

The BINOC Project: A Milestone for the Operations Systems Business of AT&T

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The contract for a Belgian Integrated-Network Operations Center (BINOC) was signed in 1991. It was then the largest-ever operations systems (OS) contract for AT&T in the international market. This paper describes both the requirements for the BINOC project and the network of the customer, the Belgian telecommunications operator BELGACOM. After reviewing the architecture of the BINOC, the various systems involved are described. Some recommendations for the globalization of AT&T products are also discussed.

Introduction

In October 1991, when the contract for a Belgian Integrated-Network Operations Center (BINOC) was signed between BELGACOM (then known as RTT) and AT&T Network Systems Belgium, it constituted the largest-ever international contract for the operations systems (OS) business unit. The initial plan calls for a ready-for-acceptance status for the entire center by December 1994. Trials are to be scheduled throughout 1995. Subsequent extensions and adjustments led to a three-phased approach. Phase A is the initial schedule described above; phases B and C specify 1995 and 1996 delivery schedules.

The need for the BINOC grew out of BELGACOM's search for a solution to the problem of managing the digital transmission network, which consisted of equipment from many different vendors. The European Commission's efforts at establishing an open telecommunications market were providing a strong incentive for improving all aspects of network performance. The gradual introduction of competition, first into the terminal market and then into leased lines and wireless—with even regular voice service being “opened up” by 1998—forced BELGACOM to concentrate on the goal of improving its service and reliability, especially for many of its business customers. A modern, comprehensive management center appeared to be the essential element in reaching this goal.

AT&T initially made an unsolicited offer to build such a management center on

the basis of its involvement in a BELGACOM-funded research-and-development project. The project's purpose was to specify and build prototypes of mediation equipment that would allow the digital transmission network to be managed, eventually, by OSs. Several months later, BELGACOM rewrote the specification for the management center and negotiated a contract with AT&T during a thrice-yearly selection of infrastructure suppliers.

AT&T's reputation as a fully capable manager of its own network, BELGACOM's conviction that AT&T had the resources for completing such a complex project—as well as the ready availability of local technical expertise—all proved essential in closing the agreement. The fact that network management was still a “green field,” in which such traditional suppliers as Alcatel and Siemens were still active, was a decisive factor in making the agreement attractive to the Belgian government, the ultimate decision maker in those days. (Alcatel and Siemens are registered trademarks of Alcatel Inc. and Siemens Corp., respectively.)

BINOC Requirements

When the contract was signed, the requirements for the BINOC were specified only succinctly. An operations center was required that would provide management support for the following five individual sub-networks (SNs):

- SN1: national network of digital, leased lines from 1.2 kbits/s to 2,048 kbits/s,

- using the existing transmission infrastructure;
- SN2: national network of digital, leased lines at 64 kbits/s and Nx64 kbits/s, using semipermanent connections through digital exchanges;
- SN3: international, digital, switched-telephony network.
- SN4: national, digital, switched-telephony network including integrated services digital network (ISDN), freephone, and mobile telephony capabilities; and
- SN5: digital transmission network, currently the pleiochronous digital hierarchy (PDH). (The future extension to the synchronous digital hierarchy (SDH) must be possible for the BINOC, but will be included under a separate contract.)

BINOC management support includes the four functions of configuration, fault location, performance measurement, and security provision as defined in the context of the International Telecommunications Union - Telecommunication Standardization Sector (ITU-T) architecture for a standardized telecommunication management network (TMN)¹. The fifth TMN function, accounting, is not part of the BINOC requirements.

The BINOC contract stresses an integrated solution for various network operations. The information gathered or processed by one system in the center must be usable if required by another system. For example, alarms from transmission equipment are primarily processed by TransVu, the TM-SUP system (see Figure 1). TM-SUP must be able to pass information over faulty equipment to the leased-lines management system (LLM-SF). This will provide operators with complete, unambiguous, and nonredundant information.

Figure 1, compiled from the BINOC requirements, identifies the required, high-level functional entities, as well as the data flows between functions.

The BELGACOM Network

For a good understanding of the rest of the paper, it is useful to look briefly at the architecture of the BELGACOM telecommunications network.

The BELGACOM network includes 55 *Centres de Zone* (CZs), or zone centers, which are large central offices. The CZs are grouped administratively into 13 districts or SVCs (SVC is derived from the word *surveillance*). The network operations center (NEC, or *Nationaal Exploitatie Centrum*) is responsible for the interzonal transmission network.

Panel 1. Abbreviations, Acronyms, and Terms

AZERTY keyboard—standard keyboard layout used for the French language, comparable to QWERTY, which is standard for English

BELGACOM—the Belgian public telecommunications operator

BINOC—Belgian Integrated Network Operations Center

CC—control center

CZ—zone center

DCS-mail—BELGACOM's public e-mail system

FTP—Internet file-transfer protocol

GUI—graphical user interface

IP—Internet protocol

ISDN—integrated services digital network

ITU-T—International Telecommunications Union - Telecommunication Standardization Sector

LAN—local-area network

LDC—local distribution centers

MT—transmission means (*moyen de transmission*)

