The SAS Multiuser Interactive System in Version 6 of the SAS System
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ABSTRACT
The SAS Multiuser Interactive System in Version 6 of the SAS System allows an alternative to running the SAS system under ICCF. This approach enables the SAS System running in a single region to service multiple terminal users, workstation users, or both. Benefits include better memory utilization, increased capacity for interactive users, and faster response time.

This paper addresses the design considerations of the SAS Multiuser Interactive System. Included are discussions of the management of multiple users, the VTAM Interface, asynchronous processing, the relationship to CICS, and extensibility issues.

INTRODUCTION
The SAS Multiuser Interactive System provides the capability for running multiple online users on one copy of Version 6 of the SAS System under the VSE operating system. This allows more efficient use of VSE system resources and the ability to exploit the strengths of Version 6 of SAS software. Also, SAS Institute is positioning the SAS System to take advantage of the significant enhancements that IBM is considering for VSE. The Multiuser Interactive System is included in base SAS software for the SAS System under VSE. Version 6 of the SAS System under VSE does not support execution under ICCF.

HISTORY AND STRATEGY
The Approach to the SAS System under VSE before Version 6
Prior to Version 6, the SAS System was implemented under ICCF for interactive usage. There were several reasons for this. First, the VSE operating system imposed severe functional limitations. Also, the SAS System architecture at the time favored an ICCF implementation. Additionally, SAS Institute did not have the development resources to make architectural changes to the SAS System. These considerations are explained in more detail in the following sections.

VSE Version 1 Limitations and Restrictions
When the SAS System under VSE was developed, the VSE operating system had many more limitations than it does today. The state-of-the-art release of VSE was 1.3.0. This release and subsequent releases of VSE Version 1 provided only one 16-megabyte address space to contain all partitions and the operating system itself. A partition was required for POWER, the VSE spooling subsystem. If a VTAM network was desired, VTAM would run in another partition, usually requiring 2 to 4 megabytes of virtual storage. The remaining address space could then be divided between interactive partitions and batch partitions. Interactive partitions usually ran either a pure CICS system or a combination CICS/ICCF system. If ICCF was desired, the partition was further subdivided into a subpool area for CICS transactions and pseudo-partitions for ICCF interactive jobs.

Figure 1 SAS System Version 5 / VSE Version 1

One way to relieve the memory shortage was to run multiple copies of the VSE operating system. This required either more software or more hardware. By running VM, additional VSE operating systems could be run as guest virtual machines. Or, additional processors could be obtained and VSE could be run on each processor. Assuming the money was available for these acquisitions, there was still a limitation. VSE Version 1 allowed only four copies of the operating system to share the LOCK FILE, which manages the sharing of disk packs.

These limitations in the VSE operating system made it impossible to implement the SAS System as a VTAM application. The implementation of the SAS System could not require a separate partition. The SAS System would have to run in an established interactive environment, either as a CICS transaction or in an ICCF pseudo-partition.

The SAS System's MVS TSO Orientation
The first release of the SAS System under VSE was built upon the SAS System, Release 79.6. At that time, the architecture of the SAS System was based on running under MVS and using TSO for the Interactive environment. Under TSO, the interactive user was given a protected region of a fixed size for the application to use. TSO provided each user with a unique region usable only by the user to which it is assigned. The SAS System knew that it could obtain as much memory in the region as it needed without affecting other users. A feature of TSO allowed a program written for batch execution to run interactively, with unit record input (card images) and output (print lines) directed to or from the terminal without programming changes. The SAS System exploited this feature for line-mode execution. Also, the SAS System was written in a conversational manner, which means that it remained active while communicating with the terminal user. Furthermore, the data areas and control blocks of the SAS System contained many pointers, which were saved as addresses.

Because of these characteristics, it became obvious that a CICS implementation for VSE would require major architectural changes.
to the SAS System. The ICCF environment on VSE had many of the characteristics of the TSO environment, and therefore the implementation would be much more straightforward.

Development Resource Limitations
The first release of the SAS System under VSE was implemented by a single developer. This occurred at the time that SAS Institute had about 200 to 250 employees. At that time, the resources were not available to pursue a radically different approach to implementing the SAS System under VSE within a reasonable time frame. And, as previously mentioned, the VSE operating system did not provide many alternatives.

