireless services. Only truly mobile users will need cellular so that they may communicate with the network while in motion.

Paging: Paging systems and its variations (e.g., alphanumeric dispatch applications) have seen tremendous growth over recent years as these services have become cheaper and cheaper to use. However, the one-way communications restriction of paging services and the decreasing costs of cellular services will have considerable impact on this market. DCT systems may also provide substantial added function compared to paging systems at a cost that may shrink the paging market.

Private Automatic Branch eXchange (PABX): The potential business applications of cordless telephones were one of the early drivers for the development of wireless voice communications. Wireless PABX enables the user to roam throughout the business site while retaining the features of the PABX (unlike cellular). Additionally, wireless PABX can provide cost-effective, quick, and convenient access for users within new or existing premises that have insufficient wired facilities. Available wireless PABX products are based on proprietary protocols. Some manufacturers are developing products that will support one or more of the various standards (e.g., DECT, CT-2, CT-3) that have been adopted by various interested parties around the world (e.g., Canadian and Swedish governments, European Telecommunications Standards Institute (ETSI)).

LANs: There are a small number of wireless products on the market today that may be used to construct local area networks or pieces thereof. The role that the wireless component takes on in the LAN environment is varied and may differ by manufacturer. A network concentrator, a PC interface, or a LAN modem may all be replaced with wireless "equivalents". The capabilities of these wireless components and the vendor's implementation vary. A key element that should be highlighted is the method used for the transmission. Spread spectrum, narrowband microwave, and infrared are the three commonly used systems. Each system has different operating parameters such as the frequencies used for transmission, the maximum coverage, whether line of sight is required, and whether a license is required.

4. Wireless Issues

The are many technical and non-technical issues associated with wireless communications technologies. Some of the more salient issues are addressed below.

Health Considerations: The primary metric used to measure the health risk of exposure to radiating energy such as is emitted from a wireless transmitter or a video display is based on the ELF (Extremely Low Frequency) rating of the radiating device. None of the foreseeable modulation schemes for wireless technologies use ELF modulation, rendering the current methods of assessing health risks useless for wireless devices. The health issue is very contentious - vendors will need to convince users that their health is not at risk when using wireless devices. In particular, significant research into long-term exposure to low-power, high-frequency radiation needs to be done.

Security/Integrity: The jury is still out on this one. Vendors like to believe that their systems are secure. Users like to prove them wrong. Certainly for some types of wireless systems the security is very weak or non-existent. Other systems are much more difficult to "break" due to the difficulty of

Low Frequency) rating of the radiating device. None of the foreseeable modulation schemes for wireless technologies use ELF modulation, rendering the current methods of assessing health risks useless for wireless devices. The health issue is very contentious - vendors will need to convince users that their health is not at risk when using wireless devices. In particular, significant research into long-term exposure to low-power, high-frequency radiation needs to be done.

Security/Integrity: The jury is still out on this one. Vendors like to believe that their systems are secure. Users like to prove them wrong. Certainly for some types of wireless systems the security is very weak or non-existent. Other systems are much more difficult to "break" due to the difficulty of interpreting or capturing the wireless signal rather than the provision of any intentional security scheme. However, a few systems do claim to provide a "secure" channel intentionally. Unfortunately, one of them, the digital cellular standard IS-54, has already proven to be readily defeatable.

Wireless communications must be secure from the standpoint of eavesdropping and not allow any alteration of the content of the "call". Additionally, the communications signaling and "call" setup must be protected to avoid fraud and abuse. All this must be done without adding features and capabilities that frustrate the rights of the law enforcement and protection agencies. This has already become a big issue with the FBI in the U.S. vis-a-vis the upgrade of telco central office equipment to support advanced services such as ISDN (Integrated Services Digital Network). With this new central office equipment it is much more difficult for the FBI to wire-tap a conversation!

The integrity of a wireless communications session may be affected from outside sources (e.g., radio frequency) whether the interference is intended or not. Furthermore, wireless systems can be influenced by multipath effects, "dead" zones, etc. that may ultimately affect their deployment in some areas. For example, leaded or gold plated glass in buildings could make wireless systems unreliable.

Privacy and Etiquette: The PCS concept touts the ability to communicate with "anyone, anytime, anyplace". While this is an interesting concept it may not always be appropriate. Some people view the beeping of pagers and cellular phones in meetings and in public spaces as an annoyance. User perceptions of privacy and etiquette issues may even be a limiting factor in the market success of some wireless technologies. A parallel in the wired world may be made with one of the new features offered on the Public Switched Telephone Network (PSTN) in the Toronto area. "Call Display", which provides the telephone number of the calling party to a called party, has met with some very negative consumer reaction. The effectiveness of this feature will be greatly reduced if significant numbers of the consumer base refuse to allow their telephone numbers to be transmitted on the network.

Mobility: Distinguishing what is meant by the term mobility is extremely important in the design and expected use of a system. For example, while the CT-2Plus DCT standard allows for mobility, a system based on this standard will not allow a person to communicate with the system while traveling in a car at high speeds.

Spectrum: The allocation of frequency spectrum for wireless technologies is one of the hottest issues. Spectrum is a limited resource. Most of the "currently useful" spectrum has already been allocated. To complicate matters, the assignment of spectrum to specific technologies and services varies from country to country. This will make it extremely difficult to coordinate global services, and in particular, a PCS system. The World Advisory Radio Council (WARC) and the International Telecommunications Union (ITU) are two major players dealing with spectrum allocation and other PCS-related issues, on a global basis.

Contiguous spectrum is another concern. There have been some discussions in the U.S. to move certain technologies to a different area of the spectrum so that large chunks of contiguous spectrum for new wireless services may be allocated. This is extremely contentious as there are differences of opinion on who should pay the bill for such a massive reorganization.

Techniques for the co-existence (same spectrum) of new and current technologies and services are being explored. Compression algorithms to make more effective use of spectrum are being studied.

Licensing: Some wireless technologies need to be approved by a government agency to ensure that the wireless transmitting device will not interfere with existing systems. This can be a very time-consuming venture. For example, one major vendor of wireless LANs encourages potential customers to buy its products by handling the licensing arrangements on the customer's behalf at "no charge".

The method of handing out licenses to carriers so that they may allocate spectrum and provide wireless services is also a hot topic. Spectrum is a scarce resource that is managed by government and awarded to interested parties in some "equitable" manner. There are undoubtedly disagreements with the level of fairness no matter what method is chosen. In the U.S. the hot debate before the Senate as to whether licenses should be awarded by lottery or by auction has concluded. It is expected that the FCC will auction radio frequencies in the 2GHz range for "emerging technologies" in late 1994.

Standards: It took over two years for Canada to decide upon a standard for the radio interface of the portable unit of the DCT. And there were only two standards in the running! There are potentially many standards for the various areas of the provision of wireless services. As in other areas of IT, much work needs to be done to settle on some reasonable standards. Unlike other areas of IT, the diversity and number of players in wireless who have vested interests in standards is huge. And with the eventual goal of PCS, it may be argued that international issues and standards are more of a concern than any other single sector of information technology. Note that some efforts have been made to standardize LAN technology under the IEEE (Institute of Electrical and Electronics Engineers) 802.11 work group.

Bandwidth: As with the wired world bandwidth is always a consideration in the delivery of applications. However, wireless speeds do not compete well with the speeds of their wired equivalents. Furthermore, what is possible to deliver via the allocated bandwidth and what is actually delivered as a service may differ greatly. It is generally believed that wireless networks will not have the bandwidth to deliver multimedia applications to a mobile user within the foreseeable future.

Intelligent Networks: PCS will require an extremely intelligent network to support roaming capabilities and to integrate multiple networks. Such a network will require excellent network management and will be software-intensive. The complexity of the networking software of traditional LANs and the PSTN pale in comparison.

Even in the wireless world of today there are examples of missing features that are provided in the wired world. To take one, some wireless ethernet hub products do not provide any network management capabilities (such as SNMP).

There are also certain aspects of networks that prove to be problematic whether the communications takes place over wired or wireless technologies. For example, network addressing either in wired-based or wireless LANs is not a well structured area.

Reliability/Quality: There is a lot of research being performed in this area. If wireless services are unreliable, or this is perceived to be the case, then the market will not grow enough for the services to be cost-effective. The quality of the wireless channel is also important and should at least meet, or exceed, the standards of the wired equivalent.

The software that is required to keep track of mobile users such that the user may originate or receive a call from "anywhere" is estimated (in current proposals) to be 25% larger than the software proposed for the ill-fated U.S. Space Defense Initiative (SDI). A major reason why the SDI did not proceed into development was the near-universal agreement that the problems of creating, testing, and maintaining software of this magnitude was not solvable at the current state of technology[2].

Cost: While on the surface it may look like wireless communications are more costly than their wired equivalents, this is not always the case. Installing wiring in certain areas within a building or to a building may be nearly impossible or prohibitively expensive. Wireless solutions may also be cheaper when long term network costs are considered. For example, in environments where a structured wiring plant does not exist, it can be very expensive to relocate or install wires when people are moved within the workplace. On the other hand, the complexity of wireless systems may increase overall network maintenance costs.

5. Wireless and the University of Toronto - Institutional Opportunities

Wireless technologies are being used at the University today but with one exception - satellite, these technologies only support the transport of voice or brief alphanumeric text messages. Some thoughts on, and the current status of wireless technologies that are of relevance to the University follow.

Satellite: The University currently has a satellite reception and rebroadcast system which is used to support distance education and conference participation. Two receive dishes, one C-band, the other C-band and Ku-band, are mounted on the roof of a central building on campus. A transmitter is used to broadcast received satellite signals to various locations on campus which have a receive antenna. The demand for this service is increasing.

A need to transmit signals to satellites for distribution to other locations has been identified. For example, the University has hosted several occasions where leased, uplink satellite facilities were used to distribute programs. The possibility of acquiring a permanent uplink facility so that the University of Toronto may be a more active participant in distance learning activities is being investigated.

[2] R. A. Stanley, "Systems Issues in Wireless Communications", IEEE International Conference on Selected Topics in Wireless Communications, June 24-26, 1992.

Paging: Paging systems are used by highly mobile staff within the Facilities and Services (e.g., building property managers) and the Computing and Communications (e.g., field technicians) divisions. These systems provide the ability for a caller to leave a brief one-way voice or alphanumeric text message for the person carrying the paging device. Falling costs for cellular services will eventually replace a large part of this market.

Cellular: As the costs of buying cellular devices decrease, more and more mobile staff are considering using this form of wireless communications. Currently, the cost of using cellular is about an order of magnitude greater than that of paging. Some University staff have replaced their paging services with this more functional but more costly alternative.

Digital Cordless Telephone (DCT): It is unclear when DCT services will become available to our University. Ultimately, the service providers must install infrastructure (base stations) on our campus for the community to be able to tap into a DCT network. The initial offering of this service is likely to include only voice services since voice is the driver of this technology and the largest market. Opportunities to apply this type of wireless technology in the University environment will depend on the service roll-out, the types of services offered (voice, data, facsimile), and the cost of the service as it compares to other services such as cellular, paging, or the traditional wired access.

Narrowband Microwave: This technology is not being used within the University. However, the advent of low-powered microwave and the simplified regulatory process associated with this technology, may provide some opportunities for deploying this technology. For example, the Computing and Communications division has proposed that this technology be used for connections to buildings where it is prohibitively expensive, or next to impossible, to connect the building to the campus network with fibre-optics. Additionally, a project has been launched to connect two remote campuses to the main campus using narrowband microwave facilities.

Local Area Networks (LANs): To the best of our knowledge there are no LANs on campus that make use of wireless products. Providing the ability for students to "roam" on campus, asbestos-related concerns with the installation of wiring, and the difficulty of wiring architecturally-sensitive buildings are a few of the challenges that wireless LAN technology may help to resolve.

General Mobile Computing and the LAN: The cost of purchasing small lightweight computing devices such as laptops and notebooks is rapidly decreasing. Many of the portable devices include "wired" modems to connect to the PSTN. In some niche markets, such as the trucking industry, these devices may have a built-in proprietary wireless modem that makes use of cellular or satellite networks. However, it is currently very difficult, if not impossible, to provide a LAN environment for highly mobile users of these types of equipment. Dealing with the addressing of the network component is a major problem in the wireless LAN. Additionally, providing distributed functions, such as a file system that "follows the user", prove to be problematic.

The common LAN protocols need to be enhanced to allow the highly mobile user to be a participant of the LAN via a wireless service. In the meantime, these users will have to use terminal emulation in conjunction with wireless services to access non-LAN facilities. For example at our University, it may be possible to provide access to our terminal-switched backbone through private wireless PABX or concentrator facilities.

6. The Future of Wireless

Not surprisingly, based on the very large potential market for wireless communications, there is no shortage of standards, implementation proposals, architectures, grand architectures, and suggested evolutionary steps being proposed by a host of players, nationally, internationally and globally. Most of these proposals are <u>intermediate</u> steps to the ultimate in wireless communications, a Personal Communications System (PCS).

The wireless systems that exist today are categorized as "first generation" or "second generation" systems. These generations differ in their capabilities and in the ability to deliver a PCS environment. Third generation systems are being researched and are not publicly available (although there are some trials in progress). It is not known how many generations will be required to reach the goal of a PCS system but it is unlikely that "n=3" will get us there.

Digital Cordless Telephone (DCT): The Canadian Department of Communications (DOC) recently approved the technical standard CT-2Plus for the radio interface of the wireless telephone handset. This standard is based on digital communications and will allow for a much more reliable and noise-free communication channel than the current analogue wireless telephone (a first generation system). In the U.S. there is no movement to select a standard for DCT.

Third Generation Systems: Third generation systems could add significant improvements in functionality to the second generation systems. Five of the key areas being researched are bandwidth, compatibility with multiple wide-area networks, true mobility, the provision of an intelligent network infrastructure, and the provision of new services such as data and video.

Personal Communications System (PCS): PCS will be an evolution of existing and future services and not an outright replacement of existing technologies. Some suggest that a PCS will be available in the year 2000. While it is true that forms of PCS, based on one's definition, will exist over the next number of years, it is extremely unlikely that a PCS that is ubiquitous, seamless, and provides multimedia capabilities, will be in place by the year 2000.

The Author's Predictions: Predicting the future of wireless communications is a very onerous task. Wireless technologies and services are expanding in scope with the ultimate goal of providing a PCS. The number of stakeholders is increasing dramatically. For example, in the U.S., over 250 companies have shown interest in wireless communications by requesting test licenses for PCS trials. Recently, there was a "merger" of a very large U.S. telephone company and a cellular telephone company which some industry analysts believe has a good chance of resulting in a defacto standard for wireless communications in the wide area environment. Of course only time will tell.

It is likely that wireless technologies and services will polarize around two important markets - the application of "fixed wireless" in situations where installing wiring is not possible or is expensive, and the application of wireless to provide mobility. Initially, the driver for the former will be connecting machines to networks. The latter will be driven initially by voice applications and some use of low-speed, terminal emulation data applications. In both cases, in the U.S., there are no wireless standards and this will result in incompatible networks and customer equipment. Wireless will be more expensive than "wired" until the customer base is large enough to drive down the costs of manufacturing wireless equipment, and, the cost of sharing the network infrastructure. Once the standards obstacle is overcome there will still be the issue of network provisioning. This will be more of a problem for the mobile market than the fixed wireless types of applications. Wireless networks will first be installed only in high-traffic corridors and large cities since the potential for revenue is higher in these areas. We have already seen this phenomenon with the cellular telephone. While various forms of PCS will exist over the next few years, the required integration of multiple media and the geographical coverage that will make the Dick Tracy wrist-watch a reality, will not occur before the new millennium.

How will this affect using wireless in an institutional setting? The answer is unknown and is one of the reasons as to why the following recommendations were made.

7. Recommendations - What We Chose To Do About Wireless and Why

Based on the current status of the various wireless technologies and the opportunities that may exist within our University for the deployment of wireless technologies and services, we recommended that:

1. *Basic Infrastructure:*

- we make use of proven wireless technologies, where appropriate, for basic (physical) infrastructure (e.g., cost-effective application of microwave facilities for the "hard to reach" buildings and for intercampus connections).

- we investigate or implement a pilot use of emerging wireless technology for basic infrastructure (e.g., wireless LANs).

Why? A stable, proven technology such as microwave is a good candidate for providing basic connectivity to buildings that are difficult to connect to the campus network via wiring. It may be possible to connect some of these buildings using infrared or spread spectrum technology but the few products that are available to implement these types of connections have met with mixed success. On the other hand, there is great potential in using wireless technologies to form fixed LANs where installing wiring is not possible or the costs are prohibitive. We have had no real experience with wireless LANs. A pilot implementation would give us the opportunity to understand when and where to use this technology.

2. *Wireless Services and Applications:*

- we continue to make use of proven wireless services and applications where appropriate (e.g., paging/cellular services for campus dispatch, support of highly mobile University staff).

- we continue to monitor emerging wireless services and applications in the University context (e.g., DCT services for campus dispatch, personal security).

Why? Wireless services such as cellular and paging are well established and provide a reasonable level of service to highly mobile staff. New services, such as DCT or digital cellular, which will become available in the short term, may provide added function such as wireless data access to mobile staff and students.

8. Conclusion

While there have been forms of wireless technologies around for years (e.g., satellite television, analogue cordless telephones) the true potential of wireless has not been tapped. Major issues such as spectrum allocation, standards, and government policies need to be addressed and resolved before this burgeoning technology can begin to realize its full potential. This area of information technology is undergoing rapid growth resulting in a plethora of wireless technologies and potential services (and a lot of confusion!). Vendors, governments, researchers, carriers, and "educated" consumers all agree on the vast potential markets and economic opportunities that exist for wireless. For example, the Canadian government believes that the research, products, service development, etc. that will be made possible due to the recent selection of the CT-2Plus DCT (Digital Cordless Telephone) standard for cordless telephone service in Canada, will position Canada as a significant player in the global production and deployment of wireless technologies and services. However, there are a lot of stakeholders in wireless and if the Canadian experience of deciding upon a standard for DCT is any indication, it will take time and a lot of hard work for wireless services to become pervasive and cost-effective.

In this vein, it should be stressed that there are wireless products and services that exist today. However, most of these products and services (with perhaps the exception of cellular) are either too expensive, limited in geographical coverage, or just too limited in function to be used as the primary method of allowing people and/or machines to communicate with one another. This is not to say that wireless is not being used cost-effectively in certain niche markets. There are many examples where wireless is quite cost-effective. Two prime examples are the delivery of POTS (Plain Old Telephone Service) to rural areas, and the provision of local area networks in large open areas where workers are relocated frequently.

In conclusion, our wiring "problems" are not going to be solved by wireless communications in the foreseeable future. The typical wired campus plant provides much better bandwidth, reliability, and coverage than the wireless alternatives that exist today. Wireless communications does have a role to play on campus in serving highly mobile staff. Fixed wireless LANs will become popular through the use of the IEEE 802.11 wireless LAN access protocol standard. As can be seen from the number of issues that need to be addressed, the scale of the effort required to provide a personal communications system, and the vast number of parties competing to provide a PCS, the Dick Tracy wrist-watch is not around the corner.

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VOICE, VIDEO & DATA BACKBONE NETWORK PROJECT IMPLEMENTATION

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Abstract:

Monroe Community College is committed to the strategic goal of the advancement of technology within the institution. To that end, the College has actively promoted the use of information technologies throughout the academic and administrative communities of the College.

MCC is challenged with supporting an anticipated four-fold increase in demand for voice, data, and video services as a result of a steady and dramatic increase in the overall student population, additional campus locations, and an increased use of network services for instructional purposes.

It is the College's desire to support this increase in demand, and the need to interact and share information between any device, anywhere, by enhancing the College's current network environment through the implementation of a new, high speed integrated college-wide voice, video and data communications backbone network capable of supporting a wide variety of communications technologies and protocols.

MCC is underway with implementation of this project, and would like to share our experience with others who are interested in pursuing implementation of an integrated network environment. The presentation will highlight a historical summary of the network, including where the institution was when the project began, where it is now, and where it expects to be when the project is complete.

INTRODUCTION:

Monroe Community College was founded in 1961, and is one of 30 community colleges within the State University of New York (SUNY) system. It is the largest community college upstate, with 14,000 students enrolled in credit courses in a multi-campus environment. The College employs approximately 734 faculty, and 514 administrative personnel. The College is committed to it's strategic goal to support it's population in the use of information technologies, and to promote the advancement of technology within the institution.

