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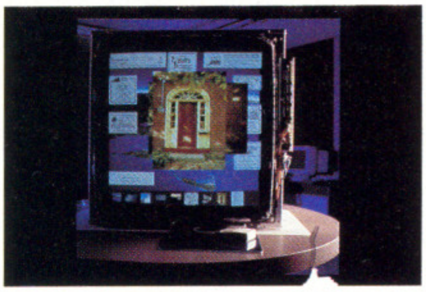

Text meets image in NYNEX multimedia prepress. ***(See page 28.)***

COLUMNS

The cover: Very hot steel as the camera sees it in an Allen-Bradley based combined machine vision/process control system at WCI Freezer, St. Cloud MN. (See page 18). And imaging joins multimedia communications in "Probity", a medical imaging/records and claims system developed by NYNEX and New York City's LaPook-Lear Systems. In a recently previewed version implemented on a Sun workstation, binary original transaction/records documents and diagnostic level high res images are combined for the first time. An alphanumeric/color medical imaging version is shown here, in a photo by Sharon Stern. (See page 28.)

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FEATURES

DEPARTMENTS

#45

Profile

Image Processing in Full Multimedia Communications

High res and document imaging are key ingredients in state-of-the-art communications systems NYNEX is marketing now

by Terrence P. McGarty

In a darkened room in a Boston hospital, a radiologist reviews the video display in front of her with the cardiologist and the surgeon. The patient is lying in his bed, having been disabled for the past three months from a debilitating infarction to his left ventricle. The radiologist reviews the flow of the dye through the arteries feeding the heart muscle and indicates where the stenosis or blockages are. The cardiologist recognizes that surgery is required and moves the pointer over the two stenossi in the patient's heart. The cardiologist pulls up a copy of the test performed three months ago and shows, with her pointer, the area at that time. Surgery must be performed, and it must be done soon. The surgeon views the location of the stenosis and recognizes that this will require a specific shunt that he has not used before. He turns to his associate at the local medical school who has developed the shunt and confirms his diagnosis. The patient is scheduled for surgery the next morning. Five minutes later, in the same cardiac catherterization lab, another patient is being prepped for a cardiologist in New Bedford. The process goes on all day, at a cost of less than half of past costs.

This is all being accomplished *remotely*—the radiologist is in Boston, the cardiologist in Concord, the surgeon in another hospital in Boston, and the consulting surgeon residing at the local teaching institution. And it's happening today.

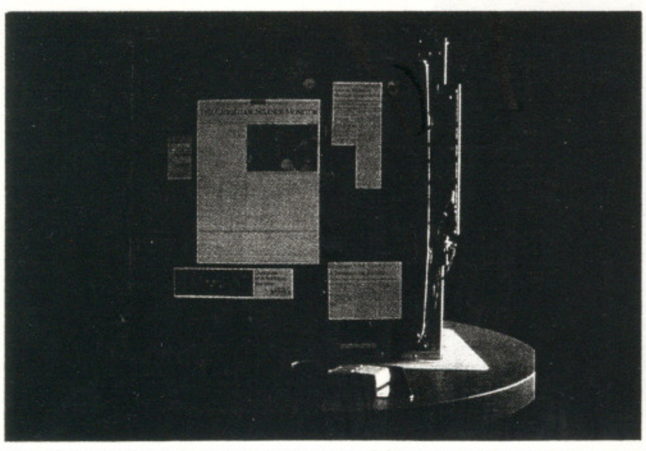
In another part of the city, a creative arts director for a local publisher is preparing a set of copy for a magazine ad. The ad copy is for the release of a new product by a packaged goods company. The ad will be run in several large metropolitan markets, and it must reflect the subtle differences in the psychographics of each of the markets. The director has laid out ten different ads, and he is ready to release them. He shows the ads to the brand manager at the client packaged goods company to obtain acceptance of the colors and the specific localization effects. The brand manager recognizes certain changes and suggests them; they are made and approved, and the copy is instantaneously laid out in final form and sent to the prepress—this has saved six hours of final copy time.

