

Systems Management in the 1990s

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During the late 1980s, business customers increasingly viewed systems-management tools as a means to increase staff productivity while lowering operational costs. In this regard, AT&T Global Business Communications Systems (GBCS) designed a suite of site-management applications to facilitate control of the hardware and software elements providing network voice communications. For example, systems-administration products simplify and accelerate the addition, deletion, and modification of stations and trunks. Traffic-management and fault-management tools help to optimize the voice network while minimizing maintenance costs. Call-accounting products allocate costs and help manage calling patterns. Since 1992, a new operational environment has begun to appear among the largest GBCS customers. This environment integrates control of voice and data communications under a single management group. Moreover, while networks have become more complex, the number of communication managers has not increased significantly. End-user demand has grown, however, for management applications that are flexible and easy to use, as well as for applications providing simple access and control of both voice and data elements. In response to these market needs, GBCS is developing a suite of network-management tools—using industry-standard protocols—to support its wide variety of core products in the integrated network. These applications will be part of the AT&T OneVision™ Network-Management Solutions.

Introduction

During the early 1970s, if customers wished to modify their premises telecommunication features, they asked their local exchange carrier (LEC) to do it for them. The LEC provided the service—everything from a simple relocation of a telephone set to a complex call-routing change—and the customer waited for the change to be made. While the LEC's service technicians sought to make every change expeditiously, it often was not soon enough for customers. Before the late 1970s, customers could request specific service directly through an asynchronous terminal, which provided access to the central-office (CO) switching system. They could, therefore, make simple changes to the telecommunications features for themselves.

The introduction of premises switching equipment and private branch exchanges (PBXs) provided greater end-user system control. The AT&T DIMENSION® telecommunication system supports up to 2,000 lines, and has features and functionality similar to that found at the local CO on the 5ESS® switch. Moreover, the DIMENSION system also offered customers on-site control of their telecommunications environment by means of a small access module known as the Maintenance and Administration Panel (MAAP). This panel allowed customers to accomplish their own adds, moves, and changes to telephone sets on the switch using numeric codes called *procs*. Such service changes required considerable expertise among the customer's support staff, many of whom learned to "speak

proc" like a second language. Administration of more complicated features, such as routing patterns, required expertise not only in the procs themselves, but also in the complex algorithms that gave the switch so much of its flexibility. System management, therefore, remained the responsibility of only a few individuals who took the time to learn about these many details.

Administrative challenges notwithstanding, the extraordinary, intelligent, call-handling capabilities and elegant network-access flexibility of the PBX caused its market to grow rapidly during the 1970s and 1980s. As the market grew, so did PBX technology, providing the switch with ever-more-extensive features and functionality. As the DIMENSION system evolved into the AT&T System 85, as System 85 evolved into the DEFINITY® Generic 2 (G2) system, and as Generic 3 was introduced, features were added that enhanced the switch's core competencies. Automatic alternate routing, alternate routing system, integrated services digital network (ISDN) support (both primary rate interface and basic rate interface), and other networking capabilities allowed the PBX to provide robust communication capabilities that optimized real-time call handling.

The development of the Distributed Communication-System feature allowed multiple PBXs to be linked together in a wide-area network (WAN), in which endpoints—the voice and data sets on user's desks—appeared (to end-users) to be on a single switch. With this added feature "richness," the role of systems-management tools became increasingly important.

Communication managers needed administrative tools that facilitated support of hundreds of users while optimizing a switch facility that used tens—sometimes hundreds—of trunking facilities in very complex setups. Without effective management tools, operational costs would be exorbitant and system control minimal.

Tools for the Revolution

The revolution in systems management took place as a result of a renaissance in premises switches. The System 75 PBX, which AT&T introduced for the mid-size business-customer market (800 lines and below), had many of the features found in the larger System 85 switch—and several new ones. In particular, System 75 had an enhanced administrative interface, which allowed an end-user to simply fill in forms—in English—and the system did the rest.

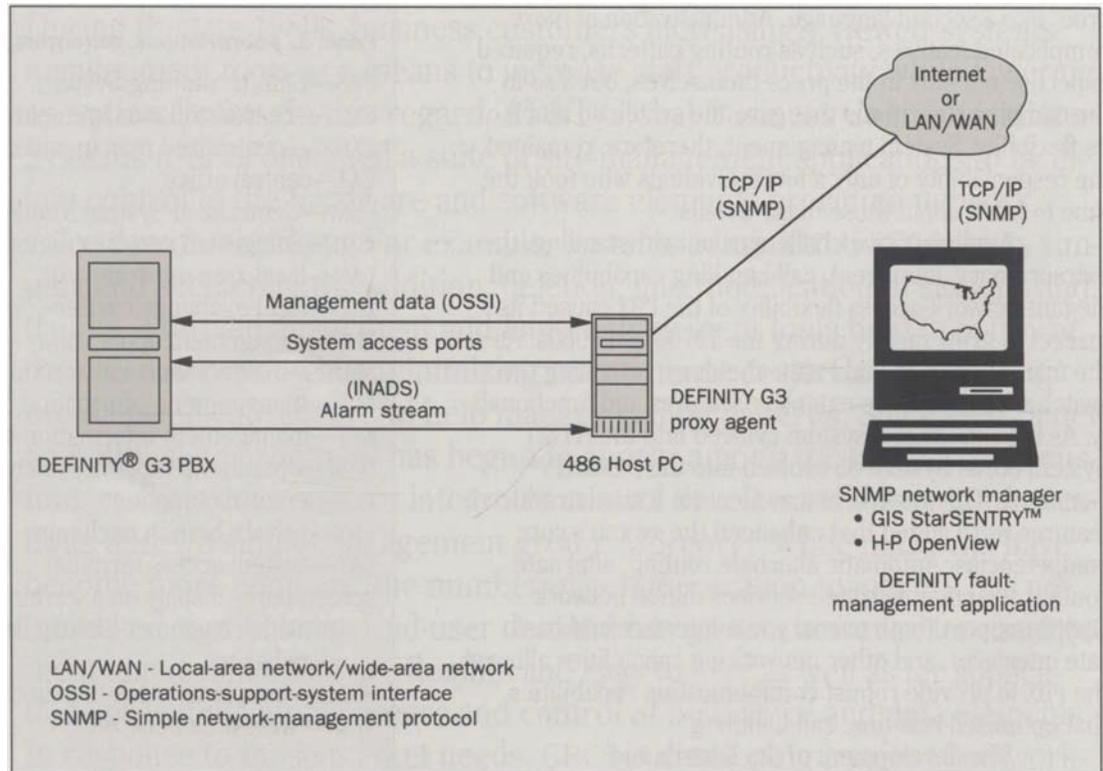
Panel 1. Abbreviations, Acronyms, and Terms

