Eating Our Own Cooking: The Role of SAS/CPE® Software in Managing Information Systems Resources at SAS Institute

Virginia M. Dineley, Robert N. Bonham, David A. Fahey, and Daniel J. Squillace
SAS Institute Inc., Cary, North Carolina

Abstract

This paper describes how the SAS/CPE family of software products is used in managing SAS Institute’s own complex networked environment, which includes IBM mainframes, VAX midrange systems and clustered workstations, and over 1,000 HP workstations and file servers. Specific examples will be drawn from the areas of ad-hoc performance studies, service level monitoring, and resource usage reporting.

Introduction

SAS Institute now provides MVS, Open Systems, and OpenVMS sites with SAS/CPE software, a comprehensive application for collecting, managing, reporting, and analyzing system and network performance and utilization data. In today’s complex, multi-vendor, and distributed environment, system managers, information systems managers, application developers, resource planners, and end users all require timely information on end user service, applications performance, and resource utilization.

- Systems managers try to maintain expected service levels, identify problems and bottlenecks before they seriously impact users, and rapidly resolve serious problems when they do occur.
- Developers of large applications are concerned with efficiency and whether currently available resources will be sufficient to run the application. They also want to identify serious performance and resource utilization problems early in the development cycle when they can be more easily fixed.
- In today’s fiercely competitive business environment, information systems managers are under increasing pressure to deliver more services for less money. They need to monitor application resource utilization and workload growth trends, see that resources are being used consistently with Information Systems policy, and anticipate timely and cost-effective resource upgrades.

The purpose of SAS/CPE software is to help you address these challenges by providing tools which

- Collect, reduce, analyze, correlate, and provide reporting on data from a wide variety of heterogenous sources.
- Extract and retain relevant information from potentially overwhelming volumes of data. A flexible and easily configurable Performance Data Base architecture is the key vehicle for addressing this requirement.
- Operate on multiple platforms in a consistent and intuitive manner. A standardized and tailorable menu system is provided for accessing SAS/CPE functions. As with all SAS software, a user familiar with SAS/CPE on one platform can easily learn to work with it on other platforms.
- Allow easy customization and extension to meet unique site or user requirements. An example of this is the ability to readily incorporate new or unique data sources.

We recognized, very early on, that a practical and highly useful test of the capabilities of SAS/CPE software would be to see how well it meets the needs of our own Information Systems Division (ISD). ISD is responsible for managing a highly complex, leading edge networked environment which incorporates IBM mainframes, mid-range VAX systems and clustered workstations, and well over 1,000 HP workstations and file servers. Add to this a “Noah’s ark” of at least one pair of workstations from every vendor of significance in the Unix marketplace.

During the past few years, SAS/CPE software has been used by the MVS, OpenVMS, and Network organizations within ISD for analysis of system performance, network activity, and disk storage allocation. This paper highlights a few of the applications of SAS/CPE using ISD data sources.

SAS/CPE and the Networking Department

Over the past several years the Institute has been pioneering methods and technologies for analyzing complex network environments simply out of necessity. Our current distributed net-
work environment consists of a centralized, highly segmented communications infrastructure composed of:

- 200 Ethernet segments
- 5 FDDI segments
- 50 Routers
- 200 Hubs
- 10 56Kb Line
- 1 T1 Network Link

From this complex environment, 300 Mbytes of performance measurement data are gathered daily. Most of the data are defined by Management Information Bases (MIBs) and are collected by using the Simple Network Management Protocol (SNMP).

Two MIBs used extensively by the Institute are the MIB-II (RFC 1213) and the RMON MIB (RFC 1271). MIB-II defines data structures to measure the usage of a device's network interface. Most devices supporting TCP/IP support the MIB-II standard including many routers, hubs, and Unix workstations.

MIB Groups | Description
---|---
MIB-II System group | The Systems group contains general information about managed objects at the interfaces layer.
MIB-II Interfaces group | The Interfaces group describes the type of interface, such as Ethernet, and provides statistics on the operations occurring at each interface.
MIB-II Internet Protocol group | The Internet Protocol group purpose is to provide information on IP operations, address tables and routing tables.
RMON Statistics group | The statistics group contains statistics measured by the probe for each monitored interface on this device. This group currently consists of the etherStatsTable.

