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End User Interactive Telecommunications Management Systems*

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ABSTRACT

Integration of telecommunications, data communications and computing implies the need for an open architecture with global access to information within all systems. In this environment, it is becoming obvious that traditional approaches to telecommunications management are no longer effective. This paper presents an overview of the problems and challenges of automating telecommunications management, integration of the end user into management of the system, organization and tools necessary for automation, and interim solutions that save time, increase productivity and improve lead time. Such access permits the end user to participate directly in the management of and control over critical communications systems. Indeed, automation of telecommunications management implies direct end user involvement.

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INTRODUCTION

With technological advances becoming more and more computer-based, the ability to distribute data across many areas of applicability gives the end user greater application versatility and enhances the level of management and control over critical communications systems and their vendors. It is becoming apparent that traditional approaches to telecommunications management no longer work, for they erroneously assume that the Telecommunications Department ("Telecommunications") performs a largely autonomous, self-contained function using primarily manual processes and procedures.

Integration of Telecommunications, Data Communications and Computing implies the need for an open project structure with global access to information within all systems. Complete integration of these disciplines will require development of industry standards, and, until these standards are established, vendor cooperation in developing product compatibility and a solid, cohesive working relationship between various organizational groups will be crucial. Within an organization, Telecommunications and Data Communications professionals together bring great strength to the partnership: Data Communications professionals through their technical understanding of systems, and Telecommunications professionals through their in-depth understanding of the needs and environment of the end user. Integrating the two groups should be viewed as a benefit to the organization, not as a political battle.

This paper describes our model for automating telecommunications management at Stanford Linear Accelerator Center (SLAC), our progress to date, and steps to be taken in the foreseeable future. It also describes benefits already derived from the automation.

SLAC is a national laboratory funded by the US Department of Energy, and is one the leading centers worldwide for basic research in elementary particle physics. It is located on approximately 480 acres, two miles west of Stanford University's main campus and 40 miles south of San Francisco, California.

SLAC cut over (changed) from a 25-year-old, 1,600-line electromechanical PBX to a 3500-port-equipped Northern Telecom SL–1 XT electronic digital switch in March 1988, six months after signing a contract with Pac*Tel Info Systems. A small staff managed the installation. Because of budget constraints and limited resources, and to gain maximum community support, SLAC management assigned 53 scientists, engineers, secretaries and administrative assistants as ATOMs (Area Telecommunications Office Motivators) to represent the entire telephone user community of 2,300 people (3,100 telephones), during both the pre- and post-cutover phases of the project. Each ATOM represents from 5 to 200 telephone users and telephones. ATOMs gather information pertinent to constructing the telephone database and serve as liaison between Telecommunications and the end user. In some cases, they even helped design the system and changed the lab's direction on telephone instrument choices.

END USER INTERACTIVE TELECOMMUNICATIONS MANAGEMENT: A MODEL

Our model for an end user interactive, distributed communications management system (see Figure 1) calls for **all** computer services—telecommunications, data communications, or other applications—to be accessible to: end users through a universal, menu-driven interface on the users' workstations; distributed department computers; remote network services; and distributed user printers. The telecommunications portions of the model—switch and facilities management, call accounting, traffic analysis, and systems monitoring—are integrated by sharing common information and user interfaces. A single distributed database is the key to data integrity and efficient data management. The model views end users as partners in telecommunications management; through information and tools accessible from users' workstations, end users make choices that affect their immediate environment. The Telecommunications specialist serves as a user consultant, system administrator and developer, and also interfaces with the telecommunications industry.

The uniqueness of this model over that implied by prevailing telecommunications management practices lies in:

- total automation and integration of all telecommunications management functions;
- a single distributed database; and
- involvement of end users as partners in communications management.

Benefits we expect to derive from the implementation of the model include:

- greatly increased system integrity and reliability;
- immediate access to vital system information;
- greatly increased responsiveness to user requests for services;
- increased accuracy in service delivery; and

- marked reduction in staff needed to administer, manage, and operate the system.

This model was articulated in 1985 as part of our initial request for proposal (RFP). None of the bidders on our RFP, though, were able to meet the model's requirements, forcing us to downgrade them. Because of this, we decided to pioneer the project and develop the model in-house.

