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TITLE A TESTBED FOR ADVANCED MATERIALS CONTROL AND ACCOUNTING CONCEPTS

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A TESTBED FOR ADVANCED MC&A CONCEPTS

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ABSTRACT

Advanced concepts in materials control and accounting include distributed databases in a distributed processing environment and on-line instrumentation. To test various ideas in this area, we developed a testbed consisting of three personal computers (PCs) with several input devices and suitable software. The principal design aspects being tested include database structure, communication between various network nodes, database update on the host, speed of transaction processing, data input from on-line instrumentation, and a user-friendly interface with the operator. An IBM PC/XT at the local level is used to collect data using a barcode reader and balance in a mockup glove box. These represent typical examples of simple on-line instrumentation in nuclear material facilities. Manual input to the PC/XT is through a keyboard, a mouse, and a voice microphone. This PC/XT communicates with a host PC/AT that serves to post transactions for a process area or wing of a facility. A second PC/AT represents the central computer that collects data from several distributed nodes and maintains the central database for analysis and report generation. Custom software is called PC/DYMAC, a materials accounting package developed by Robert Bearse in cooperation with Argonne National Laboratory-West under the direction and funding of the Los Alamos Safeguards research and development program. It was developed using dBaseIII PLUS but was compiled with FoxBASE+ under the Santa Cruz Operations XENIX operating system.

INTRODUCTION

The traditional materials control and accounting (MC&A) systems have been designed around a single processor, with many lines to individual input terminals. This design arose naturally from the high cost of processors in years past and from the need to concentrate and control sensitive data in one area for accountability purposes.

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In addressing the issues of advanced concepts, we have reexamined these ideas in light of current technology.[1,2] The advantages of the centralized system are still the concentration and control of sensitive data in one area and perhaps simplified maintenance. If instead one chooses a computer designed for nonstop computing, then reliability is greatly improved. One such computer is made by Tandem Computers, Inc. An alternative design that is gaining favor is a distributed system with a number of nodes that distribute the processing responsibilities.

It is this latter model that we have selected to pursue. Theoretical studies have developed a methodology for designing a network based on database design theory.[3] The principal advantages of such a system are

- improved response,
- reduced traffic on the communication lines,
- autonomous operation if central computer is inoperative,
- reduced cost of processors, and
- open-ended architecture.

System response is improved because an operator at a terminal does not have to share computing resources. Many of the housekeeping tasks that otherwise would use central processor time can be off-loaded to the node. (Examples of such tasks are the painting of screens, validation of users, and range checking of entered data) If these tasks are performed at the node from memory resident code, then system response is almost instantaneous. Rapid response at this moment is good ergonomic design. In addition, it is more efficient to use less expensive processing power for mundane housekeeping tasks. This network is also not limited by a narrow bandwidth on the communication channel.

Serial communication lines have been the traditional bottleneck. Recent advances in technology have improved the speed of multiplexing and transmission, but the overhead involved in administering many terminal lines is still quite expensive. One of the standard approaches to solving the traffic problem is the use of intelligent data concentrators, which off-load the burden of multiplexing from the central processor. Effectively, that is the approach we have taken. However, considerable care must be exercised to avoid creating excessive traffic from redundant data.

If the majority of material transactions occurs within the area administered by the node machine rather than into and out of it, those transactions can be processed locally using local inventory information. This method provides a certain amount of autonomy in the event that the central machine goes down. Failure of the central machine would inhibit transfers of material between nodes but would not inhibit the processing of local transactions.

The computing power of the personal computers (PCs) and workstations has increased at a phenomenal rate. The tremendous growth and competitive production have lowered prices to the point that distributed computation is very cost effective. Those systems that can be built in a distributed fashion can make good use of a very advantageous pricing structure.

A distributed system can be designed in an open-ended fashion. As more nodes are needed, they can easily be added to the network. As the amount of data increases in size, more disk space can be added. A central system is often limited in the maximum number of lines that may be accommodated by the multiplexer. By using data concentrators, we can limit the total number of lines going into the central computer to a modest number.

DESIGN ELEMENTS TO BE TESTED

The very brief description given above of a distributed system suggests a number of design elements that differ markedly from those of a traditional system and that need to be tested thoroughly. There are also some features that are totally unavailable on a centralized system. A list of the design elements that we anticipate studying follows.

- Database structure
- Communication between nodes
- Database updating on central computer
- Speed of transaction processing
- Data input from on-line instrumentation
- User friendly interface

The database structure will depend upon a number of factors including the degree of distribution and the nature of the software system. Commercial database management system (DBMS) packages are available, or customized database systems can be developed with high-level languages such as "C." If a commercial package is chosen, its strengths and weaknesses must be taken into account in the system design for optimization.

Communication between nodes is a very involved function. The design is dependent upon the application package, the operating system(s), and the communications program itself. For an automatic system to operate correctly, there must be adequate interprocess communication. For multiple access to shared tables by concurrent processes, it is necessary to have adequate locking of the records or files with safeguards in the event of collision. Multiuser DBMSs have appeared on the scene fairly recently, so this is a relatively uncharted area.

Database updating on the central computer is a ticklish question. If there are several copies of the official tables, concurrency problems may occur. If there is only one copy, then the autonomous facility is lost. There is the question of how to handle the posting of transactions. The main program itself could do it, but only at the expense of delays for the operator. A background process could do it, but only at the risk of not having current inventory information available to the main process.

Speed of transaction processing is important mainly from the standpoint of raw computing power. Posting of transactions is the most time-consuming operation and largely determines the throughput capacity of the system. Proper design can have a very strong influence on this speed and must take into consideration the foibles of the vendor's package. Improper design can easily decrease the speed by one or two orders of magnitude.

