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IBM System/360 Operating System:

Time Sharing Option Guide

This publication describes the concepts, features and implementation of TSO, a general purpose time-sharing facility operating under the MVT configuration of the control program. This manual is intended for those who design, generate, and maintain a TSO installation. Topics discussed are:

- The capabilities and advantages of time sharing in general and TSO in particular.
- The programming languages and system facilities available to a TSO terminal user.
- The system configurations TSO requires.
- How to generate and maintain a TSO system.
- The Program Products available with TSO.

The prerequisite publication is:

IBM System/360 Operating System: MVT Guide, GC28-6720.

| Fourth Edition (June, 1971)

| This is a major revision of, and obsoletes, GC28-6698-2. Changes to text and illustrations are indicated by a vertical line to the left of the change.

This edition applies to release 20.1, of IBM System/360 Operating System, and to all subsequent releases until otherwise indicated in new editions or Technical Newsletters. Changes are continually made to the information herein; before using this publication in connection with the operation of IBM systems, refer to the latest IBM System/360 SRL Newsletter, Order No. GN20-0360, for the editions that are applicable and current.

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Preface

The Time Sharing Option is a general purpose time-sharing facility for the MVT configuration of the operating system. This manual is an introduction to TSO for the system manager, system analyst, and system programmer. It helps those with system responsibilities to evaluate the capabilities of TSO, and to design and implement a TSO configuration.

The first part of this publication is a functional description of TSO, covering:

- The advantages of a time-sharing system, the system environment required for TSO, the relationship of TSO to the operating system, and the capabilities of the command language.
- The facilities available through the command language.
- The facilities available through IBM Program Products for TSO.

The last three chapters of the manual give implementation planning information:

- A discussion of the TSO routines that have been added to the MVT control program.
- A discussion of implementation techniques.
- A discussion of TSO storage requirements.

There are four appendixes.

- A list of the TSO commands by function.
- A list of the IBM Program Products available for TSO users, and references to further documentation for them.
- A list of the Time Sharing Driver Entry Codes.
- A list of terminal messages requiring installation action.
- A glossary of terms.

Readers interested in the implementation of the system should be familiar with the information in:

IBM System/360 Operating System:

MVT Guide, GC28-6720.

Planning for the Telecommunications Access Method (TCAM), GC30-2020.

Storage Estimates, GC28-6551.

TCAM Programmers Guide and Reference Manual.

For more detail on specific components or subjects discussed in this publication, the following publications may be of interest.

For system operation and management:

IBM System/360 Operating System:

Operator's Reference, GC28-6691.

System Management Facilities, GC28-6712.

For I/O devices and control units:

IBM 2701 Data Adapter Unit, Component Description, GA22-6864.

IBM Component Description, 2702 Transmission Control, GA22-6846.

IBM 2703 Transmission Control, Component Description, GA27-2703.

IBM 2741 Communications Terminal, GA24-3415.

IBM 1050 System Summary, GA24-3471.

IBM Component Description, 2260 Display Station -- 2848 Display Control, GA27-2700.

Program Product references are included in Appendix B.

Note: For planning purposes, this manual includes information for components and capabilities that have been announced for availability after the delivery date for the Time Sharing Option. See your local IBM representative for the availability dates for:

- TSO with Model 65 Multiprocessing.
- PL/I Optimizing Compiler Program Product.
- ASCII Capability for the TSO Data Utilities Program Product.
- OS PL/I Checkout Compiler.

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Illustrations

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Item	Description	
System Implementation	A section has been added describing the techniques used in implementing a TSO system. This section consists of discussions of: Generating a Message Control Program Writing Cataloged Procedures Used With TSO Specifying TSO System Parameters Tuning the Time Sharing Driver Writing Installation Exits for: The SUBMIT Command The OUTPUT, STATUS, and CANCEL Commands The LOGON Command	
Storage Estimates	Most of the information in the Storage Estimates section, including the sample TSO configuration, has been deleted and moved to the publication IBM System/360 Operating System Storage Estimates GC28-6551.	
Driver Entry Codes	An appendix has been added containing the format and meaning of the TSEVENT macro instructions used to notify the Time Sharing Driver of system events.	
Terminal Messages Requiring Installation Action	An appendix has been added containing messages which when received at a terminal requires the installation to take certain actions.	
Message Control Program Assembly Error Messages	An appendix has been added containing the text of error messages generated by the macro instructions used to generate the Message Control Program.	

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Item	Description	Areas Affected
TMP Step Library	A discussion of the advantages of concatenating Command Library to SYS1.LINKLIB, the Linkage Library.	20,74
OS PL/I Checkout Compiler	A discussion of the uses and facilities of the Checkout Compiler.	35-36
2260,2265	The macro instructions for generating the MCP have additional operands for 2260 and 2265 support.	63-69

The IBM System/360 Operating System Time Sharing Option (TSO) adds general purpose time sharing to the facilities already available through the MVT configuration of the control program. As a result, the system provides a number of new capabilities:

- It gives users access to the system through a command language which is entered at remote terminals -- typewriter-like keyboard-printer or keyboard-screen devices connected through telephone or other communication lines to the computer.
- It gives those who may not be programmers the use of data entry, editing, and retrieval facilities.
- It makes the facilities of the operating system available to programmers at remote terminals to develop, test, and execute programs conveniently, without the job turnaround delays typical of batch processing. Both terminal-oriented and batch programs can be developed at terminals.
- It allows the management of an installation to dynamically control the use of the system's resources from a terminal.
- It creates a time-sharing environment for terminal-oriented applications. Some applications, such as problem-solving languages, terminal-oriented compilers, and text-editing facilities, are available as IBM Program Products. Installations can add others suited to their particular needs.

A major consideration in the design of TSO is ease of use. The way in which a user communicates with the system can be kept simple to encourage people who may not be programmers to take advantage of the speed and versatility of a computing system to solve their problems. There are four ways in which TSO achieves this goal:

- The physical medium is easy to use. Most users are already familiar with the conventional typewriter keyboard. Information is easy to enter through the terminal's typewriter-like keyboard, and no complex procedures are required to obtain output from the computer.
- The way in which a terminal user defines his work is uncomplicated. He enters commands which resemble English language words to describe the general function he wants to accomplish. If the user chooses, he can create his own commands and command system.
- If a user doesn't know how to define his work to the system, he can type HELP and receive information pertinent to the type of operation he is trying to perform. In most cases, he doesn't need to enter detailed parameters describing every aspect of the work he is doing; the system uses default values that are appropriate for most jobs. If he fails to provide parameters the system needs to do the work he requested, the system will ask him for the missing information, item by item, by "prompting" him for it in a conversational way.
- The system keeps the terminal user aware of what is happening, so he knows what to do next. He "converses" with the system on a step-by-step basis. The system lets him know when it is ready to accept input from him, and it tells him immediately when there has been a change in the status of his program or when an error has occurred. He may interrupt the processing of his program at any time. If the user receives a message he doesn't understand, he can request more information about the situation simply by typing a question mark. The messages he receives use uncomplicated language to describe the situation. When the messages become familiar to him, he may request the system to use the abbreviated messages that are available with some of the programming languages.

Advantages of a Time Sharing System

In a simple batch processing system, one job at a time has access to the resources of the system (main storage, the central processing unit, and I/O equipment). A programmer's job is loaded into the computer and its operation is controlled by the system operator. The job acquires the resources it needs as it runs to completion; resources the job doesn't need are unused. When the job is finished,

results are produced, a new job is loaded and executed, and the output for the completed job (for example, a printout) is sent to the programmer. An inherent problem with this type of processing is turnaround time, the elapsed time between the submission of a job to the computer center for processing and the return of results to the programmer. Another problem is the inefficient use of resources.

In a multiprogramming system (e.g., a system that operates under the control of the MVT configuration of the System/360 Operating System), several jobs share the resources of the system concurrently, so the use of resources is much more efficient. Although jobs are processed faster, the operator at the system console still controls the system, and the programmer still must wait for results to be returned to him.

A time sharing system reduces delays in receiving results. A larger number of jobs share the resources of the system concurrently, and the execution of each job is controlled primarily by a remote terminal user. Thus, time sharing can be defined as the shared, conversational, and concurrent use of a computing system by a number of users at remote terminals.

The system resources shared by the time sharing jobs (foreground jobs) entered from the terminals are also shared by batch jobs (background jobs) that are being processed at the same time. Each foreground main storage region handles many active foreground jobs, although only one job is actually in the region at any moment in time. A foreground job is assigned to a main storage region and has access to the system's resources for a short period of time called a time slice. The other foreground jobs assigned to that region are saved on auxiliary storage while the job being executed in main storage receives a time slice.

At the end of the job's time slice, or if the job enters the wait state for terminal I/O, the main storage image of the job (that is, programs, work areas, and associated control blocks) is stored on a direct access device and another job is brought into the same region of main storage and given a time slice. TSO schedules a similar time slice for each ready foreground job. The apportionment and duration of time slices is discussed in detail in the "System Summary" section of this manual.

The process of copying job images back and forth between main and auxiliary storage is called swapping. Writing an image to auxiliary storage is a swap out; reading one into main storage is a swap in.

All foreground jobs are assigned the same priority. The order in which foreground and background jobs are processed is determined by the operating system task dispatcher. Job priorities, job classes, and the dispatching of tasks are discussed in IBM System/360 Operating System: Concepts and Facilities, GC28-6535.

The apportionment of slices of processing time to foreground jobs is not apparent to a terminal user. At the terminal, the response of the system to requests for action is fast enough so that he has the impression that he is the sole user. As far as the user is concerned the distinctive feature of a time-sharing system is the way in which it "converses" or interacts on a step-by-step basis with him as he does his work. He is prompted for information the system needs to execute his job, he receives immediate responses to his requests for action, and he is notified immediately of errors the system detects, so that he can take corrective action at once.

In general then, a time-sharing system differs from a batch processing system in three ways:

1. A terminal user concurrently shares the resources of a computing system with other terminal users.

2. A terminal user can enter his problem statements and other input into the system as he develops them, and he receives immediate results. Thus the problem of turnaround time (the amount of time between when he submits his job for processing and when he receives results) inherent with batch job operations is greatly reduced.

3. A terminal user is constantly aware of the progress of his job. He requests results from the system one step at a time, he is prompted for any additional information the system requires, he receives immediate notification of the status of his work, and he is apprised of errors as soon as the system detects them. The terminal user can change his problem statements or correct errors immediately after entering each statement or at any time during the current terminal session. Thus, he minimizes the need for reruns.

