Network Management Systems for Overseas Solutions

● Steve Pelosi

(Manuscript received May 9, 2006)

The deployment and management of large-scale networks entail complex tasks that require careful initial planning and ongoing operations support. Meanwhile, telecommunications carriers are reducing staff as part of their response to increased pressure being applied by intensified competition and more competitive pricing. More than ever before, it is essential that telecommunications equipment suppliers provide complete management solutions for their products. Such solutions should include the Element/Network Management System (EMS), craft Interface, and Network Design & Planning Tools. A flexible strategy is needed to integrate the EMS with upper-layer OSS applications that may already be deployed by the carriers.

1. Introduction

Strong and complete network management solutions remain a key requirement for the successful deployment of Next-Generation Network (NGN) telecommunications equipment in North America. With continued mergers and increased competition, many carriers find themselves with fewer staff to support operations. Operational Expense (OPEX) continues to represent the largest portion of the carrier's budget, and therefore any savings in this area can significantly impact a carrier's finances. Moreover, NGN equipment vendors are expected to play a major role in providing management solutions that are suitable in the operations environment of carriers.

For North American markets, any comprehensive management system solution is generally expected to include the following components:

1) Element/Network Management System (EMS)
2) Craft interface
3) Network design and planning tools

In addition, some level of integration into the existing Operation Support System (OSS) environment may be required (depending on the carrier).

One of the major challenges posed in providing a strong network management solution is the variation of operational practices between carriers. In some cases, this means that different management solutions must be developed depending on the customer environment. For example, the Regional Bell Operating Companies (RBOCs) typically require that NGN vendors integrate with their OSS environment, while other carriers do not.

Finally, carriers in North America are in varying stages of a major transition from traditional SONET/SDH and plesiochronous networks to IP-Centric transport networks. This transition is expected to have a major impact on existing operations environments. In addition, equipment vendors will be expected to provide part of the management solutions for this transition.

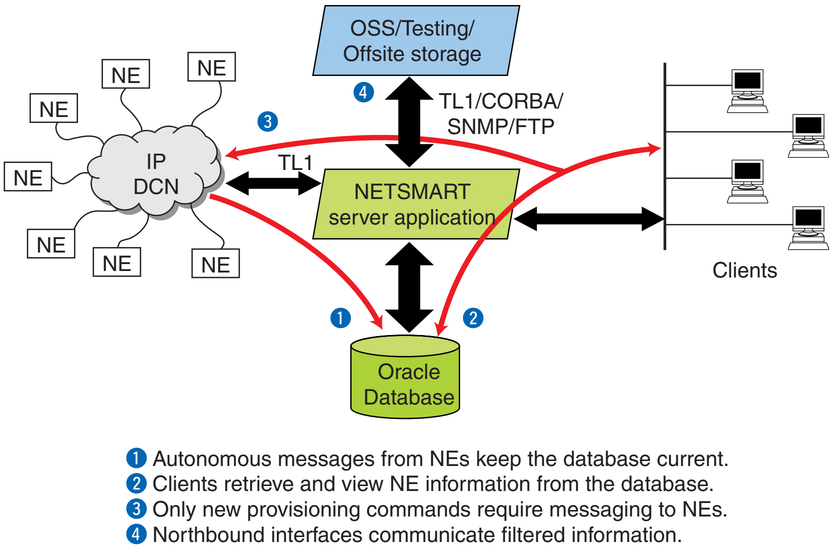


Figure 1
NETSMART 1500 architecture.

2. Element management system

A key element of the Fujitsu Network Communications (FNC) management solution strategy has been to provide comprehensive EMS support. The NETSMART 1500 EMS supports functional areas of management defined for the element and network management layers defined in ITU M.3010.[1)] **Figure 1** illustrates the high-level architecture of NETSMART 1500, which is client-server based, written in Java, and uses commercial databases for data persistence. The server runs on Solaris, and the client can run either on Solaris or Windows.