Data input from on-line instrumentation would greatly improve the quality of data by avoiding transcription errors as well as forcing better procedures. Any instrument with a built-in computer interface now used for making measurements on materials would be a good candidate. This would include balances, profilometers, NDA instruments, micrometers, and liquid level meters.

A user-friendly interface will greatly facilitate user acceptance of the finished system and improve the quality of the data. Ultimately, it will determine the success of the system. The interface takes into account ergonomic issues such as screen content and design, prefilling of forms, avoiding redundant and inconsequential information, security, convenient input and output devices, and on-line instrumentation.

TESTBED CONFIGURATION

Hardware

The basic hardware configuration is shown in Fig. 1. It has an IBM PC/XT at the lower level interfaced with a balance and barcode reader in a glove box, a mouse, a voice microphone, and a keyboard. This machine typifies a data entry terminal for entering data manually or through on-line instrumentation. The operator will interact

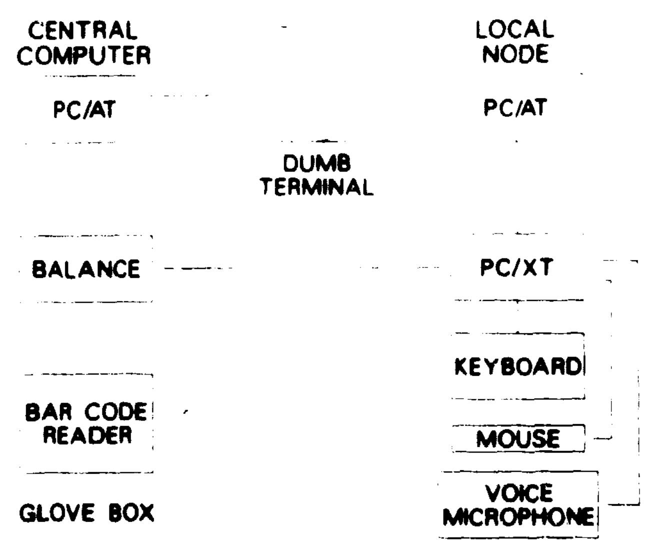

Fig. 1. Basic hardware configuration.

with the system normally through the keyboard, though alternative input can be by means of the mouse or voice microphone. At appropriate points in the program, the balance and barcode reader can be interrogated by the program for automatic machine entry of measurement data. The machine labeled 'Local Node' represents the principal machine for a building wing or control balance area. This machine will post transactions for all activity within its area but will pass through to the central computer all transactions between this area and any other area. The machine labeled 'Central Computer' is the main machine that does final and official posting of all transactions, performs the major maintenance functions on the database, and prepares all reports. The box labeled 'Dumb Terminal' represents a terminal attached to the local node for manual entry of data. The open design allows considerable freedom to configure as required by any given facility. A number of local nodes can be added to the central computer, and a number of data-entry terminals may be added to each local node.

Software

The purpose of a testbed is to test various configurations. With this in mind, we have installed two of the most popular operating systems for comparison purposes, DOS and XENIX. XENIX, from Santa Cruz Operations, Inc. (SCO), is a multitasking and multiuser system. Since DOS is a single-user system, it was supplemented with layered products called Multilink and Lanlink from The Software Link, Inc. A multitasking and multiuser extended operating system greatly simplifies the application programming task. These necessary functions are provided by the supplements to the DOS operating system.

The application program is called PC/DYMAC, which stands for PC DYnamic Material ACcounting, a nuclear materials accounting package developed by Robert Bearse, a consultant to Los Alamos, in cooperation with Argonne National Laboratory-West (ANL-W) in Idaho Falls.[4] The project, directed and funded by the Los Alamos National Laboratory research and development program, was based on the PF/LASS system developed at Los Alamos by Nick Roberts, Ferman Kelso, et al. for the Plutonium Facility at TA-55. It was written in dBASE III PLUS, from Ashton-Tate, and compiled with Clipper, from Nantucket. With the installation of XENIX it is being converted to FoxBASE+, from Fox Software. The SCO version of FoxBASE+ is a multiuser system operating under XENIX that provides the additional file and record locking facilities.

PRESENT STATUS

All the hardware has been installed as shown in Fig. 1. We are in the process of replacing the PC/AT Central Computer with an IBM PS/2 model 80 for improved performance. This configuration will be used in a full-system test for the ANL-W project. Two additional local nodes will also be added for the final test. The on-line instrumentation with the data-entry terminal will not be used in this particular test. All data will be entered at the local node level.

The balance being used is a Precisa model 3510D from Pag Oerlikon Ag, and the voice system is the Vocalink model SRB from Interstate Voice Products. Data from the balance are read directly from the built-in computer interface with a Basic program. Data from the Vocalink microphone are injected via the keyboard port. A PC board is used to handle the vocabularies and voice templates, with the resulting code passed through to the computer in keyboard emulation.

Each of the upper-two-level computers is configured with a split disk, part DOS and part XENIX, whereas the lower-level computer is strictly DOS. Communication between the lower-level DOS system and the upper-level local node under XENIX has not yet been established. This will require very modular programming with minimal interfaces between the different processes.

These machines have been configured with hard disks—primarily for convenience in program development. In an actual installation, these hard disks could be replaced with random access memory if security required sanitizing at the end of the day when unattended. This is one of the conveniences of an open-ended system.

FUTURE DIRECTION

Present plans call for a complete system under XENIX on the upper-level machines and a data-acquisition machine under DOS. We will have the capability to compare the efficiencies of multitasking under XENIX versus multitasking under LANLink. We will be able to demonstrate the advantages of on-line instrumentation and voice input when fully integrated with a data-entry program in a materials accounting system.

ACKNOWLEDGMENTS

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