NMU—network mediation unit

OS—operations system

RMS-I—Remote Measurement System - International

R-NMU—remote network mediation unit

R-QIA—remote Q-interface adapter

RTT—former name for BELGACOM

RTU—remote transmission unit

SARTS—Switched-Access Remote Test System

SN—subnetwork

SVC—districts, derived from the word *surveillance*

TCP—transport control protocol

telephony zone—a region with its own area code

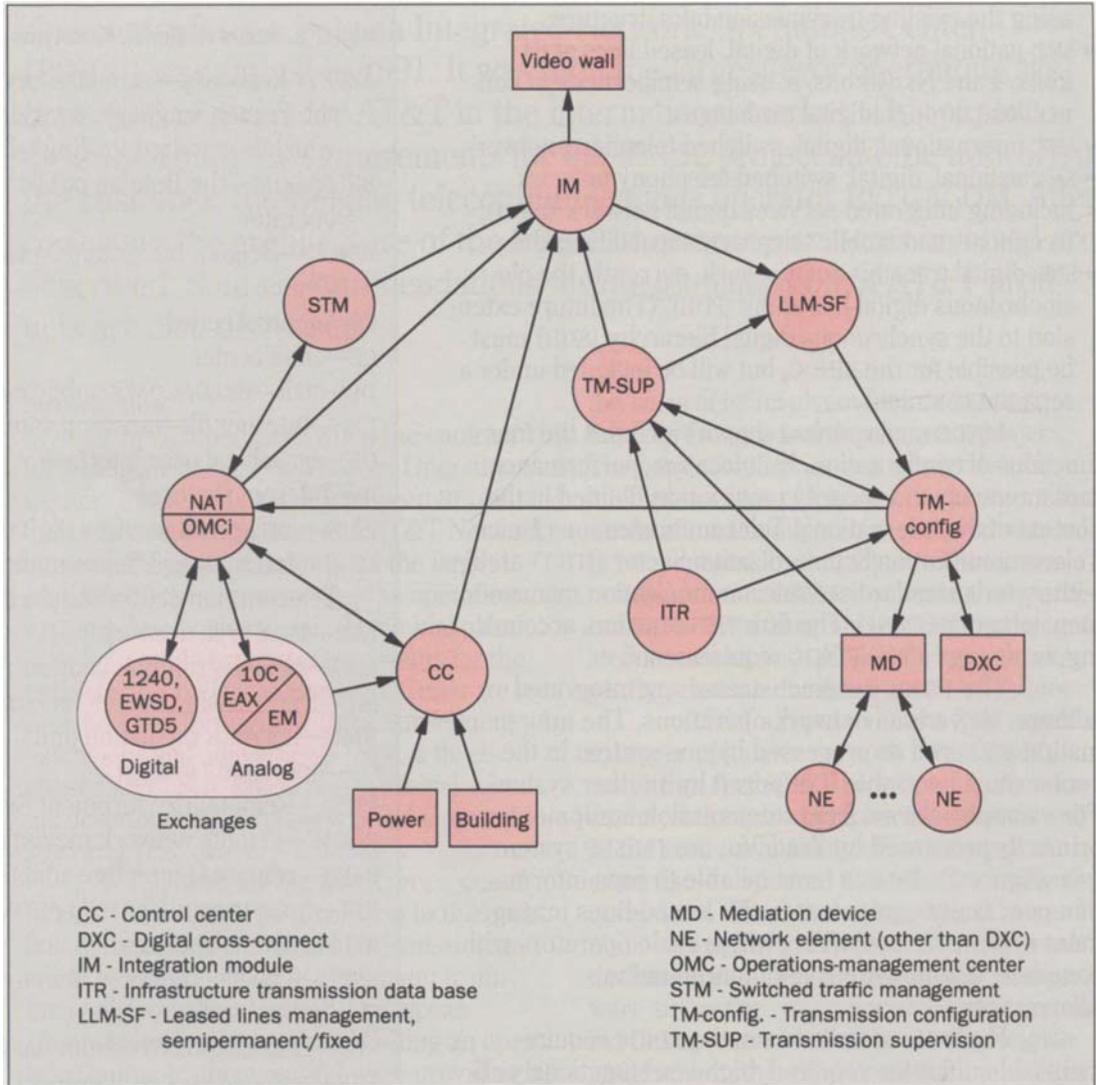
TIM—total network management integration module

TMN—telecommunication management network

WAN—wide-area network

Generally, each CZ is equipped with digital cross-connect equipment (an AT&T DACS-II system) and an AT&T network mediation unit (NMU). Each CZ is connected to several *Bureaux Central Telephonique* (BCTs), which are small central offices or wire centers. BELGACOM has approximately 600 BCTs. Each CZ is connected

Figure 1. This drawing shows the BINOC functional architecture. It stresses an integrated solution for various network operations. For example, alarms from transmission equipment are primarily processed by the transmission-supervision (TM-SUP) system. TM-SUP must be able to pass information over faulty equipment to the leased-lines management system (LLM-SF). This will provide operators with complete, unambiguous, and nonredundant information.



to at least one other CZ at 140 Mbits/s or 565 Mbits/s. Each BCT is connected with the CZ at least at the rate of 2 Mbits/s).

BCTs support an average of about three to five local distribution centers (LDCs) containing switch remote units. For example, the 5ESS® switch can support a remote switch module (RSM), which can be connected to the host switch. An RSM is typically used in rural areas. (The 5ESS switch is not present in the BELGACOM network, but other switches have similar capabilities.) LDCs are connected at least at 2 Mbits/s toward the BCT.

Switching nodes are distributed over 42 local

areas, called *telephony zones*. Each local area contains at least one CZ, in which the trunk exchange is located. Terminating (subscriber) exchanges are connected to their zone centers through a junction network. Each local exchange is built up from units of 10,000 subscribers. Presently, 579 of these units exist. They are spread over 385 BCTs. Customer premises are connected to a BCT or an LDC, as shown in Figure 3.