Alternative Approaches
SAS Institute considered several alternatives for implementing Version 6 of the SAS System under VSE. These included continuation of support in the ICCF environment, develop the SAS System as a native CICS application, or use other environments provided by third party software vendors. These were all rejected in favor of providing an environment exclusively for the SAS System.

Continuation of the ICCF approach
In 1987, SAS Institute began work on Version 6 of the SAS System under VSE. At that time, it was obvious that the SAS System could not continue running under ICCF. Many VSE users were either unwilling to run a VSE system with ICCF or provided ICCF only to support text editing and the Interactive User Interface. Among the sites with ICCF, many did not want to reserve pseudo-partitions large enough for use by the SAS System. And, even when ICCF is configured with large pseudo-partitions, you are limited by the virtual memory constraints to providing three pseudo-partitions or less.

Experience with earlier releases of the SAS System under VSE has indicated a number of usability restrictions in the ICCF environment. Many of these have had to be circumvented or tolerated. In some cases, ICCF code had to be modified to allow full functionality of the SAS System. ICCF also has an impact on CICS. Many sites have finely tuned CICS systems and cannot tolerate the impact that ICCF places on the system.

At recent GUIDE meetings, IBM has indicated a lack of interest in ICCF. Their current strategy includes encouraging users to perform interactive tasks, such as text editing, on intelligent workstations and use IWS support to transfer data to and from VSE. IBM has no plans to enhance ICCF or provide a similar alternate environment.

Implementation as a Native CICS Application
SAS Institute considered implementing Version 6 of the SAS System as a CICS application under VSE. This was appealing for many reasons. First, it would position the SAS System to run in the interactive environment preferred by a majority of VSE sites. Also, it would be portable among the major IBM mainframe operating systems (VSE, MVS, and CMS) and OS/2. And as a CICS application, the SAS System could share resources among multiple users and with other online applications.

Version 6 of the SAS System, however, is still conversational rather than transaction oriented. The number crunching required by many of the SAS procedures does not lend itself to transaction processing. Pointers to data areas and pointers to functions are used throughout the software. Also, the C language, used for at least 95% of the code, did not lend itself to CICS applications when Version 6 implementation began.

Although the SAS MultiVendor Architecture™ (MVA) makes it possible to host the SAS System under CICS, the impact of the SAS System on CICS resources would be unacceptable. Because of the drawbacks previously listed, the SAS System could not be written in the pseudo-conversational manner which maximizes CICS performance. Many programs, some quite large, would be required to be resident in memory for long durations. Data areas could not be rolled out of memory. And some SAS procedures would take a disproportionate share of processing power, thereby degrading performance of other CICS applications. For these reasons, SAS Institute decided against an implementation of the SAS System as a CICS application.

Other Environments from Third Party Vendors
Other environments, provided by third party software vendors, were not considered. SAS Institute did not want to require a prerequisite product in the VSE environment because this would reduce the market potential. Another approach would be to support several environments, but this cannot be cost justified at this time.

The SAS Multiuser Interactive System Approach
Having eliminated standard online environments, SAS Institute continued to search for an approach to Version 6 that would allow VSE sites to use the SAS System to its maximum potential. Since many benefits of Version 6 are utilized by interactive users, such as the windowing system, a solution had to be found. The solution is the SAS Multiuser Interactive System.

IBM's New Opportunities for VSE Users
In the days of the initial development of the SAS System under VSE, the operating system was too restrictive for an approach requiring a dedicated address space to run the SAS System. However, IBM has enhanced VSE and SAS Institute is utilizing these enhancements. With VSE Version 2, the LOCK file now supports up to 32 concurrent systems sharing disk space. Support of up to nine address spaces is provided by VSE Version 4. These enhancements make it feasible to dedicate a partition, utilizing an entire address space, to the SAS System for use by all interactive SAS users. Figure 2 illustrates this concept.

Figure 2  SAS System Version 6 / VSE Version 4

Future directions for the VSE operating system, which are discussed later, indicate that this approach positions the SAS System in the mainstream of IBM's strategy for VSE, as indicated at recent GUIDE meetings.
SAS Institute Meets the Challenge

The SAS Multiuser Interactive System is being developed as a result of SAS Institute's increased investment in research and development. The Institute has grown to about 2000 employees, and there are now nine developers working exclusively on hosting the SAS System on the VSE operating system. Much effort was used to design the SAS MultiVendor Architecture, which provided the efficiencies necessary to undertake this new approach. MultiVendor Architecture allows the host dependent code to be isolated, allowing development of host code to occur independent of the portable components of the software.