Using a Terminal

A terminal session is designed to be an uncomplicated process for a terminal user: he identifies himself to the system and then issues commands to request work from the system. As the session progresses, the user has a variety of aids available at the terminal which he can use if he encounters any difficulties.

Commands specifically tailored to an installation's needs can be written and added to the command language or used to replace IBM-supplied commands.

Starting and Stopping a Terminal Session

When the user has some work to perform with the system, he dials the system number if he has a terminal on a switched line, or he turns the power on if he has a terminal on a non-switched line. A switched line is one in which the connection between the computer and a terminal is established by dialing the system's number from the terminal. A non-switched line is one with a connection between the computer and the terminal. With an IBM 2741 terminal or an IBM 1050 terminal, the system responds by unlocking the keyboard. In any case, the user identifies himself by entering "LOGON" and one or more of the following fields:

- A user identification, for example, the user's name or initials, which the system will use to identify his programs and data sets.
- A password assigned by his installation, usually known only to the user and the system manager.
- An account number, which defines the account in which his system usage totals are to be accumulated.
- A LOGON procedure name, which identifies a cataloged procedure that specifies what system resources he will be using.

The user may omit the last three fields if the system manager has defined only one account number and LOGON procedure for him and no password is used.

The LOGON processor verifies that the user is an authorized TSO user, then checks the password, if it is required, and account number in a record it keeps of user attributes, called the User Attribute Data Set (UADS). From the attributes, the LOGON command operands, and a LOGON cataloged procedure, the system builds a user profile, which is used to control the processing of his job. The system assigns the user's job to a time-sharing (foreground) region of main storage and allocates other resources, such as auxiliary storage space and user data sets according to the LOGON procedure.

LOGON marks the start of a terminal session. When the user completes his work, he enters "LOGOFF" to end the session. The system then updates his job's system use totals, releases resources allocated to it, and releases the terminal from TSO. A session is also terminated any time the terminal user enters LOGON to start a new session. In this case, the old session is terminated and a new one is begun; the terminal is not released in the process.

Working at the Terminal

The user enters commands to define and execute his work at the terminal. He enters a command by typing a command name, such as EDIT and possibly some additional operands. The system finds the appropriate command processor--a load module in a command library--and brings it into the foreground region assigned to the user for execution. For example, in response to entering the EDIT command, the system brings in the EDIT command processor, the data handling routine used to create and update data sets.

If a user does not enter all the operands associated with a particular command name, default values are assumed where possible. If necessary operands are missing, the system prompts the user for them with a message such as "ENTER DATA SET NAME." The user can reply with the missing value, or enter a question mark for a further explanation of what the system needs. If the user chooses, he can specify that prompting messages be suppressed.

A terminal user can also receive assistance through the HELP facility. He can request information regarding the syntax, operands, or function of any command, subcommand, or operand. If he enters HELP followed by a command name, he receives an explanation of the command and the operands required with it. HELP followed by a subcommand name furnishes an explanation of the subcommand if you are working with the command at that time. Entering HELP by itself returns a description of the command language, a list of the commands, and an explanation of how to use HELP to obtain further information.

During a typical session, the user enters a series of commands to define and perform his work. If the sequence is one that is used often, he can store the sequence in a data set and then execute the sequence whenever he needs it by entering the EXEC command.

The commands provided with the system handle data and program entry, program invocation in either the foreground or the background, program testing, data management, and session and system control. IBM Program Products are available to support problem solving, data manipulation, and text formatting, to provide terminal-oriented language processors, and to make these processors more convenient to use from the terminal.

System Configurations

TSO is an extension of the MVT configuration of the control program on System/360 Models 50 through 195, or System/370 Models 155 and 165. TSO also operates with the Model 65 Multiprocessing (M65MP) configuration. The minimum machine configuration for System/360 models must include 384K of main storage, the required I/O devices for MVT, plus at least one each of the following:

- A terminal (IBM 1050, 2741, 2260 Local or Remote, 2265, or Teletype[1] Model 33 or 35 KSR and ASR).
- A transmission control unit (IBM 2701, 2702, or 2703), unless all terminals are locally attached 2260 Display Stations.
- Sufficient direct access storage space (IBM 2301, 2311, 2303, 2305, 2314, or 3330) for command libraries and system data sets.
- Sufficient direct access storage space to swap data sets.

In a System/360 with 384K of main storage, TSO is, in effect, a "dedicated" time sharing system. In other words, with 384K the system can run as a time sharing system or as a batch job processing system, but not both at the same time. To run both time sharing and batch jobs concurrently or to execute on M65MP or System/370 models, at least 512K of main storage is required. At least 128K of main storage is required for system generation.

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[1]Trademark of Teletype Corporation, Skokie, Illinois.

Terminals

Some remote terminals suitable for interactive applications have keyboards for entering input data and either typewriter-like printers or display screens. A remote terminal incorporates or is attached to a control unit. The control unit is in turn connected to the system by either of two ways:

- Through a device such as a data set to a dialed (switched) line to the system.
- Through either a direct or a leased line to the system.

At the computer site the communication line connects to a Transmission Control Unit, which in turn is attached to one of the computer system's multiplexor channels. The IBM 2260 Display Station can be an exception to this general configuration. Its control unit, the IBM 2848 Display Control, can be attached directly to a multiplexor or selector channel. This mode of operation is called local attachment.

TSO uses the Telecommunications Access Method (TCAM) for terminal access. TSO provides terminal handling programs for the following terminals:

- IBM 2741 Communication Terminal.
- IBM 1050 Printer-Keyboard.
- Teletype[1] Model 33 and 35 KSR.
- IBM 2260 and 2265 Display Stations.

The IBM 2741 Receive Interruption Feature and the Transmit Interruption Feature are recommended for use with the 2741. These features are described in the publication IBM 2741 Communications Terminal. The Transmit Interrupt, Receive Interrupt, and Text-Timeout Suppression features are recommended for use with the IBM 1050. 1050 multidrop is not supported. These features are described in the publication IBM 1050 System Summary. Note that some of these features are not available through the IBM 2701 Data Adapter Unit.[2]

Transmission Control Unit

TSO requires at least one of the following transmission control units to handle terminal communications:

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[2]Terminals which are equivalent to those explicitly supported may also function satisfactorily. The customer is responsible for establishing equivalency. IBM assumes no responsibility for the impact that any changes to the IBM-supplied products or programs may have on such terminals.

- IBM 2701 Data Adapter Unit.
- IBM 2702 Transmission Control.
- IBM 2703 Transmission Control.

The Terminal Interruption Features are recommended for use with the 2702 and 2703 transmission control units and must be present if the terminals are to use the features. These units are described in the following publications:

- IBM 2701 Data Adapter Unit, Component Description.
- IBM System/360 Component Description, IBM 2702 Transmission Control.
- IBM 2703 Transmission Control, Component Description.

Swap Data Set Devices

The process of copying images back and forth between main and auxiliary storage is called swapping. Writing an image to auxiliary storage is a swap out; reading one into main storage is a swap in. The pre-formatted data sets into which jobs are written are called swap data sets. A swap data set is divided into swap allocation units, each of which consists of a device-dependent number of 2048-byte records. An integral number of swap allocation units, not necessarily contiguous, are assigned to each job to contain the swapped out image of the job.

If there is more than one foreground region, they share the available swap data sets, but the cycle of swapping for each region is essentially independent of other regions. However, the system avoids queuing on swap data sets if possible.

TSO requires sufficient storage capacity on one or more of the following for swap data sets:

- IBM 2301 Drum Storage.
- IBM 2303 Drum Storage.
- IBM 2305 Fixed Head Storage, Model 1 or 2.
- IBM 2314 Direct Access Storage Facility.
- IBM 3330 Disk Storage Facility.

See the Storage Estimates section of this publication for information on swap data set sizes.

The record overflow feature is required for the devices used to store the swap data sets. One or more data sets on any of the above devices can be used for swap data sets.

The direct access storage space required for the swapped data may be divided among the devices listed above in either of two ways. The user may specify that swapped data be distributed serially among a hierarchy of data sets, or he may specify parallel distribution of data onto two devices. With serial distribution, the first data set in the hierarchy is filled with swapped data, and then the next data set in the hierarchy is used. For example, a drum, because of its higher access speed, could be assigned as the first unit in the hierarchy, with a 2314 assigned to receive any overflow of swapped data.

With the parallel distribution scheme, two devices are used concurrently to receive swap data sets. The exact order in which data sets are written on either of the devices is determined by the system, based on the I/O activity taking place in the channel at the time of a swap out. For example, if the two data sets are on devices on separate channels, swap performance improves substantially.

Before a terminal job can be swapped out of main storage, activity associated with the job must be brought to an orderly halt. The halt must be performed in such a way that the job is not aware of it, and information must be saved to restart the job when its next time slice is scheduled. The orderly suspension of a job's activity before a swap out is called quiescing the job. Quiescing includes the removal of the majority of the control blocks associated with the job from the system queues so they can be written to the swap data set along with the contents of the main storage region assigned to the job.

The Relationship of TSO to the Operating System

For the data processing center, TSO is compatible with operating system standard formats and services, while providing the flexibility needed for various time sharing and terminal-based applications.

TSO is not necessarily intended to be used as a dedicated time-sharing system, that is, a system on which only time-sharing operations take place. TSO augments the facilities already available with the operating system: batch processing, teleprocessing, and other data processing activities can take place concurrently on the same system.

Once an installation has generated a system that includes TSO, time sharing operations can be started and stopped at any time by the system console operator. The operator can specify how many regions

of main storage are to be assigned to time sharing users. Each region can serve many users, whose programs are swapped back and forth between main and auxiliary storage. Time sharing, or foreground operations, can take place concurrently with batch or background operations. (Background jobs are not swapped.) If the user chooses, he can dedicate his system to time sharing and run only foreground jobs. If there are periods when TSO is not needed in the system, time sharing operations can be stopped, and the system will then process background jobs in the usual way with MVT and TCAM.

Terminal communications are handled by the Telecommunications Access Method (TCAM) through an interface that allows the use of standard sequential access method I/O statements and macro instructions.

All of the MVT facilities are available to a background job. Foreground jobs can use most of the operating system access methods for data set access (e.g., BSAM, QSAM, BDAM etc.). All devices available to these access methods are usable by foreground jobs. A detailed list of restrictions is in the "Restrictions and Limitations" section of this manual.