Three CZs contain international gateway exchanges that are located in Brussels, Liège, and Antwerp. All exchanges are monitored by an operations management center (OMC). One OMC is located in each

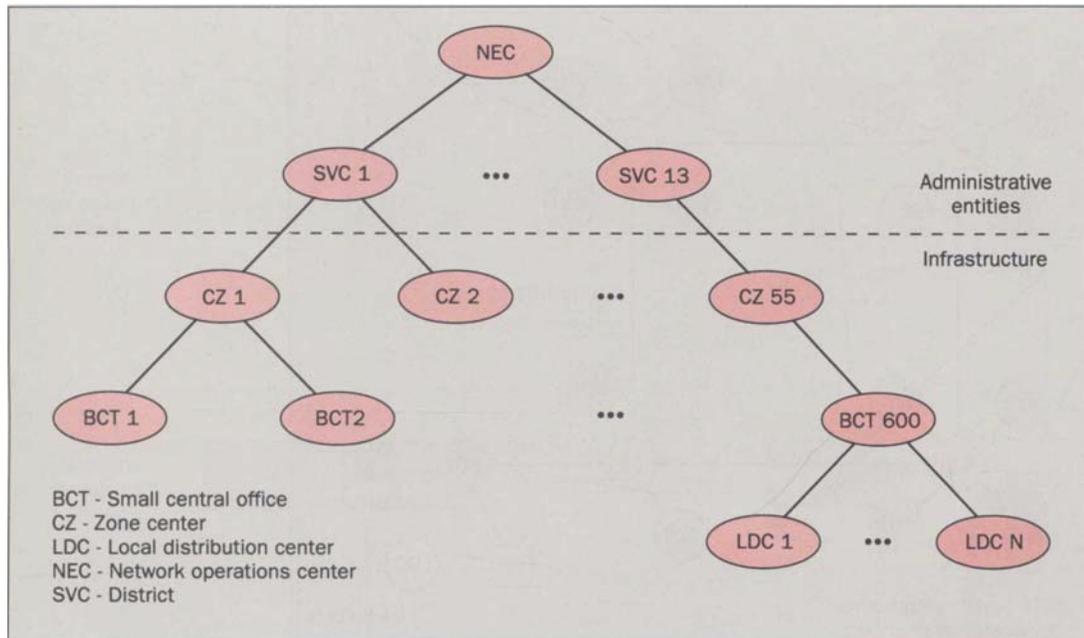


Figure 2: This illustration shows the BELGACOM network structure. The administrative entities, depicted in the top section, include the *Nationaal Exploitatie Centrum*, or network operations center (NEC), and districts (SVCs—derived from the word *surveillance*). The infrastructure is depicted by the bottom section and is composed of *Centres de Zone* or zone centers (CZs), small central offices or *Bureaux Central Telephonique* (BCTs), and local distribution centers (LDCs).

SVC. Each building of the network is monitored by another OS known as the *Centre de Contrôle*, or control center (CC). Both the OMC and CC were custom developed for BELGACOM by Belgian software manufacturers—Trasys for CC and Microresearch for OMC—with subsequent in-house development.

The Belgian network structure is illustrated by Figure 2, and its topology is shown in Figure 3.

BINOC Architecture

In the months after signing the contract, discussions centered on working out detailed requirements for each of the proposed systems. Discussion also focused on the interfaces, particularly those between AT&T and BELGACOM OSSs. The first step in this process was a critical review of the functional and physical architecture.

Due to the broad scope of the BINOC project, many systems, which are shown in Figure 4, are needed. The systems are shown in a functional context, taken from the standards work on TMN. One of the ways in which the TMN functionality is structured is by its hierarchy or layers—network element, element management/mediation device, network management, and service management. The service-management layer in this hierarchy focuses on the contractual aspects of services.

Figure 5 shows the same architecture of management systems mapped on the network structure. The figure defines the physical architecture for the management network, of which the BINOC forms the superstructure.

As part of the architecture definition of the BINOC, data flows between the various systems were specified.

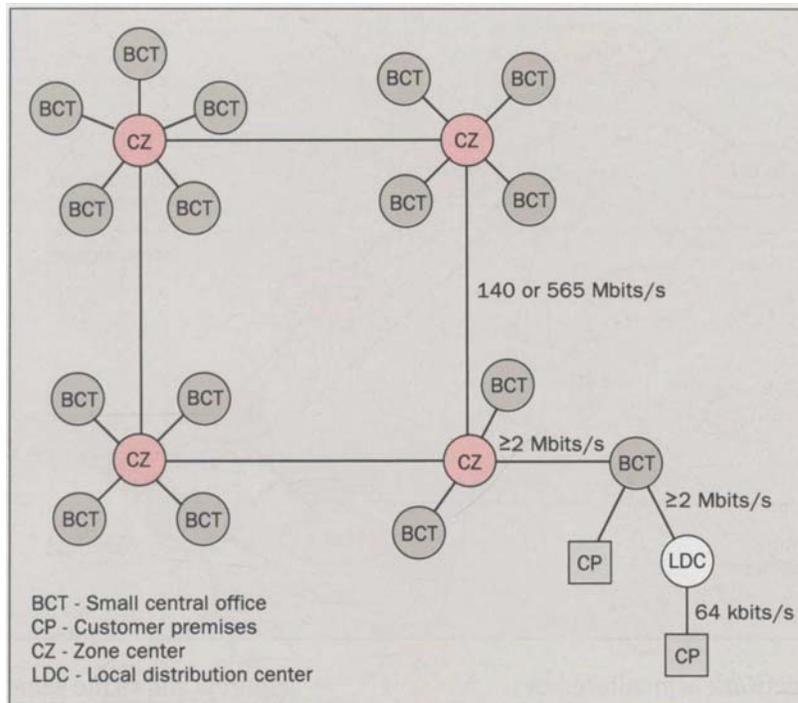
BINOC Systems

To satisfy the functional requirements of the contract, a number of AT&T OSSs were applied.