The SAS MultiVendor Architecture Benefit

To conform to SAS MultiVendor Architecture, the core and applications layers must use the same source code for all hosts. The SAS Multiuser Interactive System conforms to this requirement. Therefore, the majority of the code has been well tested on many host platforms. This insures a quality product and a timely release schedule.

VTAM Manages Terminal Communication

VTAM was chosen as the access method used to drive the terminals for the first release of the SAS Multiuser Interactive System. This allows the SAS System to be using a product that is in the mainstream of IBM's long range strategy. Since VTAM is included with the VSE/SP package at no additional cost, VSE sites will not have to acquire prerequisite software. IBM has made VTAM install automatically when the appropriate parameters are specified during VSE/SP installation. Since VTAM is available under MVS and CMS, the VTAM interface in the SAS Multiuser Interactive System can be moved to these hosts with little or no change if there is sufficient demand for this.

Multiple User Session Management

The main component of the SAS Multiuser Interactive System is the session management logic. This allows for better memory utilization, by pooling the memory resource for all SAS System users. Memory utilization is also enhanced by requiring one copy of each program to be shared by all users, even without placing them in the VSE Shared Virtual Area (SVA). Therefore, more users can execute concurrently than before. Also, response should be faster because programs which are heavily used remain in virtual storage and files common to all users are only opened once.

The session management logic is independent of the terminal management logic of the VTAM interface. This allows the SAS Multiuser Interactive System to provide support for terminals managed by other systems in the future. Thus, the SAS System is not locked into using VTAM exclusively.

MULTIUSER MODEL

Overview of SAS MultiVendor Architecture

The SAS MultiVendor Architecture comprises three separate and distinct layers. The applications and core layers compose about 90% of the SAS System code. These layers are source code portable across all hosts. This is the look and feel of SAS software is consistent across all host platforms.

The third layer is the host layer, which is implemented to exploit the features of the host platform. It contains the remaining 10% of the code and may be written in a combination of C and assembler language. Figure 3 shows the relationship of the layers of MVA.
The host layer on VSE also had to be expanded to accommodate all aspects of user management. It must handle log on requests from terminals, manage timeslicing between users, control orderly and forced termination of users, and allow orderly shutdown of the SAS System. The host layer must provide user isolation, so that problems caused by one user do not have adverse impact on other users.

VTAM Interface

The VTAM Interface provides terminal communications services for the SAS Multiuser Interactive System. Initially, LU0 (non-SNA) and LU2 (SNA) sessions between the SAS System and 3270 display devices will be supported. PCs and PS/2" workstations will be supported through these protocols. SASCONNECT software is also supported using the SAS Multiuser Interactive System.

Another function of the VTAM Interface is to manage log on events and other network events, such as terminal outage. When a network event occurs, an exit in the VTAM Interface is driven. The exit will perform some processing and schedule the SAS host supervisor task to take appropriate action.

VSE Console Operator Interface

Since multiple users share the system, a global control point had to be created to manage the SAS System. The VSE console operator subsystem provides for monitoring and controlling the system. Functions are provided to display current users, shutdown the SAS System, and force a user off the system.

EXTERNALS

Similarities

The SAS Multiuser Interactive System under VSE provides the same look and feel as Version 6 of the SAS System on other host platforms. The VTAM log on command for the SAS System can be defined at your installation to look like the command line of an interactive operating system. Thus, to log on to the SAS System, enter the following at your VTAM terminal:

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sas -d msg config=wrong config verbose
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The options shown here are passed to the SAS System as VTAM log on data. If overrides to SAS options are not needed, then simply typing sas would initiate the logon.

In the SAS Display Manager System, the full-screen user interface and window manager look and behave the same as with the SAS System under MVS or CMS. Common code is shared among the IBM mainframe hosts in these areas to provide an identical look and feel. This is also compliant with Common User Access (CUA) requirements of IBM's Systems Application Architecture (SAA).

Terminal characteristics used by the SAS System are obtained in a transparent manner, as was the case with previous releases. The SAS Multiuser Interactive System obtains information about the terminal initially from the VTAM Logmode table entry associated with the log on request. Usually, the systems programmer has assigned an appropriate logmode to the terminal, which is assigned to the session by default. You can also override the logmode on the VTAM log on command. If the terminal can be queried, as indicated in the logmode entry, the SAS System will obtain additional information from a terminal query request.