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Table 1: MIB-II and RMON Groups

RMON MIB describes measures for monitoring Ethernet network segments. Typically, RMON is implemented by a dedicated hardware device designed to listen to activity occurring on the wire. Often these remote probes are stand-alone devices and devote significant internal resources for the sole purpose of managing a network or may be contained as a component of a Ethernet network Hub.

Once the data have been collected, the Networking Department in ISD uses the SAS/CPE product for OpenSystems to analyze and manage network data. Typically reports are generated for the groups shown in Table 1.

Table 2 shows a configuration report of the type and quantity of interfaces for each router on the Cary network and was obtained from the MIB-II interfaces group.

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Table 2: Router Configuration

Table 3 displays a summary report of fourteen routers providing service to an Ethernet LAN. Several interesting trends are shown. Peak network utilization of 79% for router 'sears', output error rates > 100% for router 'pancho' and a fairly good distribution of bytes transmitted and received amongst the fourteen routers.

The SAS/CPE product is also used by the Network administrators for exception analysis. One method of exception analysis is to produce an exception matrix based on a set of user definable exception tests. An exception matrix is a count of the total number of failures for each test specified. Classification variables can be specified to further categorize where the failures are occurring. This procedure provides an excellent data exploration capability by examining the counts of failures occurring within the data population. If a failure criteria results in 50% failures, either the criteria has been improperly selected, or there are significant performance problems being highlighted by the large number of failures.

A good example of an exception report is shown in Table 4 using several metrics derived from MIB-II interfaces group. This report analyzes data from fourteen routers providing service to a number of Ethernet LANs.

Test1 through Test3 are defined as follows:

- Test1 - Network utilization > 30%
- Test2 - Network input error pct > 5%
- Test3 - Network output error pct > 5%
null
Formulated variables can also be used to plot costs of allocated storage over a month. Two formulated variables, XUSEGRP (user group) and XPSCOST (calculated rate for each user group) are used to produce the graph shown in Figure 4. This plot shows a constant rise in costs of allocated storage over the month. The same information is presented in a bar chart format in Figure 5 and uses a third formulated variable, XWEEK. This variable is created to allow grouping of data stored by days into a week format as shown.

After several weeks of data are collected, reports showing the percentage of free space and the average amount of fragmentation on the system are produced, as shown in Figure 6. In this case, the graph shows a noticeable decline in the amount of free space available on the system.

Once disturbing trends like these have been found the MVS administrators can use a SAS/CPE tabular exception report to identify users and departments that were using huge quantities of storage, as shown in Table 5.

Next, they examined exceptions at the data set level. Table 6 shows datasets with a large number of extents. If these can be reduced performance would be improved.

SAS/CPE Software for MVS also provides easy access to data that have been collected by MXG Software. This data, combined with the data management and reporting tools in SAS/CPE Software, are used by the MVS administrators for daily and long-term performance analysis, as well as capacity planning.
SAS/CPE Software for OpenVMS provides data management and extensive reporting capabilities for collectors developed and distributed by Digital Equipment Corporation:

- OpenVMS Monitor facility
- OpenVMS Accounting utility
- VAX Software Performance Monitor (SPM)
- Polycenter Performance Solution (PPS) Software

In addition, SAS/CPE Software for OpenVMS includes facilities to:

- Collect and analyze disk usage information (DISKUSAGE)
- Collect and analyze Ethernet activity (ETHERNET)

The OpenVMS Management Department in ISD is responsible for managing a mixed AXP and VAX cluster consisting of the following:

- 13 VAX 3100
- 2 VAX 4090
- 3 VAX 40XX
- 1 VAX 6550
- 10 AXP 40xx
- 1 AXP 7000
- 195 disk drives of various types

This cluster is used by over 1000 users, who have been divided into 48 groups for management purposes.