The College is challenged with supporting a four-fold increase in demand for voice, video, and data services as a result of a steady and dramatic increase in student population, additional campus locations, and an increased use of network services for instructional purposes. Space constraints mean that departmental networks will continue to spread out to various buildings on the main and downtown campuses presenting additional challenges. Trends confirm that there will continue to be a growing need to share information between a diverse set of computing platforms. This challenge is further complicated by the need to plan for the possibility of locating more college facilities throughout the county.

It is the College's desire to support this increase in demand through the implementation of a high speed College-wide voice, video and data communications backbone network capable of supporting a wide variety of communications technologies and protocols.

MCC is well underway with implementation of this project in a phased approach. It is the intent of this presentation to share our experiences in implementing the various phases of the project with others who are also interested in pursuing implementation of an integrated backbone network environment. This presentation will highlight a historical summary of the network and its design, including where the institution was when the project began, where it is now, and where it expects to be in a few years.

HISTORICAL PERSPECTIVE OF MCC NETWORK ENVIRONMENT

Before implementation of the fiber network, voice and data communications connectivity utilized separate cabling systems. Voice communications in the late 1980's were completed through the utilization of a ROLM Computerized Branch Exchange (CBX) 8004 telephone switch which serviced approximately 830 stations and 100 trunks in an analog environment. Systems administration was very cumbersome, and most service on the infrastructure was outsourced to a vendor (very expensive). Due to capacity constraints of this analog switch, incoming calls were blocked (often busy) during peak times. This switch also maxed out growth potential for additional users.

In its earliest configuration, data communications were carried out on a one-to-one basis utilizing "miles" of coax cable. 32 cables were run from each of the Computer

Center's workstation control units to 32 user workstations. This configuration eventually evolved to a 1:8 ratio by running 4 cables from the control units to multiplexors located in user areas supporting 8 users per multiplexor. This cabling process was costly and inflexible, and sometimes required months to complete requests for adding new data users. In addition, a finite number of mainframe computer ports required prioritization of which users would be fully cabled and connected.

A second connectivity method required purchase of a microcomputer, modem, communications software and a dedicated telephone line for dial-up capability to administrative or academic computing systems. Providing modems for each end user requiring connectivity became a costly operating budget expense. Response time using a modem was slower than direct cable connects, and resulted in loss of user productivity. Authorizing new user connections to MCC's computer networks was time-consuming, inflexible, costly and involved a myriad of college personnel (e.g. electricians, data technicians, systems administrators, etc.).

All of the issues related to providing timely, cost-effective service to our voice and data customers were culminating in a poor image problem. Customer service had to be improved, and the philosophy of "Do More with Less" had taken hold across the College. This crossroad led us to develop and propose a long-term strategic plan for voice, video and data technologies. It is what we later referred to as MCC's Backbone Network Project, phased implementation plan:

PHASE I	DIGITAL SWITCH IMPLEMENTATION
PHASE II	DATAPHONE AND MODEM POOL IMPLEMENTATION
PHASE III	CONSULTING SERVICES
PHASE IV	CURRENT STATUS OF THE PROJECT
PHASE V	FULL IMPLEMENTATION OF THE PROJECT
PHASE VI	PROJECT EVALUATION AND RECOMMENDATIONS

PHASE I -- DIGITAL SWITCH IMPLEMENTATION

In 1990, the College began investigating a new telephone switching system to replace the aging analog telephone system in an effort to alleviate the problems noted above. The College was convinced that by replacing its analog telephone switching system, it would realize a substantial cost savings versus upgrading the old system. A new digital switch would provide the college with the ability to implement other beneficial, cost-saving technologies and strategic initiatives such as telephone registration and other voice applications.

In line with the College's strategic goals for advancing technology and providing end users with state-of-the-art equipment and access, the Telecommunications and Information Services Departments installed a ROLM 9751 telephone switching system. This switch has full digital capability supporting synchronous and/or asynchronous data communications, centralized inbound/outbound modem pool access, a common dialing plan for off-campus sites, data group access and compression video support.

Advantages of the ROLM 9751 CBX telephone switching system include:

- Potential data communication through utilization of existing twisted pair cable located where ever telephone service was available. This was accomplished by connecting a PC with a RS-232 interface to a voice line plug for data communications;

- Office moves could be accomplished with no additional cabling, though charges for software changes in the CBX were still incurred. As we trained in-house staff to perform this software change function, associated costs were minimized;

- Ease of problem resolution through single vendor commitment to design, implement, train and support MCC staff for one year;

- Through standardization on level 3 and level 5 UTP cable, redundancy is built in. If one line goes bad, additional lines can be used for other data applications (i.e. LAN, Video, Print Sharing);

- Elimination of duplicate cabling for voice and data applications;

- Ability to establish management controls for user functionality;

- Voice mail capabilities.

PHASE II -- DATAPHONE AND MODEM POOL IMPLEMENTATION

Installation of the ROLM 9751 CBX digital telephone switching system paved the way for the College to implement a dataphone network which accommodated an escalating number of computer users, located on two separate campuses, requiring access to a myriad of on and off-campus hosts. It also allowed the College to incorporate an inbound and outbound modem pool.

The inbound modem pool allows users off campus to connect to a variety of on-campus hosts and services. The outbound modem pool allows users on campus to gain access to computing resources located off-site. The modem pools utilize ROLM Data Communications Modules (DCMs) to establish connectivity to the ROLM 9751 CBX telephone switching system.

Access to modem pools is accomplished through a user-friendly, ubiquitous menu system which requires minimal training of about one hour to become functional. Modem pooling has resulted in college-wide standardization of communications software, and a reduction in equipment expenses by eliminating the need for individual modems at each end user workstation.

The dataphone network utilizes the digital ROLM 9751 CBX switch as the hub, together with data phones at end user microcomputer workstations, providing asynchronous connectivity to various host computer systems on and off campus. With this application, the College utilizes existing unshielded twisted pair (UTP) cable to provide simultaneous voice and data transmission capability from the end user's data phone and workstation.

To place a call through the dataphone network, an end user first activates communications software on their microcomputer workstation. The switch displays a Call, Display, Modify prompt at which time the user types a call command and group name. The call proceeds through the telephone switch to the data group, and the DCM connects the call to a port on the remote system.

The College has realized several benefits as a result of this phase of network implementation, primarily in the area of end user productivity:

- Increased accessibility for end users, while at the same time drastically reducing hardware expenditures and implementation time;
- Users call host computing systems at a speed of 19,200 baud, faster than any modem currently available at the College;
- Improved College-wide communications by establishing connectivity to electronic mail systems and wide area networks;
- Increased portability by allowing users to relocate between various college campuses and offices, and resume access to the network in a timely manner. The end user simply takes their dataphone and workstation with them, reconnects the hardware, and requests minor software changes from the Telecommunications Department to complete the access path;
- Reduced turnaround time for such moves to less than 24 hours;
- Eliminated need for dual workstations (i.e. PC and non-intelligent terminal). PCs are becoming the standard workstation, providing access to more productivity tools.

The technology continues to be utilized as new users are added to the communications network system. The dataphone network effectively provides connectivity to occasional users of the computer systems in a user-friendly, cost effective manner. These users are satisfied with connectivity, and ease-of use of the dataphone network. Heavy users of the computing systems achieving connectivity through the dataphone network, have experienced degradation -- slower response times. In these instances, non-intelligent terminals or 3270 emulation connections for microcomputers are recommended, though it is a more costly connectivity method.

FINANCIALS ASSOCIATED WITH PHASE II

I. PRE-DATAPHONE NETWORK

MAINFRAME CONNECTION METHOD COSTS
DIRECT-CONNECT VIA NON-INTELLIGENT TERMINAL

LABOR Electricians, Systems Analyst, Facilities Management, Technical Support and Information Services Management	**COST PER CONNECTION** ***$155***
EQUIPMENT Multiplexor, Cable, Cable Ends, Control Unit (leased), Control Unit Maintenance (leased), Terminal (leased), Terminal Maintenance (leased)	***$722***
TOTAL	**$877**

MAINFRAME CONNECTION METHOD COSTS
INDIVIDUAL MODEM AND PHONE LINES

EQUIPMENT Modem, Telephone Line Installation, Labor, RS-232 Cable	**COST PER CONNECTION**
TOTAL	***$835***

II. DATAPHONE NETWORK

LABOR Systems Analyst, Telecommunications	**COST PER CONNECTION** ***$66***
EQUIPMENT Data Phone/Power Pak, RS-232 Cable, Modem Pool Costs, Surge Protector	***$391***
TOTAL	**$457**

III. COST COMPARISON

METHOD	PRE-DATAPHONE COST	DATAPHONE COST	SAVINGS PER CONNECTION
DIRECT CONNECT	$877	$457	$420
DIAL UP	$835		$378

The initial direction of the dataphone network was to supply connectivity to the "casual user". Expectations have been surpassed. MCC's technology goal is to forge ahead with emerging technologies, therefore we have determined the criteria for a dataphone connection to be a casual user versus heavier users of various systems. The modem pools have also exceeded our initial expectations. The trend for end users to access remote hosts has become an emerging arena. Due to this growth in off-campus network access, we are utilizing the technology of modem pools, and promoting a cost reduction in modem purchases for each user.

The dataphone network served as a fundamental stepping stone on the road to a complete voice, video and data backbone network, and went a long way in providing end user connectivity to various hosts. However, the problem of anywhere-to-anywhere connectivity for hosts and workstations still needed to be addressed.

PHASE III -- CONSULTING SERVICES

In 1992, Monroe Community College released a detailed bid request for consulting services regarding the design of a voice, data, and video cabling (Backbone) system to provide these services.

The Consultant, Rotelcom, located in Rochester, NY, completed an extensive review of all college facilities, existing cabling systems, existing computing, telephony and video support services, and the (then known) needs/wants/desires of staff, faculty, administrators.

Using the collected information, a final report recommendation for a college wide backbone system was released, including:

1. Recommendations for each building's cabling design and cost estimates to install the system;
2. Route drawings for installation of the backbone;
3. Material and installation specifications;
4. A phased implementation recommendation;
5. Finally, the ideal voice, data, video infrastructure recommendations for MCC.

The Recommendations:

VOICE

Much of the voice (telephone) network at MCC was relatively new, and had been designed to complement an integrated backbone implementation.

Briefly the recommendation outlined:

1. Standardization of telephone switches at non-compliant sites;
2. Standardization of phone mail;
3. Implementation of Automatic Call Distribution (ACD) for high-traffic areas;
4. Standardization of cable types between buildings and to the desktop.

DATA:

Topology: Physical Star/Logical Bus (10BaseT Ethernet). This physical design dramatically improves network management capabilities, and reduces failure points. The vast majority of backbone designs utilize this topology.

Media: The above design is essentially a point-to-point design, allowing inexpensive level 3 and level 5 twisted-pair wiring to be run from the hubs to the workstations. Fiber optic cable will be run between hubs and to high-bandwidth areas (conference rooms, classrooms, etc.), which also provides redundancy and eventual implementation of FDDI or ATM.

Access Method: In order to provide the most standard connectivity both internally and externally, both the MCC Committee overseeing the project, and the Project Team recognized TCP/IP as the predominant choice of access methods.

VIDEO

While there is much activity in the video products marketplace in 1993, this area is in its infancy with respect to backbone designs. Compressed video and digital transmission are several years away from economical maturity.

With that in mind, the team had presented both short-term and long-term recommendations:

Short Term (1-2 years) distribution to classrooms will continue to utilize much of the existing CATV cable that is in place.

Short Term distribution to offices will be accomplished via compressed video over unshielded twisted pair wiring (UTP) utilizing the ROLM switches.

Long-Term (3+ years) distribution to strategic areas will utilize the fiber optic cable being run to those areas.

Long-Term distribution to offices will be accomplished via an ethernet network, using PCs as the vehicle.

PHASE IV -- CURRENT STATUS OF THE PROJECT

Computing is a fundamental problem-solving tool at the College. The College community uses computing for word processing, computation, modeling, simulation, computer-based instruction, and problem solving. Today, the College community routinely uses information systems, external data bases, electronic mail and office systems for instruction, research, student services and administrative services.

In 1992 and 1993, the College experienced a dramatic increase in the number of facilities it had to support. The additions included a downtown city campus, two new main campus buildings totaling 120,000 square feet, and extensive renovations of existing space. This paved the way for the College to implement a portion of the recommendation of the consultant's backbone study.

Administrative computing functions of the College are currently supported with an IBM ES/9000 Model 210, two VAX 3100 minicomputers, three RS/6000 computers and a 9751 Model 50 ROLM CBX switch in support of voice/data networking. Instructional and Academic Computing support has migrated from an IBM mainframe computing environment to distributed workstations, microcomputers and DEC VAX mini computers. Enhanced academic management support capabilities are also provided through an IBM RS/6000 platform. The College is part of a beta group of four SUNY colleges to participate in a SUNY-initiative to implement a state-wide, automated library system on a VAX mini computer platform.

College-wide access to the diverse computing platforms noted above is accomplished through an infrastructure consisting of a dataphone network, a SNA network, and an administrative ethernet network. The key objective of these networks is to bring computer accessibility to the desk tops of faculty, staff and administrators in a user-friendly environment. The flexibility, efficiency and cost-effectiveness of this network has contributed to the successful implementation of a number of strategic applications for the College.

The SNA Network consists of the IBM ES/9000 with ten 3174 locally attached workstation controllers, each with 32 ports and a 3720 front end processor for remote site access. A variety of terminals and microcomputers with 3270 emulation cards connect to the terminal controllers through RJ62 coaxial cable and UTP.

The Ethernet Network consists of fiber optic cable and thick wire coaxial cable which allows access to all computing platforms. As recommended by the consultant, the network is designed as a physical star/logical bus topology. Primary points of connectivity include the hub at the Main Distribution Frame (MDF); the Computer Room; and the campus Library. The Damon City Center campus is linked to the main campus networking environment via a Bridge and public T1 leased lines. Currently the network uses a variety of Synoptics hubs and high speed megabyte networking functionality to provide connectivity to multiple computer platforms and host systems.

Today, by strategically placing the fiber optic cabling, we have effectively linked users on MCC's main campus and the Damon City Center campus to the networked environment. With the addition of Synoptics network equipment, we have implemented network management in a way to set the platform for future growth and migration from the existing network to a comprehensive voice, video and data backbone network.

The final backbone network will be capable of supporting all existing computing systems, and provide for an orderly conversion to future computing systems. The installation investment would allow support of multi-vendor solutions, inter-operability among diverse computers and networks, and provide solutions that could deliver savings, as well as productivity enhancements.

STRENGTHS AND WEAKNESSES OF CURRENT NETWORK

Strengths

- Increased accessibility for end users in a user-friendly environment;
- Reduction of hardware expenditures and time to install new users;
- Decentralization of data processing applications for a wider spectrum of users (promotes rightsizing);
- Improved College-wide communications by establishing connectivity to electronic ail systems, and wide area networks (BITNET, INTERNET, SUNYNET);
- Ability to allow users to physically relocate between various college buildings easily and resume access to the networks within hours;
- New users require minimal training (1 to 2 hours) to become functional;
- College-wide standardization of communications software, with fewer steps required to access wide area networks;
- The network provides for sharing resources and faster communications for intra- and interdepartmental data sharing;
- Improved data accuracy by elimination of redundant entry of data;

- Reduced obsolescence through the ability to tie older and new equipment together via the network;

- Improved network management of information systems.

Weaknesses

- Due to a lack of standardization of computing platforms, the proliferation of networks, equipment and software from a wide variety of vendors has led to incompatibility/interconnectivity problems;

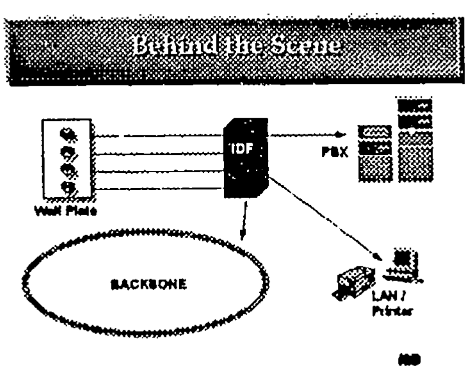
- End users not geographically located near an active Synoptics hub in an Intermediate Distribution Frame (IDF) could not easily gain access to the Ethernet Network;

- High startup costs associated with Ethernet implementation.

PHASE V-- FULL IMPLEMENTATION OF THE PROJECT

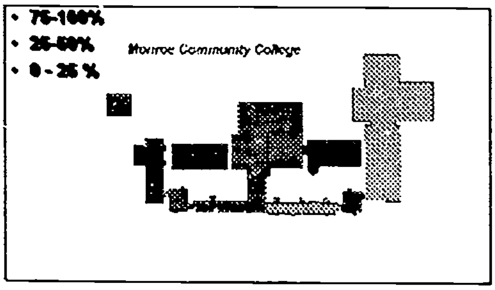
Even as MCC plans to implement the final phase of the College-wide backbone network, most of the original design and installation of the network is still working satisfactorily. This phase of implementing the entire backbone infrastructure will have to meet the bandwidth demands of the growing numbers of users, and the requirements created by more sophisticated network applications.

Utilizing the consultants study and report recommendations, the College has begun to fully implement a backbone network with a physical star/logical bus 10 BaseT ethernet topology using DECNET, Appletalk, and TCP/IP. We have migrated from expensive workstation coax cable custom links to host resources, to a less expensive level 3 and level 5 twisted pair wiring run from the hub IDF/TER to the workstation. Fiber optic 12 and 24 strand multimode cable inter-connects college buildings and floors.



This illustration depicts the standard quad plug located on each wall for voice, video and data communications connectivity, and the wiring scheme followed to connect to the backbone.

Current Backbone Installation



This slide indicates the extent to which we have already implemented fiber cable between and within college buildings. The completion date for full backbone access in all areas of the College is August, 1994.

PHASE VI -- PROJECT EVALUATION AND RECOMMENDATIONS

We believe the benefits of implementing a backbone network infrastructure outweigh the disadvantages A carefully planned, phasing-in of connectivity techniques, such as we have reviewed in this presentation allow as-needed growth in a cost-effective manner. A needs analysis is absolutely necessary and will identify the need for resource sharing, access to remote hosts for research, e-mail, file sharing, etc. The tools are placed on the desks of the staff who will benefit the most from them. The benefits lead to improved customer service.

Recommendations we leave with you are:

1. Carefully benchmark and plan your backbone network implementation. Use the findings of a needs analysis to provide direction; and

2. Do not reinvent the wheel. Yes, your environment is different from ours, however, the method or process used to sell the concept of a backbone network, to implement it in a phased approach, and to evaluate results are generic and could be adopted to your needs.

Some College/University Roles in the Transition to an Information Age Society

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Abstract

New York State, like most states, is reeling from the on-going effects of national (and global) changes. Major businesses are still "rightsizing," some military bases are scaling back or closing their facilities, defense-oriented industries are seeking new applications of their product or service capacity, rural sections of the state are continuing to lose agriculture and heavy manufacturing as a base of employment. In this period of transition, the public sector (e.g., state and local government, education, health and social services) is doubly confronted with a diminished tax revenue and an increased need to supply services.

The State University of New York (SUNY) is now focusing on how it can help meet state needs. In one facet of this effort, SUNY has spearheaded an assessment of information technology and telecommunications as a facilitating vehicle to "re-engineer" the public sector in the Information Age. In December 1992, a task force from government and education produced a report that outlined a vision and a strategy in which the educational community of the state could be "anchor tenants" of "open" community networks that could be linked together across the state and with the envisioned "super digital highway" across the nation, the National Research and Education Network (NREN).

This vision and strategy was carried forward as the starting point for the Public Sector Task Force of the Governor's "Blue Ribbon" Telecommunications Exchange, a group of key leaders drawn from both the public and private sector to examine the state's telecommunications and recommend directions for its development. This paper summarizes these efforts from the viewpoint of higher education. It outlines some roles that we can play in creating the National Information Infrastructure, and it outlines briefly some pilot projects now underway in New York to apply advanced telecommunications in telemedicine, distance learning, library access, and the creation of community networks to promote improved access to the public sector of the state.