CAS—Call Accounting System
CMIP—centralized management-information protocol
CMOT—centralized management object transport
CO—central office
CSM—Centralized System Management
ISDN—integrated services digital network
LAN—local-area network
LEC—local exchange carrier
MA—management application
MAAP—maintenance and administration panel
MIB—management-information base
MIS—management information systems
OSSI—operations-support-system interface
PC—personal computer
PBX—private branch exchange
SAT—system-access terminal
screen pop—display on a terminal or PC screen that provides customer-history details from system data bases
SNMP—simple network-management protocol
WAN—wide-area network

This forms-based administrative system resided within the switch software. The system was accessed through an asynchronous terminal, called the system-access terminal (SAT). End-users could administer all elements of the system—stations; trunks and trunk groups; patterns; pickup, coverage, and answer groups—and all the features, simply by filling in forms. Studies showed that, even without instruction, end-users could make station adds or changes within 15 minutes of accessing the terminal. Productivity of the telecommunication staff doubled. In addition, reports on configuration and performance were available directly from the switch through the SAT. This meant that the communications manager could see whether the switch and its associated facilities were being optimized. As a result, managers could both react to their environment in real time *and* plan for the future.

These capabilities resided within the smaller System 75 switch. For customers who chose the System 85, which often supported over 2,000 station users, addition of these enhanced management capabilities would affect the primary requirement for call-handling perfor-

Figure 1. The latest generation of the DEFINITY Communication System, known as Generic 3 (G3), features call-management software that can function in several ways. It can support telemarketing centers, transmit video calls, and—for LAN users connected to its facilities—can send data across switches. Its capabilities also include connecting a PBX to CO facilities and features, and allowing end-user telephone-set administration from a PC.



mance. The systems-management software was, therefore, designed to reside on an adjunct processor. The software and hardware, which used a proprietary interface specifically designed for administration, would allow administration and management of the larger switch. This adjunct product, called Centralized Systems Management (CSM), provided a tool whereby telecommunication managers could manage their switching systems from a central location. CSM also provided managers with both the operational responsiveness demanded by their end-user community and the planning tools that good business practices require.

To telecom managers, SAT and CSM provided the control that was an essential business need, driven by the arrival of applications that stretched the call-handling capabilities of the switch and extended its potential. Due to proactive maintenance and planning, telecommunication managers found they could convince their financial managers that an investment in management systems would be returned quickly by the efficient use of personnel and cost reductions within departmental operations.

These were the tools that could provide crucial

information about the system—who was using it, and how; what kind of service end-users required; human resources and job categories required by the telecommunications department to keep up with demands. Now, managing telecommunications for the company could finally be realized.

The SAT allowed customers with smaller systems to make on-the-spot changes to the switch. And because the telecom manager in the small-switch environment often had other responsibilities, the user-friendly interface made keeping up with end-user requirements easier.

For the large-switch telecom manager, systems-management tools made managing the switch feasible. The administrative staff for a large switch on a busy day could be faced with up to 80 station changes. With a product having a scheduling capability, such as CSM, implementation of these changes could be spread out over a week. This allowed more efficient work-force management, and ensured that the switch could accommodate the additional business needs when required. The traffic-management module allows administrators to view

the switch's vital connections with the outside world and to monitor the performance of the processor complex that keeps everything running smoothly. In an environment in which the telecommunications department acted as a utility to the business, the cost-management module allowed managers to capture call-detail records by individual and department.

Optimizing the Voice Network

In the ten years since System 75 and System 85 were introduced, the sophistication of premises equipment has increased exponentially. Formerly, the PBX was used simply to handle call processing. Today, the feature-rich DEFINITY system, as well as sophisticated on-board and adjunct management applications, have provided customers with the capability to design and control complex telecommunication environments. Now, the DEFINITY system hosts the most sophisticated call-processing software, allowing over 100,000 busy-hour calls. It also provides a platform for sophisticated applications to enhance the telecommunication capabilities of the business it supports.

On the latest generation of the DEFINITY Communication System, known as Generic 3 (Figure 1), call-management software can function in a number of ways. For example, it can support a telemarketing center. Managers can use it to set up and transmit video calls from any room with a digital port. Local-area network (LAN) users, connected to its facilities, can use the DEFINITY system's wideband capabilities to send data across switch facilities. Network connections, via industry-standard ISDN capabilities, can connect a PBX to CO facilities and features. End-users can administer their own telephone sets from a personal computer (PC). In multiple-switch environments, the DEFINITY Distributed Communications System software makes access across network switches invisible to users. In addition, GBCS's partnership with Novell is making computer and telephony applications, such as collaborative meeting services, available to end-users on the switch. (Novell is a registered trademark of Novell Inc.)

Business Need for Systems Management

With a business environment as complex as their equipment, telecom managers must deal with intense cost-management pressures, increasingly scarce human resources, and more demanding end-users. The

telecom manager also shares in the same intense market pressures as clients who view their telecommunication facilities as market-critical (such as call centers). Add to these challenges the need by many businesses to become "globalized," and telecom managers are faced with the following issues:

- The increasing desire to provide reliable, ever-improving service;
- Rapid response to end-users' demands;
- Detailed methods for ensuring system "health" and optimization; and
- Providing measurements of a telecommunication system's productivity.

Whether a business views telecommunications as a strategic asset—as in a telemarketing or utility-like environment to generate revenue from customers—or simply as an expense to manage, telecommunication-management tools are essential to a manager's job. As a result, from the late 1980s up to the present, telecom managers have attempted to build an essentially homogenous environment of switching platforms to support local call-processing needs and system-management administration tools. A decision to buy both switches and management tools was based on two factors: whether the new equipment was reliable, and whether the tools reduced switch operating costs over its seven-year to ten-year economic life span.

GBCS, with the understanding that life-cycle costs influence switch purchase decisions, has placed an increased emphasis on supporting the telecom manager. (An article describing the challenges a telecom manager faces is available.¹) An integrated set of applications has been developed to complement the core functionality with operations, administration, and maintenance capabilities because efficient and economical operations are essential to GBCS premises customers. These systems and network-management applications are designed in the same manner as core products, and they provide telecom managers with the technologies needed to meet the following objectives:

- Resource management for maximizing system performance with minimal administrative effort, optimizing the use of facilities and monitoring the health of the system as a whole.
- Easy access to information, and rapid data exchange over least-cost routes, to provide personalized customer service in response to end-user requests.

- Virtual community for centralized, consistent management of resources and data across the voice and data network.
- Mobility for anywhere, anytime access to multiple resources for any purpose.
- Empowerment to maximize use of employee time and talent, so that workload and business relationships are managed efficiently.