Steps taken within the past year produced a more efficient telecommunications system, a reduction in our change order backlog and a reduction in operating staff. We also reduced the lead time required to process change orders by a factor of four—from four weeks to two days. At cutover, we had two software products: station data software for making changes to our telephone switch and a call detail recording and accounting package. We also had an IBM VM/SP mainframe-resident, user-accessible telephone directory. With this, we reviewed our immediate options for automating the many remaining manual processes as quickly as possible. We considered these approaches:

(1) Using a combination of vended products and in-house hardware and software while filling the gaps with manual procedures and processes. Several vendor products, ranging from \$5,000–\$150,000, were available for many applications running on various platforms.

(2) Using a management service bureau for either internal or resale billing.

(3) Budget and time permitting, developing a customized, integrated management system in-house.

(4) Developing an integrated management system in-house using vended prod-

ucts as building blocks whenever possible—the solution SLAC adopted. This strategy would permit us to use the power of suitable vended products while we develop and integrate other components of the system. We considered transportability and file import-export capabilities for manipulating telecommunications data a prime selection criteria for choosing vended products.

ORGANIZATION

Our model of an integrated end user interactive telecommunications management system requires an organization substantially different from the conventional telecommunications organization. The automation of telecommunications management achieved thus far has allowed us to reduce our staff requirements to six: a manager, one administrative assistant (who also serves as operations supervisor), two operators, one telecommunications analyst, and one voice analyst (contract employee). One vendor technician is assigned to the site for performing system maintenance and hardware installations. All software-related switch activity is performed in-house. As automation increases, the need for the voice analyst will disappear.

We require candidates to think progressively, to be open-minded, and to be computer-oriented and computer-literate. They must understand and cooperate with our model of automation and adapt readily to the interim mixture of automated and manual work processes. Our experience with telecommunications veterans who come from a precomputerized telecommunications era shows them to be mainly hardware-oriented and set in old ways of doing things. They fail to recognize this as a problem and the need for change. In their lack of vision, they fail to appreciate the tremendous power that computers and end users themselves bring to telecommunications management: ready access to almost any information; elimination of repetitious, error-prone manual labor; enhanced ability of end users to participate in providing their own telecommunications services; and ability to deliver faster, more accurate service at lower cost.

During the system development and integration phase, the Telecommunications and Data Communications Departments are working closely and cooperatively on the project even though they reside in separate organizational units. Each department recognizes the strength of the other and the future benefits to SLAC of their collaboration. Since cutover, the managers of the two departments have been "sharing" staff. Data Communications has "loaned" Telecommunications an analyst and a senior programmer to work on Telecommunications' management system development. With respect to these "loaners," on personnel-related matters, the Data Communications manager has primary responsibility and the Telecommunications manager has secondary responsibility. On technical development matters related to the project, the primary and secondary responsibilities are reversed. This advise-decide relationship is a very strong management combination and serves to cross-pollinate the disciplines without requiring major organizational changes. When the major system development effort is complete, the Data Communications-based people can be reassigned to other non-Telecommunications projects.

IMPLEMENTING THE MODEL

We estimate complete implementation of our model within two to three years. Our short-term implementation objectives at cutover were (1) to automate as many of the labor-intensive, expensive, and error-prone manual processes as quickly as possible, and (2) to enhance existing programs and develop menu-driven, full-screen user interfaces to engage our users in managing SLAC's telecommunications resources.

The remainder of this section describes our progress to date regarding implementation of our model on a telecommunications subsystem-by-subsystem basis (see Figure 2).

Switch Management

The switch management subsystem deals with those system components that interact with the telephone switch change process and the user community. Applications in this category include: the operator interface and directory, user interface, station data management and network access management, and switch configurator.

Operator Interface and Directory

Replacing our old shared key telephone system with one based on a "single line" concept required us to update automatically and efficiently the mainframe-resident telephone directory accessed by over 1,500 users. By linking each telephone in the switch database and the directory database to a unique field common to both databases (*i.e.,* a database record number and the switch DESignation number), we were able to compare the contents, to replace the old number with the new one, and to provide users with an updated directory on the Monday following cutover (March 7, 1988).

Without this capability (which the switch vendor and the installer were not able to

Figure 2: SLAC SL–1 telephone management system status.