Execution of Background Jobs from the Terminal

In addition to the foreground execution of programs, TSO allows jobs to be submitted for execution in the background, or batch, portion of the system. If his installation authorizes it, a user can submit a background job at his terminal, be notified of the job's status, and then receive results of the job at the terminal. If he chooses, he can specify that the output of his job be produced at the computing center, rather than at the terminal.

Foreground-Background Compatibility

Because time sharing is carried out within the framework of MVT job and task management, the foreground and background environments are compatible. TSO uses the same data formats, programming conventions, and access methods as the rest of the operating system. The programming languages and service programs available with TSO are compatible with their background counterparts.

The TSO command language is also generally compatible with the Conversational Remote Job Entry (CRJE) command language. Programs can be developed in the foreground and stored in background libraries. These programs are compatible with other operating system programs. Most problem programs can be executed in either the background or the foreground without revision or recompilation.

Restrictions and Limitations

Certain facilities are unavailable to foreground jobs, although they remain available to background jobs. These include:

- The BTAM and QTAM telecommunications access methods.
- The Graphics Access Method (GAM).
- The EXCP equivalents of the BTAM, QTAM, and GAM access methods.
- Main storage requests for hierarchy 1 (all foreground requests for main storage are allocated to hierarchy 0).
- Use of Job Control Language in the foreground for other than single-step jobs (the TSO command language is used to provide the equivalent of multi-step jobs).
- Checkpoint/Restart Facility (foreground requests for checkpoint are ignored).
- Rollout/Rollin Option.
- TESTRAN Facility.
- Tape volumes are not supported.
- Multivolume data sets are not supported by Dynamic Allocation.

SVC numbers 92 through 102 (decimal) are added to the system for TSO. The following SVCs can be issued by problem programs in the foreground region:

- SVC 93--TGET/TPUT (execute terminal I/O).
- SVC 94--STCC (specify terminal control characteristics).
- SVC 95--TSEVENT (notify the supervisor of an event).
- SVC 96--STAX (specify a terminal attention exit).
- SVC 97--Breakpoint (used by TEST command).
- SVC 98--PROTECT (protect a data set with a password).
- SVC 99--Dynamic Allocation (of a data set).

- SVC 100--Submit a job to the background.
- SVC 102--AQCTL -- used by TCAM to communicate with problem programs.

Of these, only SVC 98--PROTECT--can be issued by programs executing in the background. SVCs 92 (TCB EXCP) and 101 (TCAM-TSO Communication) are used only by supervisor programs.

Including TSO in a system adds no restrictions to programs executed in the background. For example, other teleprocessing applications can be run simultaneously.

System Control

The management of an installation can shift most of the responsibility for controlling the time sharing system from the operator at the system console to users at remote terminals, called control terminals. A control terminal user can alter the system configuration to meet changing work loads. For instance, he can assign an extra region of main storage to time sharing operations during peak periods, and then release it to be used for batch operations during slack periods. Such changes require no shutdown of TSO and are not noticed by the users of other regions. Even the starting and stopping of TSO operations is accomplished without shutting down the system or affecting background operations.

Job Definition and Scheduling

To the operating system, each terminal session from LOGON to LOGOFF is one terminal job, corresponding to a single step batch job. The job control statements that define a terminal job are stored in the LOGON procedure used to begin the session. The "EXEC" JCL statement in the LOGON procedure identifies the program the user wants loaded into his region for execution. The program may be the TSO-provided command language handler or an installation provided application program.

An important feature of TSO is the dynamic allocation of data sets for time sharing users. A user may defer definition of his data sets until he requires them. During LOGON processing, any data sets named on Data Definition (DD) statements in the procedure are allocated to the terminal job. Any data sets requiring volume mounting by the operator, must be defined here. The procedure also includes dynamic DD statements (similar to a DD DUMMY), which reserve control block space for data sets the user may allocate during the session. The dynamic allocation facility allows data sets to be created, deleted, concatenated, or separated without previous allocation at the beginning of the job step.

Tuning the Time Sharing System

In a time sharing system, execution time is divided among the active foreground jobs and background jobs in brief time slices. A time slice must be long enough to perform a meaningful amount of processing, but not so long that the time between successive slices prevents quick response to conversational users. At the same time, time slices cannot be so short and frequent that system overhead for swapping and task switching becomes excessive. Balancing these factors depends on the number and type of jobs the system is processing. A solution for one job mix is not necessarily suitable for another job mix. The TSO time sharing algorithms -- the formulas used to calculate the division of time among jobs -- are based on several variables, most of which can be specified by the installation to tune the system for their particular workload. Some of the tuning variables such as the number of foreground regions and the maximum number of users, can be set by the system operator or a user at a control terminal whenever the system is running. Others are specified as parameters in SYS1.PARMLIB. These parameters are used when the operator starts the time sharing operations.

The time sharing algorithms are described in detail in the "System Summary" section of this manual. They are implemented by a subroutine called Time Sharing Driver. The Driver makes decisions about system functions such as swapping and task switching. An installation may experiment with other time sharing algorithms by modifying or replacing the driver, and specifying use of the new Driver in the SYS1.PARMLIB parameters used when the operator starts time sharing operations.

Monitoring System Use and Performance

By extending the services of the system to many concurrent users, TSO makes the operating system more useful to more people. However, installation management's job of monitoring system use and performance becomes more complex. Three tools are provided to help management maintain a clear picture of what the system is doing.

System Management Facilities (SMF): The SMF Option can be used with TSO. Both the data collection and dynamic control facilities are extended to the foreground environment.

With the data collection facility, records describing both the system environment and individual user activity are written to the SMF data sets in a format similar to that used for background records. The system environment data includes:

- Machine configuration.
- Resource status.
- Library management information.

This information is recorded whenever time-sharing operations are started, modified, or stopped by an operator. The user data includes:

- I/O device use.
- Data set use.
- Main storage used.
- Time resident in main storage.
- Time actually spent executing.

The user data is recorded at LOGON and LOGOFF and during a terminal session whenever a user changes the status of his data sets with the dynamic allocation facility. The information on the use of data sets is particularly useful to the installation for controlling the use of secondary storage in the time-sharing environment.

The SMF dynamic control exits give the installation access control program information at key points during the processing of jobs, including foreground jobs. The step initiation and termination exits are taken, if present, when a user begins or ends a terminal session. These routines can record information and control processing for foreground jobs just as they do for background jobs. SMF is discussed in detail in the publication IBM System/360 Operating System: System Management Facilities, GC28-6712.

An additional installation exit, separate from the SMF dynamic control exits, is provided from the routine handling user LOGON. This exit allows the installation to establish its own user verification and control procedures, independent of those supplied with the system. The section of this publication Writing a Logon Pre-prompt Installation Exits describes the parameters passed and what actions the exit may take.

MONITOR Command: The MONITOR command allows the operator to watch the changing workload on the system over a period of time. In addition to the job initiation, data set, and volume information formerly available with the DISPLAY command, he can request notification of time-sharing users logging on and off the system. The DISPLAY command now gives the system workload at a particular point in time, and has been extended to include information relative to the time-sharing environment, such as the number of foreground regions and the number of active terminals. Both MONITOR and DISPLAY, like other operator commands concerned with the time-sharing operation, are available to a control user at a remote terminal as well as the system operator at the console.

TSO Trace Program: The TSO Trace Writer Program provides a detailed history of what the system does over a period of time. The Trace Program records a stream of information that all components of the system are continuously passing to the Time Sharing Driver. The Driver uses this information in its calculations of resource allocation. When the operator starts the Trace Program, it intercepts these event signals and records them with a time stamp in a data set. Typical events recorded are "job requesting terminal input" and "swap completed." The TSO Trace Data Set Processor can be used at a later time to format and print out the information recorded by the Trace Program. The Trace Data Set Processor can be requested to list only those events associated with a particular component of the system, such as the dispatcher, or to list only those events associated with a particular terminal or set of terminals. Using this information, system management can determine how well the system is responding to the workload and make adjustments to the tuning variables if necessary.

System Security

The need for adequate data and program protection is increased in the time-sharing environment, where many persons are simultaneously using the system. The system itself must be protected against unauthorized users. Each user's programs and data must be protected against accidental destruction by other users. Confidential data must be safeguarded against unauthorized access.

User Verification

Any user starting a terminal session is required to supply a user identification recognized by the system; that is, one that

has been defined by the system administrator. The installation may also require the user to supply a unique and confidential password with the LOGON command.

Further verification of a user's identity can be performed by the optional installation routine called when a user logs on. This routine can request further information from the applicant and deny him access to the system if he fails to provide it.

Program Protection

Although a number of users may have jobs assigned to the same foreground main storage region, only one user's job is present in the region at a particular time -- the other jobs are temporarily stored in the swap data sets. No user can accidentally destroy or tamper with another user's job. Like the background regions under MVT, the foreground regions have unique storage keys, preventing a job from modifying any area of main storage outside its assigned region.

Data Set Security

Because any user can refer to any data set in the system catalog, the data set security facility of the operating system is extended to allow individual users to protect their own data sets from unauthorized reference. A user can assign one or more passwords to a data set. If anyone subsequently attempts to open the data set, he is prompted for the password(s). If he fails to supply the correct password in two attempts, his program is terminated.

The password assigned to a data set can be the one associated with the user for LOGON. In this case, the user will not be prompted for the password when opening his own data set. Any other user, however, must supply the correct password to refer to that data set.

Passwords can be assigned for two levels of protection:

- Modification protection. No password is required to open the data set for reading, but a password must be supplied to write into the data set, or to delete it. This type of protection is required for system libraries and data sets, to prevent accidental modification or to prevent a user from assigning a password and locking out all other users. There is no performance degradation in opening the data sets for reading.
- Read Protection. The password must be supplied to open the data set for reading.

Authorizations

Special authorizations in the User Attribute Data Set are required for the use of some TSO facilities. Specific authorization is required for:

- Submission of jobs for execution in the background.
- Use of system operator commands from the terminal.
- Use of commands to modify the User Attribute Data Set itself.

The User Attribute Data Set should be password-protected, to prevent assignment of these authorizations by anyone other than the system administrator or his designate.

Capabilities of the TSO Command Language

The TSO command language serves two separate, but related, purposes:

- It gives the terminal user a simple means to request the system to perform work.
- It gives system personnel a framework for applications.

