THE EVOLVING MARRIAGE OF A LOCAL AREA NETWORK (LAN) AND A HOSPITAL INFORMATION SYSTEM (HIS)

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Abstract

Over the last eight years, a teleprocessing/database Hospital Information System (HIS) for the Medical College of Georgia hospital and clinics has evolved to include approximately 200 terminal functions, 100 cathode ray terminals (CRT's) and 25 printers running on an IBM 4341. Concurrent with this development, several specialized stand-alone departmental minicomputer systems have evolved in response to specific requirements. In early 1981, a networking concept was proposed whereby the various information management systems within the hospital and clinics could communicate with each other. This concept has been successfully applied to several systems including a Local Area Network (LAN) of 24 processors and 45 workstations. This paper will outline the evolution from a single host processor multiple terminal oriented HIS, to a communications network of computers, to the integration of the host terminal network and a flexible Local Area Network.

Introduction

The Medical College of Georgia is the state supported medical school. The college consists of 5 schools; Medical, Dental, Nursing, Allied Health, and Graduate School plus a teaching hospital and clinics. The Eugene Talmadge Memorial Hospital, in addition to being a 400-bed referral hospital for the State of Georgia with approximately 15,000 admissions per year, is also the designated regional trauma center. Annual Outpatient visits number 177,000 in the 75 or so clinics associated with the hospital.

Host System Clinical Data Base

In the mid 1970's, the Medical College of Georgia embarked on the development of a terminal oriented, integrated Hospital Information System for the Eugene Talmadge Memorial Hospital and the associated clinics. At that time, the institution was supported by a vast variety of batch computer applications running on an IBM 370/133. A teleprocessing monitor and the TOTAL Database Management System were selected and work began. A modular or building block approach for the Clinical Data Base was adopted.

The following modules were added in succession:

Late 1975 - The Master Patient Index whereby basic patient identification information on all patients is permanently retained. This module automated and replaced in the Medical Records Department card tub file that had grown out of control.

1977 - The Patient Admission Registration and Census System whereby Inpatients are preadmitted, admitted, transferred and discharged and Outpatients are referred, registered and updated in approximately 75 clinics.

Mid 1977 - The On-line Charge Entry System provides the on-site capability for all hospital charge departments to enter and edit their charges as they occur.

1978 - The Referring Physician Directory whereby accurate up-to-date information on referring physicians is maintained and readily available as needed.

1979 & 80 - The Patient Profile System (Stay History, Operating Room Procedures, Discharge Diagnosis) through which extensive information about the events and activities in the operating room is captured for the Clinical Data Base. As part of the Patient Profile System, the previous tape oriented Hospital Diagnostic and Operative Indices were replaced by integrated database segments. From this portion of the database, Record of Operation and the Operating Room Log Book are created. Similarly, hospital facility charges for OB, Recovery, etc. are automatically generated for the Hospital Patient Billing System.
1981 - The Medical Record Completion System whereby, immediately upon discharge, a Medical Record Administrator (MRA) reviews the patient's chart for completeness, establishes the incomplete items and the system subsequently facilitates the medical staff in completing the records on time.

1981 - The Patient Accounting System whereby both inpatient and outpatient hospital billing, third party claims generations, and online review of bills and accounts receivable are accomplished.

1983 - The On-Line Accounts Receivable System, for payment posting, account review and collection followup.

To date over 200 terminal functions accessing the Clinical Data Base have been developed and are currently operational at 88 host terminals connected directly to the dual IBM 3414's.

Specialized Department Minicomputers

Concurrent with this hospital wide TP/DB development on the IBM host system, we began in 1975 to explore the potentials of and opportunities for using minicomputers in some departments to support specialized and unique departmental needs.

Our first project was in the Orthopedic Clinic where there was a desire and need for a 2-page summary of the patient's latest medical information. A single terminal, WANG 2200 minicomputer with 12K, a triple floppy disk drive and printer was selected to handle the projected 600 patient load. The system was developed and installed as a stand-alone operation in June 1975. Subsequently, a wide variety of additional features were added including a search and retrieval capability, previous medical abstract, latest progress note, daily professional billing, referring physician letters, socio-economic questionnaire and back examination questionnaire processing and analysis. The Orthopedic System load eventually grew to 6000 patients. The success of the Orthopedic WANG project led to similar stand-alone projects in Ophthalmology in 1977 and in Nephrology in 1979.