To these ends, GBCS developed a ten-year plan focusing on delivering systems-management tools and service offerings that allow telecom managers to optimize the equipment in which they invested, and to allow the DEFINITY system and its associated applications to contribute to their core businesses. The intent of this plan is to view systems management from the customers' perspective; that is, as more than only the administration of switch resources (station adds, moves, and changes). Telecommunication managers, therefore, have responsibility for five crucial business functions:

- Configuration management (adds, moves, and changes to the telecom facilities);
- Performance management (traffic optimization and trending statistics);
- Fault management (alarm monitoring and system "health");
- Accounting management; and
- Security management.

Complex application support is also part of a telecom manager's responsibilities—for instance, support of telemarketing facilities. Furthermore, there is a growing perception among GBCS customers that systems management encompasses all activities that allow manipulation of switch or adjunct resources managing the switch. In short, systems management includes managing the setup, manipulation, and tracking of the entire system—switching, call management, voice mail, and other related functions—within the GBCS product line.

In the 1990s, therefore, system management is defined to include:

- PBX feature and facilities management, both within a switch and on adjunct products (fault, performance, and configuration management in the traditional sense);
- Voice processing and switch-feature management;
- Voice processing and switching-system administration;
- Telemarketing facilities management;
- Tele-management (non-PBX equipment); inventory and spare parts; wire and cable; directory; service orders;

- Call accounting; and
- Security management, both on the switch and through adjunct products.

To address these needs, GBCS has developed a line of modular applications that optimizes the real-time management of telecommunications equipment. More importantly, the telecom manager can invest time and effort into designing an environment that supports the business' strategic goals, because operations are efficient and detailed information about the environment is available.

Realizing Customer Solutions

Implementation of the GBCS ten-year plan began in the late 1980s with the introduction of several PC-based applications. When the DEFINITY system Generic 3 was introduced in 1991, a marriage of on-board switch-management and PC-based enhancements was completed with G3 Management Applications (G3-MA), shown in Figure 2. G3-MA's high-reliability, high-speed, self-auditing interface to G3 provides a robust platform on which communications with the switch can be built.

More than a system-administration tool, G3-MA is designed as a platform for a suite of modular applications that uses the G3-MA service layer to communicate with a switch and with other GBCS products. For instance, one modular application, the AUDIX® Data Exchange system, allows an end-user both to administer stations simultaneously on a switch and subscribers on the AUDIX voice-messaging data base. A second modular application, Call Accounting Transfer, scheduled to be introduced later this year, automatically transfers data between the switch data base and the AT&T Call Accounting System (CAS) for the Windows cost-management product. (Windows is a registered trademark of Microsoft Corp.)

Three additional products also provide elegant platforms on which management tools for the 1990s can be developed.

Monitor 1. This product provides all the data-gathering power of the embedded CSM traffic-management module in an enhanced package. Performance data can be gathered and stored for extended time periods. End-users also can configure traffic studies for particular elements on a switch—for instance, automatic call distribution groups or attendant voice stations. Data can be stored, and trending reports generated, for up to two years of recorded traffic patterns. Appropriate grades of

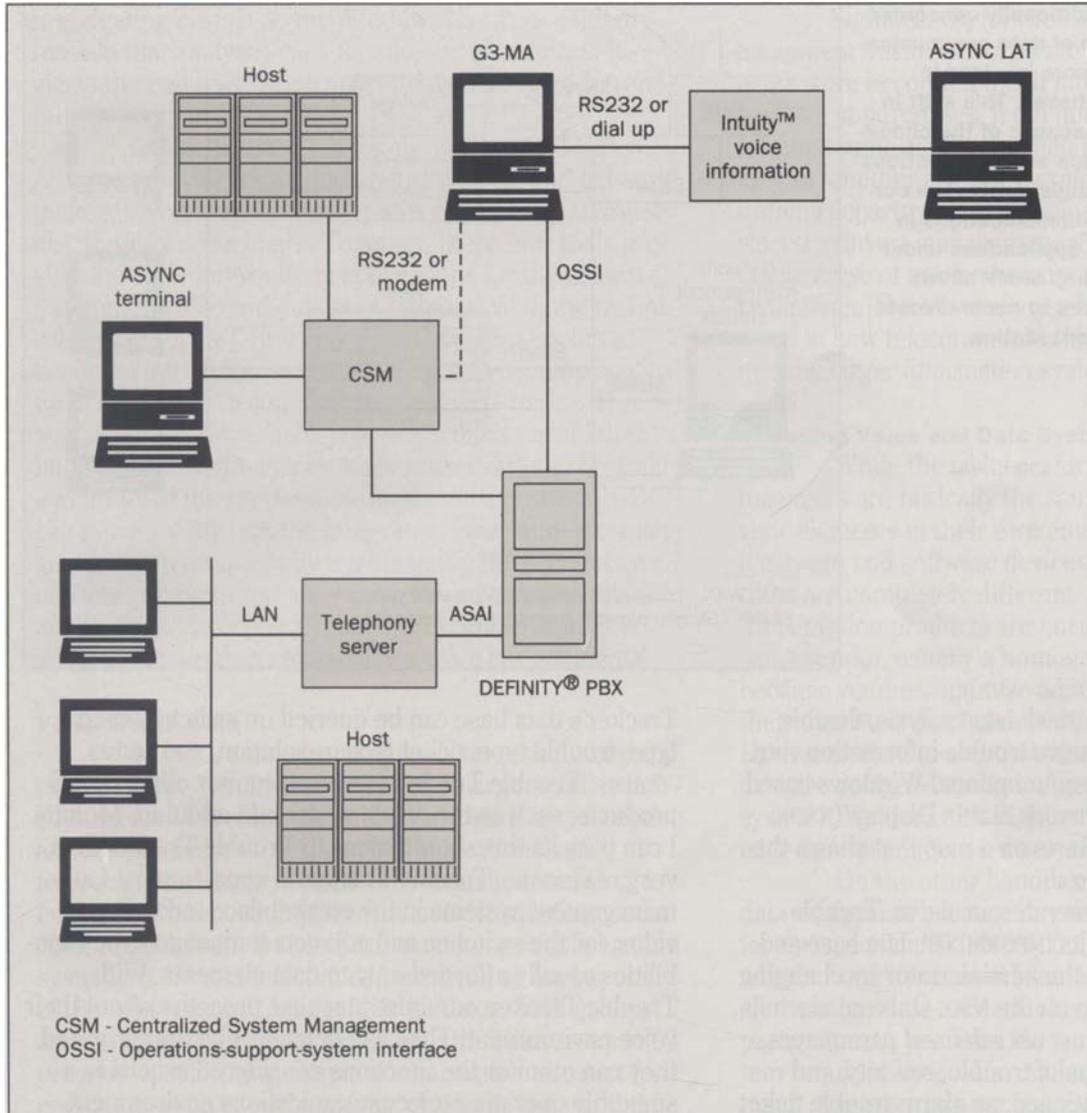


Figure 2. When the DEFINITY-system Generic 3 was introduced, a marriage of on-board switch-management and PC-based enhancements was completed with G3 Management Applications (G3-MA). This drawing also represents the current management environment for voice communications using proprietary protocols to send and receive messages. Communication protocols could be developed internally because all elements are produced by AT&T GBCS, thus optimizing operations in this homogenous environment.

