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The Use of Communication Technology in Medicine

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NYNEX Science and Technology is engineering a multi-layered approach to multimedia communications by combining high-resolution images, video, voice and text into a new fiber-optic service. The service, Media Broadband Service (MBS), is a network-based visual communications capability. It permits real time sharing of images in support of collaborative work among geographically dispersed locations. The health care industry has been identified as a primary target market due to their need for high resolution images, the need to transport these images over great distances, and the need to achieve the transport in a short amount of time.

This paper will describe the NYNEX Corporation, the current state of the MBS project, including the market needs driving the development of MBS, the overall design of the service, its current implementation and development status, and the progress of MBS projects underway for various customers participating in the initial service offering.

NYNEX OVERVIEW

The NYNEX Corporation is a major U.S. provider of telecommunication services. Its mission is to be a world-class leader in helping people to communicate using information networks and services. Through New England Telephone, New York Telephone and NYNEX Mobile Communications Company, NYNEX provides wireline and wireless telecommunications services to approximately 12 million customers in the northeast United States. The corporation also offers these services in selected markets around the world through NYNEX Network Systems Company. The BIS Group is a worldwide information services organization that provides consultancy, information systems, banking systems and marketing services to finance, industry and government.

The NYNEX family of companies provides directory publishing, database management, information delivery, software and consulting services for customers in the United states and more than 60 other countries.

NYNEX Science & Technology, Inc. is the corporation's research and development facility. Its mission is to develop strategic technologies for new and emerging products and

services within the NYNEX family of companies. Our approach is primarily customer focused and driven. We respond to requests from customers to resolve specific communication problems by conducting in-depth research into their business and communication needs. MBS has been developing in response to customer needs in dealing with image-based and multimedia data.

MEDIA BROADBAND SERVICE

Media Broadband Service (MBS) is a network-based visual communications capability. It permits real time sharing of images in support of collaborative work among geographically dispersed locations.

MBS consists of network transport and intelligent software. The software (MEDOS) has been designed to correctly identify the needs of the application user and the capability of the transport and switch to establish multimedia conversational sessions.

THE NEED FOR MULTIMEDIA COMMUNICATION SYSTEMS

In response to the needs of our customers, NYNEX Science & Technology has undertaken the development of the MBS multimedia communications service and related applications. Customers have suggested that the ability to access, transport and interact with image-based information modalities is not fully and efficiently achieved via existing services. As a result, the decision to develop a new multimedia service was taken for primarily two reasons.

First, we see an obligation to continue to serve the communication needs of our customer base as their communication requirements evolve. We are ideally positioned, in terms of resources and expertise, to facilitate the migration of customers from conventional services to more advanced ones. Our extensive fiber-based resources allow us to quickly and conveniently implement high-bandwidth-dependent services across private and public networks.

Secondly, we see the future of telecommunications to be inextricably bound to the evolution of multimedia services. Future communication environments will be permeated with image-based and mixed-media data; evolving and future networks must not only be capable of transporting increased volume of data, they must be able to manage and coordinate interaction between users manipulating that data. NYNEX recognizes the need to address this challenge in order to preserve its ability to provide world-class communication services.

THE NYNEX APPROACH—CUSTOMER FOCUS

The NYNEX strategy for developing MBS from a research endeavor into a viable product focuses primarily on working closely with, and exchanging feedback and experience with, strategic customers. In this manner, we are positioned to develop a service that is both technically and functionally responsive to the customer's needs. This strategy is pursued in a number of ways:

- Strategic relationships are formed with key customers whose needs cannot be met by existing approaches.
- Research and analysis is conducted to fully understand each customer's business and communication environment.
- A prototype system is developed in the laboratory. The prototype environment is constructed to model the customer's working conditions.
- A prototype system is deployed at the customer's site, yielding valuable feedback and experience.
- The product/service is refined to provide better service for key industries.
- The service is marketed to those industries.

CUSTOMER REQUIREMENTS

Customer requirements for image-based multimedia communications usually arise out of the deficiencies apparent in conventional communication environments and presentation modalities. Customers want to replace existing telecommunication and telecomputing environments with one that will support:

- **Image-based Conversations:** The primary element of communication should be the image rather than text or voice. Transport capacity must be sufficient to allow the conversational manipulation of images between users.
- **Collaborative Work:** Connectivity and response time must be sufficient to allow multiple users to interact as if they were face to face.
- **Natural User Interfaces:** The man-machine interface must be intuitive, flexible, and simple. (A multimedia environment makes this goal more easily attainable than conventional environments.) Esoteric command-based interfaces must be avoided.
- **Dispersed Geographical Sites:** The communication environment must be capable of spanning Local Area Networks (LANs) and Metropolitan Area Networks (MANs).