Functions available through the commands supplied with the system include:

- Data set management.
- Program development.
- Program execution.
- System control.

The following sections describe these capabilities and are followed by a description of the applications available as IBM Program Products. Installation management has complete control over which functions are available to each terminal user.

Data Set Management: The TSO command language includes commands to enter, store, edit, and retrieve data sets consisting of text, data, or source programs. Essentially, the commands give the terminal

user the data set management functions of the operating system. Through the use of default values and data set naming conventions, the commands can be simple enough for the non-sophisticated user.

Data from the terminal goes into standard operating system sequential or partitioned data sets. Conventions for immediate correction of keying errors are available for each terminal device type. At a 2741 Communications Terminal, for instance, the user can just backspace over an error and type in the correct characters.

At the user's option, the system will assign a number to each line of data as it is entered. Later, the user can retrieve and edit the line by referring to this line number. The user can also retrieve a line by specifying a string of characters contained in the line, and having the system scan the data set for it.

Program Development: TSO offers convenient facilities for program development. The programmer can use the data-handling facilities to create source programs and to have them syntax-checked line-by-line as he enters them. Any operating system language processor can be invoked from the terminal. Some language facilities and translators designed especially for the terminal environment are discussed under "IBM Program Products."

Compiler diagnostic messages and listings can be directed to the terminal, allowing the programmer to correct errors immediately and recompile the program. Once the program compiles successfully, it can be tested conversationally. The programmer can start and stop execution from the terminal, inspect and modify main storage and register contents, trace and control the program flow.

Because of background-foreground compatibility, programs produced at the terminal can be executed in either environment. Programs in the foreground can use the sequential access methods (BSAM and QSAM) to direct I/O to the terminal. In the background, the same unmodified programs can address a data set or unit record device.

Program Execution: Programs can be invoked at the terminal in several ways. Any load module can be established as a command and executed simply by keying in the program name at the terminal. Load modules not defined as commands can be invoked in the foreground with the CALL command. If a program uses data sets, a command procedure can be used to allocate them. Entering the one-word procedure name can allocate the data sets, invoke and start the program, and free the data sets again on program termination. Whenever a program in the foreground terminates with an error condition, the testing facilities can be used to determine the nature of the error.

The terminal user can also submit jobs to the background job stream. Commands similar to those used for the Conversational Remote Job Entry (CRJE) facility are used to create job control language describing the job, and to submit it to the batch job stream. The user can request notification of job completion at his terminal, and can have job output directed either to his terminal or to a device at the computer site.

System Control: Certain users can be authorized to use commands for controlling system operation. With the proper authorization, a user at a remote terminal can use standard operator commands such as DISPLAY and MODIFY to control the time-sharing portion of the system.

A separate control facility (ACCOUNT) allows an authorized terminal user to establish and maintain the profile of each system user. Using special commands from his terminal, he can define or modify user passwords, account numbers, and procedure names, and control authorizations and restrictions for each user.

IBM Program Products

The command language is designed so that new commands and applications can be easily integrated into it. Applications available from IBM as Program Products look the same as other commands to terminal users.

The IBM Program Products available for TSO systems are introduced briefly in the following paragraphs. Each is discussed more fully in later chapters of this manual.

Problem-Solving

Three language processors specially designed for mathematical problem solving by users who are not necessarily professional programmers are available. Two are part of the Interactive Terminal Facility (ITF). The third is Code and Go FORTRAN, which is discussed with the other FORTRAN Program Products in the next section.

ITF: BASIC is a simple, algebra-like language easily learned by anyone familiar with mathematical notation.

ITF: PL/I is a subset of full PL/I that provides a powerful conversational language that is easy to learn and use. Because of its relationship to full PL/I, it is an excellent vehicle for teaching. ITF: PL/I can be executed line-by-line as it is entered, or collected into procedures and subroutines for later execution. Errors in either ITF: BASIC or ITF: PL/I can be detected as soon as the statement is entered and can be corrected immediately.

Programming

Program Products to aid the users of several programming languages are available with TSO. There are three types of products:

- Compilers.
- Libraries to support the compilers and object programs.
- Prompters.

The compilers can be used in either the background or the foreground environments. In the foreground, they provide diagnostics and listings formatted for the terminal. For instance, diagnostic messages can optionally refer to source errors by the line number assigned by the EDIT command. With the line number, the user can retrieve and correct the statement without having a complete listing displayed at the terminal.

Prompters are initialization routines that allow the user to invoke a compiler with a single command, such as FORT or RUN. The prompter handles all data set allocations and sets processor options. If the user omits necessary information, such as the name of the source program to be processed, the prompter requests the information with a terminal message.

The following paragraphs introduce the Program Products available for each programming language. The chapter "Programming at the Terminal" discusses these products in greater detail and shows how other operating system processors can be used from the terminal.

FORTRAN: There are four Program Products for FORTRAN programmers: two language processors, a library for use with either processor, and a prompter.

Code and Go FORTRAN is a quick-response, high-performance processor to meet the needs of both the problem-solver, who writes, debugs, and executes relatively short conversational programs, and the production programmer, who debugs components of a large program online before running the program through a batch compiler. The Code and Go FORTRAN processor incorporates a prompter routine.

FORTRAN IV (G1) is an extended version of FORTRAN IV (G). It provides the ability to store permanent object programs, and produces source and object listings and storage maps. The TSO FORTRAN Prompter Program Product is available to invoke this processor.

The FORTRAN IV Library (Mod 1) is an extension of the FORTRAN IV library for use with either FORTRAN IV (G1) or Code and Go FORTRAN. It supports new features of these processors, such as a list-directed input/output facility, ASCII data set conversion, and PAUSE and STOP statements for the terminal.

COBOL: A language processor and a prompter are available for COBOL programmers: the American National Standard Full COBOL Version 3 compiler, and the TSO COBOL Prompter.

PL/I: Two language processors and two supporting libraries are available for PL/I programmers: the PL/I Optimizing Compiler, the OS PL/I Checkout Compiler, and the PL/I Resident Library and the PL/I Transient Library. The compilers incorporate a prompting routine.

Assembler Language: The TSO Assembler Prompter is available to invoke the Assembler (F). The Assembler (F) is not a Program Product.

Text and Data Handling

The TSO Data Utilities: COPY, LIST, MERGE, FORMAT Program Product provides four commands to manipulate data sets, and to format text for output either at the terminal or on a high-speed printer.

Command Language Facilities

TSO terminal users define their work in the TSO command language. A command can be thought of as a request from the terminal user for the system to perform a particular function. This chapter describes and gives examples of the facilities available through the command language. There are commands for elementary functions such as entering, editing, and retrieving data; remote job entry; mathematical calculation; and program development and testing in several programming languages. These important functions are the base on which the installation's own terminal-oriented applications and systems are developed.

To make the examples more meaningful, some TSO conventions for command syntax, entry format, data management, and terminal operation are presented first. Many of these conventions can be redefined at the option of the installation, or in some cases, at the convenience of the individual user.

Conventions at the Terminal

The command is the means by which work is defined at the terminal. The first word of a command is always the command name. It is used by the system to select a command processor (a problem program) from the system command library or a user command library. Any further information in the input line, the command operands, is passed to the command processor in a parameter list. Operands are separated, or delimited, by either blank spaces or commas. A few commands require that groups of related operands be enclosed in parentheses.

Most operands are optional. If an optional operand is not entered with the command, the system assumes the default value and proceeds as if the user had entered that value. If the missing operand is not one that can be defaulted, for instance, a data set name, the system prompts the user for it with a message such as "ENTER DATA SET NAME". When all the operands have been either entered or defaulted, the command processor proceeds to perform the desired function. Some of the command processors, such as EDIT, accept, interpret, and perform sub-commands, which follow the same syntactic rules as the general commands.

Logging On

To establish a connection with the system, the user activates his terminal, dials the computer, if necessary, and enters the LOGON command. He must always supply his user identification as an operand of the LOGON command; if he does not supply it, a prompting message is issued. Up to three additional levels of identification may be needed, depending on the accounting methods and security procedures used by his installation.

The installation may require users to enter a password with the LOGON command. Each user can have one or more passwords associated with his identification. At terminals equipped with the print inhibit feature, the system is able to suppress printing of the password as it is keyed in.

Associated with each password are one or more account numbers, and with each account number, one or more LOGON Procedure names. The LOGON Procedure contains the Job Control Language statements defining the user's terminal job, just as cataloged procedures define background jobs. For instance, the LOGON Procedure may have a STEPLIB data definition (DD) statement for a private command library. This library will be searched before LINKLIB or the Link Pack Area and may degrade performance. Whenever there is only one account number or procedure name, the system selects it by default, and the user is not required to enter it. Figure 1 shows a simple identification scheme, with just one value for each of the possible levels of identification.

```
CONRAD          User Identification
  ↓
JAYCEE          Password
  ↓
D76B            Account Number
  ↓
B100K           Logon Procedure Name
```

Figure 1. Simple Identification Scheme

To log on, the user defined in Figure 1 would enter:

```
LOGON CONRAD/JAYCEE
```

The system will assume "D76B" as the account number and "B100K" as the LOGON Procedure name, since no others have been defined for this user.

A user who has several account numbers and LOGON Procedures can have a hierarchy of identification values, like that shown in Figure 2. This user could still log on with the command shown above, since "D76B" and "B100K" are the only account number and LOGON Procedure name associated with the password "JAYCEE". However, to use the "X100K" LOGON Procedure, this user's LOGON command would be:

```
LOGON CONRAD/JOE#1 ACCT(D58B) PROC(X100K)
```

Both the account number and the procedure name must be included, since a choice exists for both. The identification scheme for each user is defined and maintained in the User Attribute Data Set with the ACCOUNT command, by the system manager or a user authorized to do so.

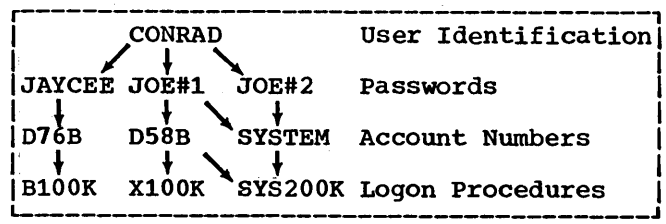

Figure 2. User Identification Hierarchy

The system acknowledges that the LOGON has been accepted when it has checked the identification supplied and has determined that the resources requested in the LOGON Procedure are available, and the user can begin his work.