Line-mode operation of the SAS System has the same look and feel as on other host platforms running Version 6. Prompting and output formatting is handled in a consistent manner.

SASCONNECT software (the micro-to-host facility) is supported in the SAS Multiuser Interactive System. The Multiuser Interactive System is an excellent environment for the micro-to-host facility because of the reduced resource requirements.

The SAS Multiuser Interactive System enables you to select the mode of operation from your terminal or workstation. Line-mode, display manager mode, and micro-to-host mode sessions are supported concurrently within a single copy of the SAS System.

Differences

No Interference from ICCF

If you are familiar with running the Version 5 of the SAS System under VSE, the major difference you notice with the SAS Multiuser Interactive System is the removal of interference of ICCF. You will no longer see the message "PARTIAL END PRINT BEFORE FULL SCREEN WRITE" or "BG IN PROGRESS - INPUT IGNORED". The full support of specialized terminal data streams allows better utilization of the features of a variety of display terminals.

When running the SAS Multiuser Interactive System, the host layer code is pre-initialized and remains up as long as the SAS System is to remain available. Log on requests establish a session between the SAS System and a terminal. A user who terminates a SAS session can log on to other VTAM applications, such as OCS, from the same terminal. Previously, a private copy of the SAS System was loaded and initialized when the SAS session began.

The SAS Multiuser Interactive System does not provide an interactive command language environment. TSO provides CLISTs and CMS provides EXECs to set up parameters and allocations for SAS sessions. Even ICCF provides similar, although more restrictive, functionality. The SAS multiuser environment is similar to CICS in that file allocations are placed in the JCL used to start the job. Research is ongoing to build facilities normally found in a command language environment into the SAS Multiuser Interactive System to minimize the impact of the lack of a command language.

Options Processing

Options for the SAS System were previously grouped as configuration options, which could only be specified at invocation time, or system options, which could be specified at invocation time or in an OPTIONS statement. The SAS Multiuser Interactive System adds a third level, global options, which must be specified when initializing the host layer code prior to a user log on. Global options cannot be specified by a terminal user at log on or in an OPTIONS statement.

An example of a global option is the APPLID= option, which specifies the application name to identify the SAS System to VTAM.

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In Version 5 of the SAS System, default options were established with the SETINIT procedure, and overrides could be provided by using a special copy of the main SAS phase which reads the initial input statement as invocation options under ICCF. The SAS Multi-user Interactive System provides default options and overrides from several sources. The system CONFIG file and the PARM= parameter on the // EXEC JCL statement provide global options and default values for all users for configuration and system options. Options on the // EXEC PARM= parameter override those from the CONFIG file. When you log on you can specify a user-specific CONFIG file plus additional options on the log on command line. The user CONFIG file and command line options override those previously specified, with the command line having highest priority. The following list shows the precedence of options:

1. user command line options
2. user CONFIG file options
3. options from // EXEC PARM= parameter
4. system CONFIG file options
5. system implied defaults for options.

There are several new options for the SAS Multiuser Interactive System. The APPLID= and PASSWORD= options are used as parameters for the SAS System to identify itself to VTAM. These options permit several SAS Multiuser Interactive Systems to be active concurrently on the same system. Options are provided to tune the system for your particular needs, especially in the areas of memory management and file management.

Systems Programming and Operations
The console interface subsystem is completely new. This allows the VSE console operator to monitor and control the SAS System. Major commands include

- DISPLAY displays users logged on to the SAS System
- LOGOFF forces a specified user off the SAS System
- SHUTDOWN brings down the SAS System
- HELP displays a menu of SAS System console operator functions

Screen 1 shows a sample VSE operator console session with the SAS Multiuser Interactive System.

Your systems programmer has to set up an APPL entry for the SAS System in an applications major node. This is easy to do and can be implemented for testing without the need to bring VTAM down. The VTAM terminal definitions may need to be reviewed to insure compatibility with the requirements of the SAS System, but few, if any, changes should be needed. VTAM terminal definitions provided by VSE/SP are compatible with the SAS System.