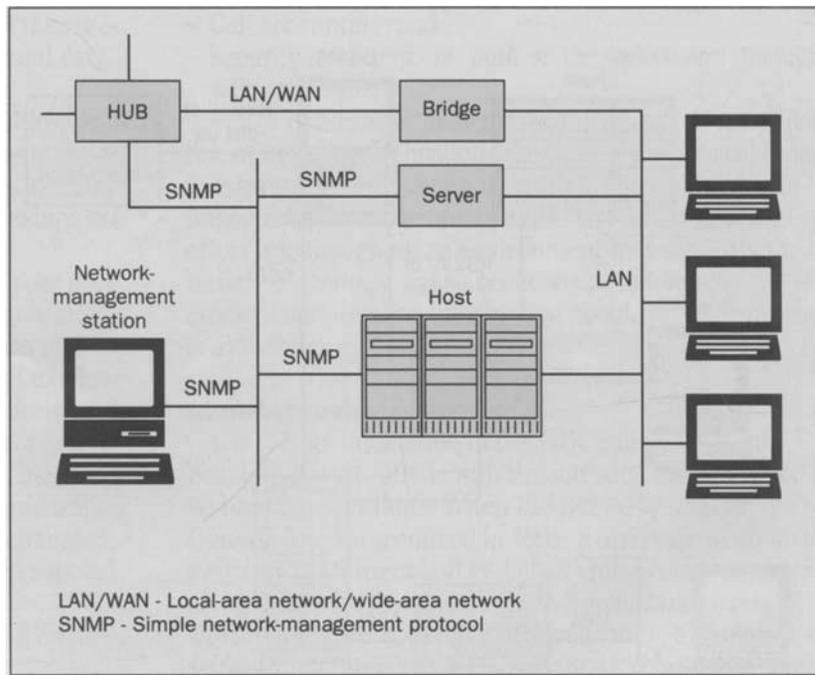
service—answer queues, calling times, and traffic load—can be set for trunks and trunk groups. Performance is automatically reviewed by means of software-violation and threshold-violation notifications sent to an administrator.

The unique tracking and analyzing capabilities of Monitor I have allowed telecom managers to optimize their switches and facilities and reduce costs, for instance, by creating an understanding of how efficiently the facilities on a switch can be used. Trunks can be allocated to different groups, added where necessary, or removed entirely. The traffic-management capabilities of

Monitor I are becoming increasingly important to communications management as costs for facilities increase, as the facilities themselves become more sophisticated, and as access to end-users from the network becomes a strategic business asset.

Trouble Tracker. This product provides the necessary elements for sophisticated switch fault management. Trouble Tracker monitors switches and other voice products, such as the AUDIX Voice Messaging system and Monitor I, for correct operation. It provides fault tracking by means of a sophisticated trouble-ticket

Figure 3. MIS managers, traditionally concerned only with the administration of data communications, are becoming much more involved in major voice-equipment purchases. This shift in responsibility is occurring because of the changing perception that both voice and data factions need to be managed as a single entity. The current environment for data communications in open-systems management applications under SNMP is shown in this drawing. SNMP allows devices from different vendors to communicate with the network-management station.



system, real-time and historical data analysis, flexible alarm definition, and extensive trouble-information routing to multiple destinations. An optional Windows-based PC program, called the Network Status Display (NSD), provides real-time visual alerts on a map that shows the voice-environment configuration.

When a switch generates an alarm, Trouble Tracker logs the alarm in its INFORMIX™ data base and provides visual alerting to the administrator by changing the color of the switch icon on the NSD. Once an alarm is received, it is tracked against user-defined parameters, such as time of receipt, type of trouble, severity, and source. As previously mentioned, an alarm trouble ticket can be forwarded to multiple destinations based on end-user criteria. If time elapses without the fault being assigned or closed, the status of the ticket advances to a “jeopardy” status and additional action is taken, including rerouting to other destinations, if defined.

Major alarms can be forwarded to the GBCS Technical Service Center in Denver, where an “expert” system can diagnose and fix a problem and then close the ticket. If necessary, a technician can be assigned. Whether the ticket is closed by the expert system or a technician, Trouble Tracker gets confirmation from the center in Denver and updates the system. Trouble

Tracker’s data base can be queried on switch, switch type, trouble type, ticket type, resolution, and status.

Trouble Tracker can also monitor other GBCS products, such as the AUDIX system. In addition, Monitor I can pass its threshold alarms to Trouble Tracker. In a very real sense, Trouble Tracker is equal to most fault-management systems in the marketplace today. It provides, for the switches and adjuncts it manages, the capabilities usually afforded only to data elements. With Trouble Tracker, administrators are proactive about their voice environment. They can detect problems early, and they can monitor the functions considered crucial to a smoothly operating telecommunications environment. Together, Trouble Tracker and Monitor I have provided telecom managers with the tools to optimize their voice-transmission operations.

Cost Allocator. CSM’s optional cost-management module was replaced by Cost Allocator, an enhanced product. This UNIX-based call-accounting system not only provides accounting information about call details, but also analyzes the information for use in customer’s billing systems. (UNIX is a registered trademark of UNIX Systems Laboratories Inc.) CAS, a Windows-based product, is available for smaller customers. It provides information on calling patterns, as well as a report set for use

in allocating costs. CAS for Windows has a co-resident module that analyzes calls for suspicious patterns. It alerts the end-user, when appropriate, and provides real-time security management.

G3-MA, Monitor I, Trouble Tracker and Cost Allocator provide a transition between local and network management, "seeing" switches as elements of a larger, distributed environment. Together, these four tools provide the basis for a suite of applications for the growing, integrated, voice-and-data environment. With the technical features AT&T Bell Laboratories engineers have designed into these products, GBCS can develop applications that are both sophisticated and easy to use. The application software itself provides a basis on which to build additional interfaces while preserving the flexibility and utility of the services the application provides. GBCS can move swiftly into the integrated, voice and data management environment by transforming the architecture of these products and leveraging the advantages of the applications. An article describes how one customer is using GBCS products to manage a voice environment.²

Voice Meets Data

In 1992, a new trend in decision making became evident in the purchasing behavior of large, multiswitch customers. This shift was due to the changing perception among businesses that data communications and telecommunications needed to be managed as a single entity. Communication platforms notwithstanding, some chief financial officers view the management information systems (MIS) and telecom departments as having many of the same responsibilities. For instance, both groups are thought to spend the majority of their time—up to 90 percent—performing simple administrative support for end-users, such as adds, moves, changes, and training. In addition, much of the equipment appeared the same—computers, wires, terminals, and PCs. Furthermore, staff operations appeared similar—maintaining equipment, supporting users, and planning for the future. Current management environments for voice and data communications are shown in Figures 2 and 3, respectively.