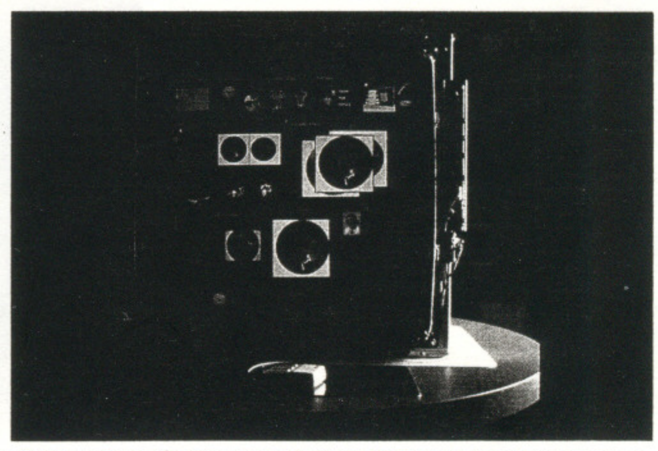
This is accomplished over the same system, using the same transport cables of optical fibers, using the same set of database access systems, and using the same set of underlying communications control software. The video of the heart arteries, the still color images for each market, the voice of the physicians, art directors, customers, and others are all treated equally as multimedia objects bound together in a session for the purpose of transmitting information: this represents the essence of multimedia communications.

Multimedia communications—the dynamic storage, processing and transmission of voice, data, video and image—is currently on trial in the Boston area. At four area hospitals and a publishing company, NYNEX designed a multimedia communications system allowing doctors to view a variety of patient information simultaneously. Multimedia Communications combines the capabilities of imaging technologies with the underlying communications structures of the distributed database and communications environment.

The Boston trial

These examples are only two based on actual efforts currently underway in the NYNEX Multimedia Communications Services trial—a trial based on the assumption that multimedia communica-





Combined text/graphic/image in publishing and multiple medical modalities in medicine, part of the NYNEX multimedia communications trials in Boston.

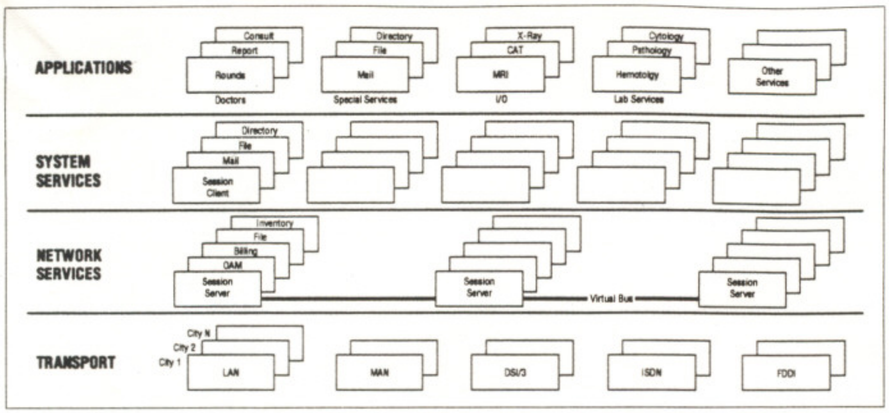


Fig. 1. Overall system architecture.

tions is user-centered and driven. Multimedia as an environment is unlike computer communications that can be controlled by the designer and engineer; Multimedia, on the other hand, is controlled by the needs of the users to communicate in a conversational fashion. The users must be able to easily interact with each other as well as with stored data elements such as images, video, voice, text, and even stored pointer movement. Multimedia Communications is then the embodiment of a capability to provide a fully distributed conversational environment for the sharing, interaction, and storage of compound multimedia objects, objects impacting on difference human senses and stored in different locations in different formats.

The system architecture

The system has been built around several important concepts; the first is that there are several users of the system, including both human users and application programs, databases, or input/output devices. The "users" must all have the capability of communicating to each other. Underlying this need is the fact that the users may be physically interconnected via a wide variety of data communications networks: these networks may be LANs, MANs, data lines, or even private data transport mechanisms. In the Boston trial we have found the customers interconnected by LANs of the Ethernet and Token Ring type, FDDI, DS 3 (45 mbps), DS 1 (1.5 mbps), as well as other configurations including a 125 mbps private line.

The second basic concept of the architecture is to provide an environment for the easy development of applications by users. Thus, it is necessary to have an API (Applications Programmers Interface) that permits the end-users to have access to all of the services that can be made available to the end-user.