DACSCAN[®]-2000 Controller C-Module. This device is a centralized provisioning, rerouting, and configuration-management system. It supports the TMN configuration-management function for the digital leased-lines-management - fixed (LLM-F) network. It controls the configuration-implementation (TM-Config) process for BELGACOM network equipment. The DACSCAN-2000 controller C-module provides the following functions:

- Transmission means and circuit management (configuration management and data base for 64-kbits/s and Nx64-kbits/s circuits and transmission means);
- DACS-II control and resource management (equipment records and data-base partitioning);
- DACS-II alarms (transmission means and equipment) management;
- SYRAR (customer-premises-equipment multiplexers)

Figure 3. The topology of the BELGACOM network is depicted by this drawing. The small central offices or *Bureaux Central Telephonique* (BCTs) are shown clustered around the *Centres de Zone* or zone centers (CZs). 140-Mbits/s or 565-Mbits/s links connect the CZs together, and ≥ 2 -Mbits/s links connect the CZs to the BCTs and the BCTs to the local distribution centers (LDCs). The LDCs are connected to the customer premises (CPs) by means of 64-kbits/s links.



- from Nokia) loop-back and channel to 2-Mbits/s transmission-means assignment;
- Data-base query capability;
- Network map management (graphical display of the network);
- Service recovery and reconfiguration;
- Report management (for example, signal-related active-alarm listing);
- Interworking with the Switched-Access Remote Test System and Remote Measurement System - International (SARTS/RMS-I) to configure circuits for test;
- Bi-directional interface to an NMU, as mediator, with respect to commands and status data to and from various types of multiplexers;
- Bi-directional interface to the transmission-infrastructure data base (ITR);
- Interface to TransVu-2000 for passing DACS-II alarms;
- Graphical user interface (GUI); and
- Audit function between DACS-II and a DACSCAN controller.

SARTS/RMS-I. This system is a distributed-architecture, computer-based OS that provides testing for digital, leased-circuit services (LL-Fixed) at 64 kbits/s, Nx64 kbits/s, and 2 Mbits/s. SARTS/RMS-I supports the TMN fault-analysis function. The following functions and

features are part of the SARTS/RMS-I system:

- Test access;
- Transmission and reception of signals;
- Logging of test sessions;
- DACS-II interface;
- SYRAR loop-back by means of a DACSCAN controller;
- GUI; and
- Interworking with the DACSCAN-2000 controller C-module.

TransVu-2000. The transmission-supervision (TM-SUP) system within the BINOC, TransVu-2000, performs the TMN fault-management and performance-management functions for the transmission network. TransVu-2000 processes alarm and performance messages from NMU and DACSCAN (for DACS-II). It provides fault-detection (alarm surveillance) and fault-analysis functions—including correlation and suppression of alarms—and fault identification. The following functions and features are part of TransVu-2000 and are designed to support TM-SUP functions:

- Fault-management capabilities, including alarm correlation and suppression, and path maintenance;
- Trouble-ticketing capabilities;
- Collection of performance-monitoring data and report generation;

