

# Incorporating Client-Server Database Architecture and Graphical User Interface into Outpatient Medical Records

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## ABSTRACT

*Computerized medical record systems require structured database architectures for information processing. However, the data must be able to be transferred across heterogeneous platform and software systems. Client-Server architecture allows for distributive processing of information among networked computers and provides the flexibility needed to link diverse systems together effectively. We have incorporated this client-server model with a graphical user interface into an outpatient medical record system, known as SuperChart, for the Department of Family Medicine at SUNY Health Science Center at Syracuse. SuperChart was developed using SuperCard™ and Oracle®. SuperCard uses modern object-oriented programming to support a hypermedia environment. Oracle is a powerful relational database management system that incorporates a client-server architecture. This provides both a distributed database and distributed processing which improves performance.*

## INTRODUCTION

Physicians are increasingly turning to computers to assist them in the management of information. Perfection of the interaction between physicians and computers is the theme of this conference. This project addresses two major obstacles to improving this interaction. They are: 1) the interface between the physician; and the computer and 2) the sharing of data among diverse computing systems. Improvements in these areas will enhance the physician's ability to manage information.

A barrier to the use of computers by physicians has been the character-based interface, inherited from the mainframe world (Cook, 1990). These character-based interfaces require that physicians possess extensive keyboarding skills, and forces them to memorize abstract strings of characters to perform tasks. On the other hand, a graphical user interface decreases the need for keyboarding skills and transforms abstract commands into

ones that are more concrete, meaningful and intuitive. As a result, graphical user interfaces decrease the cognitive demands placed on physicians.

Increasingly, the health care system requires that information be accessible by a variety of individuals and organizations. Diversity among computing systems has impeded this accessibility. A recent advancement in database architecture, known as client-server computing, allows for transparent communication among diverse computing systems. In client-server architecture the database application is divided into two parts: a front-end or client; and a back-end or server. The client executes the application that accesses database information and interacts with a user. The server executes the functions required for concurrent shared data access. Client-Server architecture allows for distributive processing of information among the networked computers which improves performance. By executing database management software at the server, and allowing a client or multiple clients to access the information at the server, data retrieval efficiency and data integrity is increased (Bobrowski, et.al., 1990).

SuperChart is a problem-oriented outpatient medical record system (Fiacco and Edinger, 1990). While this system creates individual patient "charts" in standard "SOAP" note format, the result is beyond traditional list and database report methods. SuperChart was developed using SuperCard, a modern object-oriented programming system that supports a hypermedia environment and Oracle, a state of the art relational database management system that incorporates a structured query language (SQL). The combination of these two programs allows for an improved interface between the physician and computer and improves the ability to share data in a diverse computing system.

## METHOD

Our network consists of a local area network of client Macintosh II workstations which is served by a Macintosh

SE30 and a wide area network consisting of two Digital Vax minicomputers. The LAN database is managed by a database server known as Oracle Server for Macintosh and is currently connected using AppleTalk protocol. We then connect to the Vax servers using the API (application-programming interfaces) SQL\*Net via TAU lines and asynchronous protocol.

The advantage to our network is that the client and server portions of the database are located on different computers. This configuration allows for distributed processing between the client and server machines. The server executes and administers the database while the client executes the complex instructions contained in our application to access the database servers over the network.

The physical storage of the database information is also distributed among the separate computes within the network. The data is stored at each server but also on each client workstation. This is referred to as a distributed database. The physical storage location of information is transparent to the clients of the database system and is accessible via any server on the same network (Bobrowski, et.al., 1990).

The Oracle Server communicates with client workstations and other Oracle Servers using Oracle software called SQL\*Net. SQL\*Net supports communications on all major network protocols, ranging from those supported by AppleTalk to those used by the largest of mainframe computer systems (Carnegie, D., 1990).

Our application uses a draft version of the standard data set defined by the American Society for Testing and Materials (ASTM, 1991). They are identifying and defining the general content and structure of the Primary Record of Care. These standards consist of essential data that must be present in the medical record and are defined by content and organization.

The graphical user interface has been developed using SuperCard, a modern object-oriented programming system that supports a hypermedia environment. SuperCard provides a standardized set of software tools and graphical windows that allows for application development within the Macintosh human interface guidelines (Apple Computer, 1985). It is the supported graphical interface to Oracle on the Macintosh.