This apparent redundancy in times of economic challenge often led many executives to combine the two departments together under a single manager, who could optimize efficiencies. In rare cases, the two departments may have been combined into a single organization with responsibility for both voice and data operations.

Significantly, for the GBCS premises voice-equipment business, corporate MIS and business managers were becoming much more involved in major voice-equipment purchases. It did not seem to matter whether telecommunications remained in control of a voice manager or whether it was integrated into the data-communications department. The business manager might be convinced to invest in management systems if they resulted in efficient use of human resources and departmental cost reductions. The MIS manager, however, was more interested in how telecommunication-management tools fit into the larger information-systems environment.

Managing Voice and Data Systems

While the tasks performed by MIS and telecom managers are basically the same, the way individuals view elements in their own environment—that is, the hardware and software devices—and how they manage them are completely different. As we have seen, voice-transmission products are normally acquired from the same vendor, usually a homogeneous solution. This is because vendors optimize adjunct products to work with their own PBXs (for instance, the AT&T AUDIX Data Exchange system and Call Management System products are designed to work together with the DEFINITY system). Vendors also build management tools to administer their products over proprietary interfaces.

On the other hand, an MIS manager purchases data equipment because it is the best product or element for the specific task. Rarely does a manager worry whether one element originates from the same vendor as all the other data-network elements. For instance, if a particular LAN provides the specific type of backbone system required by an information-management environment, the MIS manager purchases that LAN. If hubs, routers, or multiplexers from other vendors are the right tools for such an environment, those tools are the ones purchased. A recent article describes some of the new tools available for managing the data environment.³

This heterogeneous environment is one of necessity. Data elements are often manufactured by firms that specialize in a single product type, or that introduce product lines gradually. By the early 1990s, however, one key factor linked all these data elements: they could send messages to a centralized network-management station (NMS) in a standard format, known as the simple network-management protocol (SNMP) (see

Panel 2. SNMP Defined

When all data environments were handled through IBM mainframes, management of the assets in a data environment was relatively simple. A mainframe hosted multiple product-administration capabilities and provided a single point of access from one terminal to all the devices.

As data devices moved from a single premises, T1 trunks and other transport facilities were distributed over a wide area. As a result, MIS managers lost the capability for centralized management of their devices. Each device had a local management application, and different managers are in charge at each location. In addition, a single network could have devices provided by multiple vendors because device manufacturers proliferate, making management at each location even more complex. Managers needed a standard way to obtain information from, and send commands to, the multitude of devices.

SNMP is a data-transport protocol that is part of the suite of TCP/IP protocols. It is the standard management protocol for TCP/IP networks created for the Internet engineering task force. (Internet is a nationwide packet-switched network.) SNMP has become a *de facto* standard in the United States and, while less prevalent overseas, it is expected to become the standard there as well.

Implementation of SNMP places a minimal development effort on managed objects (multiplexers, LANs, bridges, routers, and so forth—and now PBXs), because one tool in the SNMP tool kit permits the ability to create “agents” or communication capabilities for the managed element. This leaves the burden of accepting and presenting information messages at the NMS level. The managed elements without native agents can also be provided with proxy SNMP interfaces when the market timing of development schedules is crucial.

Agents or proxy agents (Figure 5) “understand” how to “talk” to the network-management platform using SNMP. Agents are built into the management element. Proxy agents are “add-ons” to elements that can be accessed only through proprietary protocols. The proxy agent acts as a translation device that communicates between the NMS and the managed object, changing proprietary messages into SNMP format and SNMP commands from the NMS into proprietary requests the managed element can understand.

Translations for these commands are called management-information bases (MIBs). Standards have been established to ensure that these MIBs store information in a consistent manner, including configuration statistics, status of device “health,” and information on performance.

In the DEFINITY-system SNMP interface, the proxy agent translates proprietary operations-support-system interface (OSSSI) commands and proprietary-alarm message streams into SNMP format. Thus, when the DEFINITY system sends an alarm to a proxy agent, the agent translates it into an SNMP message. When a command to GET information from the switch is sent from the NMS, the proxy agent translates the command into OSSSI command language.

One particular factor is important to note. While SNMP provides many benefits for standardized communication between a device and the NMS, it does not provide a secure interface. This poses a problem for many vendors, and particularly for GBCS, because the SNMP command that allows administration of the device is not secure. Anyone with access to the command can perform device changes. This means that access to the PBX would be unprotected using an SNMP-based configuration-management tool. GBCS does not support configuration changes, therefore, by means of SNMP Version 1 (Figure 1). Instead, GBCS is examining a new version of the protocol currently being defined, SNMP V2, which will have a command-security encryption feature. SNMP V2 also promises to establish links between network-management platforms, allowing manager-to-manager communication. This capability would be especially valuable in a multivendor or distributed-management network environment.

In addition to SNMP, other protocols are being discussed within the network-management community as potential standards. It has been recommended in the European community, for instance, that the centralized management-information protocol (CMIP) become their standard. Currently, however, few network-management platforms exist that use CMIP to manage network elements. Another protocol, centralized management object transport (CMOT), also has been mentioned as a possible standard. GBCS is actively examining all these interfaces, and is participating with many standards groups to generate support and establish standards where appropriate.

Panel 2). At the NMS on a single screen, a manager could review the status and performance parameters of each element displayed in a single graphical interface. When an SNMP message sent to the NMS indicated a status change for one of the data elements, or when the NMS polled the elements and detected a change in status, noti-

fication was displayed identically for each element. Then, a manager could easily *telnet* (call over the LAN) back to the element’s management system to correct the problem. Figure 4 shows an SNMP-based management environment for both voice and data elements.