File and SAS Data Library Considerations
The disposition of a SAS data library is no longer implied by the first character of the library name. The default disposition will be OLD, allowing you to update an existing library. To override this disposition, specify the DISP= parameter in a LIBNAME statement within your current SAS session. Also, a numeric suffix on the library name, which used to indicate a VSE logical unit, is no longer necessary. The SAS System automatically determines the VSE logical unit for all SAS data libraries and external files, except for libraries and files on unlabeled tapes. A parameter is provided for the LIBNAME, FILENAME, FILE, and INFILE statements to identify the library or file as one that resides on an unlabeled tape and to provide the VSE logical unit of the tape drive. UPSI switch settings no longer have any meaning to the SAS System.

SAS data library and external file sharing considerations may be somewhat different than in Version 5 of the SAS System under VSE. SAS Institute intends to provide, at a minimum, the same level of file sharing in the SAS Multiuser Interactive System. Research is ongoing to develop file sharing strategies that provide more functionality than before.

INTERNALS

Memory Model
Memory is a global resource in the SAS Multiuser Interactive System. Rather than being partitioned by user, as TSO, CMS and ICCF do, memory is obtained from global pools based on the needs of the users running on the system at any time. The system does partition memory into two pools, one for data areas and another for program phases. In this way, the system prevents itself from becoming overrun with either programs or massive data areas. The system chooses an appropriate default for the pool sizes, based on partition size. An option will be provided to allow tuning at your site. Figure 5 illustrates the layout of the SAS Multiuser Interactive System partition.
Most of the memory in the partition is preallocated to these pools at initialization time. This provides a performance enhancement, since the SAS System is not constantly using VSE's memory allocation facilities. The SAS System's memory management subsystem provides common management of these pools for all users.

Reentrant Program Phases
All program phases for the SAS Multiuser Interactive System are fully reentrant and managed by a global program management subsystem. This allows one copy of a program to service multiple users concurrently. Thus, the incremental increase in memory required for a second or subsequent user is far less than for the first user. Therefore, more users can operate interactively.

It is not necessary to place program phases in the SVA to share them among online users. The SAS System can share them even when they reside within the SAS partition. Program phases may be placed in the SVA to allow sharing between the SAS Multiuser Interactive System and batch SAS jobs, or between multiple SAS multiuser systems.

The program management subsystem of the SAS System is designed to improve performance by allowing programs which are no longer needed to remain in memory. Subsequent requests for the programs do not require reloading the phases from the VSE librarian. Purging of unused programs occurs when the program pool is full and other programs are needed. And to further enhance efficiency, some components are only loaded if users request certain features or facilities. Thus, the overhead of loading is reduced if some features are not used.

Tasking Model
Task Manager
The SAS MultiVendor Architecture requires the host layer to provide a tasking management subsystem. Task management provides two functions. First, the task is the owner of resources such as memory, program phases, and files. Second, all tasks can execute concurrently and independently. Components of the SAS System are written to execute as concurrent tasks, which may synchronize with each other at various times.
ing of operator commands, but allow the host supervisor higher priority for completing resource cleanup at the user and task level.

**VSE Operating System Tasking**

All SAS tasks listed above are dispatched by a pseudo-task manager running under the main VSE task in the partition. This allows the SAS System to maintain control over the dispatching and synchronization of SAS tasks. Also, the VSE operating system has restrictions on the number of VSE subtasks - a maximum of 31 subtasks in the partition or 208 in the entire VSE system.

Some operations require the use of VSE subtasks to allow the SAS Multiuser Interactive System to operate efficiently. These are functional subtasks, which perform a specific service for the SAS System. A VSE subtask is provided to issue the PUTR macro for communicating with the console operator. IBM implemented the PUTR macro to run in a synchronous manner. By moving this request to a subtask, the main VSE task can continue to service interactive users while the console interface task waits for input from the console operator. Another functional subtask is used to open files for the SAS System. VSE does not provide a return code from the OPEN macro whose referenced control block is a DTF. If this type of open fails, the VSE task requesting the OPEN is canceled. By moving the OPEN request to a subtask, the subtask can be canceled and the main task continues to run and is notified of the failure. Thus, error recovery is graceful and all users remain running. Other functional subtasks will be added as needed.

VSE operating system exits are utilized for detection of external asynchronous events. VTAM provides several exits to notify the SAS System of network events such as terminal log on, terminal failure, and VTAM shutdown. The SAS System also uses the STXIT macro to establish exits for operator communications and program check interception. Whenever an exit is driven by VSE, the SAS System sets up a corresponding event to be handled by the SAS pseudo-task manager. This allows the most efficient processing of asynchronous events.