Input Editing

Some system editing is provided for every line of input from the terminal. Lowercase alphabetic characters (from terminals that have them) are translated to uppercase, except for certain text-handling applications. Each user can define his own character-delete and line-delete characters for correcting any keying errors in input lines. There are default character-delete and line-delete characters for the typewriter-like terminals (the cursor controls can be used on the 2260 and 2265 Display Stations). If a user defines the quotation mark as his character-delete character, and the percent sign as his line-delete character, then enters the line:

```
etoain%aBCc"deee""
```

it is received by the system as

```
ABCDE
```

Users whose terminals have backspace and attention keys may define those keys as their character-delete and line-delete characters.

Entry Modes

Immediately after LOGON, the system is ready to accept any command in the command libraries. The terminal is said to be in command mode. Some commands place the terminal in other entry modes: EDIT, for instance, has an input mode, that accepts successive lines of input for a data set; and an edit mode, that accepts EDIT subcommands. Other commands, such as TEST, ACCOUNT, OUTPUT, and OPERATOR also define special purpose modes.

The Attention Key

The attention key can be used to transfer from one mode to another, or to interrupt a program or command processor during execution. Any command in process can be cancelled by hitting the attention key and entering a new command. A user program can be interrupted with the attention key to transfer to the test mode for debugging activity, then the program can be restarted.

Assembler language user programs can define attention exit routines with the STAX macro instruction. Control will be passed to such a routine when an attention is entered.

An important function of the attention feature is to prevent the user from being "locked out" of the system while a long-running program executes, or while voluminous output is displayed at the terminal. For terminals without attention keys, the attention feature can be simulated. The user can specify a string of characters, such as "STP", that is to be interpreted as an attention. The system can be instructed to interrupt any long-running program or terminal output periodically to accept either the simulated attention character string, or a digit to specify the level of attention exit or a null line to continue processing.

Data Set Naming Conventions

Unless requested not to, the system appends two qualifiers to a simple data set name specified by a user: a descriptive qualifier and a user identification qualifier. The user identification qualifier is the same as the user identification specified with the LOGON command and is appended as the left-most qualifier of data set names that follow the TSO naming conventions.

The descriptive qualifier is placed at the right of the user entered data set

name. It tells the system what kind of data is recorded in the data set and for what purposes it can be used. For instance, the qualifier for a data set containing COBOL source statements is COBOL; for a load module, LOAD. Whenever possible, the system determines the appropriate descriptive qualifier from the command referring to the data set, and the user need not enter it as part of the name. In some cases, the user must supply it, as part of the data set name entered with the command, or in response to a prompting message.

The user never needs to enter his identification qualifier; it is always known to the system. Figure 3 is an example of a series of commands to enter and compile a source program (using the TSO FORTRAN Prompter and FORTRAN IV (G1) Program Products); linkage edit the object program; to display the compiler listing at the terminal; and finally, to delete all the data sets involved.

In the EDIT, FORT, and LINK commands, the user supplied only the simple data set name, "PRG1". The system assigns the descriptive qualifiers implied by the commands and their operands. With the LIST command, the user supplies the descriptive qualifier, since he might want to display either CONRAD.PRG1.FORT or CONRAD.PRG1.LIST. In the DELETE command, the user enters an asterisk in the descriptive qualifier field, telling the system to delete any data sets with the identification qualifier CONRAD and the simple name PRG1.

To refer to a data set that does not follow the naming conventions, or that has an identification qualifier different from the one specified at LOGON, the user encloses the fully qualified data set name in apostrophes. The system does not append any additional qualifiers in this case, and uses the name "as is," except for translation to uppercase, to search the catalog. Using this technique, several users may refer to a data set with the shared attribute at the same time.

Data Entry

The EDIT command is used to enter information into the system. Because almost every system application will use some of the editing facilities, an overview of the command is presented here. Later sections will demonstrate some of the particular uses of the command.

Creating Data Sets

The EDIT command processor creates or modifies data sets with sequential organization, including members of partitioned data sets. The data sets contain only printable characters in EBCDIC representation. A data set name is entered with the EDIT command. If the user specifies the data set is OLD, EDIT opens it for modifications. If it is a NEW data set, EDIT invokes the dynamic allocation routines to create it. The data set attributes, such as blocksize and record length, can be specified by the user, or defaulted to standard values. For data sets containing source-language programs, the standard attributes are determined by the compiler to be used.

Input Data Sets	Command & Operands	Output Data Sets	Comments
none	edit prg1 new fort	CONRAD.PRG1.FORT	FORTRAN source program.
CONRAD.PRG1.FORT	fort prg1 print	CONRAD.PRG1.OBJ CONRAD.PRG1.LIST	Object program. Compiler listing.
CONRAD.PRG1.OBJ	link prg1	CONRAD.PRG1.LOAD (TEMPNAME)	Load module, in a one-member PDS.
CONRAD.PRG1.LIST	list prg1.list	Display at terminal	Compiler listing
CONRAD.PRG1.FORT CONRAD.PRG1.OBJ CONRAD.PRG1.LIST CONRAD.PRG1.LOAD(TEMPNAME)	delete prg1.*		All the data sets are deleted.

Figure 3. Example of Data Set Naming Conventions

One input line from the terminal normally becomes one record in the data set. Because of this equivalency between records and lines at the terminal, data sets created by EDIT are called line data sets. On request, EDIT appends a line number to each record of the data set as it is entered.

Entry Modes for EDIT

Depending on the type of work the user is doing with his data set, he uses one of two entry modes provided by EDIT (some other modes specifically for particular programming languages are discussed later). The input mode allows rapid entry of successive lines of input for the data set. The edit mode allows subcommands to be entered to modify, insert, or delete lines.

Input Mode

In input mode, the user enters successive lines of input. The lines are normally appended at the end of the data set, although the user can request they be inserted at some other point. The only subcommand recognized in the input mode is the null line (hitting the return key with no preceding characters), which requests transfer to the edit mode.

Services available in the input mode include translation of lowercase letters to uppercase, translation of tab characters to a series of blanks, and interpretation of the character-delete and line-delete characters. If line numbers are being assigned to each line, the user may request each new number be typed out by the system at the beginning of each input line. If line numbers are not being assigned, the user can request prompting for each new line by an underscore. If no prompting is requested, lines are entered one after another, with no intervening response from the system. Programming language syntax checkers can be requested to process input lines as they are entered.

Edit Mode

In edit mode, the user enters subcommands to point to particular records of the data set, to modify or renumber records, to add and delete records, to control editing of input, or to compile and execute a program.

Whenever the terminal is in edit mode, the user is considered to be positioned at a particular record, or line, of the data set. The EDIT command processor maintains a current line pointer to keep track of the user's position. In general, the current line pointer, which can be referred to in subcommands by an asterisk (*), is positioned immediately following the last line referred to, entered, changed, or printed. Using the subcommands provided, the user can move the current line pointer to any record in the data set.

For line-numbered data sets, specifying a line number as an operand of a subcommand moves the pointer to that record before the action requested by the subcommand is carried out. This method of operation is called line number editing.

Another method of repositioning the current line pointer is called context editing. A set of subcommands is provided to reposition the current line pointer without reference to line numbers. The user can move the pointer up or down a specified number of lines, or request the system to find a line with a particular series of characters in it, and move the pointer to it.

Modifying Data Sets

The most common use of the EDIT command for existing data sets is the addition, deletion, or modification of records. The INSERT and DELETE subcommands handle single or multiple record insertions and deletions. The CHANGE subcommand allows the user to replace one character string with another, not necessarily of the same length.

Data Set Management Commands

To allow the user to manage his data stored on auxiliary storage devices, a set of data set utility commands is included in the TSO command language. All user data is kept in standard operating system data sets, and as a default, data sets used by foreground programs are entered in the system catalog, reducing the amount of information the user must supply about the data set from the terminal when he refers to it.

The LISTCAT and LISTDS commands retrieve information from the system catalog for the user. He can find out what data sets are currently allocated to him, and what the attributes of the data sets are. The RENAME command can assign a new data set name to an existing data set, or add an alias name to a partitioned data set member. The DELETE command removes a data set from the catalog, and frees the auxiliary storage space it occupies.

The PROTECT command is the facility to assign password protection to data sets. Protection can be assigned for read access, for write and delete access, or for both, and multiple passwords can be assigned to a single data set.

The ALLOCATE and FREE commands invoke the dynamic data set allocation routines from the terminal. A user who wants to run a program that requires one or more data sets not currently allocated to his foreground job enters ALLOCATE commands to have the data sets assigned. The FREE command is used to release the data sets assigned by ALLOCATE. The ALLOCATE command can also be used to find data sets not in the system catalog, and to control the size of new data sets and the volumes to which they are assigned.

TSO Data Utilities

The TSO Data Utilities Program Product is available to augment the data entry and data set management commands by providing a text-formatting capability and data set utilities for terminal users. The product provides four commands:

- FORMAT, to format textual information into pages.
- LIST, to display all or part of a data set at the terminal.
- COPY, to copy a data set.
- MERGE, to merge all or part of one data set into another.

The FORMAT and MERGE commands can also be used as subcommands of EDIT (EDIT incorporates a less powerful listing capability). The COPY and MERGE commands can be used for access to ASCII tape data sets. See the publication IBM System/360: Planning for the Use of Information Interchange Standards, GC28-6756, for details.

Text-Handling

The EDIT, FORMAT, and LIST commands provide a facility for the entry, editing, storage, and output of text. With the EDIT command, the terminal user creates a data set with the type qualifier TEXT, and enters the material line-by-line. If his terminal has both uppercase and lowercase letters, the material will not be translated to uppercase letters, but will be saved just as entered. The user can specify what tab settings he wants to use, and the system will convert tabs in the material into strings of blanks of the proper length. The use of line numbers is optional.

The user formats the data set by inserting format control records into it. A format control record is entered as a separate line in the data set, starting with a period in the first position, followed by a control word (or a two-character abbreviation). The EDIT processor does not interpret the controls; they are retained in the data set for interpretation later by the FORMAT processor. The controls allow the user to:

- Print a heading on each page.
- Center lines of text between margins.
- Control the amount of space for all four margins on the page.
- Control line spacing.
- Justify left and right margins of the text.
- Number pages of output consecutively.
- Halt printing when desired.
- Print multiple copies of selected pages.