This consistent link was not available, however,

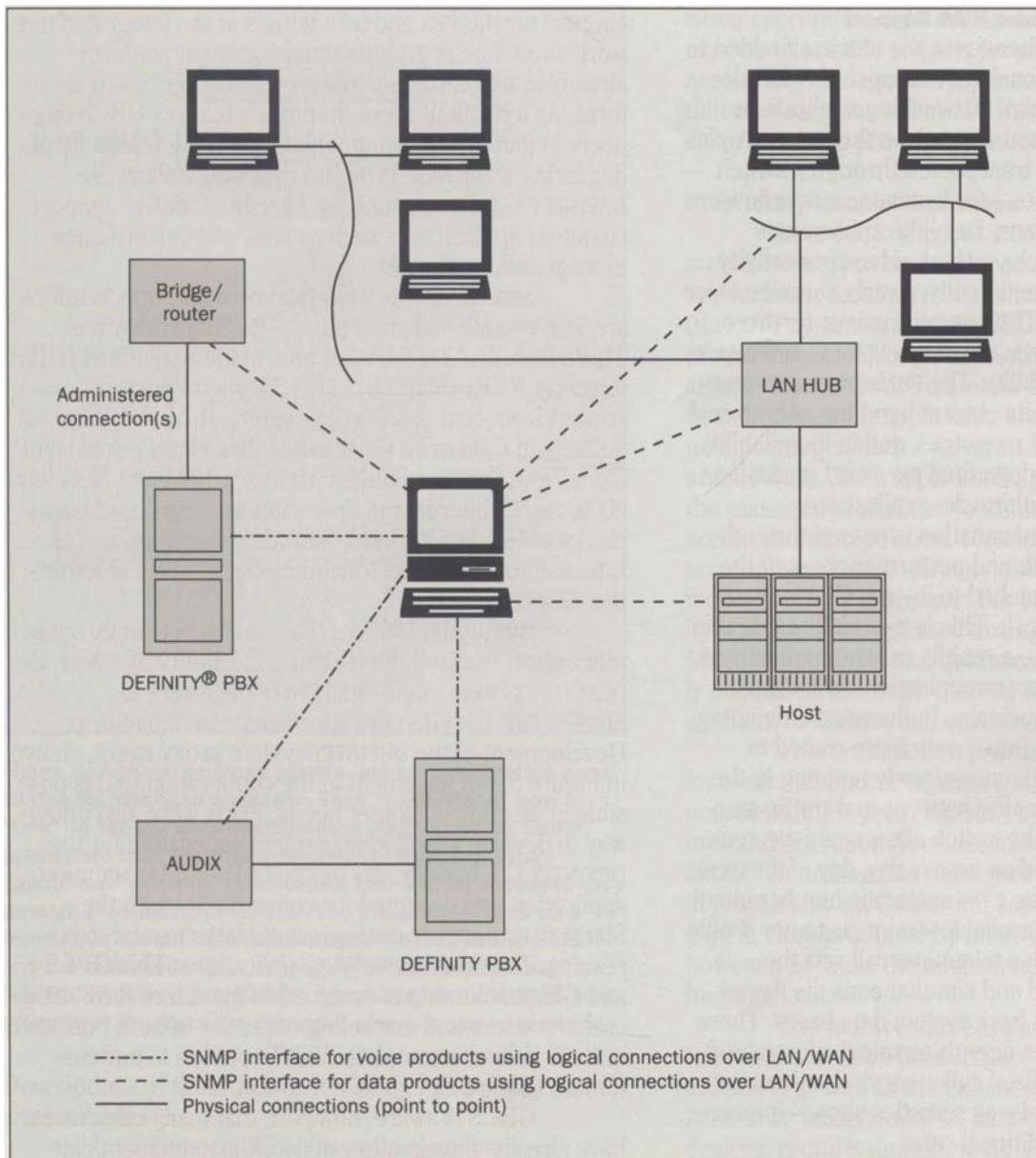


Figure 4. Within the open-systems management applications under SNMP, the target management operations, shown in this drawing, include SNMP interfaces for voice and data products using logical connections over a LAN and WAN. Physical, point-to-point connections are depicted between the LAN hub, host, and monitoring terminals; and between the DEFINITY PBX system, bridge router, and AUDIX Data Exchange system. Now, all voice and data elements are manageable from the centralized network-management station.

for the voice elements in a network. Instead, such elements could only send messages in a proprietary format, making them incomprehensible by the NMS. Voice products, therefore, were unmanageable from the NMS.

In order for an MIS manager to feel comfortable with the voice environment, it is important that it be viewed from the NMS. As a result, GBCS market management received numerous requests—both from the AT&T

sales force and existing telecommunication customers—to identify company policy concerning support of industry-standard interfaces to the DEFINITY platform. In particular, as customers planned their future systems and the paths their telecommunication environments would take during the next five to seven years, they increasingly asked GBCS to articulate its policy on the SNMP interface supported by the NMS.

New Data Features Require NMS Support

Technological changes in the PBX itself added to the perceived need for consistent support of voice elements on the NMS platform. Networking applications, such as ISDN and wideband support on the DEFINITY platform, allowed data to be transported through a switch and its associated facilities—for instance, in overflow or disaster-recovery situations. Data-like applications through and on the switch, such as video connectivity and call-management functionality, clearly combine voice and data environments. The potential exists, furthermore, for integration of the PBX into a WAN as a network-access tool of great flexibility. The PBX's proven competency in routing calls, in its elegant handling of both real-time communication and messages, and in its reliability (measured in *seconds* of downtime per year), make it an excellent platform for multimedia applications.

Once data-like information is passed through and by a switch, its health and performance—and the health of the facilities attached to it—are vital to maintaining an efficient network. This is especially evident in the telemarketing arena—a rapidly expanding business opportunity—where telecommunications is a strategic component of the core business. In the most efficient operations, calls coming into a switch are routed to “agents,” using the intelligence already residing in the switch. The complex queuing patterns and traffic-management capabilities in the switch allow sophisticated call-detail collection based on time of day, day of the week, calling area, and—with the ISDN automatic number identification information now available—even customer profile.

Concurrent with a telephone call was the requirement for retrieval and simultaneous display of customer-history details from system data bases. These so-called *screen pops* at an agent's terminal allow a business to provide personalized caller service, enhancing customer satisfaction and—as statistics show—increasing opportunities for additional sales.

Managing the Integrated Environment

When market managers and systems engineers asked GBCS customers how the PBX could be made a more effective element in this emerging voice-and-data world, they responded that the smoother the PBX's integration into the existing data communications management environment, the more likely it would be viewed as a server for data traffic. Customers also indicated that

support for the PBX and its adjuncts in the integrated network should be provided on management platforms already in place, rather than on yet another new platform. As a result of these findings, a team of GBCS engineers began investigating, in late 1992, the feasibility of delivering a software program that would allow the DEFINITY G3 to communicate by using SNMP to support customer applications, such as fault and performance management of the PBX.

Several network-management platform vendors are well established among the GBCS customer base. These include AT&T Global Information Solutions [GIS, formerly NCR] (StarSENTRY™), Hewlett-Packard (OpenView), Sun (SunNet Manager), IBM (NetView 6000), and Cabletron (Spectrum). (Hewlett-Packard and OpenView, Sun and SunNet Manager, IBM and NetView 6000, and Cabletron and Spectrum are registered trademarks of Hewlett-Packard, Sun Microsystems, International Business Machines Corp., and Cabletron Inc. respectively.)