**Asynchronous processing**

To allow truly optimal performance in the SAS Multiuser Interactive System, asynchronous services are provided in the SAS pseudo-task manager. Most VTAM and SAS data library I/O requests are scheduled asynchronously. These requests are always routed through a SAS pseudo-task running under the main VSE task. Rather than issue a VSE WAIT macro, the SAS dispatcher allows another SAS task to resume execution. In this way, all users and tasks are serviced. During periods of low activity, the dispatcher may issue a VSE WAITM macro to wait for one or more outstanding asynchronous requests to complete. Upon completion of an event, the dispatcher resumes the SAS task associated with that event. Thus, the SAS System is interrupt driven, making most efficient use of processor time while providing maximum response time.

**VTAM Interface**

Service Functions to Interface with VTAM

The VTAM interface provides terminal communications functions, such as OPEN and CLOSE for the ACS, accepting terminal log on requests, freeing the terminal, sending data to the terminal, and receiving input from the terminal. It also manages session protocols. The SAS Multiuser Interactive System allows VTAM to perform buffering operations, which reduces the amount of virtual storage needed in the SAS System's partition.

**Line-Mode Formatting and Screen Control**

For line-mode processing, a pair of functions is provided to write lines of output and read lines of input. Traditionally, the operating system environment provides facilities such as ICF or TSO to manage line by line processing. The SAS Multiuser Interactive System does not have this type of environment, so the VTAM interface provides it. These functions format simple data streams and manage line placement on the terminal. Alternate screen size, if supported, is used, based on information from the logmode table entry. Extended data stream is not used, since the line mode facilities are intended to be quick and efficient. When all users are running in line mode exclusively, the full-screen user interface is not loaded in memory. A line-mode session may invoke a full-screen SAS procedure, and a mix of line-mode and display manager users may coexist in the SAS System.

**Exits for Network Events**

Another part of the VTAM interface are the VTAM exits. As previously mentioned, these exits allow notification of external asynchronous events. The major VTAM exits used are the LOGON, TPEND, and LOSTERM exits, which service terminal log on, VTAM outage, and terminal outage, respectively.

**Isolated Subsystem**

The VTAM interface is an isolated subsystem within the SAS Multiuser Interactive System. This allows the SAS System to provide alternative terminal support in the future. Also, this isolation of the terminal manager allows a mixed terminal environment, where different terminal facilities can be used to access the same SAS System.

**Batch Mode**

**Shared Code**

While the SAS Multiuser Interactive System brings you a better VSE online environment and the power of Version 6 of the SAS System, SAS Institute is committed to maintaining a full function batch implementation of Version 6. To ensure continued reliability, the batch and online versions of the SAS System are contained in common code. Therefore, you get consistent results in both environments.

**Code for Interactive Use Not Loaded**

In batch processing, the part of the code that supports online processing is not loaded. This includes the VTAM interface and full-screen user interface subsystems. The majority of the code is used for batch and online, and very few run-time decisions are made to provide alternate processing based on run-time environment.

**EXTENSIBILITY AND FUTURES**

**Relationship to CICS**

**SAS System and CICS Run in Separate Partitions**

The SAS Multiuser Interactive System was designed to run in a separate partition from CICS. As previously discussed, the resource requirements of the SAS System would have an adverse impact on a CICS system. As separate jobs, the SAS System and CICS system have little impact on each other. The systems programmer can assign relative priorities to these jobs to meet the site's requirements.

**VTAM Allows Easy Switching Between the SAS System and CICS**

You can switch between the SAS System, CICS, and any other VTAM application by using the facilities of VTAM. Since VTAM owns the terminals, the terminal user can select the application. The VSE/SP Interactive User Interface provides a function named REMOTE APPLICATIONS, which makes the CICS give the terminal back to VTAM. This function is invoked from the sign-on screen by
pressing the PF4 key. The SAS Multiuser Interactive System automatically releases the terminal to VTAM when you enter the BYE command or ENDSAS statement.

CICS Interface Possible in Future

In the future, if there is enough demand, SAS Institute may provide an interface to CICS. The SAS Multiuser Interactive System would continue to run in a separate partition from CICS. CICS would be used to own the terminals and provide sign-on security. The majority of the processing would still be done in the SAS System partition. A small CICS application would be provided to run as a transaction to send terminal input data streams to the SAS System and to receive output from the SAS System and pass it to CICS to be displayed on the terminal.