Some College/University Roles in the Transition to an Information Age Society

Introduction

Over the past six years, SUNY has been an active participant in establishing and furthering the development of a state-level organization of public officials concerned with information management, policy, and technology. At this time, some 65 units of state government (including virtually all the executive agencies and statewide public authorities, the court system, the State University, and both houses of the Legislature) are represented in the New York State Forum for Information Resource Management (the **Forum**). In May 1991, at the request of New York State's Division of the Budget, the Forum formed a Telecommunications Task Force to examine the strategic role of telecommunications for the state. It was my distinct privilege to chair that task force effort and present our findings in a report published December 1992.[1] We believe this effort aligned well with other assessment initiatives to prompt Governor Mario M. Cuomo to deliver the following points in his 1993 "State-of-the-State" address:

- *To make sure we are prepared to seize the opportunities presented by telecommunications technology, I established a Telecommunications Exchange ... bringing policymakers together with industry, users, and other interested groups ... to develop ... a comprehensive State strategy for telecommunications.*

- *I will ask the Board of Regents, the State University, and other appropriate agencies to develop and implement an integrated statewide telecommunications system that will extend advanced voice, video, and data networking capabilities to every student, teacher, researcher, and librarian in the State. [This initiative included the development of] ... a capital financing plan ... to enable public and private schools, colleges, universities throughout New York to develop on-campus networks to allow students, faculty, and researchers to benefit from advances in telecommunications, high-performance computing, and networking.*

- *As State and local government push to make gains in quality and efficiency, they are just as hungry as the private sector for the benefits of modern technology ... To make sure New York continues to lead in this field, we will set up a Center for Technology in Government to pursue creative new ways of applying technologies directly to practical problems of information management and service delivery in the public sector — focusing on increasing productivity, reducing costs, increasing coordination, and enhancing the quality of government operations and public services.*

The state did establish the Center for Technology in Government at the State University Center at Albany. The remaining initiatives cited in the Governor's address have been folded into the activities of the Telecommunications Exchange.[2] The "Task Force on Public Sector Applications" was co-chaired by Robert B. Adams, the NYS Commissioner of General Services, and D. Bruce Johnstone, Chancellor of the State University. Task Force members were the NYS Commissioner of Education, the Deputy Commissioner of New York City Public Schools, and the Executive Director of the NYS Association of Counties. I was pleased to serve as their chief staff resource and the Forum's report was adopted as the starting point of our deliberations.

This paper summarizes the key findings of these studies, some of the major recommendations, and highlights the rationale for the proposed strategy to create New York's infrastructure for the 21st Century. We believe that the state's recommended program of telecommunications development can further the Clinton/Gore Administration's action agenda for advancing the

National Information Infrastructure. Most important, it is vital to recognize that the public sector is both a beneficiary of and an instrument for this development strategy.

Statement of the Problem

In Governor Cuomo's prior (1992) State-of-the-State presentation, one of the major concerns was that:

> *"... more and more Americans are losing their place in the income-earning, and therefore, tax-generating - sector of our population. Instead, they must rely on Government for support."*

This address cited the problems of growing unemployment, that more people are without health benefits, and that more families live in poverty than ever before in our history.

As we approach 1994, the national trend has placed even more families under the poverty rate; unemployment and underemployment continues; with a new phenomenon ... the "disposable worker" now on the scene. Major industries are still "down-sizing," some military installations are being eliminated, and many of the defense-related industries need to shift to new avenues of work. In rural areas of the Great Lake states, agriculture continues in its decade-long decline; many heavy industries are scaling back production or entirely closing down, creating pockets of unemployment, declining public school systems and health services.

The Forum's report had asserted that -

> *New York is now facing one of the most difficult challenges in decades. The fundamental problems do not stem from a transient economic downturn. . The nation, itself, is griped in a shift in global economics, resource uses, environmental concerns, and cultural changes. While business and industries are "re-engineering" themselves to become more competitive and profitable in this new age, government will be severely stressed during this period of transition. As corporations "downsize" and people lose their jobs (or fail to find appropriate work for their level of experience and education), the public sector needs to increase:*
>
> - *citizen's access to education, training, health care, food and shelter,*
> - *support for business start up and development,*
> - *maintenance of infrastructure to attract new industries*
>
> *while it tightens its belt to reduce the tax burden on the people and corporations in transition.*
>
> *With few exceptions, this challenge is beyond the labor intensive efforts of existing public sector operations* ***unless profound changes can be made in how these services can be provided.*** (p.3)

Fortunately, one of the root causes in the economic shifts taking place may also provide the opportunity for the public sector to re-engineer itself and meet these challenges of the 21st Century.

Over the past 30 years there has occurred a dramatic convergence in computing and communications technologies. These advances have entirely changed the way information can be generated, collected, analyzed, and utilized. The "information revolution" has opened global financial trading, revolutionized modern university research, transformed manufacturing with computer-aided design and plant processes, and, in general, is touching every business and industry throughout the world.

These same technologies have direct application to the information-intensive activities of education, health care, and government. It may be plausible to collect and preserve vital information electronically and share both the information and information resources (specialized hardware, software, and staff) between and among state and local government, secondary and higher education, and between the public and private sector to reduce costs of operations and increase the quality and timeliness of the results.

While the academic community may take some pride as "pioneers" in advancing the Internet as an "open digital highway" across our campuses, it is evident that we are no longer the only participants in shaping the new electronic frontier. The "commercial internet" is now growing at a higher rate than the NSFNET/Regional Internet. There are almost daily newspaper headlines featuring yet another announcement of corporate mergers and acquisitions (such as the U.S. West investment in Time-Warner, AT&T's intended purchase of McCaw Cellular, NYNEX bidding for Paramount, and the Bell Atlantic announced $30 billion acquisition of Tele-Communications Inc. and Liberty Media). The Fall *CAUSE/EFFECT* Current Issues article noted that there are "... profound opportunities ... to harness information technology for the benefits of society, [but] ... history reminds us that technical innovation and market forces alone may not unlock this potential fully for the public good."[3] A major issue will be to find an appropriate balance between the need to stimulate the "Information Marketplace" to create jobs and new business opportunities, with the evident need to bring the fruits of these technological innovations to the benefits of all sectors of our society.

Conclusions of The "Telecommunications Exchange and the Public Sector Task Force"

The major conclusion of the Governor's Telecommunications Exchange is that the state must move from a framework of telecommunications based on a regulated monopoly to one stimulating competition and innovation in the private sector. The critical centerpiece of a competitive telecommunications environment will be to foster an open "network of networks" in which any provider can participate and through which end users can seamlessly and transparently access or move any information (audio and visual) any place. Government, however, must remain an active participant in this transition to both stimulate and guide the process when necessary and to ensure that the results benefit all sectors and communities of the state.

The Clinton Administration is now also pressing forward with a program plan to stimulate the private sector's investments to create a "Network of Networks" as the underpinnings for a National Information Infrastructure. The shifting policies at the federal level are not only evident in activities of the Federal Communications Commission (FCC), but now encompass programs (particularly in the area of health care, education, and access to government information and services).

It is most likely that the National Information Infrastructure will be built on **existing local, "community networking infrastructures"** (e.g., local telephone systems, cable TV, cellular outlets, and alternative metropolitan networking providers). Thus the national program must be built on state efforts to accelerate their internal telecommunications infrastructure against global networking standards.

The telecommunications report to the Governor will not only set the direction, but can give the Governor the direct means for accomplishing the objective. State government and higher education are not only major beneficiaries of advanced telecommunications, they can be the state's prime instrument for developing its infrastructure for the 21st Century. The public sector of New York, by design, is located in every community of the state. As a workforce, it is also the single largest employer in the state.[4] State government and higher education, alone, now operate major television, telephone, and data networks that span the state; touching every local telephone exchange, many of the franchised cable TV outlets, and most of the national telecommunications providers.

By focusing the programs of the public sector, that now use (or could benefit from) advanced telecommunications, New York would create an enormous market potential to accelerate the roll out of the private sector's investment in modern communications. Most importantly, by the state's public sector adoption of "open" networking standards[5], it also sends a dramatic signal to the vendors serving the state of our intention to move away from proprietary products and services that will not contribute to the advancement of the state's open information architecture.[6]

Program

It is necessary but not sufficient to only accelerate the development of new telecommunications technologies across New York. This state must be proactive in applying the emerging infrastructure to the critical needs of its citizens and industries. Qualified workers need jobs that provide adequate compensation and opportunity for growth. Industries need access to a qualified workforce, an adequate infrastructure of telecommunications, and other supporting services to enable them to compete in the dramatic shifts taken place around the world. New York needs to have more of its citizens producing (rather than receiving) benefits for communities across the state.

Since people live, work, and seek much of their education, recreation, and services in communities, these geographic areas (urban, suburban and rural) are basic foundations for telecommunications initiatives. Figure 1 illustrates one view of the "networked community." In this depiction, each element (library, school, business, not-for-profit civic group, etc.) of the community can be accessed by each and every other element over an "open" communications environment. Figure 2 illustrates many of the physical communications services that can be found in communities. Today, however, the existing community networks are often separated by regulation (e.g., telephone and cable TV), technological underpinnings (printed newspapers, analog television, and digital data communications), and economics (rural areas may not be served by cable TV, cellular services, or a competitive access provider such as Teleport Communications).

With the convergence of computing and communications technologies, however, <u>all</u> forms of communications are adopting digital standards because this form of communications is less expensive, more reliable, and allows the information to be processed (e.g., address routing, store and forwarding, packet or cell switching) for more efficient handling. Regulatory barriers are beginning to fall. Strong proposals have been made to allow full competition in the delivery of telecommunications throughout the community ... cable TV can deliver "dial tone" and the telephone company can deliver video. Even cross-ownership may be allowed between these two dominant telecommunications industries. Uniform access to advanced telecommunications for all, however, may still be an issue.

The Clinton Administration has accepted the private sector's basic argument that they will continue to invest billions of dollars to roll out the National Information Infrastructure.[7] New York accepts this pledge from the telecommunications industries and aligns with the Administration's program calling for a "**Network of Networks**," where all providers can be interconnected in a new and "level playing field" that allows anything to be transmitted anywhere across any transport system. There are some key challenges to this concept to promote a "seamless" interface among disparate networks. Universal standards for all forms of communications are not fully in place. There will be a tendency for telecommunications providers to differentiate their services by developing distinctive networking capabilities. It is no small task to level a "playing field" that has been shaped by very different interests for several decades. Perhaps most important, there is no known operational network management system that can span a network, composed of such diverse transport services, to ensure that the applications are responsive and end-to-end delivery can be maintained.

On the other hand, if the existing networks cannot be utilized together, then the nation faces an incredible cost to rewire itself to be competitive in the Information Age. In fact, if information is separated by distinctive networks, large users (e.g., a college campus) would have to contract with multiple network providers to access a full spectrum of information products and services. This unnecessary redundancy of transport systems would not only be expensive, but could limit (if not doom) movement towards multi-media where integration could exist at the desk-top (e.g., attach a voice message and a video clip to electronic mail and forward).

To move the state's telecommunications program and enabling applications forward, the Public Sector Task Force of the Governor's Telecommunications Exchange has endorsed the Network of Networks concept and further recommends —

- Establishment of a state Office of Telecommunications, reporting directly to the Governor. This would be a small office, but the "... staffing should come from the best and the brightest in the field of telecommunications ... and have the capability to provide creative, innovative, and forward thinking policy."

- Defining initial program priorities of the Office to include:

  Secondary and higher education,
  Health care (institutions and rural medical services),
  Small and medium size businesses,
  Research and development, and
  Transfer of R&D to current and future needs of state and local government.

- Creation of a Council on Telecommunications and Information Technology---representing executive leadership in state government that are now responsible for public sector issues (e.g., education, libraries, public health, safety, etc.)---to identify **how** an advanced telecommunications infrastructure and an "open" networking architecture should be applied to improve the cost-effectiveness of public programs.

- Appointing an Advisory Council---composed of representatives from the telecommunications industries, local governments, small business, and community-based organizations (concerned with issues of consumers, the disabled, schools, health care providers, etc.)---to ensure that state programs and policies are well considered and diffused rapidly throughout New York.

It is believed that the on-going transition into the Information Age requires a new level of focus and guidance within the state and that this organizational structure can provide a foundation to better shape the evolving infrastructure.

Approach

New York State government (both the executive and legislative branches) can coordinate its efforts to influence local government and other components of the public sector while it stimulates the private sector to (a) create the new Infrastructure for Telecommunications and (b) apply this emerging infrastructure to create/expand work opportunities across the state. The key to this two-prong approach lies in clearly adopting the recommendations of the Telecommunications Exchange and creating the instrument for its execution.

One component of this strategy will be to examine the potential for this state to capitalize the financing of important aspects of the infrastructure that will (or should) not be developed by the private sector. This would include wiring premises (such as college campuses, libraries, classrooms) for information services. It might also include the construction of the "on and off" ramps for the public sector to access all appropriate networking services by defining a neutral link between major premises (e.g., major complexes of state and local government, correctional facilities, college campuses, school districts, etc.) and the new access points for the Network of Networks (see Figures 3 and 4). This latter initiative could produce four desirable outcomes, i.e., it:

1. allows the state to contract with any (and all) service provider(s) that meets the "interconnectivity and interoperability" standards established by the state.

2. removes the investment costs for this linkage from the rate structures of all affected providers (both present and future entries into the service market), thus not burdening the industries with the need to recover the capital costs for these access links.

3. eliminates this component of the infrastructure costs from the service fees to the public sector. This immediately lowers existing costs for telephone, data, and television usage across the public sector ... allowing government to reinvest these "savings" to apply to the new uses of the Infrastructure. This new market for telecommunications services provides the industry with income to pay for its upgrading of their infrastructure (switches, network interconnections, etc.) across New York.

4. creates a new form of access to government services and information.

Since there are large concentrations of public sector units in every section of the state, this approach will allow state government and the private telecommunications industries to also identify where "long haul" stretches of the state will not have adequate markets to stimulate private investment but the state would benefit from its own investment to create improved access into these regions.

Pilot Efforts Now Underway

Across New York, in many communities, there are now emerging metropolitan and rural networking initiatives that support prototype and pilot efforts in Distance Learning, Telemedicine, Improved Public Safety, etc. These are independent efforts, often sponsored by different sections of the telecommunications industries that are seeking the "killer" applications to spearhead their investments for new technology. In brief, some of the numerous initiatives include:

Rochester Area Interactive Telecommunications Network (RAITN) ... Initiated by Rochester Telephone Corporation, with the assistance of Rochester Institute of Technology and the New York State Education and Research Network (NYSERNet). A fiber optic network linking a number of high school districts, several Boards of Cooperative Educational Services (BOCES), and higher education institutions to provide educational audio/video/data services into classrooms and into the community.

INFINET 2000 (*INTERACTIVE FIBER OPTICS FOR NEW EDUCATIONAL TECHNOLOGIES*) Distance Learning Network ... A New York Telephone partnership with the BOCES that links six Dutchess County School Districts and BOCES together to provide diverse instructional offerings into small school districts.

NYNET (*The New York Network Project*) ... a NYNEX trial of ATM (Asynchronous Transfer Mode) technology at 155 mbps. The present effort links the Cornell University (a Supercomputer site), Syracuse University (a parallel computing site), Rome Labs, and the University of Rochester. Some applications include — Digital Library, Electronic Publishing, Health Care, Virtual Reality in Education, Financial Modeling, and Medical Information Processing.

Comprehensive Health Information Network ... a program of the Western New York Health Sciences Consortium, consisting of hospitals, schools of medicine, research institutes, and medical centers in the urban and suburban areas of western New York linked together in an Information System Network and connected with Rural Health Cooperatives in a pilot effort to improve and extend health care through telecommunications.

NYClassNet ... a New York City, NYNEX, New York Telephone, and Northern Telecom venture with the City School District and the City University of New York to link city government, schools, and higher education with broadband switched interactive video for education and teleconferencing.

The New York State Learning Network ... a state government, NYNEX, New York Telephone venture with the State University of New York to link the University Center at Albany, the Hudson Valley Community College, and the SUNY Satellite network together to provide high quality interactive video/data support among remote classrooms and academic resources (e.g., libraries) as well as to increase the number of campus sites that can broadcast educational programs via satellite.

Other initiatives are not pressing advanced technology, but are targeting deployment of community information networks such as the FreeNet™.[8] Presently, there is a FreeNet™ in operation in Buffalo, with several regions of the state (e.g., Albany, Utica/Rome, the Catskill region, Ithaca) in various stages of planning/implementation. The community information network is presently based on dial-up data access to community-based information provided and maintained by volunteers. It offers bulletin boards for "posting" civic events and announcements; provides electronic mail and discussion services on topics such as health care, education, government activities, recreation, and anything else of interest that the community wants to provide to itself.

While the underpinning technologies may differ, all of these innovative efforts have a number of things in common, e.g.,

1. they are separate, independent initiatives that are targeting important informational needs of communities, and

2. they all use one or more of the existing community networks beyond their original goals of providing telephone or broadcast cable television services throughout the community.

3. an institution of higher education is usually an important component of the program.

4. If successful, there is no mechanism (other than market interest) to accelerate their deployment to other needy communities throughout New York.

Another recommendation of the Public Sector Task Force is to create a public sector/private sector telecommunications laboratory test-bed environment to accelerate the test and evaluation of innovative uses of telecommunications under the new direction for developing an infrastructure for the 21st Century. The test-bed program would examine the interaction of policy, procedures, technology, economics, etc., to accelerate the diffusion of positive change. It would also provide a means for discovering and examining new issues that emerge from such a large scale interaction of novel systems. This would tap the state's considerable depth of research capability across the higher education community of New York.

Summary

New York's economic future rests in having private sector business and industries that are competitive in the world markets. This state must ensure that viable business and industries, both large and small, have access to a skilled labor pool, appropriate university technological research and development, an efficient and responsive government, and the emerging telecommunications infrastructure that can link them within this state (and across the globe) with an expanding and changing marketplace and list of suppliers.

To meet this need, it has been recommended that New York —

1. Adopt a transition strategy to move from a framework of telecommunications based on regulated monopolies to one stimulating private sector investment, competition and innovation.

2. Foster an open "network of networks" where all interested parties are able to fully participate and compete in the network fairly and without discrimination.

3. Encourage a policy of an "Open Architecture" for communications among all components of its public sector to remove incompatible technology as a barrier to sharing information and information resources when appropriate. This architecture is to improve the links among secondary and higher education, between education and employer provided training, between state and local government, and between government and the citizens and businesses that they serve.

4. Establish a Council on Telecommunications and Information Technology for state and local government that can examine and implement changes in applications and policy that can accelerate the development and use of this state's Open Architecture and the infrastructure for telecommunications to improve education, health care, economic development, and government operations at all levels.

5. Forge linkages with existing organizations of New York (through the Advisory Council) such as the Business Council of New York State, the New York State Telephone Association and Cable Television Association, etc., to maintain continuous lines of communications concerning the needs and opportunities of the private sector to develop and grow in New York.

As the concept and architecture for New York's *Network of Networks* is identified, a policy study would also be made to determine how the state's investments in its own use of telecommunications and information technology could best complement the private sector's investments in providing telecommunications and information services across New York. It may be plausible for this state to bond a portion of the needed construction to accelerate private investment opportunities to reach and better serve all areas and sectors of the state.

Higher education, as members of the community and a major outpost on the new electronic frontier, is well positioned to apply advanced technology and telecommunications within its own programs of research, instruction, and community service. It is also best positioned to ensure that the new settlers benefit from the positive aspects offered by our on-going transition into the Information Age.

END NOTES

*1. TELECOMMUNICATIONS: A Vital Infrastructure for the **New** New York. This report is available in the CAUSE Exchange Library (CSD-0711).*

2. To complete its efforts, the Telecommunications Exchange established five task forces working in the following areas:

Telecommunications-based and Related Industry
Technology Diffusion
Infrastructure, Technology and Investment
Regulatory Options
Public Sector Applications

3. "Some Roles for Higher Education in Shaping a National Information Infrastructure," CAUSE/EFFECT, p.3, Volume 16, Number 3, Fall 1993.

4. Winokur states in the Empire State Report, October 1992, that government employs 1.4 million workers, health and social services some 2.3 million ... versus 1.2 for retail trade, 1.0 for manufacturing, and 110,000 in agriculture.

5. The recommendation has been made that New York's public sector adopt the data communications protocols of the NREN. Presently this encompasses the four-layer internetworking communications architecture which includes the unique Transmission Control Protocol and Internet Protocol (TCP/IP).

6. It is estimated that the annual "technology" purchasing power of the state and some 4,000 units of local government exceeds $1 billion annually. This figure does not include the remaining components of New York's public sector (e.g., 139 private institutions of higher education, public libraries, not-for-profit organizations, and some areas of health care).

7. "...The private sector will lead the deployment of the NII. In recent years, U.S. companies have invested more than $50 billion annually in telecommunications infrastructure...In contrast, the Administration's ambitious agenda for investment in critical NII projects...amounts to $1-2 billion annually." (p.6) The National Information Infrastructure: Agenda for Action, September 15, 1993.