In addition to supporting the functional areas of management, other key NETSMART 1500 differentiators include:

1) Support of virtually all network elements sold by FNC by a single EMS
2) High scalability up to 8000 units of Network Element (NE) on a single server[note)]
3) Optional high availability configuration with automatic fail-over

This paper provides a brief overview of the main functional areas of management supported by NETSMART 1500.

note) There are currently ten commercial deployments of NETSMART 1500, each supporting approximately 8000 NEs.

2.1 Fault management

NETSMART 1500 provides centralized fault management for FNC NE. Faults propagate to nodes, links, and groups throughout all applications. NETSMART 1500 displays current alarms, as well as stores the history of recent alarms. Alarms can be filtered and exported to files or spreadsheets. **Figure 2** shows the propagation of alarms in the network topology view.

2.2 Configuration management

Configuration Management supports the full range of equipment, with a protection & facility configuration implemented through simple point-and-click operations. Cross-connects can be provisioned graphically and circuits labeled with critical customer data or redlined for additional security. **Figure 3** shows the NETSMART 1500 cross-connect screen.

NETSMART 1500 also supports a powerful automatic connection management capability that routes and provisions circuits across complex topologies (e.g., multiple rings, protected ring

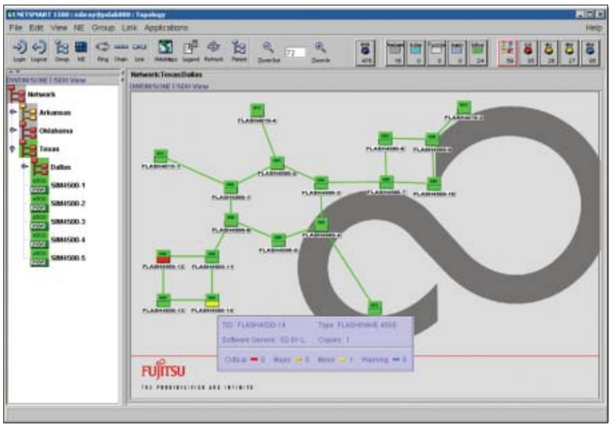


Figure 2
Alarms in topology view.

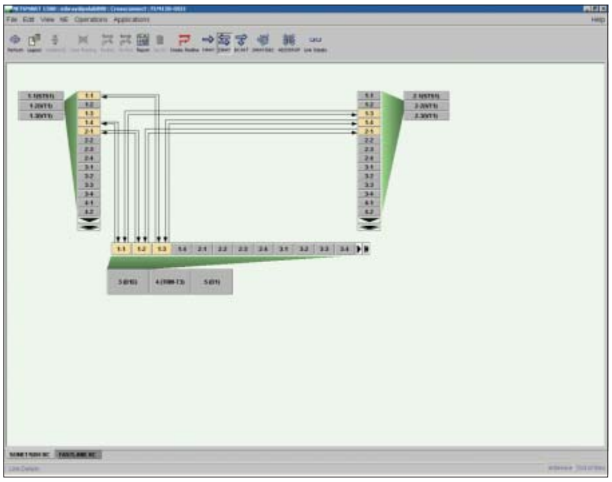


Figure 3
Cross-connect screen.

interconnects). Constraints can be also placed on the routing algorithm. Circuits can be activated immediately or at a future timing. Existing circuits (i.e., those provisioned prior to automatic connection management) can be detected and stored in the NETSMART 1500 database. Aside from providing a complete inventory of circuits, this also allows NETSMART 1500 to identify circuits that are affected by fault conditions.

2.3 Performance management

In addition to monitoring alarms, NETSMART 1500 can also retrieve, store, analyze, and report performance data to higher layer applications. Moreover, 15-minute and 24-hour performance registers can be retrieved and stored in the database. Basic sorting and filtering can be employed to analyze performance data. File transfer can efficiently send performance data to upper-layer applications (e.g., for Service Level Agreement support). The performance information can also be archived for long-term record keeping.

2.4 Software management

The capability to download software to multiple Network Elements in parallel is supported. The operator identifies the group of Network Elements for downloading and identifies any new software load, and then NETSMART 1500 completes the process automatically. A log of results including any exceptions is then provided to the operator.