The third concept is that of having access to and manipulative control over the multimedia data objects that are part of the communications environment—this has resulted in a need for the precise definition of a multimedia data object and an attempt at its standardization. The multimedia data objects may be voice, video, image, or text segments that are shared amongst the users and stored and retrieved from a plethora of different systems. The establishment of a common structure, containing a clear out-of-band (out of the internal structure of the data field) characterization of the data objects allows for the ease of access and ease of transport in this environment.

These three concepts are the cornerstones for the architecture; the actual architecture is shown in Figure 1: here we have a four layer design. The top layer is the *Applications* layer, providing all of the applications support to the end-user, and all access to all of the virtual users: human, data, application programs, and input/output devices—the API is the interface from this layer downward.

At the second layer, *System Services,* we have developed a set of services that are provided on a fully distributed basis. In addition, these services are provided on the basis of a set of standards, based around the OSI seven layer standard for computer communications. The primary focus of this layer is support of Layer 7, Applications, and Layer 5, Session. We have implemented this architecture in a client/server approach and, thus, this layer is the client part of that implementation. The four services supplied at this layer include those of session, file, mail, and directory.

The third layer, *Network Services,* provides for the management and control of the session support as well as for the specific implementation of the session server. The Network Services is, in actuality, the implementation of a session server that must function in a fully distributed fashion. In effect, the session server is a clustered embodiment of the OSI Layer 5 session protocol, which in a data communications environment is used for the synchronization of data elements only.

The lowest and fourth layer of this architecture, *Transport,* allows for the interface and support to the set of all supported communications channels: this layer allows for the ease of single access across any network interface and allows for the local control of any priority and flow control requirements of the transport elements.

The architecture, as depicted in Figure 1, shows the client/server concept at the two layers. In the actual client/server implementation we have each workstation, containing the specific applications software, and supported by the four clients, for session, mail, file, and directory. The session client is at the lowest level and is supported by the session server. In the current design, the session server may serve several workstations, and they, in turn, are connected through the network. The session server acts through a network client and a network server, namely the network. The session server binds all of the actions of the databases, served by the file server, the mail server, and the directory server.

The underlying services are those of the multimedia database objects. As indicated, the typical object can be a

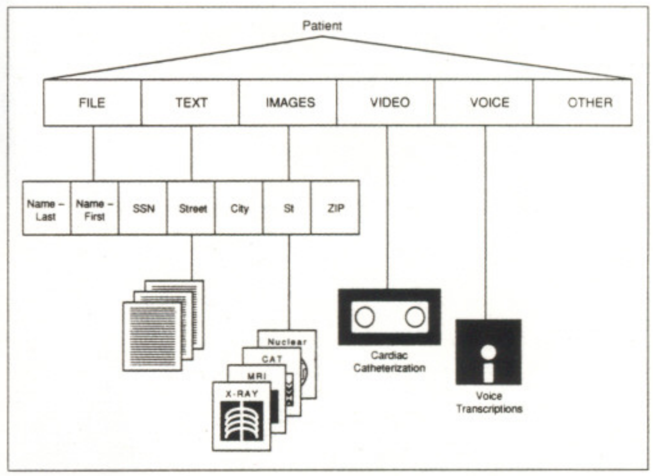


Fig. 2. Multimedia objects.

concentration of several elements (Figure 2). Here, the overall abstract construct is that of a patient record. The record is composed of a simple multimedia object, such as a single image or voice segment, and these can be combined into a compound object which is the total representation of all elements.

The session element is the most useful of the services in the system. It provides for four functions: synchronization, dialog management, activity management, and event management. Synchronization is the function controlled by the servers that assures that the multimedia data objects have their temporal, spatial, and logical structure maintained as they are transported across the network. The dialog management provides the control over the action of *who* gets to talk *when*. The activity management function provides for the control of extended sets of dialogs that combine in to a single activity—this ensures the integrity of completion of pre-defined tasks. Event management allows for overall end-to-end communications integrity.

The final element of the design is the way in which the file server is implemented. In particular, the file server element can be viewed as the front end to a multimedia database manager. The underlying constraint is that the multimedia files are stored on different machines, at different locations, and in differing formats. The challenge of a file server in this environment is the ability to access, combine, and maintain the integrity of all of the simple objects to be combined to create a compound multimedia object—this has been accomplished through one of the three architectures shown in Figure 3.

Application: medical

The strategy in the Boston trial was to have the customer be involved in the hands-on development of the applications. This has been successful in that several applications were developed, or enhanced; and that, through a users' group, the enhancements and new applications were easily done using the toolkit provided to the developers. In addition, several of the applications have been found to be modifiable and usable by several users, thus allowing for internal scale economies.

The medical area resembles the most research-oriented area for imaging applications: this was particularly so since the community of support was academically-oriented. However, the hospital operations side also had to be supported with an applications environment that could be integrated into the overall operations of the hospital.

The *Report* application permits the physician to recover, analyze, process annotate, and respond to images as a result of several diagnostic tests. Report has an interface that allows direct access to PACs and other storage devices; it also allows for voice annotation of X-rays and the transcription and release of the transcription to other physicians. Its first use was in the area of Nuclear Medicine and has now been expanded to other areas such as Radiology, Urology, and Neurology.

The *Rounds* application supports the attending physician on the floor and allows access to the patient's files, the most up-to-date radiological images, and the published transcription files. Rounds supports voice annotation as well as mouse movement and text for annotation of images.

The *Consult* application allows for the capture, storage, retrieval, and display of catherterization studies in a full motion vide format and has been primarily focused in the area of Cardiology.

Application: Publishing and Advertising

The trial included one customer in this area, in addition to the set of four hospitals previously referenced: this particular customer is a publisher of magazines and newspapers and is involved in television and radio production. The customer had their own SCITEX prepress operation and was fully integrated. The applications under development include: *Integrated Layout*—the layout of both the newspaper and the magazine, using similar ad copy and text image copy; *Prepress Integration*—full integration of the Apple Macintosh layout systems into the SCITEX environment, allowing for interactive editing and composition of new news copy on a real-time basis; and *Remote Editing*—for remote editing and edit reviews session between the editorial staff and the publisher in several locations.

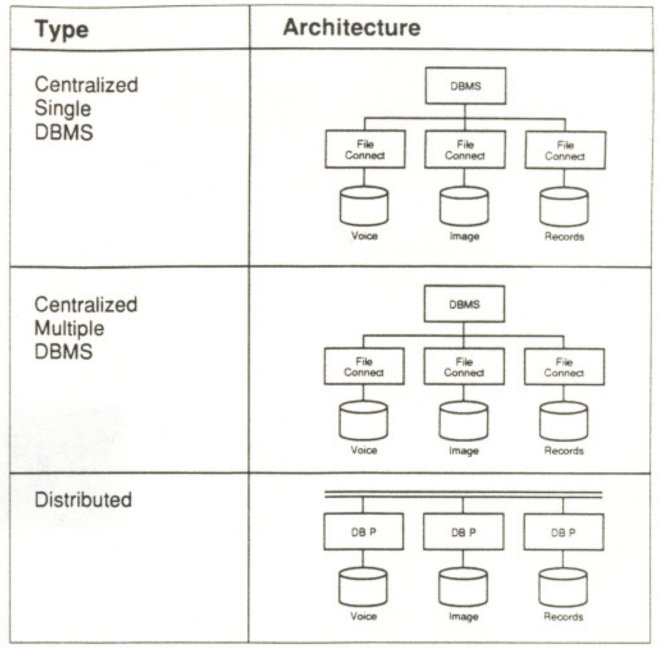


Fig. 3. Multimedia database access alternatives.

Economic factors in design

The overall driving force for the introduction of a new technology is not just the need to keep at the leading edge, but also to show significant gains in productivity of existing operations, the ability to gain better market share, or the ability to improve overall operations—ultimately to be reflected in a financial return. In the development of the trial in Boston, one of the key sets of success criteria was the establishment of financial measures of success. Specifically, in the medical area, it was necessary to understand the current cost accounting structures, develop an understanding of the flow of work in a current theater, and determine the impact of technologies on the micro structure of those tasks.