8. FreeNet™ is sponsored by the National Public Telecomputing Network (NPTN), begun at Case Western Reserve in Cleveland, Ohio, by Dr. Thomas M. Grunder. The NPTN-affiliated community information networks are provided with programs such as Academy One, aimed at providing K-12 schools (students, teachers, administrators, and parents) with "Educational Telecomputing." The NPTN also offers its affiliates with a number of information services such as electronic news (e.g., The Los Angeles Times, The Washington Times, USA Today), electronic journals and magazines (e.g., Forbes, The National Review, Insight), electronic books and documents, medical information services, software services, etc.

TELECOMMUNICATIONS + ISDN = OPPORTUNITY

CAUSE 93

by

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Abstract

On-campus connectivity is important to the daily operation of the institution. We can expect the speed and access requirements to have continued growth. As we look outside of the university, we see opportunities of significant proportions for an institution's infrastructure. Appalachian State University and Cal Poly, San Luis Obispo have used the campus infrastructure to provide opportunities to their institutions by connecting K-12 public schools and off-campus student housing through the use of narrow band ISDN. Corporate partnerships were instrumental in these installations, but operating expenses are now a part of ongoing budgets. The campus organizations have been flexible in accommodating these external networks and systems. Cal Poly has primarily data applications but has recently added distance learning and other functions, while Appalachian has interactive video, voice, multimedia and data. If you are thinking about external connectivity, networks and systems, these are both proven components of existing systems. Technical specifications, costs, development, funding and applications will be discussed.

INTRODUCTION

Higher education is going through a transition. Some have described the current situation as a revolution. Whatever one calls it, something is happening in higher education. The ground rules are changing, the "business as usual" is being challenged and the methods of funding education are being revisited. Accountability, reengineering, outsourcing are no longer confined to the corporate and business sector and are finding their way into institutions of higher learning. Strategic alliances and business partnerships are no longer found entirely in the corporate sector, they are indeed becoming a way of life at many institutions. What we are seeing is a revolution in education that happens maybe once in a lifetime. Opportunities and challenges abound for those who seize the initiative to expand their horizons, for those who seek a new way to do business. As resources dwindle and competition for those resources increases and the marketplace for our product becomes more aligned with a global perspective, the demands and necessity for change march on undiminished.

This paper will describe how two institutions, Appalachian State University in Boone, North Carolina and California Polytechnic State University (Cal Poly) in San Luis Obispo, California are approaching this revolution. Both institutions are known for their technical orientation, telecommunication infrastructure and the integration of technology into their educational and administrative processes. The process has not happened quickly, but is the result of visionary CEO's who early-on saw that education and technology were inextricably bound together in the ultimate success of the institutions. They recognized that the world was changing and positioned their institutions to change appropriately. It was at times arduous journey, but as will be shown, a successful one.

CURRENT CAMPUS INFRASTRUCTURE

Appalachian State University

Appalachian State University has a 13 year old coaxial cable system which is nearing the end of its life cycle and is currently being replaced with a fiber backbone. The new backbone will consist of an inner redundant ring with a series of six hubs around the campus. The campus buildings are being serviced with stars off each hub. Both single mode and multi mode fiber are being pulled in a 3 to 1 ratio. Class 5 wire is being pulled in all new buildings with fiber being used in specific cases and when justified. ISDN lines are available options on all campus telephones.

Ethernet is the center of the communications network and a VAX cluster forms ASU's mainframe. Standard protocols, Internet, LANs, E-mails, etc., are standard integral parts of the architecture, as is found at most institutions. What is different at Appalachian is the use of narrowband ISDN initially in the College of Education and ultimately across the campus.

Southern Bell installed the ISDN module and software on an existing 5ESS digital switch in the Boone Central office. The AT&T Foundation provided a $775,000 grant of software, computing and telecommunications equipment and the Appalachian State University Foundation purchased the video equipment. To date almost $3 million has been generated from private funds for the project. Vendors in the project who have provided equipment, technical assistance and financial support include CLI, NCR, Combinet and DIGIBOARD.

Cal Poly

In 1987, Cal Poly signed a long-term contract with Pacific Bell to provide Centrex IS telephone service. Using flexible, least-cost routing and other techniques, Cal Poly was able to reduce long distance costs and reinvest the savings to upgrade its telecommunications infrastructure.
One of the first efforts involved replacing the outmoded broadband baseband coax with a new

FDDI fiber optic backbone in 1990 supporting campuswide data and video distribution. Like ASU's, the backbone is a redundant, multi-fiber ring with a series of five CISCO hubs or routers servicing 39 core campus buildings and selected residence halls. Wiring in key instructional buildings were upgraded to support ethernet, token ring and Appletalk LANs.

With more than 4,000 on-campus connections and 15,000 accounts, Cal Poly's network provides campuswide access to academic and administrative applications on the university's IBM ES/9000-732 mainframe, an IBM RS/6000 cluster running AIX (Unix) for instruction, distributed Unix servers, local and remote on-line library systems and services, instructional databases, E-mails, Internet, Bitnet and other resources. Access to off-campus computing resources is provided by CSUNET, a T1-based systemwide regional network.

Many faculty, staff and students take this level of on-campus network connectivity for granted, and want and need the same level of connectivity at home. Older, 1200-baud analog modems used to be sufficient to dial into the campus network, but enhancements in personal computers and application software have rapidly outgrown their capabilities and the capacity of Cal Poly's 150 dial-up modems.

In December 1990, Pacific Bell installed an AT&T 5ESS ISDN-equipped switch in its San Luis Obispo office, making ISDN service an option on all campus telephones. ISDN provided not only improved phone services and simultaneous high-speed data transmission, but increased the deliverable bandwidth on campus to 57.6 Kbps. While making current networking needs easier, ISDN also opened the door to a whole new range of applications the university can deliver into homes.

As part of a joint study with Pacific Bell and AT&T, Cal Poly installed 250 ISDN lines on campus in faculty and staff offices where direct network access was not feasible, and tested ISDN service in 13 local residences. When the one-year trial ended in 1991, the results were positive and the Cal Poly Residential Information Services Project (CRISP) was born.

PROJECT DESCRIPTION

Appalachian State University

In 1991, BellSouth, Southern Bell and AT&T entered into a 10 year partnership with Appalachian and a seven county public school partnership to integrate telecommunications technology into the educational process using interactive video, voice and data.

"Impact North Carolina: 21st Century Education" came on-line in February 1992 with three ISDN lines to each of the following locations: Blowing Rock Elementary School, Parkway Elementary School and Watauga High School and four lines to the College of Education at Appalachian State University. One line is for data and is tied to a LAN. Another line is connected to a multimedia workstation. The final line is tied to a videoconferencing unit. All of the ISDN lines are dedicated and are currently used in a point-to-point configuration. There is one spare line at the university site.

The four sites have 20 computers in a LAN using NOVELL software. The file servers are connected with an ISDN line and have connectivity with Appalachian State University's Ethernet backbone. This provides project users access to the university's VAX cluster and a full array of resources that are available to the university employees, such as electronic mail, library catalogs and Internet. Software can be shared between sites and has been purchased with this in mind. The data component is the most heavily used portion of the system.

The multimedia workstation is used to enhance the data connectivity by providing interactive graphics. Images can be scanned or retrieved from storage and passed between sites. A digitizing tablet allows each site to annotate on the image. This is the second most heavily used portion of the system.

The videoconferencing unit has proven to be the culminating portion of the system for the users. After activity has been completed on the data and multimedia portions, video connectivity is generated for users to see and talk with each other. The video uses 112 Kbps for the video signal and 16 Kbps for audio.

The total video unit consists of two monitors (one for outgoing pictures and one for incoming pictures), a three chip camera, a document (overhead) camera, an audio system and a remote, wireless control unit.

This is a flexible, communications system which is being used to integrate technology into the total education process, as well as provide a communications infrastructure for all users, kindergarten through university faculty. The project is application driven and addresses issues of pre-service, in-service and K-12 studies concurrently. ASU has shortened the learning curve and implementation of results by addressing these three areas simultaneously.

Pre-service activities include integrating the telecommunications and technology into the curricula of undergraduate and graduate students, student teaching functions and hands on experience in the test bed schools.

In-service activities have focused on obtaining a lead teacher at each school who has full release time to conduct training for the teachers at the school. These lead teachers have become the resource to brainstorm with other teachers how to use the equipment and technology in their courses and involve the students.

K-12 studies have involved the students in cross age, cross discipline, and cross school and university activities and projects. Examples of the types of activities include: an at risk class at high school working with a graduate class at Appalachian to research Appalachian religions; high school math student working with an 8th grade student because he had gone beyond the teachers at the grade school: graduate student teaching a class at the high school; two 4th grade classes at different schools preparing riddles and answering them; and accessing data bases and information and communicating outside the university through Internet.

Cal Poly

In 1991, Cal Poly began providing ISDN services to staff faculty and students in the Cal Poly Residential Information Services Project (CRISP). This project provided a campus Centrex ISDN line into 13 student, faculty and staff homes initially, a number that has grown to about 60 now.

In 1993, CRISP enhanced its services through the use of new customer premise equipment (CPE) providing analog voice service over an ISDN line as well as high-speed data connectivity. As a result, CRISP members now have CPE with an analog phone jack providing up to five ringer equivalents or lines, and a simultaneous 57.6 Kbps data connection. Cal Poly makes this service available for under $40 per month. At first glance this appears expensive; however, many households have multiple phone lines for voice and data each costing approximately $15 per month, a minimum outlay of $30 per month for one voice and one data line.

Two types of ISDN lines are available: the Basic Rate Interface (BRI) and the Primary Rate Interface (PRI). The BRI provides two B channels each capable of providing voice or 64 Kb circuit switched data services to a distinct device. The BRI includes an additional D channel providing 16 Kb of bandwidth on a packet network. The BRI uses the packet network for signaling and supporting several other packet devices simultaneously. In comparison, the PRI or ISDN T-1 provides 23 B channels and a single D channel.

The bandwidth of several B channels can be combined in a process called inverse multiplexing or bonding. During this process, a single data service with bandwidth exceeding a single BRI is broken up into separate 64 Kb segments by a piece of equipment known as an inverse multiplexor. The inverse multiplexor sends each of these 64 Kb segments in parallel down one B channel. At the other end, another inverse multiplexor recombines each of the segments creating the original data service.

To deliver video data which is inherently bandwidth intensive, a compression scheme to reduce the size of video images is required. Two common formats found on microcomputers are JPEG and MPEG.

JPEG stands for Joint Photographic Experts Group, the committee that wrote the standard. Designed for compression of photographic images, it uses a lossy scheme, meaning the compressed picture differs slightly from the original. JPEG takes advantage of distortions undetectable by the human eye so that people rarely notice the difference between the original and compressed picture. When compressing 24 bit/pixel images (256 colors), JPEG typically reaches 10:1-20:1 compression ratios. For example, a full-screen 24 bit VGA picture (640x800 pixels) takes approximately 140 K.

MPEG, developed by the Motion Picture Experts Group, is used to compress video data with motion. This format allows 200:1 compression ratios in a sequential series of single frames. MPEG accomplishes the high compression ratio by compressing the original frame, and instead of compressing each following frame individually, only compressing the changes from the previous frame. Thus, a comparable television picture (512x480 pixels) MPEG picture takes approximately 3.5 Kb.

Cal Poly's ISDN network consists of two sides, the machine room (or incoming side) and private residences or offices. On the machine room side, Cal Poly owns 11 BRIs connected to AT&T 7500 terminal adapters. These terminal adapters each provide two X.25 9.6 Kbps connections over the D channel associated with the line. Users entering the Cal Poly network in this fashion connect to a terminal server for a direct Internet connection and full access to available resources.

In addition, Cal Poly owns three BRIs each connected to two Telrad 285-D1 terminal adapters providing six ports. The Telrad ports offer 38.4 Kbps connections over the B channels of the BRIs using a proprietary rate adaption format. To access these lines, the end user must use another Telrad set to place the data call. These ports allow the same access as the low speed 9.6 connections available through the AT&T 7500s, but also allow a Serial Line IP (SLIP) connection. By installing the correct drivers on a user's PC, this line in effect mimics a direct ethernet IP connection, enabling users to run telnet and file transfer protocol IP programs directly from home.

Currently, these SLIP connections require a dedicated IP address for each high speed port. However, Cal Poly is exploring new software for the terminal servers that will allow the user to choose their IP address when initiating the SLIP connection. In this manner Cal Poly can provide each user with their own independent IP address and name service.

ADVANTAGES

Appalachian State University

"Impact North Carolina" has been a cost-effective project during its first year and a half of operation. The ISDN lines received a special assembly from the Public Service Commission of

North Carolina because the rates had not been tariffed. The monthly charge for the 13 lines is $13,000 per year. The rates are distance sensitive and the lines are available 24 hours a day.

Since this is a university-sponsored project, all upgrades to the system and LAN software become a part of the university or state negotiations with vendors. Appalachian is a depot site for NCR, and hardware maintenance receives a special rate. One of the options from NCR is to purchase a specific number of hours of maintenance with parts being available at a specified discount.

Multiple user licenses have been purchased for software that will be used at more than one site. Software costs have been reduced and availability of software is from fileservers at the different locations.

With ISDN, all users on a LAN can be using E-mail at the same time. A modem on one phone line would allow only one computer to access the system at a time.

The K-12 students are bringing an increased level of knowledge of the technology and telecommunications to the next class level. Appalachian undergraduate and graduate students are using the equipment in their course work and student teaching.

Because the technology is being made available to teachers without specific instructions on how to use it, creative and innovative ideas are surfacing, being tried and used in the classroom settings.

Cal Poly

Placing ISDN in private residence makes it easier for students, faculty and staff to access the various computer systems on campus at a speed comparable to that found in campus labs and offices.

Students at Cal Poly today, regardless of major, can expect at least one class every quarter requiring the use of a computer. For many students, this means spending long hours in campus computer labs or purchasing expensive devices to access resources from home at less than ideal speeds.

Cal Poly currently supports some 2,000 student workstations in computer labs and not all are networked. Space for new and larger labs is limited and demand for access is increasing. ISDN connections could eliminate the need for "dumb" terminal labs entirely, replacing them with microcomputers linked to ISDN connections providing round-the-clock network access. Equipment could be consolidated into existing spaces, freeing up lab space for other purposes. With physical access to the labs no longer necessary, operating costs would be significantly reduced.

The ability to access campus resources from home will encourage increased use of computing in the curriculum and classrooms, providing faculty with incentives for exploring new methods of using technology for teaching and developing educational materials. Many Computer Science classes already require students to submit assignments in electronic form. As faculty and students become more comfortable with the technology and access increases, this trend towards *paperless* assignments will only expand.

San Luis Obispo County recently enacted laws requiring places of business, Cal Poly included, to reduce the number of vehicle trips made to and from their location. Increasing telecommuting and delivery of education via the network can greatly reduce the number of required trips to campus. The ISDN service enables staff and faculty to access their office computers from home using software such as PC-Anywhere, Carbon Copy or Timbuktu. With the ability to forward office calls to the home, this makes telecommuting a reality. As students become more familiar with

various information resources and the concept of telecommuting, their marketability in today's competitive job market will also rise.
Other benefits include unlimited connectivity to campus data systems at no additional cost; the ability to have multiple appearances or phone numbers ring at home including work numbers; and complete compatibility with any household phone, answering machine, modem or fax machine. This allows ISDN to completely replace existing residential telephone service without sacrificing existing functionality.

Finally, because Cal Poly provides the phone service and thus performs the billing, Cal Poly recoups the cost of providing the service as well as the costs of providing the on-campus network connections, making CRISP self-supporting. Moreover, Cal Poly anticipates significant productivity gains to result from more cost-effective and efficient use of campus resources.

IMPROVEMENTS

Appalachian State University

The data runs at 64 Kbps between LANs, which is not adequate in some situations. Combinet has provided two bridges that increase the transmission from 64 Kbps to 128 Kbps. It uses both B channels and provides for data compression to increase speed between the two sites. Initial access is to one B channel with compression and then access to the second B channel when traffic passes a threshold level. An example can be seen with loading Worldbook Encyclopedia CD-ROM at one location from another location and reducing the time from 7' 6.98" to 3' 35.65".

Interactive sessions have been held from "Impact North Carolina" sites to TRIP92 (Transcontinental ISDN Project 92) in Reston, Virginia, Governor Cuomo and New York State Technology Commission in Albany, New York, and AT&T Network Systems Executives in Basking Ridge, New Jersey. The K-12 students were active participants in these teleconferences.

North Carolina's CONCERT network is a high-end videoconferencing network that connects several universities and medical research institutions in the state. It uses greater bandwidth than "Impact North Carolina," but interoperability to the K-12 sites is obtained through service multiplexors and coaxial cable. The three public schools will have connectivity through ISDN, although with reduced bandwidth.

CD-ROMs, VCRs and portable video cameras have been used a variety of programs and projects to enhance the teaching and learning environment. The teachers and faculty are finding new uses and ways to incorporate additional equipment into the infrastructure.

Cal Poly

Current customer premise equipment allows for analog voice service on the first B channel and a simultaneous data connection of 57.6 Kbps over the second B channel. Ideally, Cal Poly would like to see a box providing bonding of the two B channels to provide a 128 Kbps connection and analog voice service. This new CPE would set up a dual bonded (128 Kb) connection, and when detecting an incoming voice call, drop the second B channel (and the connection down to 64 Kb) for voice use. When the user terminates the voice call, the CPE would again bring up the second B channel and bond it with the first.

In addition, ISDN implementation around the country is still limited, with islands of activity. Data calls within the same Centrex are easy and efficient. However, calls outside of a CO remain difficult to guarantee and manage. Local telephone companies must strive to develop a residential flat rate tariff. Although the current system allows for users to place unlimited data calls within Cal Poly's Centrex system, voice calls not within the university system are charged by message unit.

ISDN service is currently distance limited to certain areas beyond the campus. Cal Poly is negotiating with Pacific Bell to extend ISDN service throughout San Luis Obispo County in 1994. Other plans are underway to expand network capability between the campus and other parts of California through pilot projects with telecommunication vendors to develop and test high-speed, gigabit networks.

Future goals at Cal Poly include developing a method to deliver full-motion video resources over ISDN lines. As noted previously, a television quality MPEG picture requires 3.5 Kb per frame. Full-motion video is almost undetectable at 15 frames or 52.5 Kb per second. A single BRI with bonding provides 16 Kb (128 k) of bandwidth. To deliver full-motion, real-time video over ISDN will require caching or a compression scheme utilizing higher ratios. Under a caching scheme, the user would first download the data to their local machine, requiring three times longer than the actual length of the video signal, and then play it back at real time. This system would work for a video version of voice mail, or overnight delivery of a movie or a class lecture.

THE FUTURE

Appalachian State University

"Impact North Carolina" will install a multi-point control unit (MCU) to provide the users with the added capability of being able to communicate with video from one site to multiple sites. Being looked at is a central office bridge and a customer premise bridge. A decision will be made soon as to the direction the project travels. As one might expect, there are advantages and disadvantages to either approach.

The CLI CODECS at the present time operate with a proprietary compression algorithm and cannot communicate with other vendors. CLI will supply upgrades to be installed in December to modify the CODECS to meet CCITT standards. They will further add the industry standard 16 Kbps, low bit rate audio and Standard Plus software.

DIGIBOARD will supply three bridges for the data component which will allow faster communication from the LAN at the College of Education site to the LANs at two other sites. One dual IMAC bridge will be located at the College of Education and a single IMAC at the other two sites. This will provide similar improvements in transmission speeds with Combinet bridges as previously discussed.

The North Carolina Information Highway (NCIH) is a statewide infrastructure that will install nine ATM switches across the state and use SONET for transmission. "Impact North Carolina" will be connected to the NCIH through the state's CONCERT network which is a high-end videoconferencing network that connects several universities and medical research institutions in the state. It uses greater bandwidth than "Impact North Carolina," but interoperability to the K-12 sites will be obtained through service multiplexors and coaxial cable at 330 mhz. The three public schools will have connectibility through ISDN, although with reduced bandwidth.

Video technology has advanced since the inception of this project. "Impact North Carolina" started with dual monitor units for classroom conferences. In the last nine months, personal video units and small group video units have become available and will be made available to the users. The users will determine how these smaller video units can be utilized in teaching and in the classroom.

NCR will install their new WaveLAN on the local area network at the university. WaveLAN uses advanced radio-frequency communication and will be used to show alternatives to hardwired LANS. There are benefits to having this type of networking and the teachers will assess the utility and enhancements it can make to the project.

Cal Poly

In 1992, Cal Poly began using two way interactive video to distribute courses on campus and to its satellite agriculture facility at Swanton Pacific Ranch, 200 miles to the north. Just recently, Cal Poly and IBM began a joint study to test the viability of delivering instruction ("education on demand") over the network to classrooms or homes using a repository of digitized materials stored on the ES/9000.