Moreover, NETSMART 1500 can back up NE databases automatically. Database backup as a background operation or on-demand is possible. Multiple database copies can be stored (with two copies the default). In case of catastrophic failure, the operator can take action to have NETSMART 1500 restore the NE databases. This allows an operator to restore all provisioning of service in mere minutes instead of hours or even days.

2.5 Northbound interfaces to OSS

An important part of the management strategy is to offer customers a way to integrate into their existing upper-layer OSS infrastructure. To do this, NETSMART 1500 supports the following types of interfaces to the upper-layer OSS: CORBA (TMF-814),[2] TL1, SNMP, XML, and FTP.

2.6 Other management functions

For the sake of brevity, the following lists but do not describe in detail the additional management functions supported by NETSMART 1500.

1) Topology autodiscovery
2) Wavelength management
3) RPR creation wizard
4) PCN management
5) NE security management
6) Remote notifications
7) Task management (scheduler)
8) TL1 editor
9) Web reports

More information about these management functions can be obtained from the NETSMART 1500 Web link.[3)]

3. Craft interface

An updated version of the craft interface is required for each release of a new network element. Today the craft interface consists of a combination of TL1 and a stand-alone craft interface GUI application called NETSMART 500. The TL1 interface is intended to cover 100% of network element functionality. The NETSMART 500 provides GUI coverage for approximately 95% of network element functionality, including complex, frequently performed tasks. The application models network element behavior to provide an intelligent user interface. In some cases, complex tasks are supported through the use of wizards. NETSMART 500 is written in Java and runs on a Microsoft Windows based laptop computer. Currently, the single NETSMART 500 application natively supports 21 NE releases, including SONET, SDH, and DWDM Network Elements. Moreover, NETSMART 500 can intelligently invoke other craft interface applications (e.g., craft interfaces developed for older network elements).

NETSMART 500 software is distributed in one of two ways. First, customers can purchase single user copies on CD. With each new release of NETSMART 500, the customer must obtain an updated CD and reinstall the application. The second way is for customers to purchase a site license, which enables them to install NETSMART 500 software on a server from which employees can download the software to their computers.

NETSMART 500 communicates by using TL1 and FTP at the application layers. TL1 connectivity can be achieved by asynchronous ASCII connection through an RS-232 port or via TL1/TCP/IP through a LAN port. FTP is used to perform single node software downloads, as well as remote memory backup and restoration. NETSMART 500 can communicate with remote network elements over the embedded Data Communications Channels (e.g., D1 — D3 bytes of SONET/SDH overhead).

In general, a single instance NETSMART 500 is limited to the view of a single network element (as opposed to a network view like that of the EMS). However, this notion is changing somewhat with the introduction of Control Plane functionality into network elements. With the Control Plane, a single NE may have a view of the network topology and be able to perform limited network-layer functions such as A-to-Z circuit provisioning. In this case, NETSMART 500 will display the Control Plane-provided topology information and allow access to provisioning capabilities supported by the NE.

Finally, an emerging craft interface trend in North America is for data-oriented network elements to support a Web GUI embedded in the NE. The embedded Web GUI would support a single network element and be accessible through a Web browser. **Figure 4** illustrates the embedded Web GUI architecture. The embedded NE GUI can be invoked directly from the Web browser or through the NETSMART 500 application.

4. Network design and planning tools

Tools are required to support network design and planning. In North America, these tools are used both internally by FNC network designers and sales personnel, as well as externally by the customers. Today, different tools are provided to support DWDM and SONET network design.

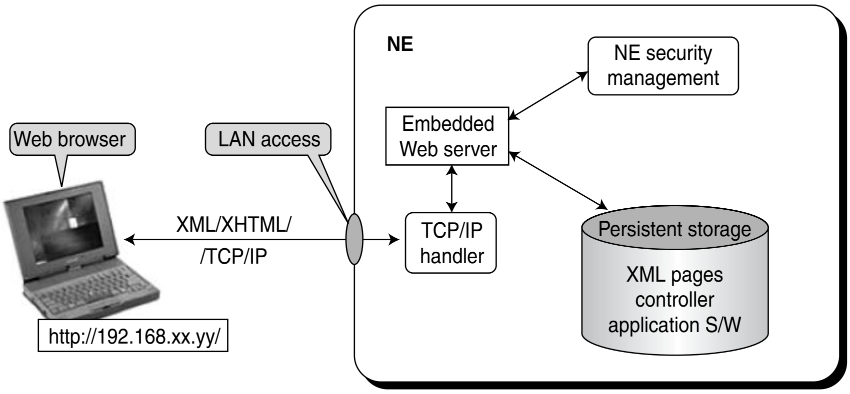


Figure 4
Embedded Web GUI architecture.

4.1 DWDM design tool

A relatively new customer requirement is for the vendors of DWDM network elements to provide a network design and planning tool. FNC in conjunction with Fujitsu has developed NETSMART 2000 to support the network planning function for FLASHWAVE 7500. DWDM network design is significantly more complex than the design for SONET. DWDM network design is largely driven by the optical characteristics of the fiber type, as well as the characteristics of equipment performance.

NETSMART 2000 is a client-server based application created according to the NETSMART 1500 EMS framework. The user enters (either through the GUI or via bulk file input) the service demands, site information, and fiber information. NETSMART 1500 will calculate the network design (based on design rules specific to the NE release), and then output complete network design information. The network design includes network and shelf diagrams, cabling information, a reachability matrix, Bill Of Materials (BOM), and pricing. **Figure 5** shows a NETSMART 2000 design for a ring network topology.

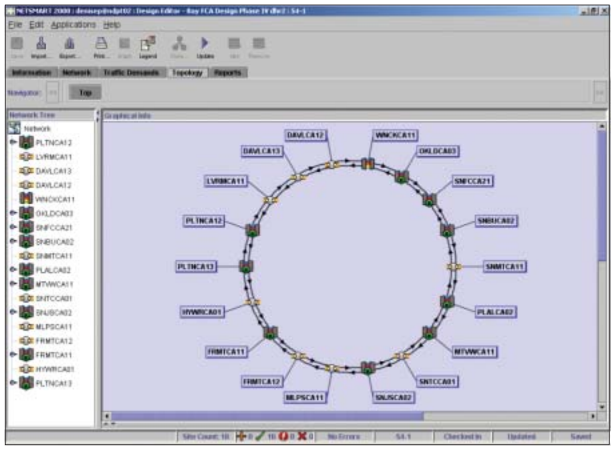
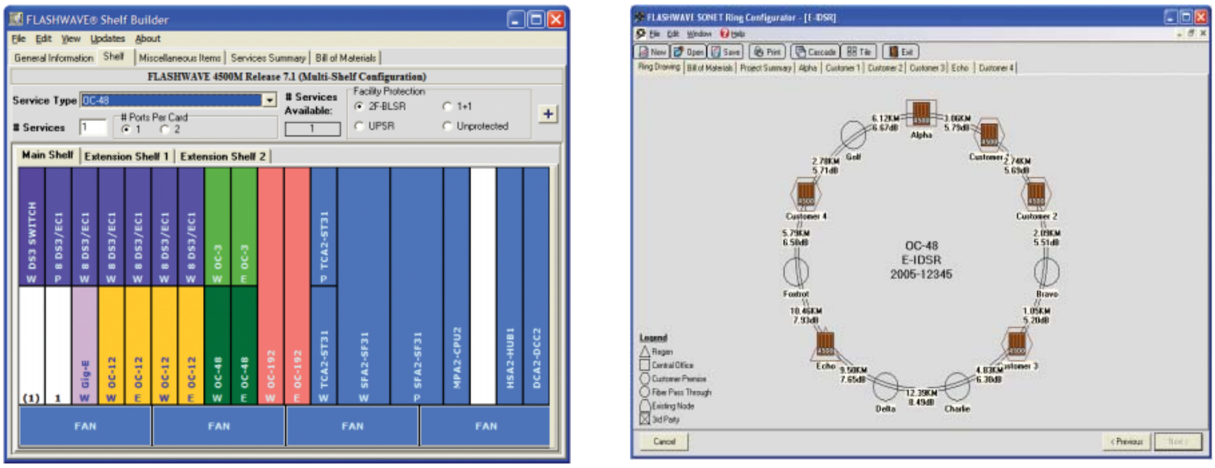


Figure 5
NETSMART 2000 ring design.