By August 1993, a GBCS and GIS joint development effort realized the technical capability by which the DEFINITY system could send SNMP messages to StarSENTRY, the GIS network-management platform. Development of the DEFINITY-system proxy agent, shown in Figure 5, is a testament to the cooperation that is possible in meeting customer needs. Plans were also underway to develop a fault-management application for the DEFINITY G3. Initially, the DEFINITY Fault-Management application was designed for compatibility with the StarSENTRY network-management platform, and to co-reside with other StarSENTRY applications. This GBCS and GIS partnership is designed to maximize the considerable product and marketing expertise of both business units to deliver a complete AT&T solution to our customers (Figure 1).

GBCS is aware, however, that many customers have already chosen other network-management platforms. The StarSENTRY version of the DEFINITY Fault-Management systems will be ported, therefore, to the Hewlett Packard OpenView platform and to Cabletron's Spectrum platform during 1994, as well as to other SNMP-based network-management platforms, including NetView 6000 and SunNet Manager, during 1995. With the recent announcement of the AT&T OneVision Network-Management Solutions, plans are in place to deliver StarSENTRY to the OneVision platform as well.

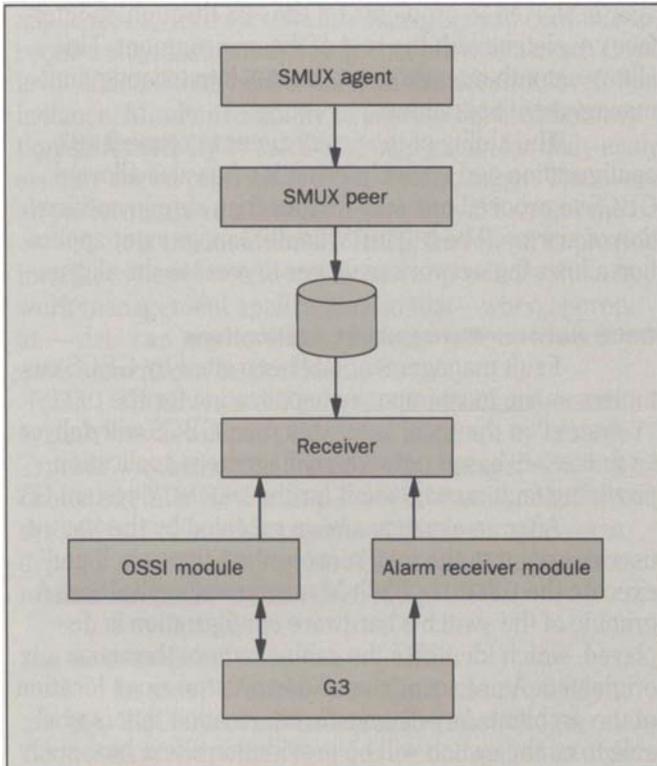


Figure 5. Agents, or proxy agents, are communication capabilities for managed elements. They “understand” how to “talk” to the network-management platform using SNMP. Agents are built into the management element. Proxy agents are “add-ons” to elements that can be accessed only through proprietary protocols. The proxy agent acts as a translation device that communicates between the NMS and the managed object, changing proprietary messages into SNMP format and SNMP commands from the NMS into proprietary requests the managed element can understand.

In addition, GBCS plans to deliver a suite of SNMP-based network-management applications to run on these platforms, with a variety of fault-management, performance-management, configuration-management, and accounting-management applications. For existing GBCS products, such as the DEFINITY G3—presently managed only through proprietary interfaces—proxy agents (Figure 5) are being developed in order to introduce SNMP-based support quickly to the market. As new products are added to the line, native agents will be integrated,

when appropriate, into the devices themselves. GBCS expects to provide support for performance, fault, and accounting management by means of SNMP. Configuration management will not be introduced until increased security can be provided with SNMP, version 2 (V2).

Proprietary-to-Open Interfaces

In order to support SNMP interfaces, a new architecture must be developed for GBCS management applications. Existing management products access the DEFINITY system and other GBCS products through proprietary interfaces. Proprietary hardware and operating-system software maintain tight control of interactions between the application and host system, often manipulating software drivers and port-access cards in unique ways. Each application and its connectivity to the managed product are optimized for rapid device access and manipulation. Physical connectivity is accomplished either directly or by means of external modems on the processor. For switch access, connectivity was also accomplished through modem pools. Management tools and the managed element are usually co-located, although there is some centralized management in multiswitch environments.

This architecture primarily addressed the need for tools that optimized management of individual products or multiple products built by GBCS. The cost savings and operational enhancements the tools provided to telecommunication managers justified the investment in proprietary hardware and software. The need to support devices produced by other vendors did not exist, however, because the environment was usually homogenous.

The multivendor environment in which telecommunication products are presently being accessed, as well as the enhanced capabilities that allow PBXs to be integrated with data-communications devices, require something different. This new architecture has to be “open” to communication protocols that are consistent with those used by other products. In fact, one of the goals of the integration of voice competencies into the data environment is to make available sophisticated call-handling and network-access capabilities to devices that previously had only rudimentary capabilities in these areas. For instance, the PBX’s least-cost routing competencies can be added and used to minimize the cost of data calls from co-located LANs.

Remote access from a centralized operations environment is *de rigueur*, and so a high-speed interface is also required. Use of industry standards, such as TCP/IP—popularized in the data environment—have to be employed. Moreover, voice elements can not introduce proprietary software or hardware platforms, because the communications environment has already made hardware and platform investments for data elements. Voice elements, therefore, must use the capabilities provided by the management platforms of the host to support their applications. These host platforms provide such features as trouble ticketing, which do not have to be recreated. Applications also have to be portable, because the investment in a network-management platform is not normally driven by the voice elements in a network.

Thus, a new approach is being taken by GBCS and AT&T Bell Laboratories engineers. It favors development of an architecture that optimizes management of future multimedia products, while allowing existing voice products to be integrated into a multivendor network-management environment.

GBCS Network-Management Architecture

Architecture design began with development of a proxy agent that would allow the DEFINITY system G3 to communicate with the network-management platform by translating proprietary commands into SNMP. Two types of messages are handled by the proxy agent. One type accepts and requests (in SNMP terms, "GET") configuration and status information about switch hardware. The second type accepts (or "TRAP") alarms sent proactively by a switch. The software that allows this communication with a switch was generated using code that already exists in G3-MA and Trouble Tracker. Within the proxy agent, the information is translated into SNMP format and forwarded to the network-management station—either proactively, in the case of alarms, or on request in the case of configuration and status information.