- **Separations in Time:** The environment must be capable of supporting disjointed dialogues between users who may never be simultaneously available. A multimedia store-and-forward system must be supported.
- **Fast Response Time:** Communication functionality must be backed up with sufficient transport and performance capability to allow near-real-time response.

THE MBS SOLUTION

While there is much discussion and research being conducted in regard to multimedia technology, there is still much confusion regarding the basic definition and tools of this technology. We differentiate multimedia communications from multimedia presentations. Whereas multimedia presentations are concerned with the rendering of mixed-media elements to one or more spectators, multimedia communications involve the interactive and collaborative manipulation of mixed media elements under the control of independent users. Multimedia presentations consist of the mere playback of mixed-media elements according to some script (either fixed or variable, i.e., under the control of the spectator). Multimedia communications, however, allow users and applications to interact with one another within an environment that supports mixed-media elements. In this sense, multimedia presentations are only one element within a multimedia communications environment.

A multimedia communications environment must support the following key elements:

- **Multiple Users:** Users must be able to interact and collaborate with one another in a dynamic and conversational mode. It must be possible to add and remove users from ongoing multi-user sessions.
- **Multiple Process/Processors:** Users must be able to interact with several different single- or mixed-media processes at the same time. This means that each user can participate in multiple sessions concurrently, and within each session, multiple processes can be active.
- **Conversational Computing Environment:** Interaction between users must be as natural as possible; dialogue must take place as if users were gathered around a conference table.
- **Utilization of Voice/Data/Text/Images/Video:** All mixed-media data types must be supported. It must be possible to recognize, combine and separate these types within the multimedia communications environment.
- **Fully Integrated Network Environment:** All users and resources on the multimedia communications network must be continuously and seamlessly accessible.

- **Transparent Interface:** All customers must be able to access the network without the requirement to manually set up, maintain, or terminate interaction with the network. All applications must be able to access network resources and users without regard to the user's or resource's particular network interface.
- **Allow Near-Instantaneous Response:** Transport and processing capacity must be sufficient to allow users to maintain a near-real time conversational mode. Network-wide resources must be immediately and continuously available.

MBS ARCHITECTURE

The MBS architecture combines an intelligent network with broadband transport.

MBS is a distributed software environment consisting of high speed optical transport, intelligent networking software, adjunct data servers and specialized imaging applications. It is based on an open network architecture employing several distributed client server relationships orchestrated by a network server. The network server is the controlling agent and can operate both at the LAN level and at the MAN switching hub.

In order to meet the demands of end users, MBS is designed to achieve its goals by providing the following key features:

- **Broadband Transport:** By making use of the existing and newly installed New England Telephone fiber networks, MBS can deliver inter-site service at a rate of 1.5 megabits to 45 megabits per second or greater.
- **Sessioning Environment:** The network software provides a session-based communication environment in which users can share, display and manipulate data. Uses of such an environment range from a common window and pointer (allowing users at separate workstations to enter into a multimedia conference to simultaneously view, point at and modify objects within a common window) to a transport environment within which data can be transmitted between end points without any special user setup or control of transport links.
- **Resource Servers:** The network supports resource servers that provide commonly used general services. The file server provides an efficient, centralized multimedia database available to users for data storage and retrieval at network speeds. The mail server provides a multimedia mail service capable of forwarding, storing, delivering and tracking multimedia messages in multimedia envelopes. The directory service provides a text-based or multimedia-based catalogue of all users, resources, servers. Media Broadband Service (MBS) is a network-based visual communications capability. It permits real time sharing of images in support of

collaborative work among geographically dispersed locations. MBS consists of network transport and intelligent software. The software (MEDOS) has been designed to correctly identify the needs of the application user and the capability of the transport and switch to establish multimedia conversational sessions and facilities available throughout the network.