System Component	Status	Present	Future
Switch Management			
Operator interface	online	IBM	IBM
Directory	online	IBM	IBM
User interface	online	IBM	IBM
Station data management	stand	PC/MS-DOS/STA	VAX/VMS/ C
Network access management	manual	none	VAX/VMS/ C
Switch configurator	manual	none	VAX/VMS/ C
Call Accounting & Billing			
Real-time data capture	integrated	VAX/VMS	VAX/VMS/ C
Call-data processing	integrated	IBM	IBM
Call-data costing	integrated	IBM	IBM/VM-CMS/SAS
Output generation	integrated	IBM	IBM/VM-CMS/SAS
User interface	integrated	IBM	IBM
Outside cost accounting	manual	none	IBM/VM-CMS/ ?
Facilities Management			
Work order management	manual	none	IBM
Equipment inventory	manual	none	VAX/VMS/ORACLE
Cable plant management	online	IBM	IBM
Systems Monitoring			
Problem detection & reporting	online	IBM	VAX/VMS/ORACLE
Trunk testing	manual	none	VAX/VMS/ C
Traffice Analysis & Capacity Plan			
Network performance	manual	none	IBM/VM-CMS/ ?
Intrasystem performance	manual	none	IBM/VM-CMS/ ?
Network simulator & model	manual	none	IBM/VM-CMS/ ?
Intrasystem simulator & model	manual	none	IBM/VM-CMS/ ?
Rate analysis	manual	none	IBM/VM-CMS/ ?

provide), it never would have been possible to check the validity of the 2800-entry telephone database 19 times in the three months prior to cutover, or to correct the many errors. For example, the first switch database review revealed a 25% error rate.

We supplemented the online directory and operator screen interface with a utility that permits users to interrogate the ATOMs responsible for their area and features assigned to a given telephone number.

Successful uploading of the switch database to the mainframe marked the beginning of our model (see Figure 1) becoming reality.

User Interface

We developed an ATOM change order submittal and order status inquiry system to bring regularity to what was initially a chaotic situation—for three months after cutover, we received massive numbers of change orders requiring 6–8 weeks lead time. At the same time, other field changes and installation issues had to be handled. We received requests from ATOMs in all forms: electronic mail, memos, phone calls, and office visits. Requests frequently required extensive analysis, often after sifting through much irrelevant information. We spent inordinate amounts of time checking order status and reporting order completion to ATOMs.

This user interface consists of online full-screen request forms for telephone hardware, software, and directory changes. The screens, simple to access on the mainframe and easy to complete, elicit from the ATOM, in plain English, pertinent change order information. The system automatically assigns a unique order number for tracking the order and facilitating communication about the order between

ATOMs and Telecommunications personnel. At the push of a button, the ATOM sends the order electronically to Telecommunications and prints a hard copy, if desired. When Telecommunications receives the order, the system automatically acknowledges receipt. Similarly, when the order has been completed, a push of a button simultaneously archives the order and notifies the ATOM of completion.

The system minimizes the need for clarification from ATOMs and reduces change order analysis time. Automatic acknowledgment of order receipt, status, and completion has practically eliminated ATOM requests for such information. Finally, the entire program has tremendous reporting capabilities, allowing management to monitor and oversee telephone activity.

In the future, we will assign switch mnemonic equivalencies to the English version of feature descriptions so that an order can: be analyzed from one terminal and, upon approval, be sent to the switch for implementation; automatically update other databases affected by the change [*i.e.,* directory, call detail recording (CDR) for number changes, additions, cable records]; and notify the ATOM of order completion, archive the order, and report on batched change activity (*i.e.,* error correction and detection).

Station Data Management (SDM)

We currently use a PC-based switch interface product for making, displaying, and batching changes to our switch. It has several reporting capabilities, can generate telephone DES strips, and has a switch terminal emulation module.

Disadvantages of the program include slow transmission speed and limited searching capability. Efforts to speed up transmission have been unsuccessful because of the limited speed with which the switch can accept information. Telephone templates can be accessed and searched using only one field, the telephone's location number, rather than any arbitrary field available for the query. Current information about a telephone can only be obtained by printing a hard copy report that gives locations associated with a telephone number.

On the other hand, the program's user interface is much friendlier than that of the switch, making the change process much more efficient. The batch capability requires little operator intervention. Making changes directly through the switch is very cumbersome in comparison. Of course, telephone switches were not designed to be user friendly, but to switch calls. Certainly, that is the position that switch vendors take!

Future plans for the station data management subsystem include: incorporating the station data management program into our model, if it is sufficiently flexible and transportable; developing a new program and interfacing it with already existing programs, such as the ATOM user interface program; or enhancing the ATOM user interface program to perform that function.

Network Access Management and Switch Configurator

The network access management subsystem manages the switch's automatic route selection program. This system is truly independent of all other switch management subsystems except for the switch configurator. The analysis and design for both the network access management and the switch configurator subsystems are just beginning. The network access management subsystem will monitor network access, and provide the switch configurator with information necessary to automatically reconfigure the switch (*e.g.,* to reassign trunks and routes) when network conditions dictate such a change. This will be a very sophisticated and complex system to implement.