For performance analysis of the cluster and network, and analysis of disk utilization, the OpenVMS administrators make use of the SAS/CPE product to collect and analyze several different types of data, including data that have been collected by the Data Collector portion of Polycenter Performance Solution (PPS), the SAS/CPE Diskusage Facility, and the SAS/CPE Ethernet Facility.

PPS data is collected daily at two minute intervals. At midnight, these data are read by SAS/CPE Software and collapsed to 15 minute intervals. The collapsed data are used to generate daily reports. These reports are used by OpenVMS administrators to quickly review performance of the system. Over 100 supplied reports are provided to quickly analyze memory and file system performance, as well as disk and page file utilization.

Analysis of the responsiveness of the memory management subsystem begins with the graph shown in Figure 7. This graph shows mean page faults per second by type. From this graph, it can be determined if there has been excessive faulting. An excessive rate of free list faults and modified list faults can indicate that working sets are too small and should be adjusted.

A high level of demand zero faults can indicate a high number of image activations. This can be confirmed by reviewing a graph of image activations over time, as shown in Figure 8.

After daily reports are generated the collection is collapsed to 30 minute intervals and added to a group. Typically a group contains data collected for a month. This data can be combined with other groups to predict long-term trends and assist in capacity planning.

The OpenVMS administrators are responsible for managing 195 disk devices of various types. It is their responsibility to ensure a sufficient amount of disk space is available to the different groups within the user community at all times. This responsibility requires a knowledge of disk utilization by each user group over time combined with a knowledge of the
expected increase or decrease of utilization as projects begin or near completion.

The SAS/CPE Diskusage Facility is used to collect disk space utilization statistics over time. Reports on disk utilization by UIC, UIC group, volume and directory can then be produced.

Several graphs have been developed to analyze current usage and predict future utilization. These graphs show the percentage of free and allocated space over time per volume. Figure 9 shows the percentage of free space for volume CMGT1. This volume is used by the Code Management group at SAS Institute. Currently free space on this volume is over 30%, but the graph shows that in January the percentage of free space dropped to 15%. This corresponds to an increase in the number of SAS source and image levels that were contained on this disk at that time. Knowing that the number of levels was due to increase as the Code Managers geared up for another maintenance level and Version 7 development, the OpenVMS administrators reorganized the current levels and moved some of the existing levels to volume CMGT2. This enabled the OpenVMS administrators to ensure that the Code Management group will not be short of disk space at a critical time in the development cycle.

The SAS/CPE Ethernet facility is used by OpenVMS administrators to monitor network performance. The Ethernet facility data collector gathers information on network traffic by node, send/receive pair, and protocol activity. The Ethernet facility is used to gather data daily during peak hours. Supplied reports are generated showing traffic loads, top nodes by activity, network traffic rates over time, etc.

Figure 10 shows a graph of traffic byte rates over time. This shows peak network usage time. It is obvious by looking at this graph that the network is heavily used right before lunch. Usage drops considerably during lunch hours and picks up again right after lunch. Activity slows again around 2:00 p.m. This is probably due to the preponderance of meetings scheduled for the late afternoon. Typically, the data can be correlated with network performance fluctuations.

The daily Ethernet data is then combined with previously collected daily data and graphs are generated to show general trends. If it is detected that the traffic byte rate consistently spikes at 11:00 a.m., then the administrators would further investigate the type of activity occurring at or around 11:00. It is possible that this activity is caused by batch jobs which can be run at off-peak hours to reduce workload.

Another graph that the OpenVMS administrators find useful is a chart of message rates by protocol. An example of this chart, shown in Figure 11, shows that DECnet protocol has the highest message rate. This indicates that the traffic byte rate shown in Figure 10 is generated by DECnet traffic. DECnet traffic is typically caused by intra-OpenVMS communication.

The analysis capabilities provided with SAS/CPE Software enable the OpenVMS administrators to not only determine the cause of problems that occur today, but prevent problems from occurring in the future.
Using a variety of examples drawn from our complex multi-vendor networked environment, we have demonstrated ways that SAS/CPE software can meet the needs of today's complex information systems organizations.

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