In a separate study, a methodology was developed to determine the micro structure of information based on processing tasks; this methodology was extended to include the micro cost elements; results of this detailed analysis are shown in Figure 4. This case was based on the operations of a Nuclear Medicine center at one of the hospitals

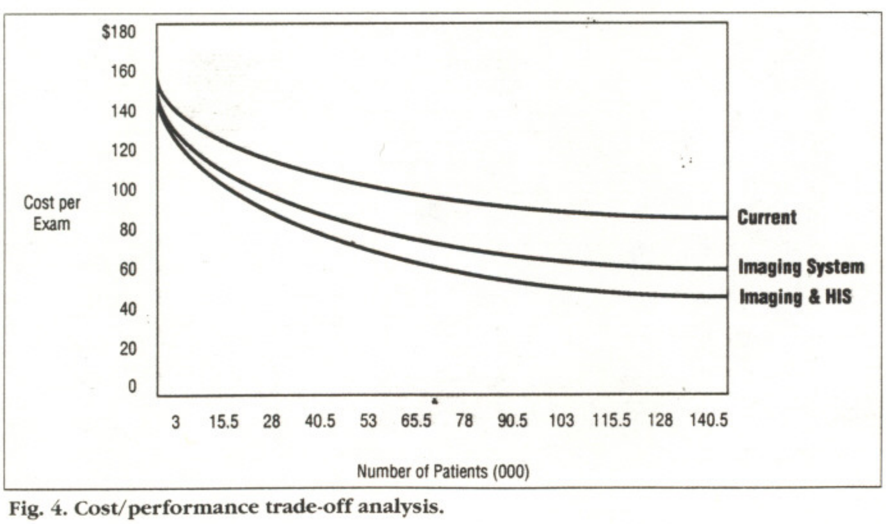


Fig. 4. Cost/performance trade-off analysis.

in the trial. The figure shows the cost per unit procedure as a function of the total procedures. Displayed are the results for three cases: the first case is that of the current operations; the second includes the effect of an imaging system only; and the third includes a HIS system plus an imaging system.

The conclusions drawn from this figure are significant: First, in the operation, there are many scale economies—namely, the unit costs decrease significantly from 3,000 cases per year upward. A dramatic decrease in costs can be achieved by merely placing more throughput in the center. Second, at a low throughput level, no significant cost improvement can be obtained by the addition of an electronic system: this is due to the fact that large fixed human costs and the reduction of any of those costs would eliminate the ability of the center to function at all. Third, at high loads or throughput, we clearly note a 40% saving in per unit costs with the addition of an imaging system, and a 50% decrease with imaging and HIS—it is this level of savings that has the most impact.

From a strategic viewpoint, this clearly says that significant cost savings can be made in health care by use of a two-pronged strategy. First, increase case load per fixed asset facility through collaboration or acting as an outsourcing facility for HMOs or other service providers. Second, once scale is achieved, introduce the electronic systems to gain full leverage from the system. A combination of both of these strategies simultaneously has been employed by some of the trial participants.

Future applications

The list of current applications, by itself, is significant. In the future, however, there appear to be significantly more interesting and expanding ideas that can be developed. In medicine, *Surgical Planning* allows surgical experts to plan and rehearse surgical procedures utilizing data generated from MRI scans, resulting in significant reductions in surgical time: this is particularly effective in areas such as neurosurgery and maxialfacial surgery. An *Image Transaction System* allows for the integration of patient care with payment collection and billing. And *Interactive 3-D Imaging* takes two-dimensional data from a single modality and provides a manipulatable three-dimensional image, providing for the integration of multi-modality data (MRI, CAT, etc.).

In printing, publishing and advertising, further extensions would include: *Micro Segmentation*, the targeting of markets by not only geographical but also through all demographic and psychographic factors (tuning the message to the individual allows for self-segmentation of the consumer); *Integrated Media Layout*—developing a complete promotional campaign includes the integration of all elements—video, ad copy, radio message, and even packaging (allowing for the integration of the total campaign and for the ability to rapidly change the campaign if there are market forces impacting it); and *Integrated Printing*—the ability to layout an ad and integrate that with packaging: critical for significant cost reduction and time-to-market effect as we see the introduction of lower costs presses and new techniques for color composition and editing.

Conclusion

Multimedia communications is more than moving varied information on different storage devices from one place to another: it is an environment for shared communications in an interactive fashion between multiple users using multiple senses, it is something that requires the intimate involvement of the customer, the user, the buyer, and the decision maker. ■

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