Call Accounting and Billing System

Subsystems in this area are: real-time call data capture, call data processing, call data costing, output generation, user interface, and outside cost accounting. The real-time data capture subsystem deals with the collection of raw CDR from the switch. Call data processing refers to massaging raw call data records (defining and performing sorts, etc.). Output generation provides the information to interested parties in a timely fashion and assigns algorithms to cost calls using a variety of input (*i.e.,* rate tables, etc.). Reports containing general and detailed information are made available to users via an online, full-screen user interface.

We have made significant progress in this area. This subsystem is integrated with the switch management subsystem. We are now collecting CDR information directly on the mainframe computer using a small front-end computer instead of a PC-based product. Now the end users can access standard call detail reports from their mainframe-connected workstations and even analyze the data using their own programs. Telecommunications no longer needs to update yet another database and handle user report requests.

We plan to incorporate outside cost accounting into this function through vendor call charges supplied in machine-readable form so that we can bill back the user and provide online billing information to the Accounts Payable Department.

Facilities Management Subsystem

The facilities management subsystem deals with hardware-related applications, such as work order management, equipment inventory, and cable plant management.

Work Order and Equipment Inventory Management

Work order and equipment inventory management subsystems are directly related to each other and to two switch management subsystems—the user interface and the SDM. Once an electronic work order is generated from the switch management application to the vendor technicians for equipment installation or disconnect, the automated physical inventory package reflects additions or deletions in the appropriate category. Further, the program maintains par equipment levels and notifies the Telecommunications analyst when additional equipment needs to be ordered, even generating purchase requisitions automatically.

Cable Plant Management

The cable plant management subsystem will be part of an organization-wide cable database. The Telecommunications cable plant management system automates tracking and updating of telephone cable records. It helps the technician find the path of a cable, assigns new cable pairs, and builds connectivity records. The SDM dynamically interacts with this database so that when numbers change, it automatically updates the cable records database.

Systems Monitoring

Systems Monitoring is comprised of problem detection and reporting, and trunk testing.

Problem Detection and Reporting Subsystem

The problem detection and reporting subsystem automates the repair process. The mainframe-based user interface of this subsystem is founded on a concept similar to that of the switch management user interface. On an online screen, Telecommunications reports details of the user's telephone problem and sends hardware repair problems electronically to the vendor technician for correction. When the problem has been resolved, the technician completes an online, full-screen "trouble ticket" and sends it electronically to Telecommunications. Like the switch management user interface, this program has powerful reporting and status tracking capabilities. Telecommunications can monitor vendor performance, assess problem areas, and determine equipment and cable failures in the field. This program will interface with the cable plant management program. We expect to introduce it in the near future to help end users report telecommunications troubles.

Trunk Testing Subsystem

The automated trunk testing subsystem interfaces on a daily basis with the switch management subsystem to test and report on trunk status, and to create a blueprint for this function. Additionally, operators manually test trunks daily. Future plans for the trunk testing subsystem include automatically opening a trouble ticket using the problem detection and reporting subsystem.

Traffic Analysis and Capacity Planning

The traffic analysis and capacity planning category is comprised of five subsystems:

(1) network performance;

(2) intrasystem performance;

(3) network simulation and modeling;

(4) intrasystem simulation and modeling; and

(5) rate analysis.

These subsystems will: monitor off-site networks for optimal performance; implement regular system traffic studies and provide comprehensive reports based on built-in traffic engineering formulas; simulate network and intrasystem models based on "what if" analysis; analyze other common carriers (OCC) rates; and produce recommendations for preferred carriers, so that least cost routing (LCR) algorithms can be changed for maximum reliability.

While the blueprints for traffic analysis and capacity planning are a reality, design and implementation are a few months away. In the meantime, we are pulling intrasystem statistics and manually analyzing them and reporting on the results. Again, this is a time-consuming exercise and requires a very skilled analyst to interpret the data, do the calculations, and prepare the reports. In the offsite network area, we have had a consultant perform one study; we plan to perform future studies in-house.

THE FUTURE

The next step is to extend this end-user driven management system to incorporate data communications and distributed computing components so that SLAC management has a single focal point for all communications questions, and the end user has a single integrated interface for questions regarding communications costs, usage, changes, and repairs.