When an alarm is received by the network-management platform, an icon representing the switch is highlighted by the platform software, just as alarms from other network elements are highlighted. This information also can be logged into the errors data base, which is kept on the network manager, or forwarded by the network-management software to other functions available on the platform—for instance, to a trouble-ticket-generation application or routing service. Thus, a network man-

ager is alerted to problems on the PBX through an interface consistent with the rest of the environment. This allows smooth integration of the PBX into existing fault-management operations.

The ability of the proxy agent to request PBX configuration and status information has also allowed GBCS to proceed one step further than simple notification of alarms. The DEFINITY Fault-Management application allows the network manager to *react* to the alarms.

GBCS Network-Management Applications

Fault management has been cited by GBCS customers as the most important application for the DEFINITY system on the NMS. Later this year, GBCS will deliver its first SNMP-based network-management application providing fault management for the DEFINITY system G3.

After an alarm has been received by the NMS, a user can point to the icon representing the switch and execute the DEFINITY Fault-Management application. A graphic of the switch's hardware configuration is displayed, which identifies the cabinet where the alarm originated. A user can "zoom" down to the exact location of the problem. Any diagnostic information that is available from the switch will be provided in a text box, such as an error message identified by G3's self-diagnostic software. If the problem requires action on the switch, a user can telnet to G3-MA to make the change. G3-MA is used because its proprietary interface to the switch is secure, while SNMP V1 is not.

Because DEFINITY messages will be sent in standard SNMP format, which the platform can understand, the information provided in these messages will be usable in other areas of the network-management platform. This means that, in addition to being notified of alarms in the interface used by other network elements, the information provided in the message can be sent to other applications already on the platform. For instance, DEFINITY alarms can be tracked in the NMS data base and trouble tickets issued, just as they can be for other elements in the network. This will reduce training requirements and allow rapid use of the DEFINITY Fault-Management application, once again streamlining operations and reducing costs.

Integration With Site-Management Tools

GBCS network-management applications are being designed to complement existing site-management

applications, because telecom managers will continue to require site-management tools that provide a much finer level of detail than is necessary at the network level. For instance, Monitor I's ability to provide detailed information about activity in a call-coverage group for daily analysis may not be relevant to a network manager. The overall performance of a switch, however, will be relevant.

It is the intention of GBCS, therefore, to provide interfaces between site-management products and network-management applications so that—when appropriate—data can be shared and features unique to each environment can be provided.

Thus, when the DEFINITY Fault-Management system was developed, a two-way interface to Trouble Tracker was included. The telecom manager now has a choice of either forwarding Trouble Tracker alarms to the DEFINITY Fault-Management system or vice versa, depending on the hierarchy of the operations' environmental demands.

The Next Steps

In order to deploy new applications quickly to market, GBCS has established a new marketing strategy. Cooperation with other vendors is encouraged in order to certify GBCS network-management applications on other vendors' network-management platforms, and to develop new and enhanced applications for AT&T products. The introduction of the DEFINITY Fault-Management application on Cabletron's Spectrum is an example of such a cooperative venture. Many DEFINITY-system customers in the northeastern United States are also Cabletron customers. At their request, AT&T and Cabletron have agreed to deliver the DEFINITY Fault-Management application on the Spectrum platform.

Because use of trunk facilities is usually the most costly aspect of communications, AT&T customers have indicated that performance-management applications are their next priority. In addition, because the PBX collects an extraordinary amount of information about call placement, duration, and destination, customers have requested that GBCS deliver call-accounting information appropriate to the network level in an accounting-management application. If the PBX is used to route data calls, such accounting information as duration, origination point, and destination can be collected, allowing call billing. This capability is not available for data calls that are sent over dedicated trunking facilities.

Integration With Other Efforts

The 1990s have seen an acceleration in the evolution of distributed computing, systems, and applications for communications. This has resulted in a blurring of hard boundaries between computers, private and public networks, and managed premises elements. To date, network-management applications were designed to support one product or service, and often resided on a variety of management platforms. As a result, when a business purchased products and services from multiple AT&T business units, there was no single platform for the management environment. To partner with its customers in simplifying management of this complex environment, AT&T announced a new approach to network management—AT&T OneVision Network-Management Solutions. With the introduction of the OneVision family of products and services, AT&T is making a strategic commitment to an open architecture that allows applications to be built following common engineering rules based on international standards (International Telecommunications Union - Telecommunication Standardization Sector/International Organization for Standardization), consortia/industry specifications (Network Management Forum⁷/OMG/OSF/XOPEN), and *de facto* standards (IETF/SNMP). As an extension of this common platform, there also exists the potential of delivering integrated applications, which provide support for multiple products in a premises environment.

Enabling this vision is common, network-management-platform technology based on the Hewlett-Packard OpenView network manager, a platform that is viewed within the industry as having enjoyed both marketing and technical success among premises customers. Moreover, OpenView has a high level of support by independent software vendors. AT&T, by choosing OpenView as its primary platform, expects to provide customers with a flexible platform for management of its network and system resources in an existing enterprise network. OpenView also allows for easy extensibility in providing new applications to manage evolving technologies.

As a participant in the OneVision architecture, GBCS hopes to provide even more help to its premises switching customers by combining expertise with other AT&T business units to develop and deliver network-management applications that provide integrated support across a number of products and services. For instance, in a telemarketing operation having a GBCS switch and

the DEFINITY Call-Management system—using AT&T Network Systems' 800 service to route calls and GIS processors to host call-management software—a single AT&T application could oversee fault and performance management from a single network-management station.

Many companies will be taking advantage of network-management applications because of the rapid growth of high-bandwidth applications, both in premises equipment and the network, and the potential use of asynchronous transfer mode for driving multimedia to the desktop. Network-management applications will help control costs and manage resources, as well as satisfy end-users, staff members, and management with all aspects of the communications environment.

Summary

GBCS systems-management applications have become crucial to cost-effective, efficient operation of the voice-communications environment. Today, the modularity of applications delivered to support the PBX and its associated adjuncts has provided telecom managers with increased control and flexibility, permitting them to focus on optimizing equipment utilization and managing resources.

With the growing integration of the voice-communications and data-communications environments, the development of SNMP-based network-management applications for the DEFINITY system is an important step in melding the PBX into the data world.

The DEFINITY system has established its role in GBCS customers' data networks with the implementation of PBX-to-host integration and narrowband/wideband data applications. GBCS is in a unique position among PBX vendors to optimize the core competencies of its products in the enterprise network. This is accomplished by using GBCS expertise in designing sophisticated site-management products to develop network-management applications, allowing GBCS products to be seen from the single-console, network-management platform currently used for data networks. Such a process will help

continue the leadership role that GBCS has assumed in the system-management discipline. In addition, the partnership forged between GBCS and the other business units places AT&T in the lead as a provider of total multi-media network-management solutions.

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