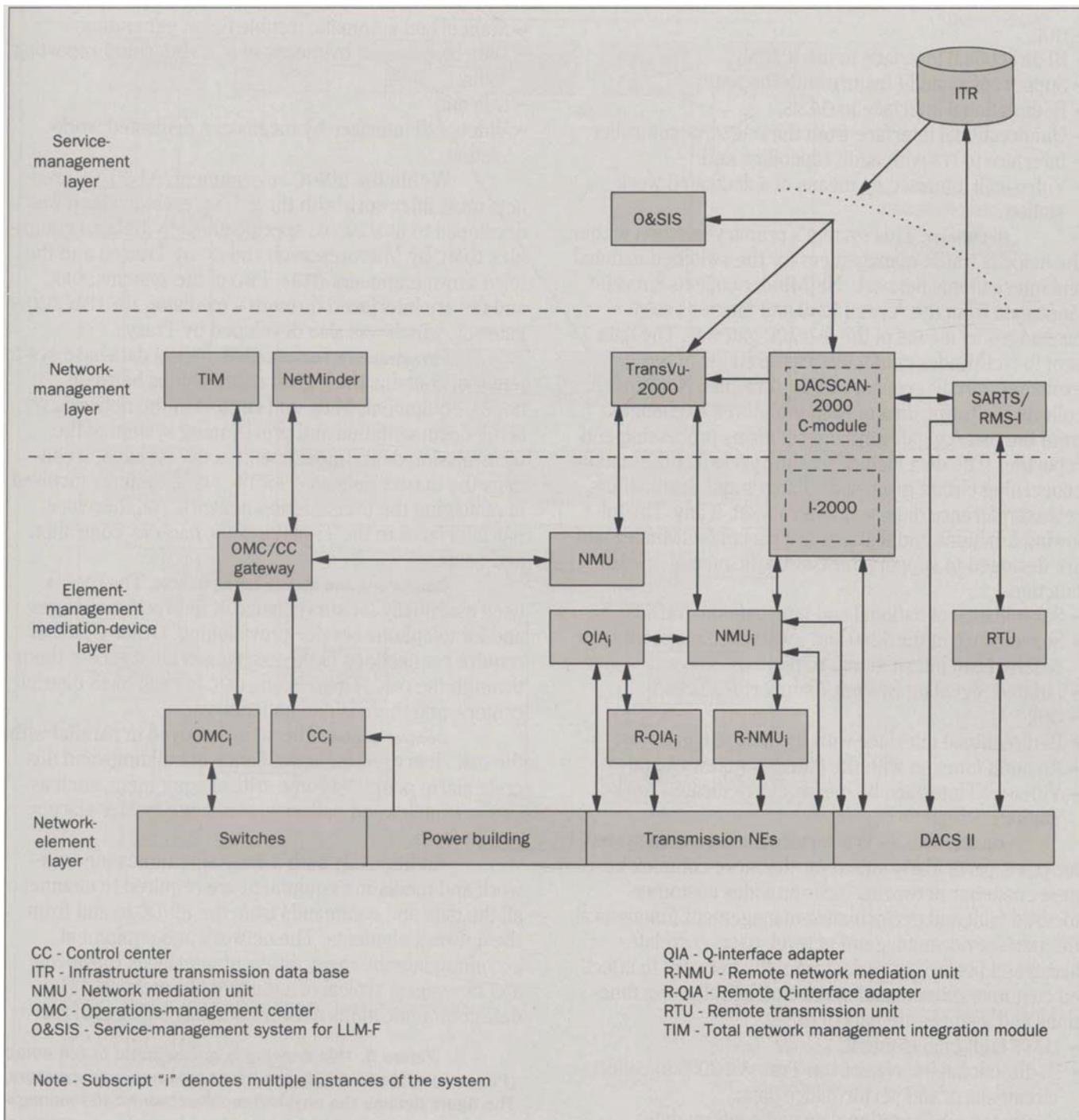


Figure 4. This drawing shows the BINOC (Phase A) systems against the backdrop of the functional hierarchy, taken from the standards work on TMN. The layers include network element, element management/mediation, network management, and service management. The service-management layer focuses on the contractual aspects of services. TMN also has a business-management layer, but this is outside the scope of BINOC.

ment, and service management. The service-management layer focuses on the contractual aspects of services. TMN also has a business-management layer, but this is outside the scope of BINOC.

- GUI;
- Bi-directional interface to the NMU;
- Support of an audit feature with the NMU;
- Bi-directional interface to O&SIS;
- Unidirectional interface from the DACSCAN controller;
- Interface to ITR with audit capability; and
- Video-wall interface by means of a dedicated workstation.

NetMinder. This system's primary function within the BINOC is traffic management for the switched national and international network. NetMinder collects surveillance data from the Alcatel 1240 and Siemens EWSD exchanges by means of the OMC/CC gateway. The data sent to NetMinder characterizes the status of the exchange, circuit groups, and destinations. NetMinder collects the traffic data of each monitored exchange, from the OMC/CC gateway, and performs processing and reporting. The data include alarms, periodic information concerning circuit groups, exchanges and destinations, related reference data, and controls set, if any. The following functions and features are part of NetMinder and are designed to support the TMN traffic-management functions:

- Surveillance of national and international traffic;
- Surveillance of the 1240 and EWSD exchanges used for national and international traffic;
- Limited Signaling System 7 support features;
- GUI;
- Bi-directional interface with the OMC/CC gateway;
- An audit function with the OMC/CC gateway; and
- Video-wall interface by means of a dedicated workstation.

O&SIS. This OS is a service-management system for LLM-F, particularly suited for the more complex business-customer networks. O&SIS provides customer-focused fault and performance-management functions at the TMN service-management level. O&SIS correlates alarm and performance data from the network to affected customer circuits and services. The following functions and features are part of O&SIS:

- LLM-F fault management;
- Bi-directional interface from TransVu-2000 to collect circuit-alarm and performance data;
- Customer-configuration data and contract-data management;
- Interface to ITR with audit capability;
- LLM-F performance monitoring;

- Manual and automatic trouble-ticket generation;
- Data-base access by means of ACE (Informix) reporting tools;
- GUI; and
- Video-wall interface by means of a dedicated workstation.

Within the BINOC environment, AT&T OS products must interwork with three OSs, each of which was developed to BELGACOM specifications by Belgian companies (OMC by Microresearch and CC by Trasys) and the telco's own engineers (ITR). Two of the systems, OMC and CC, are interfaced through a mediator, the OMC/CC gateway, which was also developed by Trasys.

Infrastructure Transmission. ITR is a data-base system that contains the logical relationships between nodes, equipment, MTs, and circuits in the network. ITR is the documentation and provisioning system of the transmission department in BELGACOM. As such, it contains the master data base for the BINOC systems involved in managing the transmission network. ITR, therefore, has interfaces to the TransVu-2000, DACSCAN controller, and O&SIS.

Operations and Maintenance Center. The OMC is used essentially for surveillance of network exchanges and for telephone-service provisioning. Other OSs that require connections to the exchanges must access them through the OMC. There is one OMC in each of 13 district centers, and there is one national OMC.

Control Center. The CC is deployed in parallel with the OMC. It is used for surveillance of buildings and discrete alarm points on some critical equipment, such as power supplies and batteries, exchange master alarms, and so forth.