EXISTING TECHNOLOGY

Although we have found no products on the market that satisfy our model of automated telemanagement, we see signs of increasing recognition of this need. For example, IBM in San Jose has developed an impressive communications tracking/monitoring system. However, it presently lacks a user interface subsystem. IBM's staff recognizes the benefits of such an interface and expects to implement one as a future enhancement.

CONCLUSION

We expect that this model, once fully implemented, will become an industry prototype which demonstrates that cooperative automation and integration of communications management systems can save organizations significant amounts of time and money, while enhancing service and end users' satisfaction with the quality, quantity, and timeliness of service.

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FURTHER READING

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INTEGRATED USER-DRIVEN DATABASE MODEL

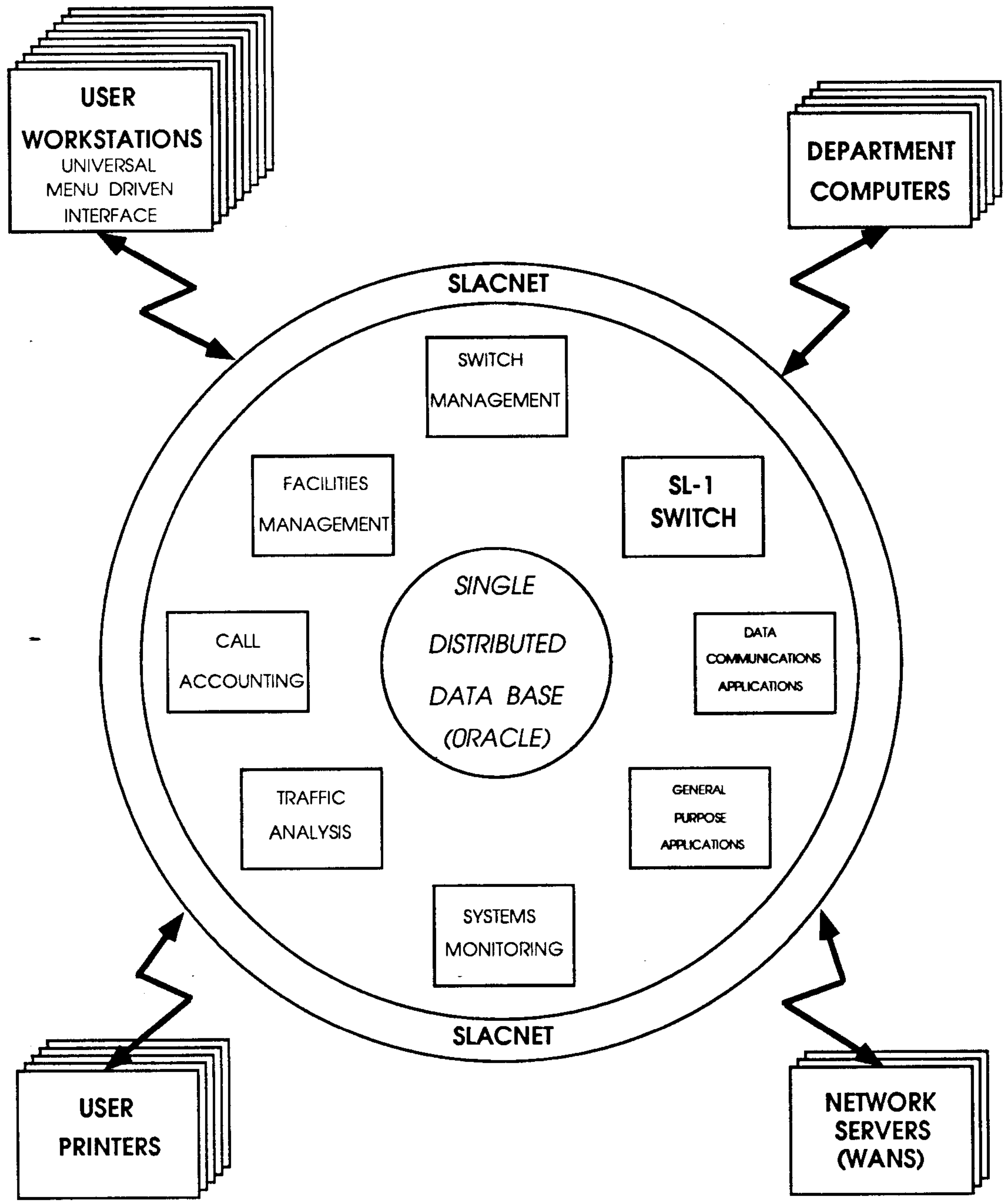

Fig. 1

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