## DESCRIPTION

SuperChart is an integrated system which provides multiple levels of access to patient charts by various users. Access to the appropriate system level is granted

when a valid user name and password is entered. Upon opening a patient chart, the program searches and presents the Routine Health Maintenance, Medication, and Diagnosis files. The following sections describe the respective screens or "windows" used by the system:

### Profile

The "Profile" window contains general demographic data. Windows in the Profile section include; Biographical Data, Past Medical History, Past Surgical History, Prior Hospitalizations, Family History, and Social History.

### Reminders

The "Reminders" window serves to display important clinical notes. When this screen is opened it displays the indicated Routine Health Maintenance items not yet completed, any patient-specific periodic lab tests, chronic medications due for refill, and any lab results since the prior visit. In addition periodic reminders for future testing can be initiated.

### Subjective & Objective Notes

The "Subjective and Objective Notes" window contains vital signs, chief complaint, subjective and objective notes and a list of performed procedures.

### Chronic & Acute Problem Lists

The "Chronic and Acute Problem Lists" window contains separate alphabetic listings of all medical and psycho-social problems.

### Assessment and Plan Notes

Each "Assessment & Plan Notes" window is stored by problem, time of presentation and by diagnosis code. Whenever a new medication is prescribed, the entry appears in the "Medications" field on the Assessment & Plan screen allowing all medications to be problem specific. The name of any physician consulted is listed for each problem.

### Medications

The "Medications" window is modeled on a "Prescription Pad" format. It contains a scrolling list of all medications previously prescribed. Medication allergies and refill dates are displayed. In future versions, drug interactions will be checked and the user will be prevented from entering new medications which appear in the "Allergies" field.

### Routine Health Maintenance

The "Routine Health Maintenance" window allows the user to customize the routine health maintenance file or choose from existing protocols (ie; the Frame Study or the American Cancer Society recommendations). Patient

specific periodic lab testing may also be entered.

### Genogram

Using techniques from combinatorial topology and recursive function theory, our program supports the drawing of genograms with an unlimited number of generations, children per couple significant others per person, and nontraditional families. Notes on every familial relationship and on significant medical and psycho-social history is recorded here.

## DISCUSSION

Distributed computing technology, using the client-server model of system organization in conjunction with multitasking operating systems, intercomputer communications, etc. provides the flexibility to link heterogeneous hardware and software systems together effectively (Shortliffe, 1990). There are several benefits of the client-server architecture in a distributed processing environment. Client workstations can use any application that will access the remote data of the server. These applications submit database requests to the server using SQL statements. Once received, the SQL statement is processed by the server; no information is processed over the network. Therefore, the network traffic is kept to a minimum. The workstations can be optimized for presentation of data by graphical user interfaces while the server can be optimized for the processing and storage of data. Multiple servers can be configured in a network to share the data processing load and increase the overall performance of the database system (Bobrowski, et.al., 1990).

Without the uses of an API, an application developer has to manually code all communications in an application that accesses a distributed database. If the network hardware, topology, or protocol changes, the application has to be modified. However, by using an API, the application developer does not have to be concerned with supporting network communications in a database application. The major advantage is that users and applications do not need to know where data resides. For example, users can access database tables by name and if the table is not located on the client computer, the appropriate remote table will be accessed. Users can access data without having to change computers or do file transfers across the network to get the information they need (Bobrowski, et.al., 1990).

Graphical user interfaces have been proven to provide a more intuitive, convenient, and effective way for diverse system users to communicate with and control workstation functions (Shortliffe, 1990). This interface decreases the need for keyboard skills and transforms

abstract commands into ones that are more concrete and intuitive. The marriage of the graphical user interface with the recent advancement in database architecture, client-server computing, offers significant advantage in dealing with the current diversity of clinical practices.

SuperChart takes advantage of both the client-server model of system organization and graphical user interfaces. Its byproduct is clinical data that can be used for epidemiologic studies and research. It offers the ability to construct medical education files composed of instructive cases pulled from residents' patient encounters. It also encourages increased communication between residents and faculty by allowing teaching staff greater ease of chart auditing, thus enabling more frequent and comprehensive resident performance evaluations and quality assurance checks. From an educational standpoint, the system allows residents access to existing medical information databases. It facilitates the documentation of procedures, and can be useful in identifying a resident-medical student case mix, thus guiding administration in the assignment of patients to ensure comprehensive training.

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