Adjacent to Cal Poly's video production and distance learning facilities, a Faculty Multimedia Development and Testing Center was established in March 1993 and equipped with a variety of hardware, software and consulting assistance to encourage and support faculty interested in developing and integrating materials into their courses or for delivery over the network.

Cal Poly is committed to developing electronic classrooms equipped with high-resolution projectors, quality audio, microcomputers with high-speed network access, and presentation software. Faculty will be able to bring their own presentation control software to the classroom, connect to a local or remote server, and access a wide variety of digitized materials to enhance a classroom lecture under their individual control. Cal Poly envisions having the capacity to "digitize" lectures which can be edited, indexed and stored along with course materials. Both the lectures and materials can be retrieved later to supplement existing classroom instruction or as education courses delivered "on demand" in non-traditional settings, such as a graduate-level degree program for students who work full-time.

Electronic textbooks and libraries will become the standard rather than the exception. Cal Poly is working with BellCore to implement ***SuperBook***, an electronic document "browser" that can deliver library materials, journal abstracts and other documents with text, graphics and video to the desktop via the network. Future enhancements will include electronic or video mail to enable instructors and students taking "education of demand" courses to interact, remote registration and payment of fees, and sharing of courses between multiple campuses.

ISDN in the community will play a major role in bringing "education on demand" to the home. With high-speed ISDN data lines, users can access Graphical User Interfaces (GUIs) like X-windows to take advantage of integrated multimedia applications like ***SuperBook***.

Several related issues will be addressed as these concepts are implemented, including licensing and copyright protection of intelligent properties; faculty release time and compensation for developing course materials; and the impact of non-traditional educational methods on learning and interpersonal relations. Transactional monitoring and pricing techniques will be explored in a joint study between Cal Poly, Bellcore, Lawrence Livermore Lab, Chevron, and the American Chemical Society.

On a systemwide level, CSU is spearheading Project DELTA to support multi-campus efforts to develop new methods of delivering instruction using technology. For example, Cal Poly is working with CSU Long Beach to develop a distributed database of digital information provided by CSU faculty. Cal Poly is also cooperating with local community colleges and K-12 school districts to implement distance learning and multimedia services, and assisting with efforts to develop community access networks. One concept currently being explored is a "Video Yellow Pages" in which users would connect, enter the name of the service they want, and retrieve multimedia "want ads" such as a restaurant menu featuring pictures of that day's specials.

Companies, such as Hewlett-Packard, have expressed interest in having Cal Poly deliver graduate level degree programs remotely to their employees in Silicon Valley, and Cal Poly is working with Pacific Bell, SP Telecom, Sprint and other vendors to establish the necessary high-speed data links to facilitate these and other "education on demand" services.

CONCLUSIONS

"Impact North Carolina" and "CRISP" have proven that strategic alliances and partnerships can work effectively between public education, business and higher education. Commitment, compromise and common goals are indispensable in the success.

Prototypes and models can be initially funded through a partnership, but expansions must be accomplished through hard dollars, budgets and purchases. The corporations cannot be expected to fund expansions since their initial involvement was to develop a process, a model or a prototype. The cost of expansion has been found to be less than the initial project cost. Product improvements and unit prices have fallen in most instances.

With ISDN as a telecommunications infrastructure, the on-going annual costs are reasonable and affordable. These costs are divided between the user groups and placed into the fixed budgets of each user. Major annual expenses have been identified as hardware and software maintenance, ISDN lines and additional equipment, such as CD-ROMs, VCRs etc. Software purchases have been handled out of existing budgets. ISDN provides an affordable way for students, faculty and staff to access the campus network from their homes. It also provides the university with a revenue source to continue network enhancements.

The opportunity to work with the education community has been stimulating to faculty. A sense of ownership has been generated in the project and curriculum revisions have started. The inclusion of the technology in courses is expanding in the public schools, Appalachian and at Cal Poly. Students and faculty are all levels of education are participating and benefitting from the enhancements.

A paradigm shift is taking place in instruction, from a mode of faculty–student interaction taking place in specified locations (campus classrooms) at specified times (class schedules, office hours) to one in which students have access to most of the information content in a variety of forms at their convenience (when they choose, and where they choose from a variety of locations, including their living quarters). This shift is possible because several technologies have matured which provide the basis for major changes in the delivery of instruction.

Education in the future must support delivery of real-time, simultaneous two-way video presentations, multimedia presentations, and "education on demand" to students, faculty and staff both on- and off-campus in their homes and work places. This is vital to overcome economic, cultural and physical barriers to learning. Shrinking resources and increasing demand require innovative methods of delivering education and services to traditional and non-traditional students, and appropriate use of information technology is critical to meet this need.

Both ASU and Cal Poly are exploring several cost-effective technology solutions designed to improve productivity, reduce labor intensity, provide new ways of delivering education and better services to students, "customers" and "stakeholders," while maintaining their competitive edge. Achieving these goals will move the institutions towards becoming fully integrated "electronic campuses" in which students, faculty and staff are linked to information services and technology without regard to their physical location.

Eventually ISDN will be replaced with something newer, faster, and cheaper, just as it is replacing analog telephones. However, ISDN represents an important breakthrough in preparing society for the concept of providing information services in their homes. ISDN allows the leap forward from providing simple text information over the telecommunications line to a full-scale multimedia delivery system.

Strategies for Recovering the Costs of the Campus Data Network

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1. Introduction

This paper explores the methods an institution might use to recover costs associated with an internal campus data network. Choosing and implementing such a strategy is becoming more important as data networks grow in size and complexity. Such growth brings increasing operational and management costs. Pricing network services is an extremely delicate task. If not done correctly, network growth could be stifled, or, alternately, over built and misallocated.

2. Background

Approximately two years ago, the University of British Columbia changed the way service units derived their operating budgets. Instead of relying on central funding from the President's office, the service units would be paid for services rendered by individual schools, departments, and other functional groups on campus. This represented a major departure from prior budgetary policy. Luckily, the transition was to be staged rather than occurring overnight.

The term "cost recovery" has become synonymous with this type of decentralized budgetary scheme. That is, selected support services recoup their costs from other groups within and outside of the campus community.

Institutions are beginning to explore cost recovery for data networking for several reasons. First, it introduces an element of market forces into the decision-making process with regard to allocation of information technology resources. Second, it holds the promise of bringing costs under control, and increasing efficiency. Expenditures are made only if the users of related services demand them. Whether these advantages accrue in reality lies outside of the realm of this paper, but is an extremely relevant topic.

The UBC Computing and Communications unit was given the mandate to operate using decentralized funds as soon as possible. The telecommunications group was already cost-recovered. Telephone users paid monthly and long distance fees, which included internal staff and overhead costs. This example is often cited internally at UBC as a successful cost-recovered organizational unit.

Other units within C&C were given the task of becoming cost-recovered. In particular, the MIS development group started operating on a contractual arrangement with clients. The Academic Systems group started to charge for UNIX computer usage. Use of the modem pool was billed at $1.20 per hour to individual users. Well over 50% of the C&C budget is currently derived from cost recoveries and decentralized funding sources.

The Central Networking group, with a mission of designing, monitoring and managing the campus backbone, was given the task of cost-recovering its activities as well. Unfortunately, little was known as to how to proceed in this area.

Augustson, in Gillespie(1989) proposed three criteria for determining whether computing services should be cost-recovered. First, the service should be strategically important to the university and its competitive position. Second, the service should be emerging, immature, or innovative. Finally, the service should be viewed as infrastructure. By these criteria, data networking would seem to be a perfect candidate for central funding.

The UBC Data Networking Task Force (Tom et al(1992)) took a slightly different position. The task force noted that by not allocating the costs of the network to users fostered the notion that it was in fact free. Of course, backbone networks are very expensive, and some method for cost allocation as well as market feedback was necessary. The task force suggested that capital costs of the network be taken from central funds, with operating, management, and maintenance costs passed on to individual units.

With scant literature on the specific topic of data-networking cost recovery in the university environment, Central Networking began to search for a method of implementation. First, a business plan was formulated, defining a market and proper vehicle for delivery of backbone networking services. Second, an advisory group of departmental network administrators was formed. One task of the advisory group was to outline possible schemes for backbone cost recovery. Finally, Central Networking undertook a survey of academic institutions which indicated that they cost-recovered data networking wholly or in part. The indication was obtained from the CAUSE on-line database at cause.colorado.edu.

This paper will be limited to discussion of the survey methods and results, presented in the sections that follow.

3. Methodology

A survey questionnaire was developed to determine the different strategies used to cost recover central data networking services. The questionnaire is included in Appendix A.

The questionnaire was constructed with two purposes in mind. First, background information regarding the respondent's institution was solicited. The questionnaire asks for the size and type of the network and whether services are provided to the wall plate. Second, and most important, the respondents were asked to describe the method(s) for recovering networking costs, and to what extent the method(s) were utilized (i.e., percentage of budget recovered).

The questionnaire was mailed electronically to institutional contacts in the early part of May, 1993. A second, follow-up mailing was done in the last week of the same month.

The responses were classed according to types, based on both budget recoveries and method employed.

4. Sample

The sample consisted of approximately 90 institutions indicated either partial or full cost-recovery of data networking according to the profile in the CAUSE database. The database was located at the Internet site cause.colorado.edu.

The report from the database indicated the institution name, the contact, and whether services were cost recovered. Email addresses for each contact were determined by querying the member database at cause.colorado.edu. Roughly 5% of the institutions listed in the initial report had contacts with invalid or missing email addresses.

The questionnaire was mailed to 90 institutions. Responses were obtained from 28, or 31%. 5 responses were not usable. Either the site did not cost recover data networking, or the responses to most questions were in large part missing. Thus, the final sample size was 23.

Table 1 contains a summary of the survey responses. It also shows some characteristics of the sample. 54% of the sites had networks comprised of 2000 nodes or more. The average number of networked nodes per institution was 3440. All budgets were $200,000 US or greater. The average number of subnet segments per site was 86, although the variation was quite large.

5. Results

Five strategies were found to be used by the respondents in the sample. Each is described below. It should be noted that none of the respondents used any type of per-packet or volume-based charging. Updegrove's

Penn State summary, found in Appendix B, makes a cogent case against such a policy. The fact that no volume-based charges were levied by any of the the institutions came as a surprise.

Mixed service offerings. This strategy offered the widest variety of products and accompanying charges. Users arranged for simple backbone connections via a wide range of media, or opt for per-node wall plate service. The fee structure was somewhat flexible, depending on the type of service desired.

Per-node fee structures. Each node on the network is assessed a monthly or yearly fee. Usually this implies that service is supplied to the wall plate. Although departments might obtain bulk discounts for large number of nodes, the fee charged is essentially fixed, regardless of the service type.

One-time Installation Fees. Costs are recovered only when a network port or subnet is installed for the first time. No recurring charges are assessed.

Telecom Subsidy. Network service costs are hidden within a cost-recovered telecommunications budget. The income from voice services subsidizes the data network.

Computing Services Subsidy. Network service costs are hidden within the general computing services budget. The income from email and cpu utilization charges subsidizes the data network.

Table 1 below summarizes the survey results, categorizing respondents by type. Network characteristics are shown. Nodes indicates total number of network endpoints. Segments indicates the number of segments or workgroups within the network. Management shows whether responsibility extends to the communications closet (CC) or the wall plate (WP). Yearly operating budget, in $1000s, is listed. Finally, the percentage of the operating budget that is cost recovered is shown. Within each category, institutions are rank-ordered by network size (node count).

Table 1
Cost Recovery Strategies and Network Characteristics

	Nodes	Segmts	Mgmt	Budget ($1000s)	% Rec	Comments
Mixed Services						
Univ Wyoming	1400	50	WP	350	100	
Univ Texas HSC	1450	70	WP	200	70	
Penn State	4200	300	CC	7000	100	
UC Davis	4500	140	CC	600	20	Moving to full rcvry
Per-node Charges						
Fort Lewis Coll	134	20	WP	200	22	
UC Irvine	4500	180	WP	500	50	% Recvry estimated
Harvard	17500	200	WP	1000	100	Fees are 50%
Installation Fees						
Queensland Ins AU		61	WP	1600	10	
Macalester	415	6	WP	800	10	
Univ Nebraska	1725	76	WP	2900	100	
Kent State	2550	8	CC	200	100	
Univ Colo HSC	2650	250	WP	2500	100	
Univ Kentucky	2900	55	WP	700	100	
Univ Arizona	6210	100	WP	2000	10	
Univ Georgia	8235	80	WP	1000	10	
Eastern Wash					10	
Telecom Subsidy						
West Michigan	837	22	WP	300	100	40% from install fee
Grand Valley	870	10	WP	300	70	
Baylor	2690	30	WP	2000	100	50% from install fee
South Ill Edw	2050	35	WP	300	100	10% from install fee
Univ New Hampsh	4100	30	WP	400	100	35% from mixed svcs
Computing Services Subsidy						
Dallas CC	2000		WP	400	100	Uses email fees
U Cincinnati	2650	50	WP	500	100	15% from install fee
Average	3503	84		1170	69	
Std Dev	3671	81		1491	39	

6. Analysis

Reliability and Validity. The validity of some of the responses is questionable. In particular, the budget figures should be considered carefully. Most respondents had difficulty determining the exact budget for central data networking. The sites with the best budget estimates are most likely the largest ones, which have cost centers dedicated to the data network. This makes it simple to determine the budget size. Second, the budget question did not asked to specify capital versus operational costs. The two were sometimes mixed by some respondents, while others just gave operational costs.

Network size estimates probably contain some error, but most seem to provide the figures with confidence. Segmentation estimates vary, as the exact definition of the term is hard to pin down. Sites with bridged networks will report few segments. Still, most of the sites use routed networks, such that the segmentation estimate holds some validity.

Charging Model. Clearly, the two most prevalent models were installation charges and service subsidy. 69% of the responses fell into these categories. Only one major university, Harvard, completely recovered costs using per-node charging. Three other major universities used the mixed service model.

7. Discussion

It was hoped that the survey would have produced larger variation in the types of solutions. Unfortunately, there were few real attempts to treat data networking as an actual cost center. This is probably due to the newness of the technology, and the propensity to treat the network as infrastructure overhead rather than a service.

Using installation fees as the sole basis for cost recovery seems untenable over the long run. In fact, the largest cost over time is more likely the operations and maintenance charges for keeping the network running. If one has to front load these expenses entirely at installation time, the users would be disinclined to join the network, and growth would slow.

Installation fees are acceptable if one makes a speculative assumption. Assume that technology is consistently changing, and that by the time the network reaches saturation, a new technology, requiring new hardware and installation schemes, will arise. This guarantees a steady income stream. Unfortunately, this is a difficult assumption upon which to build a source of revenue.

The subsidy models (central computing or telecommunications) use older technologies as an income stream to support up the data networking services. This works in the early phase of network startup, but can present problems if the old source of revenue dries up, or the user demand for networking services sharply increases. This scheme also inflates the prices for voice or central computing, making alternative technologies or third parties competitive, and possible erosion of the market. Overcharging on voice to pay for data might lead users to look for alternatives. However, distributed services such as email, directory services, CWIS, etc., might provide a future income stream that might subsidize the basic network infrastructure. However, like the installation fee scheme, the subsidy model is not likely tenable over the long term.

69% of the respondents indicate using the schemes above, which do not hold out promise for the future in a decentralized, cost-recovered environment. Two models, per-node charging and mixed services, are used by Harvard and Penn State respectively. These sites are leading the way in showing how to operate data networks in an atmosphere of decentralized funding. An edited questionnaire response from Penn State's Steve Updegrove is contained in Appendix B. The response from Harvard's Steve King can be found in Appendix C.

The mixed services model seems to make the most sense. At UBC, we have asked the network administrators for input on this issue. Most felt that if we had to charge for network services, a market basket approach was the best. This allows the departments the largest amount of flexibility. Some departments may want to install their own LANs to their own specifications (following standards, of course), and may only want a backbone connection. Others, with less technical expertise, might opt for to the wall plate service, with monthly charges per port. This scheme seems to follow the one currently followed on the Internet, whereby one can place (theoretically) unlimited number of nodes behind a router connection. Charges accrue on the basis of bandwidth allocated, and the cost of equipment and management.

The mixed service model has another advantage. Providing a market basket of services encourages the organization to broaden the offerings in order to achieve large penetration. One can establish "soft" network services, such as distributed printing, email, and conferencing. All of these depend on the network infrastructure directly, and can contribute funding as overhead. Such "soft" service offerings can foster network growth by adding to the traffic mix, and providing a revenue stream for upgrading as necessary.

The mixed model also adapts better to new technologies. One can envision setting up a wireless hub/subnet. How is one to determine the number of nodes behind this hub? Registration is obviously necessary, but the problem of enforcement can be daunting.

The per-node model is also usable. It scales the income stream to the size of the network, allowing for orderly capacity planning. However, it only works if the institution has full control to the wall plate. Speaking from experience with users at UBC, clients will balk at paying per-node fees if they are only using a backbone connection to their own custom LANs. If most LANs and requisite internal wiring are under central control (like the telephone system), then per-node charging makes sense. It is related to the way one charges for telephones - i.e., per circuit.

In summary, offering a market basket of services, tailored to the needs of the users probably makes the most sense. It allows the user to fashion a LAN to their liking, with the ability to purchase extra services as necessary. Our users at UBC seem to prefer the approach, and Penn State has provided an excellent example as a starting point.

8. References

Gillespie, R.G.*Chargeback Revisited*, in Brian L. Hawkins (ed.),**Organizing and Managing Information Resources on Campus**, EDUCOM, 1989.

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Appendix A

Survey Questionaire

Dear fellow CAUSE member,

We are conducting a survey to determine the various methods of recovering costs for data networking at academic institutions. We decided to survey CAUSE member institutions identified in the CAUSE member database as having implemented a cost-recovery mechanism for data networking. This survey is being distributed to roughly 100 CAUSE contacts from those institutions.

The purpose of the survey is to inform our own planning process. We will make public (possibly presenting a paper at the next CAUSE conference) our findings to assist others struggling with the same thorny issues.

Please take a few moments to fill in the form below and email it back to me. Since the sample is small, a reasonable percentage is necessary to obtain valid results. Please respond no later than May 14, 1993 to be included in the survey.

Hopefully, the form should take no more than 15 minutes to complete. Thanks in advance for your time.

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Data Networking Cost Recovery Questionnaire

Name:

Title:

Institution:

Department:

1. Are central data networking services provided (e.g., campus backbone)? Please describe *briefly*. [e.g., network management, DNS, Email]

2. Please *briefly* describe the campus network: type, topology, protocols. [e.g., inverted fibre backbone, ethernet, 10 based-T LANs, TCP/IP, Appletalk, DECNET]

3. Please give the number of total network endpoints (computers, peripherals).

   Break this down by

Number of Intel-based PCs/servers:
Number of Mac-based PCs/servers:
Number of RISC-based workstations/servers (SUN, HP, RS6000, ...):
Number of network-attached printers:
Other:

4. Please provide the approximate number of network devices (routers, bridges, hubs) managed by your networking organization.

5. How many subnets/workgroups are connected within the campus network?

6. How far does your responsibility for network management and service extend?

   [ ] To the building communications closet.
   [ ] To the building floor closets (including risers)
   [ ] To the wall-plate.
   [ ] Other:

7. How are data networking costs recovered? Please mark the percentage of the data networking budget covered by each.

   a. Individual user fees per unit time: %
      [where such a fee is a charge per user per month]

   b. Network endpoint fees per unit time: %
      [where such a fee is a charge per workstation/PC per month]

   c. Subnet/workgroup fees per unit time: %
      [where such a fee is charge per LAN per year]

   d. Overhead fees charged to other service offerings: %
      [i.e., internal charges to other computing or network services]

   e. Lump sum payments by faculties, schools, or departments: %

   f. One-time network endpoint installation fees: %
      [where such a fee is a charge per PC network hookup].

   g. One-time LAN installation fees: %

   h. Per-data-packet or other volume usage fees: %

   i. Grant funding: %

   j. Other: %

8. Please *briefly* elaborate on the cost-recovery methods listed in the previous question. In specific, how are central facilities charged versus local LANs?

9. What is the approximate size of the budget for central data networking services?

10. Does your organization cost recover academic and administrative computing?

11. Would you like to receive an electronic copy of the survey results? Please provide an email address for delivery if different from the one in the email header.

Again, thank you for your time.

Appendix B

Case Study
Pennsylvania State University

The response from Penn State was very thorough. It is presented here in its entirety.

From: Steve Updegrove
Administrative Director
Office of Telecommunications
Penn State University

The Office of Telecommunications is responsible for video, data, and voice communications services, and is organizationally part of the Office of Computer and Information Systems, which in turn reports to the Provost of the University.

The data network is rapidly growing and dynamic within the 23 campuses that comprise Penn State. Our philosophy is to encourage individual colleges and departments to add to their LAN's without centralized "policing" of number of devices

We administer a University-wide data backbone service, which includes the responsibility for centralized network management, all facets of providing, maintaining, and perpetuating the functions represented by the various types of equipment and services which are a part of that (including inter- and intra- LATA T-1 and 56K circuits, packet switching nodes, routers, and distribution cabling), and assisting each campus, most colleges, and numerous administrative departments in design of their LAN's. Email and other services used by those who have been networked are provided centrally by other divisions within our parent organization, or within the context of the attached networks. As the client-server model of computing matures, the nature of these are changing, but there will be some form of central data networking services, regardless of how one defines that, provided for a long time to come.

Standards of all natures have been defined as strategically desireable. Among these are the use of TCP/IP as the data backbone protocol. However, in response to pressure by DECnet users, a policy has been developed requiring us to continue support of DECnet for at least a period of one year after DECnet Phase 5 is fully announced, providing a transition time for those users to move to the OSI suite. We currently tolerate tunnelling of Appletalk. Even so, periodic spurts of interest arise in supporting Appletalk in the native mode, despite its proprietary, non-standard nature. To date, the additional costs to manage a separate logical Appletalk network have not been justified by the set of Appletalk features that cannot be supported by TCP/IP, but the evaluation is an ongoing one.

At the physical level, the backbone is based on FDDI, with some remnants of a past Pronet-80 and -10 being used to meet specific needs, and the pathways to the campuses providing at least a full 56K, and in many cases several times that. (Several campuses are connected via T-1's, which support bandwidth needs for both compressed interactive video as well as data.) Backbone services are provided centrally to a point on each campus, from which either 802.3 or 802.5 (ie., Ethernet or Token Ring) networks can be extended. Cabling is considered as being infrastructure, both among and within buildings, and is generally installed in a physical star within the buildings from a few telecommunication closets. We have adopted the use of Type 2 cabling as a minimum cabling standard, allowing for additional types of cabling (such as fiber or unshielded twisted pair) to be used where conditions warrant. We are currently evaluating the possible adoption of level/category 5 cabling as a potential successor to the use of Type 2, based on it's slightly lower installed cost, and it's similar performance capabilities. Fiber is used between buildings, with over 75% of our major buildings currently connected. At least 6 fibers are installed to each of these, with up to 144 to facilities such as the main Library build- ing.

We currently have about 4200 registered addresses, about 1200 of which are for pc's in laboratory environments. There are probably several more (100 s) of unregistered machines scattered among the local networks. (Central registration is strongly encour- aged but not required. Although there are certain limitations for unregistered machines, and there is no fee to register, registration is at the discretion of the individual user or department.) There is also a large administrative SNA- based network with a 2000 users or so that is slowly being transitioned to the TCP/IP backbone.

We manage 4 class B and 10 class C networks, broken into roughly 300 sub- nets, with an additional 100 workgroups networks being divided within that structure. (These are exclusive of the network at our Hershey Medical Center, which is managed locally, except for name service which is provided centrally for this large multi-router network.) We manage abour 40 routers, 30 bridges, and 40 concentrators/10BaseT hubs.

Our responsibility includes everything "inside" the network, with the for- mal demarcation point being the end of the cable attached to the back of the router. With SNMP, we "look" further into the individual LAN's, and in some cases directly into the pc. We offer a cost-recovered service to design, install, and maintain local networks for those who do not have or want to pro- vide that expertise themselves. This applies both at our University Park cam- pus as well as at the other campuses located throughout Pennsylvania. We are also responsible for the management of the centrally installed cabling systems. This is true regardless of whether the cabling has been upgraded to meet minimum cabling specifications or is still previously installed telephone wire. The main areas, in terms of data networks, for which we are NOT responsible are for LAN electronics (concentrators, bridges, servers, communication cards) for individual LAN's which are managed by individual departments.

It will take some time to define and align our data networking budget in accordance with this criteria. We do not define a DATA NETWORKING budget per se--there is an overall telecommunications budget which includes data networking services, but which is subdivided by different criteria.) In the spirit of trying to provide something useful, there are a few comments worth offering:

--our philosophy is to avoid penalizing anyone based upon which Penn State location they happen to be at, so fees are generally location-independent.

--rates are developed based on different services, in turn functions of connect ion speed, cost of leased facilities, and whether it is useful to stimulate its growth by subsidization with central funds. (Note that there is no specific subsidy of data, voice, or video services by rates generated from either of the other two services.)

--When a service is to be fully cost-recovered, we make every effort to include in that rate not only a reasonable amortization period for up-front costs, but also a mechanism to generate both maintenance and replacement (life-cycle) funds.

--Two distinct telecommunication budgets are administered--one to account for the use of central funds (generally to support infrastructure, and to support "immature" services) and the other to account for "mature" services, for which all provisioning costs are recovered.

--To pay for fringe benefits, office space, and other services used by that portion of the office providing "mature" services, most rates include a 22% overhead to pay for those types of costs. Exceptions are notable for services having high percentages of equipment costs (assessed a half the rate) and for labor costs of networking services within residence halls (billed to the Housing office at cost).

--Departments are expected to pay for their LAN from their departmental budget.

--The data backbone service is sold at a fee of $3200 one time cost, and a recurring monthly charge, regardless of the number of devices attaced to the LAN, of $275. This pays for the electronics, installation, maintenance, and replacement necessary to continue up-to-date service levels. The connection can be either 802.3 or 802.5, at the department's direction. We also encourage individual departments within buildings to consolidate their needs. In those cases where segregation of the building is warranted (e.g., for security or performance reasons) we will install and manage a "building backbone" consisting of a small network-in-a-box, and bridges to networks attached to it. This also requires one person in the building to assume the role of a "broker" for the building networks. (This is in addition to persons being identified as the network's administrative, technical, and security contacts for that connection.

--We also offer an "individual backbone connection" in certain buildings (those in which we can make it financially viable) which is currently billed at $750 one time and $15/month, which is equivalent to past data-switch and SNA service connection costs. In those cases, we provide and manage not only the routers, wiring, and 10BaseT concentrators, but also the card and communications software in the pc itself. IBC's are provided on only individual bases--they may not be used as network connections.

--We do not count packets, and in general do not base rates upon usage level, instead using flat rate monthly costs as our preferred model. As noted above, we also encourage autonomous growth of local networks, with registration of addresses being about as close as we get to monitoring that aspect (unless we are retained to manage the network, in which case we do keep close tabs on it).

--Because we are not a academic entity, we do not directly submit grant request s, although we oftentimes work closely with those who do for telecommunications related items.

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The telecommunications budget for this year is slightly over $15M, with 1/6
of that centrally funded, and the remainder cost-recovered.  I'd estimate that
about 1/4 of the $15M supports "central data networking services" directly, and
another 1/4 indirectly (meaning it is shared with other services which bear a
portion of the costs of circuits and the like.)
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Appendix C

Case Study

Harvard University

The response from Harvard is included here, edited for readability. Harvard has by far the largest network of all of the respondents in the survey, and recovers most costs from monthly node fees.

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From: Stephen J. King
Associate Director
Office fcr Information Technology

Harvard has installed a 10MB, fiber backbone for the University, a very
capital project, and OIT has a high speed data network business unit doing
network operations center, LAN support, and consulting

The Harvard data network is a distributed architecture, with 7 major
nodes, based on TCP/IP and supporting IPX, Appletalk, and Ethernet protocols

Number of Intel-based PCs/servers: 6000
Number of Mac-based PCs/servers: 9000
Number of RISC-based workstations/servers (SUN, HP, RS6000, ...): 500
Number of network-attached printers: 2000

7 major hubs or nodes, lots of central monitoring equipment, hardware in
over 500 buildings, approximately 200 LANs being connected over time
Responsibility extends to the wall-plate.

50% of the budget is recovered from node fees per unit time. 10% comes
from workgroup/subnet fees. 10% is derived from installation fees.
The rest is made up from overhead and lump sum payments by departments.
Note that the entire budget of approximately $1M is cost-recovered.
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NIC Knack Paddy Whack Give That Information a Home: Campus Wide Information Systems and its Service Agent the Network Information Center (NIC)

William (Skip) Brand
Program Coordinator Senior
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ABSTRACT

The global web of computer networks called the Internet is an open door to information for campus staff, faculty and students. While the potential is immense, the challenges faced by the information technology organizations and libraries is daunting. When planning for, implementing and managing this new catalyst for change; information professionals need to provide an infrastructure and support mechanism for this service in order for its use to be successful. The Network Information Center (NIC) and the Campus -Wide Information System (CWIS) will play a primary role in helping its users to master the language, culture, and tools of the next decade in education. Never before has an information technology infrastructure been such a strong catalyst for change, which will totally alter the educational process as we know it. In the wake of these changes this presentation will discuss:

- How to organizationally set up a NIC and CWIS:
- Getting the NIC and CWIS funded;
- Getting them started;
- Multiple uses of the Internet, CWIS and NIC;
- Ethics and security issues;
- Academic information delivery;
- Administrative information delivery;
- Library issues;
- Encouraging faculty, staff and student access;
- Navigating tools and services for the Internet, CWIS and NIC;
- Campus-wide issues.

Campus Wide Information System and Network Information Center as Catalysts for Change

The phenomenon of virtual communities on-line has deep roots in Campus Wide Information Systems (CWIS). Although CWISs and Network Information Centers (NIC) are sometimes hard to label, they're real, growing and affecting your life whether you participate with them or not. In the last few years we have witnessed major advances in technology and public awareness of networking solutions.

Well, time has passed since personal computers started a minor revolution. Another revolution, argumentatively larger than the first even has the President's office mentioning *the information infrastructure as a catalyst for change*[1]. Since the Internet has become mainstream there has never been a better time for properly managing the CWIS and NIC to create a positive change that can truly transform the campus and its people.

CAUSE's statement about optimizing the infrastructure should be the creed of those who develop the next generation of CWISs and build its service agent, the NIC.

> "As our need to be connected--to each other and the world--grows, networks proliferate and the clamor for new networking access grows. Tantalized with the possibilities for instantaneous communication and immediate access to vast sources of new information, staff, faculty, and students hold high expectations for the new order. However, while the potential held by the new infrastructure is immense, so are the challenges for those who plan for, implement, and manage it."[2]

In the wake of these challenges, great opportunities lie where the NIC and the CWIS will play a primary role in helping "Infonauts" master the language, culture and tools for the next decade of world wide education.

This paper's intent is to discuss the CWIS and its servicing agent the NIC and to enlighten the reader with relevant examples and experiences. Arizona State University makes no claims to be the model Campus-Wide Information System nor Network Information Center, but ASU does feel we have gained some important insights, hindsights and lessons learned on our journey to develop our new CWIS and NIC. Our method of developing these two entities on the cheap did initially hamper our efforts, but current senior management approval is providing the resources for new, more responsive, user centered systems. Practical application methods will discuss: how to organizationally set up a NIC and CWIS; getting the NIC and CWIS funded; getting them started; multiple uses of the Internet, CWIS and NIC; ethics and security issues; academic information delivery; administrative information delivery; library issues; encouraging faculty, staff and student access; navigating tools and services for the Internet, CWIS and NIC; and campus-wide issues.

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[1]The National Information Infrastructure: Agenda for Action, Vision Statement of the Presidents Office for the NII by the National Telecommunication and Information Administration, September 1993.
[2]Kathleen Martell Ciociola, Track V Coordinator and CAUSE Program Committee, "Optimizing the Infrastructure: Track V Statement," CAUSE93, December 7-10, 1993.

What is a CWIS?

According to the Internet Glossary, "A CWIS makes information and services publicly available on campus via kiosks, and makes interactive computing available via kiosks, interactive computing systems and campus networks. Services routinely include directory information, calendars, bulletin boards, and databases."[3] This definition is accurate, but quite limited. For example when Brown University first talked about the future of their CWIS, they mentioned it being a paperless society, marketing tool, menu system which integrates all campus services, latest course announcements, database applications, collection point for all campus policies, frequently asked questions , personal calendar/scheduler, and electronic forms.[4] CWISs are virtual kiosks in the sky with on-line "anytime anywhere" access to a wealth of campus resources.

Campuses are not the only organizations running wide area information systems businesses, government agencies, and cities have grasped the concept and joined the Internet world to share their resources. Since many CWISs are letting users out the back door of the system to the vast resources of the Internet, the new generation of CWIS administrators like the term World-Wide Information System (WWIS). Not only are CWISs more available to other Internet resources, but the new generation of CWISs are more responsive and user centered for all users. In order for any information system to be successful, it must have support.

What is a NIC?

Sitler, Smith and Marine (1992, p. 4) state, "A Network Information Center is an organization whose goal is to provide informational, administrative, and procedural support, primarily to users of its network and, secondarily, to users of the greater Internet and to other service agencies."[5] Just like CWISs, NICs can be anywhere in the Internet world. Because of the Internet's growth, users find it increasingly difficult to navigate through the maze of available resources, such as the hundreds of CWISs. NICs contain information of interest to the target user community (campus, community, state, world). Generally, a NIC lists information on what to do on the Internet, as well as specific local information, such as newsletters, guides, travel logues and popular navigation software.[6]

A NIC has three main functions. The first is called information services or help desk functionality. This is the place where you call, email or fax to get help about network resources like a CWIS. The NIC is your first aid station for finding out how to get connected and where resources are on your CWIS or other CWISs and the Internet. InterNIC refers to this reference desk service as the "NIC of first and last resort." What InterNIC means by this is they will answer beginners questions and expert navigators questions. The information services also handles the training and educational material for the CWIS and networks.

The second function of a NIC is directory and database services. Sometimes referred to as the yellow pages and white pages of the networked world. This is where

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[3]G. Malkin and Tracy LaQuey Parker, "Internet User's Glossary," Request for Comments: 1392, FYI 18, January 1993, p. 9.
[4]Mary LaMarca, Suggestions for Future use of CWIS, Brown CWIS, Brown Gopher, February 8, 1993.
[5]D. Sitzler, P. Smith and A. Marine, "Building a Network Information Services Infrastructure," Network Working Group, Request For Comments: 1302, FYI: 12, February 1992.
[6]Susan Calcari, "What is the InterNIC?, NIC fest '93, November 6, 1993.

someone would ask questions like: How do I find curriculum resources on the CWIS?; and how can I put my information onto the CWIS and the Internet? The directory of directories is the road map to finding rich resources like library catalogs and data archives.

The third function of a NIC is registration services. Registration services for a CWIS sets up accounts for members of the community to be information providers and provides users with assistance on policy issues. This third essential function usually operates the accounts and access privileges of the CWIS and the corresponding Internet connections.[7]

The NIC is one stop shopping for information about the CWIS and the Internet. One important aspect of the NIC is its ability to coordinate services which are across many organizations and levels within the campus. Personnel from varied functions interact and exchange experiences to provide help for the end users. The NIC support can be as instrumental as establishing on-line help for the CWIS, to working off-line with faculty on using the CWIS and network tools effectively in the classroom. In order to support these varied tasks, collaboration is a key.

Think Globally, Act Locally

The strength of the Internet's current success is collaboration, cooperation, and communication. The Internet's success teaches us the key to ultimate success of implementing a CWIS and NIC is coordination and the collaborative culture of the Internet. Never before has there been a time when so many people can communicate so much information with so many people. There are many organizations that can help, co-develop, and pool resources to ensure the CWIS and NIC at the local level is satisfactorily serviced.

Most everyone believes information is power and knowing what is occurring with other organizations trying to solve the same problems that your organization may have is what the collaboratory nature of the Internet is all about. There are many organizations at the world, federal, state and local level that can assist your campus with administering the CWIS and servicing your end users with a NIC.

World Level

A world wide group, the Internet Engineering Task Force, is the protocol engineering, development and standardization arm of the Internet Architecture Board (IAB). It has grown to be a large open international community of network designers, operators, vendors and researchers concerned with the evolution of the Internet protocol architecture and the smooth operation of the Internet. A CWIS and NIC project team does not need to reinvent the wheel, rather make adaptations and changes to other CWIS and NIC software, documentation, policies and procedures from thousands of world wide organization doing just what your organization is doing.

Federal Level

At the federal level funded, by the National Science Foundation, is InterNIC which is a focal point between Network Information Centers and end users. The InterNIC cooperates with regional, campus, governmental agencies and international

[7] InterNIC Backgrounder, NIC fest '93, November 6,1993.

NICs to stay abreast of the current requirements of these organizations and their users. Another entity at the Federal level is The Clearinghouse for Networked Information Discovery and Retrieval (CNIDR). CNIDR is sort of a 'Consumer Reports' type group which works closely with the developers of other network navigation tools to move them toward providing compatibility and consistency. CWIS developers can get help from CNIDR regarding which CWIS software to use at your campus. These two groups are only a few of the very helpful federal level groups to cooperate with to run a successful CWIS and its service agent the NIC.

State Level

The Arizona State Public Information Network (ASPIN), with funding from the National Science Foundation, is developing a Network Information Center for the State of Arizona. The Governor's Strategic Plan for Economic Development is writing legislation to fund the State NIC and is planning on giving additional funds to the ASPIN to help expand the state network to the rural areas. Some of the rural area expansion dollars are to start CWISs in the rural community colleges. Arizona State University is helping to coordinate all of the new Internet connections in the rural community colleges and to form a cooperative NIC of NICs to help support end users and develop CWISs. Arizona's Freenet organization called Arizona Community Computing (AzTeC) is looking to join forces collectively with community level CWISs and NICs to provide seamless support for all communities, equal access and support for state internetworking

Local Level

ASU's NIC

Organizationally, the ASU Network Information Center consists of a help desk with four part-time phone consultants, a NIC-Q@ASU.EDU email list for questions, a populated on-line consulting system, and a virtual NIC, which is a Gopher directory containing items that help users find information about the Internet, NSFNET, WESTNET, ASPIN, and ASU networks and navigational software. The NIC is especially intended as a reference point for new CWIS and Internet customers to use in obtaining general information about the ASU Gopher CWIS and the Internet, especially how to connect, usage policies, and user guides. A pointer to the InterNIC (Network Information Center) of first and last resort, InterNIC, is included here. Other useful NIC Gopher Servers, general purpose Internet guides, information, newsletters, phone books, and Internet navigation information are also included.[8]

The Network Operations Center menu provides up-to-date information about Internet outages that are scheduled or have just occurred which can be used to help one plan one's use of the Internet. By checking here, a user may discover that the site they are trying to reach is down, and not a result of their own software/hardware configuration. Any user can also see various statistics for usage on the Internet/NSFNET as well as ASU's Gopher Server usage statistics.

ASU Information Technology also provides an on-line consulting service for Internet related questions as a part of ASPIN (the Arizona State Public Information Network). Questions and requests for information can be sent in an e-mail note to NIC-Q@ASU.EDU or you may call the ASPIN NIC consulting line at 965-7000.[9]

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[8]Baldwin, Doug, About the Network Information Center, Gopher CWIS ASU, November 18, 1993.
[9]Baldwin, Doug, About the Network Information Center, Gopher CWIS ASU, November 18, 1993.

ASU's CWIS

At the campus level, the Arizona State University Gopher is our Campus-Wide Information System, which provides a central delivery vehicle for information about Arizona State University. It is easy to use, and finding information is facilitated through a simple searching mechanism or browsing a hierarchy of menus. As an added benefit, the interface has the same "look and feel" of a variety of platforms, so computer users familiar with Gopher on one system can easily adapt to Gopher on the other systems. Finding information on the ASU Gopher is as simple as selecting a cheeseburger from a menu. The ASU CWIS gives computer users at ASU access to similar systems throughout the world and those at other universities access to information about ASU.

The "ASU Campus-Wide Information" directory contains information from various departments and organizations at Arizona State University. Some of this information is located on various college or department gopher servers, however, some is located on the ASU CWIS Gopher Server. In any case, the information providers are responsible for the contents of their own particular "branch" of the ASU CWIS Gopher system. ASU Information Technology makes no claims for the accuracy, currency, or reliability of the information contained in these sub-menus.

ASU departments and organizations, and soon off campus organizations, that would like to contribute their own sub-menu should read the item "How to Contribute to the Arizona State University Gopher" in the same directory and as seen below.