By late 1979, our thoughts expanded to multiple terminal minicomputers, when we acquired an IBM Series 1 with 1656K, 64 meg fixed disk, diskette cartridge and 5 terminals for a special Cost Containment Study Project in the Department of Medicine. This was followed in 1980 by the implementation of a 4 station WANG MVP with 10 meg removable disk in the Medical Record Department to handle their Medical Record Chart Control and Tracer System (Tracy). To date this system has grown to 7 terminals in 4 dispersed physical locations within the hospital complex. The TRACY maintains on-line the location and status of 317,000 medical records, (each of which may consist of multiple volumes), and the control of over 155,000 microfilmed medical records.

In 1981, the original Orthopedic WANG 2200 System was upgraded to a multi-terminal WANG MVP with 10 meg storage. A Nursing Service Personnel System and a Capital Equipment Planning and Acquisition Control System were implemented on this equipment.

Our Networking Plan

In early 1981 we also embarked on a change in direction of our development efforts. We now had considerable experience in TP/DB applications on the large central computer and we had proven to our satisfaction that specialized departmental computers were a valuable alternative to solving user computing needs. Why not have the best of both worlds? Why must it be an "EITHER/OR" solution - solve the user's need by developing his application on EITHER the host computer OR on a stand-alone minicomputer?

We addressed this problem by developing a Networking Plan for Clinical Information Systems. First, we identified the various system configurations in our installed information systems. We studied the features and characteristics of each and resolved them into 5 basic models:

Model I - Local Interactive Communications
Model II - Remove Interactive Communications
Model III - Batch RJE Communications
Model IV - Batch Media Transfer
Model V - Host-Independent

Based on these models we completed our Networking Plan that includes:

- The use of database management system (DBMS) technology on the central host computer to organize, maintain, and manipulate the Clinical Data Base.

- The use of the central host computer to service the common information processing needs of the overall hospital and clinics operations through the structured and controlled sharing of the common data elements of the Clinical Data Base.

- The use of the on-line interactive user terminals, where appropriate and justified, thereby providing the user with better control of, and timely access to, information in support of more efficient operation of his organization.

- The use of distributed processing systems where appropriate and justified, to serve the unique information processing needs of individual hospital department and clinic operations.
The integration of hospital and clinic distributed systems with the central host computer through established data communications protocols; thereby permitting the orderly transfer of data between computer systems.

Using this modeling concept, we proposed that all future Clinical Information Systems Development be directed so as to fit into this plan.

We developed this Networking Plan on the basis of what we felt was needed at the Medical College of Georgia without regard to what was or was not the current state of computer communications technology at the time. We knew very little about emulators or which vendor's systems could partially or totally emulate what other devices, etc. We proposed what we thought to be desirable in our institution in Augusta, Georgia. What was fact and what was fantasy was irrelevant at that moment. We wanted a guiding plan that said "Mr. User, in satisfying your information system needs, we no longer must up front commit you either to the large host computer or to a smaller stand-alone system. Within certain parameters we can offer you a set of variable alternatives whereby you can benefit from the best features of both worlds."

Applying the Networking Plan

Shortly after the plan was proposed, we encountered 3 separate projects in which we attempted to apply the plan.

Our Family Practice Center wanted to acquire an information system to facilitate their residency program by more closely simulating the private practice situation regarding office billing, appointment scheduling, and accounts receivable processing. In addition, they wanted a Residency Encounter Tracking System. Due to the need to model the private practice situation, they decided to acquire an Appointment, Billing and A/R Package and develop their Residency System based on this package. We worked with them during the development of their system specifications in an attempt to include the necessary requirements for their system to ultimately operate by Remote Interactive Communications (Model II) and/or by Batch RJE Communications (Model III). An IBM System 34 Computer and several IBM Software Applications were obtained.

Our second application of the Networking Plan involved the acquisition of a packaged Radiology Information System running on an IBM Series 1 Computer. Again we attempted to include the necessary requirements to allow their system to primarily operate with a Batch RJE Communications (Model III) connection to our host system and possibly later fit the Model II (Remote Interactive) category. This system was installed and successfully interfaced as a Model III (RJE) in 1982.