SAS/SHARE® Software

No History of SAS/SHARE Software under VSE

SAS/SHARE software, which allows multiple users concurrent access for updating SAS data libraries, has never been offered on the VSE host. Therefore, implementation of this facility will occur after all features and products currently offered in Version 5 of the SAS System are complete.

Minimum Commitment for Sharing SAS Data Libraries

The minimum commitment for the first release of the SAS System under VSE is the same level of sharing SAS data libraries as existed under Version 5 of the SAS System. Only one user can update while multiple users read the SAS data library concurrently.

Future: Multiple Online Update with Locking

Research is ongoing to provide a more incremental level of sharing SAS data libraries. This would involve locking pages or observations in the library, thereby allowing concurrent update capabilities within the SAS Multiuser Interactive System.

A Real SAS/SHARE Server

A SAS/SHARE server may be incorporated into the SAS Multiuser Interactive System to allow concurrent update between online users and batch jobs. This would provide an enterprise system solution which services local and remote users using all combinations of terminals, personal computers and workstations, and batch processing.

VSE Enhancements

IBM is demonstrating a renewed commitment to the VSE operating system, which provides SAS Institute with opportunities for enhancements to the SAS Multiuser Interactive System. In VSE Version 4, VTAM Release 3.2 is supported, which provides the Advanced Program to Program Communications (APPC) component of Systems Application Architecture. This can be used by CICS Inter-System Communications (ISC) to allow the SAS System to provide an interface to use CICS terminals. VSE 4.1.1 was made available at the beginning of 1990.

Removing VTAM and POWER from Shared Area

VTAM and POWER will be removed from the shared address space in the next release of VSE. This alone will provide an additional 4 megabytes of virtual memory in all private address spaces. In turn, the SAS Multiuser Interactive System will benefit from this increased memory by allowing more users to run concurrently, and allowing more program phases to reside in virtual memory.

IBM has offered an interim solution to allow VTAM to be removed from a private address space. This should be avoided if you intend to run the SAS Multiuser Interactive System. The interim solution requires a terminal owning CICS system and all other VTAM applications to reside in the same address space as VTAM. This will decrease the amount of virtual storage available to the SAS System, severely limiting its capacity.

VSE Future Environment

IBM has described a strategy at GUIDE and at VSE user briefings to develop Enterprise Systems Architecture (ESA) facilities for VSE. A future version of VSE will eventually support up to 200 address spaces, each of which is equivalent to a partition. 31-bit addressing will also be supported, thereby allowing 2 gigabytes of virtual memory. Also, data spaces will be supported, which will increase virtual storage to hold data areas. These enhancements will provide relief from virtual storage constraints that have hindered VSE for years. And the SAS Multiuser Interactive System is positioned to utilize these facilities for better response time and increased capacity for online users.

OTHER HOSTS

Concept Can Be Generalized for Other Hosts

The SAS Multiuser Interactive System was created because of a necessity to provide online support in a VSE environment. The virtual memory constraints and limitations of ICF require SAS Institute to provide a new facility for the SAS System. The concepts of the SAS Multiuser Interactive System can be generalized for use on other host platforms. This would allow the framework for a computer server system, where workstations and terminals format the display but intense computations and data management can be done on a larger machine or at a central site. The SAS Multiuser Interactive System provides an excellent environment for remote processing when using SAS/CONNECT software. The VTAM interface is portable to MVS and CMS, since these environments support VTAM and the application interface is the same.

Potential Portable Implementation

SAS Institute will study the feasibility of providing a portable implementation of the SAS Multiuser Interactive System. This would facilitate the implementation across all host platforms and provide greater efficiency of execution. The SAS supervisor could manage the users on the system, and could maintain data areas with less redundancy. Also, this approach provides consistency across all host platforms.

CONCLUSION

Your input is always important to us at SAS Institute. In the past, you have indicated that it is not feasible or practical to run the SAS System under ICF. The SAS Multiuser Interactive System addresses this problem by providing a central SAS System to service multiple terminals and workstations. The SAS Multiuser Interactive System is positioned to utilize IBM's current and future strategy, including VTAM, ESA, and SAA. SAS Institute is providing a strategic applications system environment, which includes a windowing system for nonintelligent terminals, a built-in text editor, and a full set of fourth generation application development tools.

As our research and development of this facility continues toward our initial release in 1991, we look forward to your input and suggestions. If this approach does not meet your needs, or if you desire different functionality, please let us know at your earliest convenience.

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