Figure 1 **How to Contribute to the Arizona State University Gopher**

How to Contribute to the Arizona State University Gopher (11/18/93)

As you are probably well aware, the potential for Gopher as a tool for distributing information of all kinds, from all sorts of places, is great. It takes creative ideas from all kinds of people to make a truly useful Gopher. The very nature of Gopher lends itself well to bringing information from a wide range of providers into one integrated structure.

At ASU, we are attempting to make it easy for departments and organizations to become information providers for the ASU Gopher Server. ASU Information Technology (IT) is providing the "conduit" and support for these contributions. Individual organizations and departments are responsible for their own "branch" of "gopher-space". All an "Information Provider" needs is their own Gopher server or authorization to use a new facility called "Gopher-Lunch" to "feed" the main ASU Gopher Server maintained by ASU IT.
Access to ASU department/organization Gopher Servers/sub-menus will be through the "ASU Campus-Wide Information" item from the main ASU Gopher menu. An "Information Provider" has the following options available for contributing:

1) Run your own Gopher server on a Unix workstation.
   + The Unix Gopher Server software is the most robust and reliable.
   + WAIS full-text indexing is available for database searching.
   - Unix workstations tend to be more expensive to buy/administer.

2) Run your own Gopher server on a Macintosh computer.
   + The Macintosh Gopher Server software is extremely easy to install and use, making this a good solution for new providers.
   + Macintosh computers tend to be less expensive than Unix workstations.
   + If most of your information is in Mac format, there will be less file conversion/transfer involved.
   - Depending on the processing ability of the Mac, this may not be

a good solution if traffic to your information gets very heavy.
- WAIS full-text indexing is not available for database searching.
- Disk storage space tends to be an issue.

3) Run your own Gopher server on a PC computer running Unix.
+ PC compatible computers tend to be less expensive (and used ones more available) than Unix workstations.
+ There is public domain Unix software available for PC's
+ WAIS full-text indexing is available for database searching.
+ If most of your information is in DOS format, there will be less file conversion/transfer involved.
- Depending on the processing ability of the PC, this may not be a good solution if traffic to your information gets very heavy.
- Disk storage space tends to be an issue.

4) Submit information to IT's ASU Gopher Server with "Gopher-Lunch".
+ The easiest way to get information into the ASU Gopher.
+ Gopher-Lunch works through a Gopher Client or through simple E-mail.
+ You do not have to administer the server's platform/operating system.
- You may be limited to a certain amount of disk space.
- You will have to transfer files to the system.

In all cases, you will have to coordinate with ASU Information Technology to have your submenu added to the "ASU Campus-Wide Information" menu.

For easy access, pointers to the Gopher Server software described above are included in the same directory as this file is in. The Gopher-Lunch command menu is also included here so once you get authorized as an Information Provider, then you can begin adding items.

To get authorized for Gopher-Lunch, or to have the ASU Gopher Server point to your own Gopher Server, send an e-mail note to "gopher-help@info.asu.edu". Or, easier yet, if you're running a Gopher+ Client that supports ASK blocks, select the "Request to become an Information Provider to the ASU Gopher" item in this directory, which will let you fill out and submit a request form to "gopher-help" automatically.

NOTE: Supported Gopher+ clients are: Macintosh TurboGopher (version 1.0.7 or greater), PC Gopher III (version 1.1.2 or greater), HGopher for Windows, or Unix Gopher (version 2.0 or greater). The Gopher Clients on the ASU Academic IBM VM/CMS and Academic VAX currently do not support ASK blocks and will not work). Once your request has been approved or denied, you will be contacted with more information on setting up your part of "gopher-space". Thanks for your interest!

--The ASU Gopher Team[10]

At ASU we are moving to a production Gopher CWIS server, which will be automated with the software product mentioned above called Gopher Lunch. Gopher Lunch will help ASU finish migrating off our old mainframe CWIS system. The Gopher Lunch software will allow ASU to automate and coordinate the CWIS to help lay persons to be information providers at ASU.

What Gopher Lunch Is

Gopher Lunch is a system for submitting and maintaining "gopher data" on a Gopher Server, via Gopher+ clients, electronic mail, and anonymous ftp. As it is often

[10]The ASU Gopher Team, How to Contribute to the Arizona State University Gopher, Gopher CWIS ASU, November 18, 1993.

unpopular to generously assign remote login accounts on Gopher Server systems, and as the methodologies and learning curve for updating and maintaining "gopher data" is equally unpopular, Gopher Lunch was developed as a more secure and intuitive distributed system of maintaining "gopher data."

There are two interfaces for administering all of the Gopher Lunch commands. The first is through the Gopher+ client ASK blocks. ASK blocks are simple on-line forms that providers fill out and submit. An example of a Gopher Lunch ASK block is in Figure 2. The other interface to Gopher Lunch is Internet electronic mail. Most mail clients with gateways to the Internet work fine for Gopher Lunch. Coupled with anonymous file transfer protocol (for binary and large files) both interfaces allow a validated provider to maintain his/her own files, create searchable indexes to those files, and perform various accounting functions---all from the provider's native platform. Creation, deletion, and maintenance of the CWIS accounts can be done through the same interface(s) by a "CWIS maintainer."

Figure 2. Example of a Gopher Lunch Ask Block for Adding a File

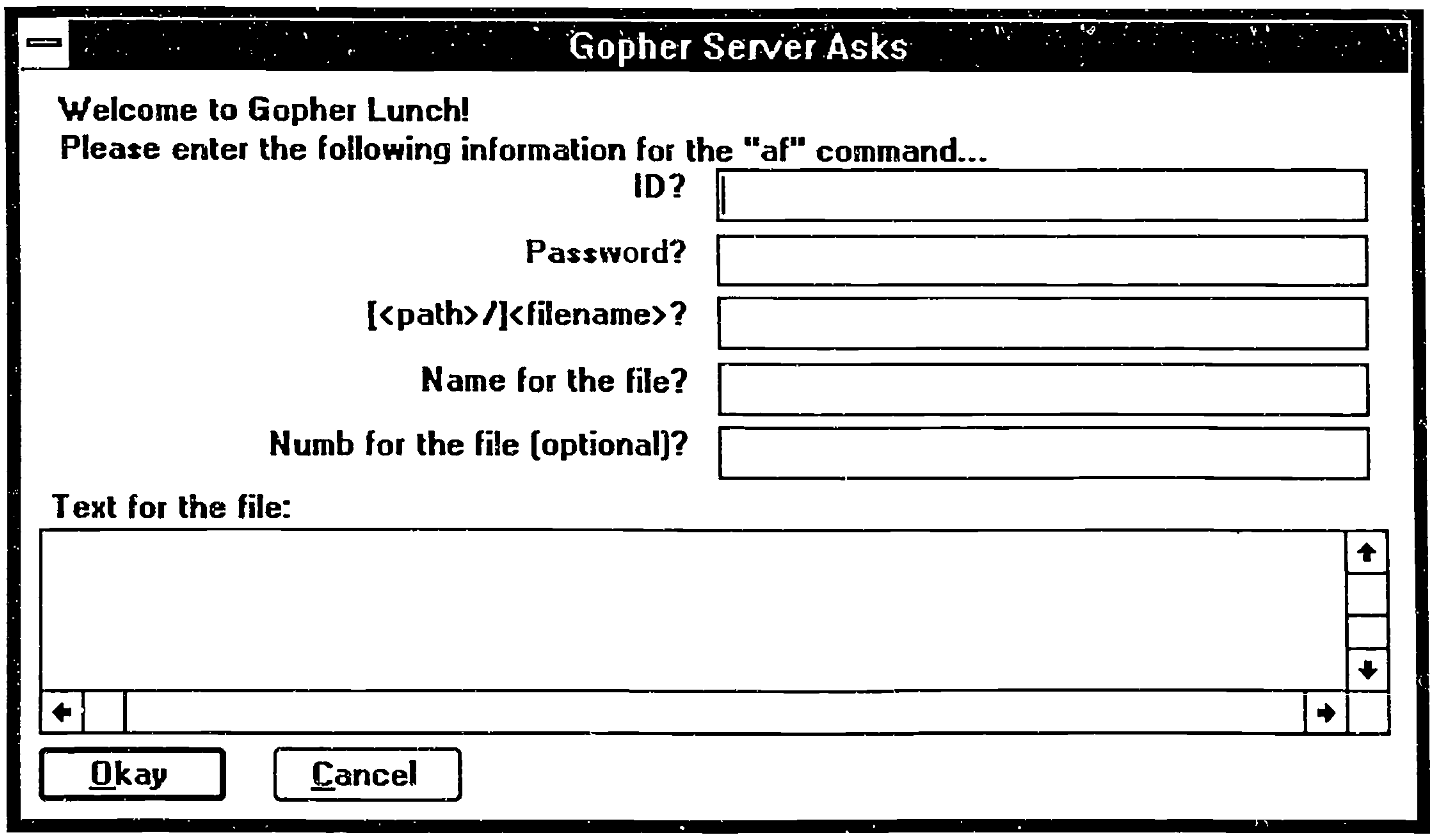

Figure 2. *The Gopher Lunch ASK block requires the Information providers identification and password for his/he account. The [<path>/]<filename> is the location of where the file should be placed in the CWIS. The "Name fo section is where the Information provider gives the new information a descriptive name for the file everyone will s for the file (optional) field is for the order of directory occurrence the Information provider wants the information The text for the file section is where the information provider types of pastes in the actual text.* \

Getting a CWIS or NIC Funded and Started

Although the CWIS and NIC are entirely different organizations they have many areas which are mutually inclusive and co-dependent on each other. One common element they share is their haphazard beginnings and practically no budget start. ASU, for example, slated that the NIC be a zero dollar budget start up, but coordinate services that are already being done and not called NIC functions were costing a considerable amount of money. Even at these early stages there was an acknowledgment for the need of future funding sources. On the other hand, the CWIS became an after hours project over two years ago, when ASU was looking to support its' distributed computing consultants with an on-line consulting system. When the consulting systems engine was designated to be a Gopher server, management desire to replace the mainframe CWIS emerged. Through the hard work of the ASU Gopher Team and their ability to educate others about navigating the Internet, progress was made and Information Technology dollars followed the progress and action. The ASU CWIS Gopher server was born by riding the coat tails of another project (on-line consulting). Presently, ASU has a test CWIS, a production ASU CWIS Gopher server, and a production server for Netnews and other future CWIS engines.

At the same time CWIS project was having its' eager beginnings the State Network Information Center became funded by an NSF grant (ASPIN) intended to network the rural areas of the state. In the grant was funding for starting a NIC of NICs for Arizona (de facto ASU for now) and geographically distributed NICs for the rural community colleges and their new Internet connections. The awareness and excitement generated by the promise of the "data superhighway" prompted a Governor's level group to request funds from the state to help enlarge the NIC development efforts and separately fund Internet applications like CWISs around the state.

There are many different strategies to getting NICs and CWISs started. Some methods include just renaming old services, organizing the elements of both that already exist, adding CWIS and NIC functionality to projects already under development, and adding another phone number to the phone consulting line or departmental gopher The ideal method of establishing a model NIC or CWIS is not to just throw things on a server and dish out ad hoc help, but to form a steering committee including faculty, staff, administration, and students to direct the structure of the CWIS and functionality of the NIC. ASU may not have had ideal starts for both of these projects, but with a "just do it" mentality the initial success developed into a clear vision, which has now been articulated by the Vice Provost. ASU's Gopher CWIS Server and the NIC are new emerging services reborn with strong commitment and new leadership.

Multiple Uses of the Internet, CWIS and NIC

The CWIS administrator and the NIC support staff person are expected to be Internet gurus. This is just not possible with the size of the network, the number of applications, and the speed of network development. The information served up by many CWISs is not just ASCII text anymore. There are many new forms of information like audio (Internet Talk Radio), video (mpeg), and multicasting (mbone) that not only require lots of bandwidth, but a technical savvy administrators and knowledgeable NIC staff people. With all of the multiple uses of the Internet a successful CWIS administrator needs to encourage others to serve up information they require, so as to not force the central IT unit to hold everyone's hand in becoming an information provider. The key to making information providers self-sufficient is a "training-free" and consistent graphical user interface. Along those same lines the NIC staff needs to have one skill greater than any other, and that is not to have all of the information needed for all types of uses, rather knowing where that information is. Bucking and referring to the appropriate location for help is the only way for ASU IT to support multiple uses of the CWIS and NIC.

Ethics and Security Issues

Ethics and security go way beyond netiquette. The NSFNET acceptable use policy used as the networking administrator's crutch is currently not enforced and therefore has no teeth. There are also trade offs that occur between ease of use and the building of fire walls for security. The most appropriate way to address security is to discuss it from the first day of the CWIS project. For example one security issue at ASU is having public dial up access to a secure Gopher CWIS server and not allowing anyone connecting to it to create links to off campus. This is so ASU does not give out entire Internet access to the general public.

Ethics and world wide cooperation is essential because anyone can easily become an information provider to the world. Educom's "Bill of Rights and Responsibilities for Electronic Learners" is an excellent document that every NIC should have and organizations like the Electronic Frontier Foundation should be consulted when dealing with responsible citizenship in the electronic community. The best way to be prepared for ethical and security issues is to have policies in place and study security case studies from other campuses.

Academic and Administrative Information Delivery

A successful CWIS can create a culture change of moving from a paper-based process to an on-line browser or search and query database process. The information resources on the CWIS get interwoven in the academic discipline and the NIC staff people are regularly helping faculty teach navigation skills to the classes. Faculty are feeling empowered at the office ethernet jack. Due to the marketing work of the NIC, academics are using the CWIS for many different things from publishing electronic journals to displaying CD photo images of the Mars probe.

Administrative users have been excited about not having to reinvent the wheel when creating policy by viewing other universities policies and procedures through the CWIS and the Internet. Many administrators after receiving training from the NIC at ASU, point up to their bookshelves and state, "We do not need all of these out-of-date paper manuals when the information is at our fingertips on the CWIS." Many of the administrative offices are interested in becoming information providers, especially those in areas such as admissions, registration and student affairs. The new CWIS has raised the eyebrows of many budget minded administrators who envision cost savings and increased administrative productivity. ASU's NIC is trying to ensure that none of the administrative or academic users will fall through the cracks.

Library Issues

The CWIS and NIC should not ask for help from the library, but *include* them. The library community has many valuable contributions to offer the users of the CWIS and the Internet. Libraries have been exposed to the paperless society; the library without walls; the move from collections to access; and the shift in emphasis from quantity to quality.[11] Libraries have experience in training patrons to glean information resources

[11]Susan Martin, "Libraries in the 21st Century: What We Should Do With NREN," in *Library Perspectives on NREN*, Chicago: Library and Information Technology Association, 1990., p. 35.

and have a large part to play in the full circle development of the ASU NIC and CWIS. For example, librarians at ASU have partnered with the NIC to teach navigation of the CWIS and the Internet. The librarians handle the resource questions and the techies handle the tools questions. Until both librarians and information technology professionals work together the CWISs and NICs will not reach their full potential.

Encouraging Faculty, Staff and Student Access

ASU's NIC staff, through the faculty development department, started teaching introduction to the CWIS tools and Internet navigation. Classes were booked solid for weeks. The NIC staff was quick to notice the only way to keep the faculty interest was to "hook them" by setting up discipline specific training sessions for each subject area. The NIC trainers even trained from the department sites. The most important teaching motto for the NIC staff was just teach them one thing they will use everyday. About five hundred of the faculty trained also challenged the CWIS and NIC teams to make tools user friendly and classes very short. The faculty interest was in the resources first, the tools second, and running a server in a close third.

Having 42,000 students puts an ASU CWIS Gopher Team of under ten staff members and a NIC staff of under ten members at quite a disadvantage. However, due to the faculty excitement and efforts, many classes on campus were going on Internet hunts and frequently meeting in computer labs to get aquatinted with the Gopher client for student survival training in the 1990s. Every campus computer lab had CWIS and Internet access and it did not take long for student Internet Users Groups to form and for a few student organizations to become information providers for the campus and the world. The students are used to training themselves at ASU and take full advantage of the on-line consulting database and tutorials.

The administrative training was much different than faculty and student training. The administrators wanted demonstrations first, then maybe hands on classes. The administration at ASU was more interested in the new CWIS conceptually, then as a personal productivity tool. Generally, the administrators wanted the NIC team to train their trainers first, and then have their trainers teach each of them. This train the trainers concept worked fine unless one of their trainers just could not grasp the material. Training administrators to be information providers involved lots of piloting first, show and tell second, then development. The administrators' culture change happened most drastically with many of them trying to think of innovative applications such as preparing for campus imaging and electronic work flow.

Navigating Tools and Services for the Internet, CWIS and NIC

The speed of development of new client/server tools is exciting, but very problematic for NIC support when a new version of a tool comes out every week and the ASU CWIS server software changes every two weeks. The policy project team screams for stability on the server side so the CWIS can be called "production," but can something that changes this much and is experimental so often, be called production? The arguments will go on for months, but the CWIS will keep functioning with over 7,000 visitors and approximately 3,000 searches a day. This CWIS traffic is increasing geometrically each month. The funding of the ASPIN state network increases the CWIS potential users to over 500,000.

The challenges of so many new CWIS users for the NIC makes the task daunting, but the research and development team is finding new tools and automated services to give end users a better interface and more advanced searching capabilities. Due to the small size of the CWIS and NIC staff ASU draws on the experiences of others and collaborates interstate and world-wide for internetworking solutions. Many of the new tools like Mosaic and WWW servers are being experimented with to see if they meet our needs. The future of the ASU CWIS does not lie within the next new navigational tool, but with the strategies for serving the campus and state with the NIC.

Campus-wide Issues

There are so many issues concerning these two entities. Most of the issues are not problematic, but opportunistic. Outreach efforts for the campus are improved immensely by effective information dissemination and strengthen linkages to others at geographic distances because of the CWIS. The ability for everyone on the campus to become an information provider and the ability to listen to audio and see video brings up an old issue of capacity. ASU has not had capacity problems yet, because many CWIS providers are willing to run their own servers. The other issues that ASU will wrestle with for some time to come is:

- Responsibility of information;
- Wide accessibility;
- Funding;
- Governance/ Policy-making;
- Network management;
- Intellectual property rights/copyright;
- Privacy/data security;
- Technical standards and;
- User training and support.

The Electronic Kiosk: Interactive Multimedia Goes Enterprise-Wide

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Abstract

This presentation will provide an overview of the University of Texas' new electronic kiosk and how it was developed. The Kiosk project is a joint effort between The University and Apple Computer to create a series ATM-like microcomputer workstations that provide campus-wide information services. The kiosks employ client/server and multi-media technologies to give University constituents access to a variety of information types (e.g. maps, sound, original images) without prior training or assistance. The kiosks provide University administrative offices with a cost-effective means for delivering official electronic information services to students, faculty, staff, and visitors. The presentation will focus on strategies for initiating and managing a university-wide project.

The Electronic Kiosk: Interactive Multimedia Goes Enterprise-Wide

I. INTRODUCTION

The University of Texas at Austin is in the early stages of deploying a series of electronic Kiosks designed to support a variety of campus-wide information services. These Kiosks are similar in concept to automated teller machines (ATMs) in that they are publicly available computers linked to common servers via network connections and are housed in enclosures protecting the equipment from damage or theft. While these Kiosks will not dispense cash, they do deliver a wide range of information from different sources and employ interactive multimedia as the user interface. All major elements of the Kiosks, from the software to the physical enclosures, were developed in-house at The University of Texas. The focus of this presentation is to relate the strategies employed in the initiation and management of this project and describe how it is being integrated into the existing information technology infrastructure.

Original Project Description

The Kiosk project is a joint development effort between The University of Texas at Austin and Apple Computer. The project was initiated with The University's Data Processing Department in 1992. In addition to the development of the Kiosks themselves, the stated purposes of the project included demonstrating the effectiveness of interactive multimedia as user interface and producing portable software tools which could be used by other institutions to build similar Kiosks.

The functions which have been developed for the first version are:

- A Multimedia Introduction to The University of Texas at Austin
- A Campus-wide Events Calendar
- An Interactive Map of Campus
- Maps of Shuttle Bus Routes
- A Directory of Students, Faculty and Staff

The multimedia introduction makes extensive use of digital video (QuickTime) to provide visitors and prospective students and faculty with background on the history and traditions of The University as well as an orientation to campus and essential facts for visitors. The Student, Faculty, Staff Directory and the Events Calendar provide real-time access to information from The University's corporate database on the Administrative Computer System. Both the Events Calendar and the Directory are linked to the interactive map so that campus locations of people and events can be displayed directly from those lists. The map may be searched by a variety of criteria ranging from building name to department, and photographs of buildings are displayed whenever they are selected.

In addition to the digital video described above, the major elements of interactive multimedia employed in the Kiosk include color graphics, digitized photographs and other images, sound, and touch screen monitors. The touch screen technology enables users to indicate selections by simply pointing. The project's goal is to make the system simple enough to be used by any adult without training or assistance. Survey results from early prototypes and other similar projects around the nation indicate that this objective will be achieved. Multimedia also enables the delivery of types of information not easily conveyed through text (e.g. the maps.)

The Kiosk client machines are Apple Macintosh Quadra 840AVs. The Kiosk software is primarily written in HyperTalk with numerous external functions in other languages to perform some of the communications and utility functions. Communications with the Administrative Computer System are handled via 3270 front-end using Software AG's (SAG) Natural Connection and its HyperCard API. The 3270 front-end is intended to be temporary as work is currently underway to convert to the SAG ENTIRE family of products enabling true program-to-program communication with the Administrative Computer. Likewise, although the QuickTime movies are currently stored on CD ROM with drives local to each machine, real time access to networked video servers is planned for eventual implementation.

One of the primary goals of software development for the first version of the Kiosk has been the creation of a developers' tool kit. The developers' tool kit includes a package of standard routines to process common functions, technical standards, documentation, and classes all of which are intended to enable individual administrative offices to produce their own Kiosk services as efficiently as possible. As of this writing, the Office of Personnel Services is the first department outside the core Kiosk Development Group to use the tool kit. They are creating an available job listings function.

This paper is, in effect, a case study on how The University tapped available resources, built on the existing information infrastructure, and leveraged alliances to create its own unique multimedia campus-wide information system.

II. DEFINING OBJECTIVES

Creating a True Campus-wide Effort

Soon after the project began, the Data Processing Department determined that the Kiosk should be managed and developed as a full campus-wide effort. This direction was both logical, since the Kiosk was intended to be a campus-wide information system, and necessary, because the expertise required to build and manage such a system did not reside in any single department. With separate departments for academic computing (Computation Center) and administrative computing (Data Processing Department) at The University, overall responsibility for information technology infrastructure is relatively decentralized. Although institution-wide technology projects have become more common, there was little precedent for providing for the ongoing development and management of an information system which crossed academic and administrative lines and potentially served all students, faculty, and staff.

To fill the void, the Data Processing Department sponsored an effort to form an ad hoc Campus-wide Steering Committee. The Steering Committee has no formal standing or authority with in The University structure, but it does have the practical effect of providing guidance from the perspective of most major campus constituencies. The positions represented on the steering committee are:

Assistant Dean	Graduate School of Business
Associate Director	Recreational Sports
Assistant VP	Development Office
Assistant Director	Division of Housing and Food

Associate Professor	Faculty Computer Committee
Associate VP	Student Affairs
Associate Director	Computation Center
President	Students' Association
Assistant Director	Library
Registrar	Registrar's Office
Auditor	Internal Audit

From the beginning, both the Data Processing Department and the CWIS Steering Committee viewed the Kiosk project as one element in an emerging direct service strategy for administrative information systems. This perspective refined the specific objectives of the project and shaped it to complement other CWIS systems.

The Direct Service Strategy

The concept of a direct service strategy simply referred to the trend in administrative information systems to provide services directly to the ultimate consumer without the need for intermediaries. During the 1980's, The University had automated almost all of its significant administrative procedures from accounting and purchasing to student records and financial aid. For services used by students and faculty, however, most of this automation was designed around a model that involved intermediaries. Specifically, administrative personnel were typically the direct users of the computer systems, and they in turn exchanged information over the counter or via telephone with students and faculty.

By the 1990's, striking examples of a new "direct service" model were evident everywhere, both inside and outside The University. Automated Teller Machines (ATMs) are probably the most common and widely used examples of this direct service paradigm. On The University of Texas campus, two of the most successful information technology projects of the last few years have been UTCAT, the On-line library catalog system, and TEX, our telephone voice response registration system. Both of these projects clearly demonstrated that providing information services directly to students, faculty, and staff could work the apparent marvel of improving service while containing costs.

Both the Data Processing Department and the CWIS Steering Committee sought to articulate a generalized direct service strategy that would enable any administrative office to provide electronic information services efficiently to students, faculty and staff. From a technical perspective, primary objectives would be 1) to develop a technical infrastructure that would enable departments to provide new information services quickly and inexpensively, and 2) to make these services as accessible as possible for the customers.

From the perspective of administrative offices, the goal is to have a cost-effective method for providing routine information services to their clients and free staff from a substantial portion of the "counter service" workload. From the customers' perspective, the goal is to reduce University bureaucracy by providing convenient "one-stop" shopping for many common administrative functions.

In short, we wanted to provide the ability for all university offices to achieve on a generalized basis what TEX, UTCAT, and ATMs had done for their specific functions. We wanted a unified campus-wide information system that would be a cost effective information delivery vehicle for all information providers and an easy-to-use single system image for all information clients whether they were students, faculty, staff or any other constituents of The University.

Kiosk as Part of a Multi-prong Approach

By the early Fall of 1992, the discussion on campus about direct service systems shifted from defining goals to implementation strategies. The ideal would obviously be to have a single campus-wide information system. Everyone involved in the discussion wanted to avoid a situation in which individual departments were developing numerous single-purpose information services. Such a balkanized information environment would produce a confusing array of choices for users and an inefficient use of resources by The University.

At the same time, it was clear that a single information system capable of meeting all requirements was impractical in the near term under existing budgets. So, a compromise plan was devised under which a limited number (primarily three) of campus-wide information umbrellas would be encouraged. Each of these systems focused on a different needs, built on existing technologies, and provided open architectures within their defined limits.

The first CWIS, UT's implementation of the Internet Gopher, was already in existence and operating successfully. Gopher is supported by the Computation Center and is used primarily for academic purposes. It is not yet feasible to place sensitive, real-time administrative functions under the Gopher menu, so the Data Processing Department set about to create a campus-wide information system umbrella that would fill administrative needs and complement Gopher. In addition to the Kiosk, Data Processing is supporting the development of a public access application, called UTACCESS, to provide campus-wide information services from the Administrative Computer System (see "Building on Previous Projects" below.)

Strengths and Objectives of the Kiosk Concept

The Kiosk was quickly accepted as a potentially important element in a strategy of providing administrative services directly to students, faculty. It is, however, definitely seen as complementing network-based services which are accessed from users' own microcomputers in offices, homes, and dorm rooms; and not as supplanting such services. Serving as one component of an overall strategy, the Kiosk concept has many strengths. First, there is no requirement that the individual user own or have access to his or her own computer workstation. The entire information delivery infrastructure is provided by The University. A further technical advantage of institutional ownership of the workstation is that developers know the exact hardware and software configuration of the client machine and can optimize the system for those requirements.

Another advantage of the Kiosk concept is that it is a true client/server system and can provide information services from a variety of services. The Kiosks are extremely convenient to use. The user is not required to go through any logon procedures (although PIN numbers will be required for personal information) or in any other way set up the machine before it can be used. Kiosks make it easy for anyone to access information quickly as they move around campus irrespective of whether they own or can use a networked personal computer.

The Kiosk is ultimately intended to bridge the barrier between administrative and academic resources through a series of networked public workstations that draw information from a variety of sources.

III. STRATEGIC ALLIANCES: GATHERING RESOURCES

"Don't try to do more with less, and don't do less." Carole Barone, Associate Vice Chancellor for Information Technology at UC/Davis, speaking at CAUSE92.

From the beginning, the Kiosk project has sought to follow Carole Barone's advice and increase available resources by pursuing unconventional approaches to funding and in-kind support. This strategy was not an exercise but a necessity. The University of Texas is no exception to the national trend toward tighter budgets. For the last several biennial sessions of the Texas Legislature, state-funded institutions of higher learning have witnessed ever strengthening movements to freeze and even reduce their allocations as the state battles to balance its own budget in difficult economic times. These budget constraints are coming at a time when overall administrative workload is expanding, and expectations for quality of service are increasing.

In this environment, the Kiosk project would not have been possible, either financially or technically, without the extensive use of alliances and partnerships. Campus-wide information systems are by their very nature projects which span The University's organizational hierarchy. No single entity has the resources or authority to undertake the challenge alone.

Internal Alliances: Building on a Base of Cooperation

Several important informal processes began on The University of Texas campus in the early 1990's which greatly facilitated the joint efforts necessary to undertake campus-wide information systems. The General Libraries initiated formation of an informal "Information Services Discussion Group" which included management representatives from the Computation Center, Data Processing, Student Affairs, and General Libraries. Although the group has taken no action to date, a number of important cooperative efforts have arisen out of the monthly discussions of institution-wide information technology challenges and solutions. The Direct Service Strategy for administrative campus-wide information systems was first discussed and refined in ISDG.

Prior to the start of the Kiosk project, the staff of the Data Processing Graphics Center had sponsored the formation of a campus-wide users group for graphics developers. The membership of this group included many of the most talented and accomplished graphic artists and multimedia developers on campus. When the Kiosk project started, a presentation was made to the graphics group introducing them to the project and requesting their input. Many of the members were immediately enthusiastic about the potential for the project and over time participated directly in the design and creation of the graphics and other media used in the Kiosk. At least four members of the graphics users group became active participants in the Kiosk Development Group.

Forming a Campus-wide Development Group

The core Kiosk Development Group was staffed by the Data Processing Department, but DP had neither the available personnel nor all the expertise required to complete every phase of the Kiosk. The core Kiosk team structured the project as a campus-wide development effort and actively sought assistance from other University offices. The response to these appeals was overwhelmingly positive (see below). In all cases, this support was voluntary.

At least three general factors motivated the enthusiasm and spirit of cooperation that characterized the Kiosk Development Group. First, the project was positioned both as a showcase for University talent and as a rare opportunity to create something in which the entire institution could take pride. Secondly, many members viewed the project as an opportunity to work with new technologies and learn new skills. The College of Pharmacy Staff indicated that their considerable commitment of time in the Kiosk was repaid by the skills they acquired in the production of QuickTime videos. That expertise is already being applied in many of their academic projects. Finally, the Kiosk became an excellent vehicle for University service. The Architecture professor who designed the physical enclosure stated that he appreciated the opportunity to make a professional contribution to the University environment.

Listed below are some of the contributions made to the Kiosk project by University departments.

- Graphic artists from several departments, such as UT Publications, volunteered their services to assist in the creation of color art work and backgrounds used in the Kiosk.
- The staff of the College of Pharmacy Learning Resources Center assumed primary responsibility for the design and production of the video, animation, and graphics used in the multimedia "Welcome" section of the Kiosk.
- The Manager of the Computation Center's Micro Technologies Group taught classes in HyperTalk to Kiosk developers.
- The School of Architecture donated the services of one of their faculty members to design the Kiosk physical enclosure.
- A programmer on the Computation Center Staff wrote several of the external utilities not producible in HyperTalk.
- Programmers from General Libraries, the Computation Center, Apple Computer, and Data Processing participated in writing HyperTalk code.

IV. INTEGRATING INFORMATION TECHNOLOGIES

The electronic Kiosk is not an isolated, independent project, but rather an integral part of The University's overall information technology environment. The Kiosk is built on the foundation of existing applications, databases, networks, and communications. It is designed to complement and extend both current and future information technology projects.

Tapping into the Existing Infrastructure

The focus in administrative computing at The University during the 1980's was automation of official administrative procedures. Electronic documents have now replaced paper forms to hire and reclassify employees, purchase anything from office supplies to laboratory equipment, transfer funds, pay vendors, and process internal billing. These electronic documents automate virtually every aspect of the manual procedures they replace, including auditing of routine data, routing for review and approval, elimination of duplicate data entry, updating of accounting records, and storage of official information.

Almost all of The University's official records are maintained in electronic form on a single database management system that is easily accessible by authorized personnel. In 1980, the Data Processing Department adopted Software AG's DBMS ADABAS as its official DBMS. Since that time, ADABAS has evolved into the central repository for virtually all of The University's official electronic records. The University of Texas now has a single, unified corporate database which supports the relatively easy development of real-time, integrated applications.

During the same period The University has also constructed a comprehensive campus-wide network system. In fact, two essentially parallel wide area networks exist on campus to serve the different requirements of administrative and academic computing. The administrative network, UTAN, is a fiber optic SNA token ring network that provides 16 Mbps service to all administrative and most academic building on the UT main campus. UTAN is a controlled access network providing a high level of security and capacity for confidential administrative traffic. UTAN is primarily used for 3270 traffic between the Administrative Computer System and departmental LANs. UTAN is supported by the Data Processing Department.

The University's academic network, UTnet, is a fiber optic TCP/IP network providing open access to a full range of Internet services primarily for academic purposes. UTnet serves all major academic buildings on campus and is accessible via departmental LANs, microcomputer labs, and a high speed modem system called TELESYS. UTnet is supported by the Computation Center.

The current Kiosk prototypes are connected directly to the administrative SNA network for secured access to administrative services via the UTACCESS application (see below.) A joint project between the Computation Center and Data Processing is now under way to develop the encryption software necessary to provide secure access to administrative data over the Internet. Once this project is complete, the Kiosks will be moved to UTnet.

Building on Previous Projects

Much of the underlying technology used in the Kiosk was pioneered in earlier projects at The University. In particular, it would not have been possible to produce the Kiosk economically without the benefit of software and techniques developed as part of the Executive Workstation and the UTCAT online library catalog. The Executive Workstation is a Macintosh-based executive information system developed within the Data Processing Department to give management level personnel point-and-click access to official administrative functions. In addition to providing a GUI style interface to mainframe functions, the Executive Workstation gathers and assimilates information from several different applications to deliver summary displays which are not available in any other system. The Executive Workstation is a HyperCard application which communicates with the Administrative Computer System via an API to a 3270 emulation session running on the Macintosh. The Kiosk, also developed in HyperCard, employs 3270 emulation communication with the Administrative Host which is based on the code developed for the Executive Workstation.

The UTCAT online library catalog system is a mainframe-based 3270 application which was developed in-house. In recent years, UTCAT has been used as the foundation for an expanded menu system, called UTCAT Plus. UTCAT Plus is essentially a campus-wide information system incorporating not only Library information, but also administrative policies, The University telephone directory, and available job openings. Access to UTCAT Plus is available to anyone via terminals in the UT libraries, by connection to the Internet, and by dial-up to the UT TELESYS system. The Library has contributed the UTCAT Plus core software for menu management, navigation, and access to be used as the basis for the UTACCESS project. From that starting point, UTACCESS has become an independent CWIS in its own right which provides easy access to information services on the Administrative Computer System. UTACCESS is also the 3270 system that provides official administrative information to the Kiosk. As with the contribution made by the Executive Workstation, UTCAT Plus paved the way for the Kiosk.

Coordination with Complementing Projects

The Kiosk has also achieved a level of cost savings and efficiency by coordinating closely with separate but related projects on campus. For example, a task force is working on producing an RFP for a campus-wide image server. The goal of the Image Server Task Force is to acquire imaging technology that is compatible with existing information technology infrastructure and can be implemented on an institution-wide basis. The task force is working to ensure that the Imaging products can be integrated smoothly with the administrative corporate database (ADABAS) and our administrative programming language (NATURAL 2) so that images can be readily included in existing and future administrative applications.

Another project with direct implications for the Kiosk is the Campus-wide ID Card project. There, yet another task force is generating a recommendation for a single, multi-purpose ID card that can serve all needs on campus for student, faculty, staff identification. The project is based on the principle that a credit card-like ID with a standard, machine-readable magnetic stripe can be implemented to address the full range of identification requirements of all University offices. In addition to the traditional manual identification using the photograph and signature, the new card can be "machine read" by electronic card readers. Through network connections, the machine card readers can be fully integrated in with existing databases and electronically validate requests against existing information systems.

The Kiosk Development Group communicates regularly with both the Image Server Task Force and the ID Card group to ensure that the technology in all three is fully compatible. The benefits to the Kiosk are clear. The availability of institution-wide, network-based image servers mean that the ability to display graphics such as images of buildings, floor plans, and maps will soon become a practical option. The ID Card project will enable the Kiosk to serve as a true ATM for University services that require positive identification and, in some cases, charge for services. For example, in the future, students may be able to buy concert tickets or pay library fines and have those fees charged against the debit card stripe on their campus-wide ID cards.

V. MANAGING A CAMPUS-WIDE EFFORT

Role of the Steering Committee

Since its formation, the Campus-wide steering committee has met at irregular intervals and communicated frequently through e-mail to oversee overall project management, establish policy, and set priorities. The Kiosk project has benefited enormously from the experience and diverse backgrounds of committee members. They have been able to provide crucial advice and guidance on how to tailor systems for students. This was an issue of particular concern within the Data Processing Department since, until recently, our focus has been on services for administrative staff. We had not acquired the expertise of many of the offices represented on the Steering Committee in serving the large student population.

Below are examples of some of the issues handled by the Steering Committee.

- Selection of the on-campus sites where the Kiosk will be located
- Establishing policy on the types of services considered appropriate for delivery via the Kiosk

- Review of ADA compliance measures
- Review of testing and quality control measures
- Ensuring all effected campus constituencies are consulted regarding significant implementation issues
- Review and approval of implementation procedures and schedule
- Communications with campus constituencies and Executive Officers

Getting Input from 70,000 People

The Data Processing Department has generally employed users groups as the chief mechanism for promoting customer participation in the process of designing and refining administrative information systems. Traditional users groups were not practical, however, for a potential customer base of all 70,000 students, faculty, and staff at The University. Other techniques had to be found to evaluate how well the Kiosk would perform and be received in real-world situations. The techniques chosen were those now commonly used in the testing and evaluation of all types of commercial products which are intended for mass markets: focus groups, customer surveys, and observation.

Two successive prototypes of the Kiosk software have now been produced. Each prototype has been subjected to focus group analysis. The feed back from these groups has served as the basis for refinements incorporated into the next version. The focus groups for the first prototype were structured, but generally informal and not conducted according to strict scientific method. Specifically, the Students' Association was invited to send up to eight students each to twenty different sessions scheduled shortly after completion of the first prototype. No effort was made by the Kiosk Development Group to ensure that statistically random groups were selected. Each group met for 90 minutes in which they were given the opportunity to use the Kiosk, participate in a panel discussion, and fill out a survey questionnaire. The Development Group then generated a package of changes and enhancements for the second prototype based on their own observations of focus group participants using the first prototype, the suggestions made in the panel discussions, and the results from survey forms.

The evaluation of the second Kiosk prototype was significantly more structured and thorough. Once the second prototype was ready, it was set up for public access on an information desk in the student union. This unenclosed unit was used as the base for several different types of evaluation. At the same time a class in the Marketing department had requested permission to use the Kiosk as the basis for a class project on product testing. The project was approved, and the Marketing students have since conducted formal surveys of students who have used the public prototype. The class has also conducted telephone surveys of students and administrative offices to determine what types of services the campus would most want to see on a Kiosk. Members of the Development Group have periodically spent one to two hours a day unobtrusively watching students use the prototype. These observation sessions have been used successfully to identify elements of the Kiosk user interface that are confusing and difficult to use. The observations have served as the basis for a second round of refinements, and the Marketing class surveys will be reported to the Steering Committee for its consideration.

VI. CONCLUSION

It is too early to predict what overall impact the electronic Kiosk will have on University operations. At the time of this writing, two unenclosed prototypes are available for public access. These units are being used in part to assess the effectiveness of the overall Kiosk concept and to measure the costs associated with their operation. Bids are being taken for the construction of the first five Kiosk enclosures. These units will be installed in the early part of the 1994 Spring semester. The remaining 12 enclosed Kiosks and possibly more will be deployed as soon as the performance of the first five has been thoroughly evaluated.

Many important questions remain unanswered. Will we be able to fund and support enough units to have a significant impact on a campus community of 50,000 students and over 17,000 faculty and staff? Will administrative offices view the Kiosks as a cost-effective mechanism for delivering routine services? What will the operational and maintenance costs associated with the Kiosks be? Does the Kiosk concept represent a viable long term solution for delivering administrative information services in a large University environment? What is the Kiosk's logical relationship to information services delivered directly to user-owned client computers over the network or telephone lines?

It is reasonable, however, to draw at least four significant conclusion at this stage.

- Interactive multimedia technology has advanced to the point that it can be used to produce practical information systems which are both easy to use and well received.
- Multimedia Kiosks make it realistic to provide public information services that almost anyone can use with no prior training.
- Kiosks alone do not constitute a comprehensive campus-wide information system, but they can play a vital role as one element in an overall CWIS strategy.
- The concept of a multimedia CWIS at The University has attracted sufficient enthusiasm, support, and resources to produce a competent first version.