The third situation involved the acquisition of a packaged Clinical Laboratory Computer System. This system was to provide extensive Interactive Communications (Model II) between the Lab and Host computers for patient admissions, discharges, and transfers plus test result inquiries. Batch Media Transfer (Model IV) by means of a daily magnetic tape of billable charges was also required. Extensive interfacing specifications were developed involving several new host system functions. A MEDITAB Laboratory System was acquired utilizing a CDC computer. As of the drafting of this paper, the MEDITAB system has only recently been installed and interactive communication (Model II) testing has not yet been successful.

Local Area Network

By September 1981, we had thus far attempted to apply our Networking Plan to 3 system projects. In each of the projects the vendor had not indicated any difficulty in meeting either our interactive or batch RJE requirements; however, as of that time we did not have any working installation.

The fourth project to be developed under this plan originated in the Department of Surgery with their need to collect encounter information and discharge order information for a departmental patient database and to provide improved administrative services to the internal sections. Similar needs were identified by the Department of Medicine at about the same time. Since the 2 departments were geographically dispersed over the same 4 buildings, the 2 departments decided to cooperatively approach their joint problems. This wide geographic distribution confronted us with some significant problems if we were to adhere to our Networking Plan guidelines of distributed processing for unique departmental information needs.

The solution to this dilemma became evident when we were exposed to a viable Local Area Network (LAN). The Datapoint ARC Network of mini-computers was found to possess several existing features, applicable to not only the needs of the Departments of Surgery and Medicine, but also to the longer range needs of our overall information system development plans.

An extensive 2 month evaluation of the Datapoint ARC Network was undertaken. During this evaluation we were able to develop, test and demonstrate all of the features of the proposed joint department system. This evaluation project established our confidence in the LAN concept, established our technical understanding of the system and most of all, established our credibility with the 2 departments that this was a sound, though different, approach to solving their needs.

Desirable Features of the Datapoint LAN

The Datapoint ARC System offered us several important features:

1) Data Processing (DP) and Word Processing (WP) on Same System at the same workstation terminal
2) DP and WP accessing data in the same files
3) Interactive Communication to Hospital Computer
4) Batch Communication to Hospital Computer
5) Five Languages - COBOL, BASIC, FORTRAN, ASSEMBLER, & DATABASE
6) ARC Network:
   - proven networking capability
   - modular
   - easy to expand without reprogramming
   - multiple processors
   - hardware redundancy and backup
7) Several Security Levels
8) Very Powerful Retrieval Capability (Associated Index Method, AIM)
9) Vendor Software Bundled - Not Individually Priced
10) Local Maintenance
11) Excellent Vendor Technical Support
12) Easy Application Development

The Surgery/Medicine ARC System initially consisted of 18 processors, 38 workstations, 17 printers, and 120 megabytes of data storage. The first phases of the system were installed in late August 1982. Prior to January 1983, the ARC System was integrated with our Host IBM System both by Batch RJE Communications (Model III) and by Remote Interactive Communications (Model II). Through 2 Datapoint Communication processors (emulating IBM 3271 Control Units) the ARC workstations have interactive access to the appropriate existing terminal functions on the host computer.

Two distinct interactive host terminal (3270) emulation capabilities were achieved on the Datapoint ARC System. The first capability is the straightforward emulation whereby the Datapoint CRT looks and acts like an IBM 3270 CRT, initiates an interactive host function program and receives back for display 3270 screen formats. The second capability involves the situation where the Datapoint CRT user is exercising an Interactive Datapoint Network program which, as needed, in turn initiates an interactive host function program, receives the returning 3270 screen format and selects only certain elements for subsequent processing in the Datapoint Network program. We have found this dual 3270 emulation capability to be invaluable in system applications.

Current LAN Status

In April 1983, we were notified that the Surgery/Medicine ARC System was the 5000th installed Datapoint LAN installation. There are now 24 processors, 45 workstations, 20 printers and 360 megabytes of storage on the Surgery/Medicine ARC Network. The available functions include:

- System Security by User
- Activity and Workstation Monitoring and Logging
- Message Posting System
- H E L P (AIM) Search Functions for ICD-9-CM Diagnosis Codes and CPT Procedure Codes
- Encounter Form Entry with integrated 3270 Host Edits, Update and (AIM) Inquiry
- Host Computer Functions via 3270 Emulator
- Add, Update and Delete Functions for the following Master Files: