Operations Support for High Capacity Lightwave Systems.

W. A. Vande Wall
AT&T Bell Laboratories

ABSTRACT

Since the introduction of lightwave systems in the late 1970's, they have become widely deployed for long-haul, interoffice, loop and private network transmission. With lightwave's advantages of large bandwidth and quality of service they are becoming the medium of choice to carry voice, data, and video. With the high capacity of lightwave systems and the types of services carried, it is important to be able to detect, isolate, and repair troubles quickly to minimize or eliminate service impairment.

This paper discusses remote maintenance support for high capacity lightwave systems from a network point of view in order to minimize service impairment, and to maximize the usage of trained operators. Specifically it addresses what functionality is needed for an operation system in today's environment to provide the tools necessary to maintain the growingly complex lightwave networks of the future.

1. INTRODUCTION

The demand for communication services today is exploding. To answer this demand established communication carriers are expanding their networks while corporations and entrepreneurs are establishing new private networks. As these networks emerge and grow the overwhelming problem is how to ensure day-to-day and long term service quality and cost-effectiveness. In other words the efficiency of any network's operation is directly related to the mechanisms through which it is maintained.

2. LIGHTWAVE MAINTENANCE OPTIONS

There are basically two choices for maintaining a lightwave system. The system can be maintained locally using the system's panel display, or operator interface terminal, or the system can be maintained remotely using an operation support (OS) system. In order to maintain the system, whether locally or remotely, operators must be trained to understand and interpret alarm conditions, performance data, and fault location information. If the

network is comprised of only one span[1] the system can be adequately maintained by stationing a trained operator at the lightwave terminal using the facility-specific operations system. However as the network expands, in order to maintain cost-effectiveness the operations support of the network must be centralized. The overall motivation for central operation support comes from the need to gather, store and interpret data in order to maximize the efficiency and service of the network, not a single node or facility within the network. Also the coast of personnel, training, and facility specific operation systems provides another strong argument for the centralization of the operation support functions.

3. CENTRALIZED MAINTENANCE

In the past, centralized maintenance consisted of gathering information generated by each node within the network, logging the information for further reference as well as reporting the alarms lo the operator. It was up to the operator to take the nodal information and correlate it to determine not only what was happening to a particular system but how the service problem was impacting the network and the the customer. Although time consuming, this was not a major issue when the network was relatively small and comprised of only a few different types of vendor's equipment. Today's networks, however are comprised of multivendor equipment having different line rates and capacities and providing varying levels of sophistication in maintenance information. Another major issue is the absence of standards; the maintenance information provided by these various systems can be presented in different languages and have unique meanings to each system.

In addition, the capacity of lightwave systems is doubling approximately every two to three years, which means that a service degradation or outage within the network will increasingly impact more and more customers. Reflecting on this trend it becomes evident that to maintain the network you can no longer afford the time, training, and possibility of error in letting the operator correlate and sort through the individual nodal information. The OS systems must begin transition from nodal monitoring to a network monitoring and administration tools.

4. NETWORK MONITORING

In order to be a useful tool in the maintaining the network the OS must provide some basic functionality to compensate for today's network trends.

---

[1] A span is comprised of bidirectional transmission path(s), line repeater stations (depending on the distance), and lightwave line terminating equipment.

4.1 multiple vendors/manufactures

The new communications demand and multivendor market provides the consumer with low cost lightwave products. Unfortunately, lightwave products from different vendors often use different maintenance scenarios and maintenance information for the support of their equipment. This becomes a problem when the equipment is placed in the network and needs to fit into an existing maintenance plan. What usually happens is that the operator is forced to learn the idiosyncrasies of each new lightwave system and do a mental translation between the information generated by the lightwave system and the maintenance plan in effect. This is undesirable because of the increase in training, and the confusion and possible error resulting from the same information having different meanings between vendors. To overcome this problem and to enable the support of a single network maintenance plan regardless of the particular vendor's equipment, the OS be able to translate incoming messages to a standard form before they are presented to the operator and to translate the operator's commands into the particular format that the lightwave facility will understand. This allows operators to be trained on how to maintain a lightwave system in general and react to specified messages regardless of the vendor's system.

4.2 available information

With the OS feature just described the problem of understanding different vendor's information has been solved. However this does not address the operator's dilemma of sorting through the voluminous data received from each system in order to determine exactly what and where the problem is within the network. With the availability of performance and fault location data the task of detecting service problems has become easier. However in today's environment it is still up to the operator to sort through the information to determine what is the actual problem as opposed to merely reacting to the symptoms being caused by the problem. In order to provide the operator with pertinent and worthwhile data the OS system must provide some basic functionality such as:

- event threshold: The ability to notify the operator only if a specified condition occurs a certain number of times in a specified time period.

- time threshold: The operator is notified after a certain condition is active for a specified time period.

- correlation of nodal information: This allows the user to be shown any supplementary abnormal conditions within the node that pertain to the problem being reviewed. This also includes the capability for the OS to display only the highest priority event that occurs in the node and suppress other alarms resulting from that event.

- correlation of information between nodes: This allows the operator to see the big picture by showing other abnormalities that have occurred in the network which pertain to the problem.

- trend analysis and report generation of operator specified data: This provides the operator with reports of alarm or performance monitoring information for nodes or the network. It is important that the reports call be generated on a demand basis, at preassigned times, or as a result of an exceeded threshold or condition. The OS should also provide the flexibility to allow operator definable time increments within the report.

4.3 multiple line rates and capacities

The reason to maintain the network is to keep satisfied customers and therefore maintain a level of revenue. One of the major problems of the nodal maintenance approach is that there is no correlation between the customer and a failure within the network. As the network expands and capacity of systems within the network increases it is imperative that failures of a high capacity system be automatically, correlated to the problems it will cause to the customer. In other words you want to know which customers are having service problems before they call and complain. With this ability and performance monitoring information it is possible to optimize the routing of service within voice and data networks and to maintain high levels of service for important customers.

4.4 basic functionality

The preceding discussion of OS features has been based on what is needed for network support. However the basic features used today for nodal support will need to be carried over into the next generation of OS products. These basic features are:

- active notification: This is real time notification when an event occurs in the network.

- clear notification: This is the notification that a previous reported event has now been corrected. It is important that this be when the event has been corrected in the network, not when the craft have been dispatched to work on the problem.

- alarm duration: To keep track of the amount of time a condition is active.

- alarm inhibiting: This would allow the operator the ability to select which conditions are reported.

- selective logging and retrieval/display: To be able to dictate which events are stored for future reference and to have only selected events retrieved and displayed from the log.

- scheduled commands: This allows the OS to automatically retrieve data or issue commands to the network elements at specified times during the day.

- event driven commands: The OS responds with pre-specified commands when a certain event occurs in the network.

- security: As the complexity of the network and OS expand a critical concern is the protection of the equipment and data being carried in the network. In order to provide this protection from unauthorized personnel the OS must provide multi-level security for access/control to the network.

4.5 ease of operation

One of the last requirements for the network monitoring OS is that the OS itself must be easy to operate. The OS should provide help functions and menus for the novice user as well as abbreviations and direct command entry for the experienced user. It must be flexible enough to allow multiple users with selective routing of information to those users. In essence the operation of the OS must be flexible enough to adapt to each individual administration scenario as its feature functionality adapts to network maintenance needs.

5. SUMMARY

As previously stated the next generation of OS products must provide the functionality and flexibility to aid in the diagnosis, isolation, and administrative support needed to maintain and maximize the expanding digital network. The major OS functionalities that were presented in this paper are:

- The support of standard interfaces to the network elements.

- Collection and thresholding of the network element data on a nodal basis.

- The correlation and analysis of the pertinent data between different nodes within the network.

- Correlating the network troubles to the affected customers.

- Historical and trend analysis of the network data for preventive and routine maintenance.

- OS user interfaces that are friendly, and provide adaptation to varying degrees of user expertise

6. CONCLUSION

This paper has presented a view of functionality required for a network maintenance operation system. However it is impractical to consider throwing away the embedded base of OS equipment and install a new operation system. Rather the last requirement for a network maintenance OS is that it can incorporate the information and processing of existing OSs into a single operator interface. This provides a transition path for monitoring the complex high capacity lightwave and networks elements by the new OS and phasing out the existing OS as the opportunity or the need arises.

REFERENCES

AT&T, “Mainteriance Standards for Digital Transmission Systems’, Compatibility Bulletin # 149, Issue 2, April 30, 1985.

AT&T, “ACORN™ Network Control System Technical Description”, CIR 190-099-031TD, January 1986.

Allan,D.G., Pon,H., Ostaszewski,J., ‘Design of Integrated Surveillance Systems For High Capacity Fiber Systems” *Proc. IEEE GLOBECOM,85* pp. 1370 through pp. 1375.

Burke,J.L., “Running your own operations center” *Telecommunication Technology* Vol.4, No.5, May 1986, pp. 18 through pp.22.