The FORMAT processor scans the data set for the format controls and inserts blanks, carrier return characters, headings, and page numbers as needed. At the user's option, the output can be formatted for a terminal or saved in a data set for deferred printing, either on the terminal (with the LIST command) or on a high-speed printer. Either an all-capitals or an uppercase and lowercase print chain can be used on the printer.

Data Set Manipulation

The COPY, LIST, and MERGE commands allow the terminal user to move information between data sets and to display data sets at the terminal.

The COPY command will duplicate sequential or partitioned data sets or a member of a partitioned data set. While doing so, it can resequence or change the record length, blocksize, or record format as requested. The MERGE command will copy all or part of one data set or member into another data set and will resequence the record numbers in the target data set if requested. Both these commands will process tape data sets in ASCII format. Tape devices must be allocated to a user in his LOGON procedure.

The LIST command displays all or part of a data set at the terminal. The user can request that fields within records be rearranged for output, and line numbers can be suppressed or included.

Compiling and Executing Programs

A variety of commands are provided to give the user control over program compilation and execution. The form of the program determines command selection. For those language processors that are supported by a prompter Program Product or that incorporate a prompter, the terminal user requests a compilation of a source program with a single command. The prompter performs the following functions:

- Requests any necessary operands with messages to the terminal.
- Sets other compiler options to default values suitable for the terminal environment.
- Dynamically allocates the data sets needed by the compiler.
- Invokes the compiler.

For instance, if an installation has the TSO COBOL Prompter and the American National Standard Full COBOL Version 3 processor Program Products, the user can enter the COBOL command to compile his program and produce an object module. The LOADGO command can then be used to call the OS Loader to bring the program into main storage for execution, or the LINK command can be used to call the Linkage Editor to create a permanent load module.

During program development, when a programmer is repeatedly compiling and testing a program, he can use the RUN command to invoke it. RUN first calls the appropriate prompter and compiler, and then the OS Loader. It provides a compile-load-go sequence with a single command. RUN can be used as a command, or as a subcommand of EDIT. Figure 4 is a summary of the commands for executing programs. The chapter "Programming at the Terminal" has examples of the use of these commands. You must use RUN with ITF: PL/I, GOFORT, and ITF: BASIC.

Any load module, including language processors for which there are no prompters, can be invoked with the CALL command. For instance, the FORT command provided by the TSO FORTRAN Prompter Program Product invokes the FORTRAN IV (G1) compiler. If a programmer wants to use the FORTRAN (H) processor for a particular compilation, he can enter the command:

```
CALL 'SYS1.LINKLIB(IEKAA00)' 'MAP,OPT=1'
```

The compiler is loaded into the foreground region and given control. The options are passed to it as though they had been specified in the PARM field of an EXEC statement in Job Control Language. It is necessary for the user to allocate data sets for the compiler's use before entering the CALL command. A series of ALLOCATE commands can be defined in a command procedure, so that they need not be entered every time a compiler is used. An example of such a procedure is included in the chapter "Programming at the Terminal."

Form of input:	Form of output: OBJECT MODULE	LOAD MODULE	EXECUTING PROGRAM
SOURCE PROGRAM	COBOL FORT ASM PLI	--	RUN
OBJECT MODULE	--	LINK	LOADGO
LOAD MODULE	--	--	CALL

Figure 4. Program Control Commands

The TEST command can also be used to invoke a user program, and to control its execution. Before passing control to the program, TEST allows the user to establish initial values to be passed to the program as test data, and to set up breakpoints where execution is to be interrupted for displays and other debugging activity.

Breakpoints are established with the AT subcommand in test terminal mode. AT specifies a symbolic or absolute address in the program where execution is to be interrupted. The action to be taken at the point of interruption, such as listing or modifying storage and register contents, can be specified in a pre-stored string of TEST subcommands, or entered through the terminal at the time of interruption. Main storage contents can be displayed at the terminal or stored in a data set for deferred printing. TEST subcommands allow the programmer to load additional programs into storage, to delete or replace programs in storage, to issue GETMAIN and FREEMAIN as subcommands from the terminal, to define the location and attributes of symbols, and to start and stop program execution.

Remote Job Entry

The command language includes the SUBMIT, STATUS, OUTPUT and CANCEL commands to handle submission of jobs for execution in the background. These commands have the same format as the commands available with the Conversational Remote Job Entry (CRJE) facility of the operating system.

To have a job executed in the background, the user places the job control statements defining the job in a data set. By convention the jobname is the one- to seven-character user identification, plus a single character to provide uniqueness. The user then enters a SUBMIT command, including the name of the data set as an operand. SUBMIT will generate a standard jobname and a JOB statement if one is not included in the job definition. One data set can contain more than one job definition. Any time after entering the SUBMIT command, the user can inquire about the status of the job. The STATUS command returns information such as whether the job is waiting for resources, is executing, or is completed. The job can be terminated with the CANCEL command.

A new keyword has been defined for the JOB statement to allow automatic notification of the user when the job is completed. By coding NOTIFY= with his user identification, the user requests a message to his terminal when the job completes. The OUTPUT command allows the user to display job output (SYSOUT) at his terminal, to save it in a data set, or cancel it.

System Control

Two facilities are provided for the installation manager or system programmer to control operation of the system from his terminal. The ACCOUNT command adds, changes, or deletes entries in the User Attribute Data Set, which is the list of all authorized users of the system, together with the characteristics defining their profiles. The OPERATOR command places a terminal in a special mode allowing entry of commands normally available only at the system console. Use of either of these facilities requires special authorization. Users with such authorization are called control users.

User Authorization

When a control user enters an ACCOUNT command, his terminal is placed in account mode. With subcommands, the control user defines each user to the system, specifying his identification, passwords, account numbers, and LOGON Procedure names. This information is placed in the User Attribute Data Set, along with indications of any special authorizations the user may have, such as permission to use the ACCOUNT or Remote Job Entry facilities, and a limit on the region size he may request. This information will be retrieved whenever the user logs on, to verify his authority to use the system, and to define his foreground job.

System Operation

By entering the OPERATOR command, a control user has access to the system operator commands MODIFY, DISPLAY, MONITOR, CANCEL, and STOP. The commands have the same format and affect the TSO system as if they were entered through the operator's console, as specified in the publication IBM System/360 Operating System: Operator's Reference, GC28-6691.

Command Procedures

A command procedure is a data set containing a list of TSO commands and subcommands. The data set name is entered as an operand of the EXEC command, and the commands are executed, one-by-one in the order in which they appear in the procedure. When one command or subcommand is completed, the next is read from the procedure and processed as though it had been entered from the terminal. The commands can be typed out at the terminal as they are executed, or the user can suppress the listing with an operand of the EXEC command.

The EXEC command can also be invoked implicitly if the procedure is a member of the command procedure library. The member name of the command procedure can be entered as a command name. When the name is not found in the command libraries, the system assumes it is in the command procedure library.

Operand Substitution: Symbolic operands, starting with an ampersand (&), can be placed in commands and subcommands within command procedures. Values for these operands are supplied in the EXEC command invoking the procedure. A procedure (PROC) statement at the beginning of the procedure specifies how many positional operands will be supplied, and what keyword operands may be present. Default values for symbolic operands can be specified in the PROC statement.

Conditional Statements: The WHEN statement tests the return code from any command or program invoked during a procedure. A condition is stated with relational operators such as GT or LT ("greater than" or "less than"). If the condition is satisfied, the command in the WHEN statement is executed. If it is not satisfied, the command following the WHEN statement is executed. The command in the WHEN statement can itself be an EXEC command, invoking another command procedure.

Figure 5 shows a command procedure with a symbolic operand and a conditional execution statement. The procedure has commands to linkage edit an object program (LINK), and bring it into main storage for testing (TEST). The symbolic operand "PROGNAM" is defined in the procedure statement beginning the procedure. If the member name of this procedure in the procedure library is "LDTST", the command to invoke it is:

```
LDTST MYPROG
```

The commands in the procedure are then executed in order, with the substitution of "MYPROG" for "&PROGNAM" wherever it appears. A period with the symbolic operand specifies concatenation with the adjacent field. The value for "&PROGRAM." is concatenated to "OBJ" the second ".", and the LINK command as executed is:

```
LINK MYPROG.OBJ TEST MAP XREF
```

The WHEN statement causes the return code from the linkage editor to be tested. If it is zero, indicating no errors, execution proceeds with the TEST command. If the return code is greater than zero, indicating linkage editing errors, the procedure is terminated, and the next command can be entered from the terminal.

```
PROC  1 PROGNAM
LINK  &PROGNAM..OBJ TEST MAP XREF
WHEN  SYSRC(GT 0) END
TEST  &PROGNAM..LOAD(TEMPNAME)
END
```

Figure 5. A Command Procedure

Other Commands

Several other commands are provided to allow the user to control the terminal environment and to aid him in using the command system.

The TERMINAL and PROFILE commands are used to tailor the data entry conventions to the terminal type and user's preference. TERMINAL allows him to specify the character string to be used to simulate an attention interruption if his terminal does not have an attention key, and to specify how often he is to be given an opportunity to simulate an interruption during long-running execution or output sequences. The PROFILE command is used to specify the character-delete and line-delete characters, and other user options such as whether he wants prompting messages suppressed.

The HELP command is available in all entry modes. It provides the user with reference information on command and subcommand syntax, function, and usage. For example, if a user has forgotten the function of the DELETE command, he can enter:

```
HELP DELETE FUNCTION
```

The HELP command will return information explaining the function of the DELETE command:

```
THE DELETE COMMAND IS USED TO DELETE A
SEQUENTIAL DATA SET OR A MEMBER OF A
PARTITIONED DATA SET.
```

Requesting this information through the terminal is faster than searching for it in a printed manual.

The SEND command is used to send a message to the system operator or to another user. The sender must know the user identifications of other users to whom he directs messages. Messages are displayed immediately at the receiver's terminal unless he has requested they be suppressed or is not logged on. Messages not sent immediately are saved for transmission when the addressee next logs on if requested.

Programming at the Terminal

The time sharing environment is especially well-suited to program development. The advantage of programming at a time sharing terminal is the reduction of job turn-around delays. The programmer can profitably devote himself to one project at a time -- he does not need other projects to work on while waiting for results from a batch computing facility. TSO provides services for terminal users at each step in program development: coding, compiling or assembling, testing, implementation, documentation, and program maintenance.