Additionally, both a data-communications network and mediation equipment are required to channel all the data and commands from the BINOC to and from the network elements. The network and equipment accommodate the many different interfaces (protocols and messages) typical of a multivendor network. The data-communications network actually consists of the

Figure 5. This drawing is a schematic of the BINOC (Phase A) systems within the BELGACOM network structure. The figure defines the physical architecture for the management network, of which the BINOC forms the superstructure. As discussed in the paper, most operations systems (OSs) in the BINOC interwork with one or several other OSs. This relationship is also illustrated.

following five, individual, interlinked networks:

- *Megapac*. This internal, packet-switched (X.25) BELGACOM network interconnects all the offices within each district.
- *DCS*. This public, packet-switched (X.25) BELGACOM network is used as a backup, in some cases, and also for access to the electronic mail service known as DCS-mail.
- *Telanet*. This local-area network/wide-area network (LAN/WAN) is internal to BELGACOM and is used mainly for terminal access to the telco's data-processing applications. In the BINOC, it is used to connect the ITR system to the OSs that need to interwork with it. The protocols used are FTP/TCP/IP.
- *Datakit® II VCS*. This AT&T data switch is used in an overlay network consisting of 13 district nodes, with one central node situated where the BINOC OSs are located. The AT&T StarKeeper®-II system is used for monitoring the Datakit network. Datakit nodes are interconnected by means of 2-Mbits/s trunks. These nodes provide X.25 access to Megapac and DCS, asynchronous service, and LAN interconnection using the frame-relay protocol.
- *Local Area Network*. At the BINOC location, as well as in the districts, an Ethernet LAN is used to interconnect one OS to another, one workstation to its OS, and one workstation to another workstation. The LAN at the BINOC location is managed by the AT&T StarSentry systems manager.

The mediation equipment consists of the following four systems:

- *Network Mediation Unit*. In line with the mediation device "foreseen" by the TMN architecture, the NMU provides protocol-conversion and data-translation functions for alarm and performance messages, collected from network elements, which are forwarded to TransVu-2000. The NMU also passes configuration information from the DACSCAN-2000 controller C-module to other vendors' element-management systems, such as the Alcatel Q-interface adapter (QIA) and to the SYRARs.

There is an NMU in each zone center that is connected into the BINOC through the Megapac and Datakit networks. The NMU can interface directly to transmission-network elements. In many cases, however, additional mediation units are used, either to interface with some other vendor's equipment or with the satellite offices of a zone (for example, the

remote network mediation unit [R-NMU]). The following functions and features are integral parts of the NMU:

- Protocol conversion and data translation for TransVu-2000;
 - Bi-directional interface with TransVu-2000;
 - Network-configuration-data download from TransVu-2000;
 - Bi-directional interface with the DACSCAN controller;
 - Audit capability with TransVu-2000;
 - Bi-directional interfaces to the OMC/CC gateway, Alcatel QIA and R-NMU; and
 - Interface to Nokia SYRAR through the R-NMU.
- *Remote Network Mediation Unit*. The R-NMU is an NMU satellite designed to gather remote surveillance information using either the AT&T telemetry asynchronous block serial (TABS) protocol, Nokia's protocol, or discrete inputs from relays or analog-to-digital converters. The R-NMU also has the ability to control systems, on request, from the NMU. The R-NMU relieves the NMU from polling tasks and provides autonomous reporting of alarms. It also collects performance data available from some supervised network elements. R-NMU was developed by the Belgian company Gillam in collaboration with AT&T.
 - *Alcatel QIA*. This system performs configuration-management, fault-management, and performance-management functions for Alcatel network equipment. The QIA interfaces with the NMU using the proprietary Q3LTS protocol.
 - *Alcatel R-QIA*. Similar to the NMU/R-NMU relationship, the QIA also has a remote unit known as the remote Q-interface adapter (R-QIA). It serves as a satellite of the QIA.

Putting It All Together

The "I" in the acronym BINOC, signifying the word "integrated," merits its own separate section. There are four key aspects requiring discussion that are related to integration: interworking, total network management integration module (TIM), universal workstation, and video wall.

Interworking. As discussed earlier, most OSs in the BINOC interwork with one or several other OSs. This relationship is illustrated in Figure 5.

Total Network Management. TIM is a system designed to provide an integrated and centralized alarm-

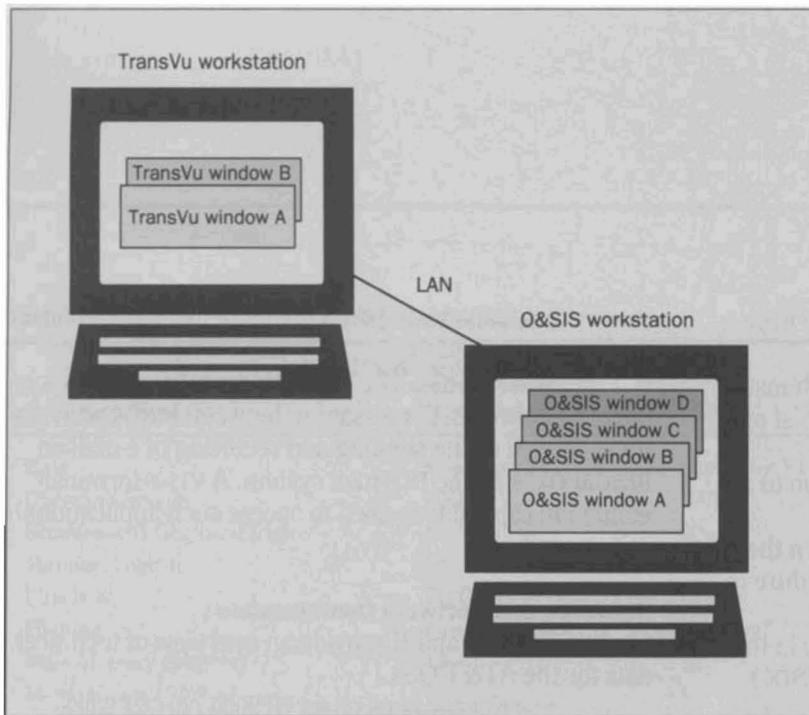


Figure 6. This drawing portrays an example of access on the integrated workstation. Users access a BINOC system by bringing up an on-screen list of systems accessible from a workstation. An example of a session in which a user is already connected to O&SIS and wishes to access TransVu-2000 is described in the paper. Such a scenario is also illustrated by this drawing.