- **Open Interface:** By providing an open and flexible interface to the network's sessioning capability, existing applications can be modified and new programs designed to run in a multi-user, multi-session environment.
- **Public Access:** By making MBS available as a public switched network, any subscriber can make use of the service from any network-accessible location, allowing maximum flexibility for businesses to decentralize their operations and also allowing consumers to access the service on an as-needed basis.
- **Flexible Configurations:** MBS supports centralized, localized, and distributed configurations. The network processor(s) can be located in one or more private LANs, one or more public network central offices, or a combination of both.

MARKET OPPORTUNITIES

MBS addresses and fulfills a number of existing market requirements that would otherwise be addressed through disjointed or modular approaches. A common requirement across all industries is the need to increase revenue while containing expenses. This is achieved in a different fashion in each industry.

Healthcare. This industry relies heavily on very high quality images. Currently there is a strong reliance on hardcopy images and LANs. MBS offers the opportunity to move away from hardcopy images to electronic representations, easing the current burden of archival and transport of physical images. Perhaps even more significant, MBS allows specialists to be physically separated from each other (specialists can confer between workstations with full visual/audio communication, and specialists from remote hospitals can pool resources), as well as the point of data generation (allowing remote viewing of medical imaging studies from home or office rather than the location at which the study originates).

In the healthcare industry, the goal of generating new revenue can be achieved via MBS by making existing and new services available to remote locations, meaning that strategic equipment and expertise do not have to be in the same location to be used effectively. Expenses can be controlled and minimized by maximizing professional productivity through consistent and immediate access to images and information that would otherwise be inconvenient to obtain.

Similarly, hardcopy duplication, equipment redundancy, and reduction in the volume of hardcopy-production consumables could be achieved.

Publishing. This industry relies on high-quality images in a time-critical production environment. Page and document review/modification can take place over great distance without producing or transporting hardcopy representations. Pre-press production cycles can be shortened or more pages can be produced in less time. Archived elements can be retrieved or stored more efficiently and in a more timely manner.

Advertising. This industry relies on high-quality images throughout the review and production process. Interdepartmental and client-agency exchange and review of ad proofs can be greatly streamlined. Changes to images can be generated and presented within a multi-user interactive session, greatly reducing the necessity, as well as the time and expense, of moving physical images or personnel between locations.

In the advertising/publishing industries, increased revenue can be generated by reducing time to market via the increased efficiency in production and review cycles afforded by MBS. Expenses can be contained by making individuals more productive (through increased access) and resources more widely available. Real-time electronic proofing of images within a multi-user session will greatly reduce the expense associated with hardcopy proofing and the delay in transport between geographically diverse locations.

WHO IS THE CUSTOMER?

Other image intensive industries that could benefit from MBS are:

- Education and Training
- Manufacturing and Retailing
- Real Estate and Tourism
- Architecture and Construction
- Design and Engineering
- Banking and Securities.

BOSTON TRIALS

NYNEX has a mutual commitment with four major hospitals and a major publisher in Boston to conduct trial implementations of the Media Broadband Service. The trial participants are:

- The Children's Hospital
- Massachusetts General Hospital

- New England Medical Center.
- Brigham & Women's Hospital

The goals of the trials are:

- To gain experience in how the system functions under real-life conditions;
- To acquire feedback from customers on the performance and design of the service;
- To solve particular communication problems for each of the trial participants;
- To provide high quality service in an environment that matches actual public networking conditions.

THE CHILDREN'S HOSPITAL

The Children's Hospital is well along in their effort to create an automated electronic medical record system; however, that system is text-based and does not allow for image-based or multimedia communication. MBS provides a multimedia communication environment that allows TCH to make use of the following image-intensive applications:

- **Report:** This application will be used to assemble multimedia medical reports comprised of images, voice annotation and text. Users will be able to access, manipulate and enhance the associated images from remote and local facilities.
- **Review:** This application will allow users to make use of existing multimedia reports either to acquire up-to-the-minute patient information, or to use in the construction of new reports. Users will be able to review the reports and associated images from remote and local facilities.
- **Consult:** This application will allow multiple specialists in separate locations to confer while simultaneously viewing diagnostic images and associated test and voice annotation.

MASSACHUSETTS GENERAL HOSPITAL

MGH is a large organization spread out over a relatively large geographical region. Access to information, images and personnel is hindered by the inability to conduct real-time collaboration between sites. The difficulties in transporting hardcopy medical imaging studies between facilities results in significant loss of opportunity in providing patient care and maximizing revenues.