Any compiler or assembler designed to run under the operating system can be invoked from a TSO terminal. Compilers can be executed in the foreground, or, via the SUBMIT command, in the background. Command language prompters are either incorporated in or separately available for several of the language processors. The TSO prompters, all IBM Program Products, provide specific commands to invoke the associated processors, and perform the following functions:

- Requesting the user to enter necessary information such as the name of his source program.
- Allocating data sets required by the processor and freeing them on completion.
- Setting any compiler options specified by the user and setting to default values those options the user omits.

Prompters are available for American National Standard COBOL Version 3, FORTRAN IV (G1), and Assembler (F). Prompters are incorporated in the PL/I Optimizing Compiler, the OS PL/I Checkout Compiler, and the problem-solving language processors. Each of the processors accepts a TERM option, a request for special formatting of diagnostic and listings for the terminal, and a NUM option, to control the use of EDIT line numbers in error messages. Syntax checking of source programs is provided for PL/I (F), FORTRAN IV levels (E), (G1), (G), and (H), and the problem-solving languages. The test mode gives the user real-time control over program execution for debugging. Similar facilities for ITF: PL/I, ITF: BASIC, and Code and Go FORTRAN and the PL/I Checkout Compiler are discussed in the next chapter, "Problem Solving."

Either the loader or the linkage editor can be invoked from the terminal. Users authorized to do so can add load modules to the system command library, where they will be available as commands to all system users. Any user can add programs to his own command library. Programs written in any language can be defined as command processors, but only assembler language has the facilities to make use of the command service routines such as input scanning and prompting.

Because of foreground-background compatibility, production programs that will eventually be run in the background environment can be written and tested from the terminal. I/O that goes to the terminal in the foreground can be re-directed to a sequential data set in the background. No recompilation is necessary.

The following sections describe the special terminal support provided for COBOL, FORTRAN, PL/I, and Assembler language programmers. Language processors for which no specific terminal support is provided can also be invoked in the foreground. See "Other Compilers" in this chapter for an example showing how to invoke the PL/I (F) compiler.

COBOL

TSO provides the COBOL programmer with facilities for entering, compiling, and testing programs from his terminal. The programmer can use the COBOL command for compiling his program with the following IBM Program Products:

- TSO COBOL Prompter.
- American National Standard COBOL Version 3 compiler.

The user can also invoke the COBOL (E) and (F) level compilers, either in the foreground or the background, but only the American National Standard COBOL compiler provides listings and diagnostic messages specifically formatted for a remote terminal environment. The full American National Standard COBOL is provided, with the IBM extensions to the language as defined in the publication, IBM System/360 Operating System: American National Standard COBOL, GC28-6396.

Entering the Source Program

The COBOL programmer uses the TSO EDIT command to create or modify his source program. With the EDIT command, he enters operands to name the data set containing the program, and identify it as an old program to be modified or a new program.

With the terminal in input mode, the user enters successive lines of the program. The system accepts each line when he hits the return key of the terminal, and types out the line number of the next line. This line number becomes the sequence field of the COBOL statement in columns 1-6, and in addition is used in place of the compiler-generated "card number" in program listings and diagnostic messages. Automatic line numbering can be suppressed, if desired, by an operand of the EDIT command.

After the line number is typed out, the terminal is logically positioned at the continuation column (column 7) of the COBOL statement. The user can space or tab to Area A (column 8) or Area B (column 12) of the statement. These logical tab settings are automatically set by the EDIT program whenever a COBOL program is being processed. EDIT converts the tab characters to the necessary number of blanks to format the statement correctly. The number of blanks generated is independent of the physical tab settings at the terminal. The user can, if he wishes, override the standard settings by specifying his own with an EDIT subcommand.

```
edit query.cobol new
INPUT
00010 identification division.
00020 progrmm-id. query.
00030 remarks. sample inquiry program.
00040 environment division.
00050 configuratdon section.
00060 source-computer. ibm-360-i65.
00070 input-outpu!D
00070 object-computer. ibm-360-i65.
00080 input-output section.
00090
```

Figure 6. Entering a COBOL Program

Figure 6 shows an EDIT command to create a new data set, and some lines from the user's COBOL program as he enters them. The five-digit line numbers are generated by EDIT. A high-order zero is appended to form the six-digit COBOL sequence field. In this example, the backspace key is used as the character-delete character, and the attention key is the line-delete character. In lines 00020 and 00050 the user backspaces over keying errors to correct them. Line 00070 is cancelled with the attention key and re-entered. The lowercase alphabetics are automatically translated to uppercase by the EDIT processor.

Compiling a COBOL Program

The American National Standard COBOL compiler is invoked with the COBOL command. The only required operand is the name of the data set containing the source program to be compiled. However, any of the compiler options (except DECK) can be entered with the command as operands. These options are documented in the publication IBM System/360 Operating System: American National Standard COBOL Programmer's Guide.

Two compiler options are available: TERM and NOPRINT. The TERM option orders the compiler to issue progress messages to the terminal as it processes the source program, for instance, "ANS COBOL IN PROGRESS," and to issue diagnostic messages formatted for the terminal. An error or warning message directed to the terminal includes the line number of the source statement in error, and the compiler error message. Using edit mode subcommands, the programmer can retrieve the statement by line number, and correct the error.

The PRINT/NOPRINT option, available only in the foreground, allows the programmer to choose whether the program listing is to be placed in a data set, displayed at the terminal, or suppressed. When developing a program from the terminal, it is not normally necessary to have the complete listing generated and displayed, since the error and diagnostic messages are extracted and displayed through the TERM option. NOPRINT is the default value, and suppresses the listing. When source program errors have been corrected and the program is compiled a final time, the programmer specifies PRINT to generate the listing, which may be displayed at the terminal, or saved in a data set for deferred printing, either at the terminal or on a high-speed printer. The contents of the listing are controlled by the other options such as SOURCE, PMAP, and XREF.

Figure 7 is an example of a COBOL compilation, correction of a source program error, and re-compilation. The PRINT operand of the second COBOL command causes a listing to be generated and saved in the data set QUERY.LIST.

```
cobol query
*STATISTICS*   SOURCE RECORDS = 59  DATA DIVISION STATEMENTS = 15
    PROCEDURE DIVISION STATEMENTS = 18
*OPTIONS IN EFFECT*  SIZE = 81920  BUF = 2768  LINECNT = 57
*OPTIONS IN EFFECT*  SPACE1, FLAGW, NOSEQ, NOSOURCE, NODMAP
*OPTIONS IN EFFECT*  NOPMAP, NOCLIST, NOSUPMAP, NOXREF, NOSXREF
*OPTIONS IN EFFECT*  LOAD, NODECK, APOST, NOTRUNC, NOFLOW, TERM
*OPTIONS IN EFFECT*  NUM, NOBATCH, NONAME, COMPILE=01, NOSTATE
001 COMPILATION ERRORS.HIGHEST SEVERITY  E
000290  IKF3001I-E  INV-KY-READ NOT DEFINED. STATEMENT DISCARDED.
READY

edit query.cobol
EDIT
list 290
000290 READ PARTS-FILE INVALID KEY GO TO INV-KY-READ.
change /ky/key/
save
SAVED
end
READY

cobol query source xref dmap pmap
ANS COBOL IN PROGRESS
READY
```

Figure 7. Compiling a COBOL program

Program Execution

The object program created by the COBOL compiler can be invoked with the LOADGO command, which calls the Loader to bring the program into main storage and pass control to it. The user enters ALLOCATE commands for any data sets needed by the program before invoking it.

The object program can also be defined as, or as part of, a load module with the LINK command. As a load module, the program can be placed in a private or system program library. To define the program QUERY as a command in a private command library CONRAD.COMMANDS.LOAD, the LINK command is:

```
LINK QUERY.OBJ LOAD(COMMANDS(QUERY)) COBLIB
```

Once part of a command library, and once the private command library is concatenated to the command library (and linkage library), the program is invoked simply by entering the program name (or an alias) as a command. To invoke the program defined above, the user would type:

```
QUERY
```

The RUN subcommand of EDIT functions as a combination of the COBOL and LOADGO commands. It is especially useful during the testing phase of program development, since it can be used without leaving the edit mode. When a source program is complete, the user enters the RUN command, invoking first the compiler, then his object program. Whenever he detects an error requiring a change to the program, the programmer can immediately update his source program with EDIT subcommands, and enter another RUN subcommand.

Interactive Programs

COBOL programs can be designed to interact with a terminal user simply by defining the terminal as a file. Programs can read input lines from the terminal, act on the information, and respond. Because the terminal is defined as a sequential utility file, the same program can be executed in the background, reading and writing to sequential data sets or devices, without recompilation.

To define the terminal as a file, the user enters ALLOCATE commands for the external names used in the name field of the ASSIGN clauses in the program. Figure 8 shows a FILE-CONTROL statement in a COBOL program, and a corresponding ALLOCATE command that assigns the file to the terminal at execution time.

The DATASET operand of the ALLOCATE command corresponds to the DSNAME field of a DD statement. The * is a conventional symbol for the terminal. The FILE operand corresponds to a DDNAME. In this example, any output written to ANSWER-FILE in the program will be displayed at the terminal.

The same program could be executed in the background, with a DD statement directing the output to the printer or data set.

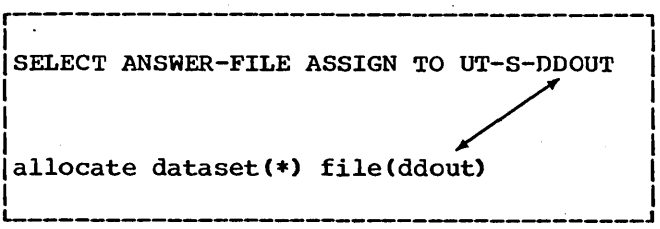

Figure 8. Defining the Terminal as a File

For programs containing ACCEPT and DISPLAY clauses, or which generate TRACE and EXHIBIT output for debugging, the SYSIN and SYSOUT files can be defined as the terminal. The ALLOCATE commands are:

```
ALLOCATE DATASET(*) FILE(SYSIN)
ALLOCATE DATASET(*) FILE(SYSOUT)
```

DISPLAY output is sent to the terminal instead of system output. TRACE and EXHIBIT output is also sent to the terminal.

A COBOL Example

Figure 9 is an example of a terminal session in which the user writes, compiles, and executes a simple inquiry program in COBOL. The program uses a part number entered from the terminal to select a record from an indexed file, and prints the information from the record out on the terminal.