surveillance function for telecommunication networks. TIM presents an integrated and graphical network overview to a manager in a clear, comprehensive, and user-friendly manner. A potential service-affecting incident or other problem can be detected immediately and accurately. This integrated view facilitates the correlation of alarms, identification of the most crucial service-affecting events, and coordination of repair actions. TIM supports a two-tier approach to network surveillance, with itself at the highest tier. OMC and TransVu occupy the second tier, and so on. The following functions and features are integral parts of TIM (Phase A):

- Signaling System 7 alarm surveillance;
- Alarm surveillance for switches and buildings;
- Message manipulation, such as browsing, data distribution, and so forth;
- GUI;
- Unidirectional interface to the OMC/CC gateway; and
- Video-wall interface by means of a dedicated workstation.

In later phases, TIM will also be connected to TransVu-2000 and NetMinder.

Universal Workstation. This equipment provides operators with the ability to access information from multiple BINOC OSs without having to switch from one workstation to another. Furthermore, to maximize ease of use, the various systems are given a common look and feel, as well as multiple-language support. A more detailed discussion of the universal workstation follows in "The Integrated Workstation" section.

Video Wall. This facility projects an overview of the most important screens generated by such systems as NetMinder, TransVu-2000, O&SIS, and TIM. The video

wall consists of a frame that accommodates four subwalls. Each subwall is set up in a 6x6 configuration, for a total of 36 monitors per subwall. Two subwalls will be set up in Phase A. The video wall features a wide viewing "window," permitting operators and visitors to view, at a glance, the network's "health." The video wall is being developed by the Belgian company BARCO.

The Integrated Workstation

The BINOC must allow users unified access to each application, with the exception of StarKeeper and StarSentry systems. For example, BINOC operators must have access to the surveillance functions provided by TransVu-2000 while maintenance work is progressing on the leased-lines service-management system O&SIS. This unified-access requirement is satisfied by the integrated workstation.

Each BINOC workstation is dedicated to one OS. The workstations can, however, access the graphical applications of multiple OSs. While working with one application, a user can gain access to another application at any time. Any needed additional accesses are dictated by operational requirements, which differ for the district and BINOC centers. User profiles determine which systems and applications are authorized for access by a given user.

User View

Users access a BINOC system by bringing up an on-screen list of systems accessible from a workstation. An example of a session in which the user is already connected to O&SIS and wants to access TransVu-2000 is described in the following six steps. This scenario is also illustrated by Figure 6.

1. An O&SIS user decides to access TransVu-2000 from a workstation running O&SIS.
2. The O&SIS user calls up a list of accessible systems.
3. The O&SIS user chooses TransVu-2000 from a list of options.
4. The O&SIS workstation establishes a connection to a TransVu-2000 workstation.
5. The initial window for TransVu-2000 appears on the O&SIS workstation screen (no new login procedure is required).
6. The O&SIS user can now employ TransVu-2000 in the same way as if a user logged in at the local (BINOC) TransVu-2000 workstation.

Common Look and Feel

A user's view of a GUI can be characterized in terms of the appearance details of the user interface, sometimes called the "look," and the user-interaction procedures, sometimes called the "feel." Examples of the look of a GUI include the particular graphic used to represent a scroll bar, the visual appearance of temporarily inaccessible menu items, and the shape of an on-screen button. Examples of the feel of a GUI include the way a pointing device is used to manipulate a scroll bar, the way the keyboard is used to select menu items, and the way a pointing device is used to select and activate on-screen buttons. Two applications with GUIs are said to have a common look and feel if a user can switch from one application to another without the user's performance being impaired by significant differences between the two applications.

All BINOC systems have a common look and feel. Each system has a GUI built on the open software foundation (OSF)/Motif and is based on the same user-interface design specification. Areas addressed in the search for commonality include:

- Meaning of color;
- Terminology;
- Network map backgrounds;
- Meaning of symbols;
- Font styles; and
- Access to on-line help.

Multiple Language Support. The common look-and-feel specification for the BINOC also defines a common strategy for uniform, multiple-language support within each application. For Phase A, the BINOC system provides BELGACOM users with on-line help text in Dutch, French, and English.

Character Set. The character set supported for the BINOC is ISO8859-1.

Mail Function. The integrated workstation supports electronic-mail messaging between BINOC workstations, as well as the sending and receiving of e-mail on BELGACOM's public DCS-mail system. A VT100 terminal-emulation capability is used to access such applications as DCS-mail.

Hardware and Software Configuration

Tables I and II provide an overview of technical data for the AT&T OSs.

StarKeeper runs on an HP9000-720 CRX workstation, together with the HP UX operating system, and Informix as a data-base system. (HP is a registered trademark of Hewlett Packard Inc.) The workstation has 32 megabytes of RAM, a 2x420-megabyte hard disk, and a digital audio tape.

StarSentry runs on an NCR 3335 (486SX-MCA), equipped with a 1.44-megabyte floppy disk drive. This configuration can be upgraded to another 213-megabyte hard drive and 16 megabytes of RAM. StarSentry runs with the network file system operating environment, C development tool kit, and the X-windows/Motif development kit.