MBS will provide the capability to conduct multi-user multimedia sessioning between sites in collaboration with the existing PACs (picture archiving system). As a result, MGH will be able to transport, access and share multimedia information across the following locations:

- Somerville Film Library
- Charlestown MRI Site
- Spaulding Hospital
- Harvard Community Health Plan
- Massachusetts General Hospital.

BRIGHAM & WOMEN'S HOSPITAL

Brigham & Women's Hospital (B&W) will use MBS primarily for teleradiology applications. With various SUN workstations located throughout the institution on an ethernet LAN, radiologists, physicians, and surgeons will be able to simultaneously review magnetic resonance imaging (MRI) and computed tomography (CT) images. Additional workstations will be located in the homes of specialists who will be able to review images and consult with on-site personnel on an on-demand basis, greatly reducing the time involved in responding to emergency situations. The ability to conduct teleradiology through the MBS network will not only benefit clinical diagnosis and treatment, it will also enhance the research capabilities of the institution by facilitating the increased flow of information between departments.

NEW ENGLAND MEDICAL CENTER

New England Medical Center (NEMC) will integrate MBS network service into its existing FDDI LAN. DEC workstations will be used for a telecardiology application allowing for both remote private viewing and multi-user collaborative viewing of full-motion video images of catheterization of a patient's heart or blood vessels. When conducted within a multi-user session, this application will allow physicians at remote locations to simultaneously view a video loop while having access to a common pointer, useful in isolating or describing a particular part of the video.

This application will allow technicians to present studies to specialists moments after they are generated, allowing those specialists to determine diagnosis and treatment immediately. In emergency conditions, the time saved by such an application can mean the difference between life and death; in non-emergency cases, such an application can significantly reduce costs and time. For example, if a specialist has access to a study while a patient is still "on the table," the specialist can order additional studies to be conducted upon the patient immediately, rather than on a subsequent visit.

TRANSPORT REQUIREMENTS

The trial implementation configuration consists of a combination of local and centralized MBS network processors linked via T1 and T3 transport links. At the hub of the network is the Cambridge Applications Services Center, in which a centralized MBS processor and simulated central office (CO) are located. Linking each of the trial participants' sites to the CO are T1 (1.5 Mbps) and T3 (45 Mbps) capacity transport links.

The connections allow for inter-site communication, access to centralized network services, and in the case of MGH, they also allow for intra-organization inter-site communication. Local to each of the sites is a dedicated MBS processor that is responsible for all intra-site multimedia communications, either over ethernet or FDDI, depending on the facilities available.

TRIAL RESULTS

The trial implementation will yield valuable information for future refinements and enhancements to the service. Specific areas of interest include:

- **Usage Patterns:** Indicate how to provision and configure processing and transport resources.
- **User Preferences:** Indicate how to refine existing functionality.
- **Design Discrepancies and Omissions:** Indicate how to enhance the service.
- **Basic Functionality Requirements:** Indicate common features for all target industries.
- **Ease of Application Integration:** Indicate how to facilitate and encourage application development.
- **Actual Revenue/Expense Benefits:** Indicate cost-effectiveness of the service.

FUTURE DIRECTIONS

We have outlined our strategy in developing and implementing MBS. Our basic approach has been to respond to the specific requests of our customers in conjunction with general market requirements in order to provide a communications network capable of supporting a multimedia environment. This environment has been specifically designed to integrate with existing and emerging technologies so that required modifications to technologies already in place will be kept to a minimum.

Significant progress has already been achieved in the healthcare and publishing industries. As existing industry-specific applications are refined and new ones developed, the benefits of

multimedia communication will emerge and stimulate further development of enhanced network services and general-purpose applications.

To continue upon this course, several additional steps must be taken. the service must be field tested in other industries and with more complex configurations. New applications must be developed to take full advantage of current and future network services. Established applications must be ported to MBS to allow users transparent access to network capabilities.

Development of a market for multimedia application will rely on software being produced to provide multimedia communications, continual advances in multimedia terminal development, willingness of the hospitals to encourage cooperation between their clinical systems and their fiscal systems in the areas of billing and transaction processing, and industry cooperation in the development of standards and open network interfaces.

As these challenges are met, multimedia communications will become an essential tool for business and industry. This communication environment will offer new ways of maximizing expertise and resources, allowing increased efficiency and productivity in image-based and mixed-media applications.