4.2 SONET design tools

Network design for SONET is less complex than for DWDM, but still requires support by design tools. For this reason, FNC has developed two design tools called SONET Shelf Builder and SONET Ring Builder. These tools are used today both internally to generate sales quotes, and externally by FNC customers. Both are considered lightweight applications that run only on a Windows laptop computer. Shelf Builder outputs a shelf diagram, BOM, and price list. In addition, Ring Builder outputs a ring diagram and verifies that there is enough ring capacity to service traffic demand inputs. Both tools model slot restrictions (both inherent to the NE and additional customer-specific restrictions). **Figure 6** shows examples of output from these tools.



(a) Shelf Builder (b) Ring Builder

Figure 6
Shelf and Ring Builder tools.

5. Existing carrier OSS environments

The large incumbent carriers in North America have invested significantly in their existing OSS infrastructure. For example, Telcordia Technologies[4)] provides much of the existing OSS infrastructure for the RBOCs. For transport services, these Telcordia OSSs primarily support alarm monitoring and flow-through provisioning.

In order to deploy transport network elements to the RBOCs, equipment vendors must first undergo a process to characterize those network elements in the Telcordia embedded OSS (TIRKS, NMA, & Transport). This characterization process is called “OSMINE” (Operations Systems Modifications for Intelligent Network Elements). The process usually takes about nine months and involves an exchange of information on paper as well testing the interface to the Telcordia OSS. Once the process is complete, the RBOCs implement their own process to verify OSS implementation, and then put the OSS solution into production.

At this time, it is necessary to study the issue of how extensible the existing OSS infrastructure will be as the core network transitions from connection-oriented transport to packet data transport.

6. Migration to IP-Centric transport layer

Over the next five to yen years, North American networks will be transitioning from connection-oriented transport to packet data. This transition will significantly impact the day-to-day operations of the carriers and their OSS infrastructure. FNC believes that such types of EMS as NETSMART 1500 will play a key role in supporting packet-oriented transport networks. The implementation architecture will consist of the EMS connected to the upper-layer OSS (see Section 2.5 for more information about interfaces to upper-layer OSS). In some applications, the upper-layer OSS may still have direct connection to the NEs (e.g., for alarm processing).

One of the biggest unknown factors is whether carriers will continue to maintain separate operations centers for transport versus data services, or try to combine these separate operations centers into one. Most likely, there will be no single answer to this question; some carriers will continue to maintain separate centers or may engage in transition over a long period of time.

7. Conclusion

This article briefly introduced the key components required for operations support of our current transport products deployed in North America. These components include the EMS, craft interface, planning tools for DWDM and SONET, and their integration into the existing carrier OSS environment. With ongoing mergers and increased competition among carriers, strong and complete operations support solutions from NE vendors are perhaps more important than ever.

New operations challenges are being posed as carriers transition their networks from traditional SONET/SDH and plesiochronous networks to IP-Centric transport networks. FNC believes that the EMS will play a key role in this transition and be interconnected with upper-layer OSS applications via a standard uplink.

References

1) ITU-T: Principles for a Telecommunications Management Network. M.3010, Feb. 2000.
2) TeleManagement Forum. *http://www.tmforum.org*
3) NETSMART 1500 manuals. *http://tpg.web.fnc.fujitsu.com/techpubs/tpg/docfiles/netsmart/NETSM.pdf*
4) Telcordia Technologies Web site. *http://telcordia.com/*

Steve Pelosi, *Fujitsu Network Communications Inc.*
Mr. Pelosi received the M.S. degree in Industrial and Operations Engineering from the University of Michigan at Ann Arbor in 1982. He began his career at Bell Labs and Bellcore from 1982 to 1987 in the field of transmission. From 1987 to 1993 he worked at Bell Northern Research in the field of switching. He is currently vice president of Network Operations Planning and Development at Fujitsu Network Communications.