The NMU is a VMEbus system using a mixture of Motorola and AT&T circuit boards in an AT&T frame. (Motorola is a registered trademark of Motorola Inc.) UNIX is used for the application software and VMEexec is used for the driver software. (UNIX is a registered trademark of UNIX Systems Laboratories.) Ctree+ is used as the data-base system. The hardware currently has 16 megabytes of RAM and a 520-megabyte hard disk.

The target hardware platform for workstations is the HP9000 Series 700.

AZERTY Keyboard Support. The workstations that are deployed as part of the BINOC support the AZERTY keyboard (French and Dutch character sets) with English annotations.

Lessons for Globalization

The BINOC project is a great learning experience for all involved, and it seems worthwhile to share some lessons learned during its implementation, as they may be valid for other international business ventures.

What Works Well. In spite of the fact that there is such a profusion of vendors' equipment and communica-

Table 1. NetMinder, TIM, and SARTS Configuration Summary

Category/System	Hardware/Software Configuration		
	NetMinder	TIM	SARTS
Host	StarServer FT	StarServer FT	StarServer FT
Operating System	UNIX	UNIX	UNIX
Simultaneous Graphical Logins	8	40	14
Terminal Logins	12	40	None
Data Base	TUXEDO	Oracle	Informix
Platform	BaseWorX	BaseWorX	BaseWorX
Main Memory (Mbytes)	128	96	96
Mass Storage (Gbytes)	8	4	2
External Drives	DAT	1/4-inch/DAT	DAT
Interfaces	CPM-HS, TCP/IP	TCP/IP, CPM-HS	TCP/IP, XIM
Printer (Host)	HP2563C	—	—

tion protocols, there have not been any major difficulties in accommodating this diversity.

Customization capabilities—where available—such as those on TIM, are excellent. They allow simplified product adaptation to specific customer requirements. They also allow some freedom as to who actually performs the adaptation: AT&T, a customer, or even a third party.

AT&T's willingness to subcontract or partner with local companies can prove advantageous. A good example of partnering is the development of two interface cards for the DATAKIT virtual-circuit switch: a G.703/G.704 card at 2 Mbits/s, and a V.11 card for the X.25 network. AT&T, in cooperation with the Belgian firm VDH, developed these cards quickly and at very competitive prices, mainly due to VDH's ongoing experience in working with BELGACOM. Modems, previously used for such interfaces but providing only G.703 functionality, proved to be much less cost effective.

OSs that are built on the common AT&T application platform, known as BaseWorX, are generally more adaptable. Their development requires fewer people and is, therefore, less costly. As more OSs migrate to BaseWorX, AT&T's integration and adaptation capabilities will increase considerably.

Desirable Improvements

As mentioned earlier, BELGACOM requires a character set containing both French and Dutch diacritical symbols. Customers who speak other languages have similar needs. It has been difficult to provide this feature

in the BINOC, and AT&T must improve its capabilities to offer such flexibility.

Names of equipment, circuits, and nodes must be changeable for each customer, and there must be some freedom in their format. Several BINOC systems initially had rather rigid formats and required additional development to accommodate BELGACOM's needs. Flexibility must be designed into products from the outset.

Objects, such as switching nodes, are sometimes given different names in systems developed by separate organizations. An effort must be made to establish one common set of terms. This issue may seem trivial, but actually it is very important, as well as not easily accomplished. For example, even such a large organization as the ITU-T lacks common, easily understood terminology in its recommendations.

Designers must continue learning about the international standards that apply to their own products. They must consider such standards as basic requirements in all product-development work.

Designs must be as flexible as technology allows. They must also be open, in that it should be relatively easy to tailor products to the specific needs of customers. Customization capabilities should apply to most aspects of the user interface.

Design guidelines must ensure uniformity in all aspects that affect end-users. The same problem must be approached in the same manner in every system. Of course, this is an area where generalized use of object-oriented technology—and the trend toward further inte-

Table II. DACSCAN, TransVu, and O&SIS Configuration Summary

Category/System	Hardware/Software Configuration		O&SIS
	DACSCAN	TransVu*	
Host	HP9000/857S	HP9000/870S-100	HP9000/870
Operating System	HP-UX	HP-UX	HP-UX
Simultaneous Graphical Logins	16	64	70
Terminal Logins	None	†	None
Data Base	Oracle	Informix	Informix
Platform	—	—	BaseWorX
Main Memory (Mbytes)	96	128	256
Mass Storage (Gbytes)	1.3	14.7	6.7
External Drives	DAT	DAT	DAT
Interfaces	TCP/IP, XIM	TCP/IP, CPM-HS	TCP/IP, CPM-HS, XIM
Printer (Host)	—	HP2563C	HP Rugged Printer

* TransVu-2000 has a dual-host configuration. The data presented in Table II is for each host machine. The disk is shared.

† Total of 64 simultaneous graphical and terminal logins.

gration—will bring considerable improvement.

Although many AT&T systems have wonderful user interfaces, there are still a few mature, old-fashioned systems being used. A simple, easily understood user interface is an important product benefit. The easy-to-use, graphical, PC user interfaces set the trend.

Conclusion

It is clear that the importance of the BINOC project cannot be overstated. For BELGACOM, the project provides a significant extension of its network-management capabilities. In addition to the sheer size of the contract, the BINOC project provides a great opportunity for AT&T Network Systems to adapt better to the needs of today's globally expanding telecommunication markets by gaining experience in all aspects of large-scale integration of management applications.

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