At 1, the user enters an EDIT command to create a new data set that will contain the COBOL source program. The EDIT processor recognizes the descriptive qualifier "COBOL" in the data set name, and sets the record length and blocking factor to values acceptable to the ANS COBOL compiler. The tabs in the data set are set to "columns" 7,8,12, and 72. Since it is a new data set, the EDIT processor requests input (at 2), and types out the first line number ("00010" at 3). The EDIT processor continues to generate line numbers until 5, where the user enters a null line to request transfer to edit mode.

In the program itself, the user defines an indexed sequential file in the INPUT-OUTPUT section. This data set is permanently allocated by a DD statement in the user's LOGON procedure. No files need to be defined for the terminal in the LOGON procedure, since the ACCEPT and DISPLAY statements can be directed to the terminal with ALLOCATE commands defining SYSIN and SYSOUT.

At 7, the user saves a copy of his source program, and enters the END subcommand to terminate the EDIT processor. The COBOL command at 10 invokes the ANS COBOL compiler to process the source program.

At 13 and 14, the user assigns SYSIN and SYSOUT data sets to the terminal. This same COBOL program could be executed in the background by including SYSIN and SYSOUT DD statements in the Job Control Language.

The LOADGO command at 15 calls on the Loader to bring the object program into main storage and pass control to it. The COBLIB operand specifies that the standard COBOL library is to be used to resolve external references.

At 16, after his keyboard unlocks, the user enters a part number to test the program. The program locates the corresponding record in the indexed file, and displays the information in it at 17. The user repeats the test at 19, but with a non-existent part number. At 22, the user invokes the Linkage Editor to create a load module, and add it to his command library, a partitioned data set concatenated to the system command library. Once the member is added to his command library, the user can invoke the program by entering the program name as a command, as he does at 23.

```
1  edit query.cobol new
2  INPUT
3  00010 identification division.
   00020 program-id. query.
   00030 environment division.
   00040 configuration section.
   00050 source-computer. ibm-360-i65.
   00060 object-computer. ibm-360-i65.
   00070 input-output section.
   00080 file-control.
   00090     select parts-file assign to da-2314-i-ddparts
   00100     access is random
   00110     nominal key is key-in, record key is rec-key.
   00120 data division.
   00130 file section.
   00140 fd  parts-file
   00150     block contains 5 records
   00160     record contains 80 characters
   00170     label records are standard.
   00180 01  parts-record.
   00190     02 delete-code            picture x.
   00200     02 rec-key                 picture 9(7).
   00210     02 part-history            picture x(72).
   00220 working-storage section.
   00230 77  key-in                    picture 9(7).
   00240 procedure division.
   00250 begin.
   00260     open input parts-file.
   00270 para-1.
   00280     accept key-in.
   00290     read parts-file invalid key go to inv-key-read.
   00300     display rec-key, part-history.
   00310 eojb.
   00320     close parts-file. stop run.
   00330 inv-key-read.
   00340     display 'no record found'.
4  00350     go to eojb.
5  00360
6  EDIT
7  save
   SAVED
8  end
9  READY

10 cobol query so x d pm
11 ANS COBOL IN PROGRESS
12 READY

13 allocate dataset(*) file(sysin)
   READY
14 alloc da(*) f(sysout)
   READY

15 loadgo query coblib
16 6367220
17 6367220 SHIM CLIP   24 ON HAND   10 ORDER POINT    SUPPLIER 17688
   READY

18 loadgo query coblib
19 9999999
20 NO RECORD FOUND
21 READY
```

Figure 9. A Terminal Session Creating a COBOL Program (Part 1 of 2)

```
22 link query load(commands(query)) coblib
   READY

23 query
   3288540
   3288540 PAWL SPRING (4-INCH) 13 DOZ ON HAND        7 ORDER POINT
   READY
```

Figure 9. A Terminal Session Creating a COBOL Program (Part 2 of 2)

FORTRAN

Two versions of FORTRAN IV with special support for the foreground environment are available as Program Products to TSO users:

- Code and Go FORTRAN.
- FORTRAN IV (G1).

Both processors can also be used in the background environment. Two additional Program Products are available to complement the processors:

- FORTRAN IV Library (Mod I), for use with either processor to provide list-directed input/output support, ASCII data set handling, and PAUSE and STOP output to the terminal.

- TSO FORTRAN Prompter, which allows the terminal user to invoke the FORTRAN IV (G1) processor with the FORT or RUN commands.

A FORTRAN programmer can also invoke the FORTRAN (E), (G), or (H) processors with the CALL command, but not with the RUN or FORT commands. The user is responsible for allocating the data sets needed by these compilers, and for specifying the compiler options. The prompter performs these services for the FORTRAN IV (G1) compiler, which also has output specially formatted for the terminal.

Code and Go FORTRAN is optimized for a fast compile-and-execute sequence, carried out entirely within main storage for small- to medium-sized programs. This makes it a useful tool for problem-solvers. It accepts free-form source statements, and has simplified I/O statements for addressing the terminal. However, no permanent object program is produced, and some execution speed is sacrificed for fast compilation. Whenever the programmer needs to link separately compiled programs and subroutines, when he is working with very large programs, or when he wants to produce an object program he can save, he will use the FORTRAN (G1) compiler. He may develop and test his program with Code and Go FORTRAN, and then compile it a last time with the FORT command. The TSO CONVERT command will change free form source statements to fixed form or vice versa. Code and Go FORTRAN is discussed in greater detail in the chapter "Problem Solving."

Entering the Source Program

The programmer uses the EDIT command to create a source program. An operand of the EDIT command informs the syntax checker what FORTRAN compiler is going to be used. The normal value, (G1), is selected by default if no value is entered. As the program source statements are entered, the FORTRAN syntax checker processes each line, interrupting the input sequence if it detects an error. Figure 10 shows a syntax checker diagnostic response and the user action to correct the error. The first CHANGE subcommand inserts a left parenthesis, the second, a right parenthesis.

Compiling a FORTRAN Program

When the programmer finishes entering the source program, he saves his data set with the SAVE subcommand, and switches to command mode to enter the FORT command, or stays in edit mode and uses the RUN subcommand. Operands of FORT allow him to specify various compiler options: whether or not a listing is to be produced, the contents of the listing, where it is to be printed or stored, whether or not an object program is to be produced, and whether diagnostics are to be sent to the terminal. All operands except the input data set name can default to standard values.

```
      .
      .
00030  30 format (f10.3)
00040  12 read (2,30) a(i),i=1,5
) REQUIRED FOR IMPLIED DO
EDIT
change / a/ (a/
change /5/5)/
list
00040  12 read (2,30) (A(I),I=1,5)


INPUT
           do 50 i=1,5
      .
      .
```

Figure 10. FORTRAN Syntax Checker Diagnostic

As the compiler processes the program, it may find program organization errors that were not detected by the syntax checker on a statement-by-statement basis. Compiler diagnostic messages are sent to the terminal, along with the statement in error, and a pointer to the field in error, if possible. Figure 11 is an example of compiler output to the terminal during a single compilation. The number preceding the source statement is the line number assigned by EDIT when the source program was entered. The line number allows the programmer to use the edit mode subcommands to correct the statement quickly, without listing the entire source program.

```
G1 COMPILER ENTERED
000170  30  FORMAT (I6)
                  $
01)  IGI006I  DUPLICATE LABEL
SOURCE ANALYZED
PROGRAM NAME=MAIN
*001 DIAGNOSTICS GENERATED,
     HIGHEST SEVERITY CODE IS 8
READY
```

Figure 11. Sample of FORTRAN compiler Output

When the program compiles successfully, the programmer can print an error-free listing, and use the LOADGO command to load his program for execution.

Testing FORTRAN Programs

The FORTRAN programmer has two testing facilities: The debug facility of the FORTRAN language, and the TSO test mode.

The debug facility of FORTRAN (G1) allows the programmer to monitor program execution from his terminal. Output from the debug statements such as TRACE and DISPLAY is sent to the terminal, unless directed elsewhere with the UNIT option of the DEBUG statement. DUMP and PDUMP output also goes to the terminal. Execution of the program can be synchronized with the terminal by inserting READ statements in the debug packets, forcing the program to wait for the user to allow it to continue. Since FORTRAN debug statements are grouped together in the source program, they can be easily deleted with EDIT subcommands when testing is completed.

The test mode is also available for FORTRAN programmers. Using an object program listing and storage map produced by the compiler, the programmer can insert breakpoints to interrupt execution of his program, list and modify variable values in main storage, and control program flow. Some knowledge of System/360 instruction formats and hexadecimal notation is helpful in using test mode.

PL/I

The PL/I programmer can use the following language processors from the terminal:

- ITF: PL/I.
- PL/I Optimizing Compiler.
- PL/I (F) Compiler.
- PL/I Checkout Compiler.

The ITF: PL/I Program Product is a subset of PL/I designed for solving problems at the terminal. It is provided by a compiler that offers two types of processing: a rapid compile-and-execute sequence for small- to medium-sized programs, or line-by-line interpretation and execution of PL/I statements as they are entered. ITF: PL/I does not produce a permanent object program. ITF: PL/I is described in the chapter, "Problem Solving."

The PL/I Optimizing Compiler, an IBM Program Product, is a language processor for use in either the background or the foreground environment. For the foreground environment, the compiler incorporates a prompter, which allows the user to invoke it with the PLI or RUN commands. Compiler options allow the user to request diagnostics and listings formatted for the terminal, or to request termination of compilation if syntax errors are found.

The PL/I programmer can also use the PL/I (F) compiler from the terminal, but no special prompting or output format is available. The F-level syntax checker can be used to scan source statements as they are entered or to scan complete programs. The PL/I (F) compiler cannot be invoked with the PLI command, but an example of a command procedure that uses the CALL command for the PL/I (F) processor is given in the last section of this chapter. The remainder of this section is concerned only with the PL/I Optimizing Compiler.

The PL/I Optimizing Compiler implements a more comprehensive subset of PL/I than previous compilers and offers a choice of fast compilation, optimization for speed of object program execution, or optimization for minimum object program size. A subroutine library is required during linkage editing of a compiler output module. A second library is required for execution of the object program. Each library is available as an IBM Program Product:

- OS PL/I Resident Library.
- OS PL/I Transient Library.

The PL/I Checkout Compiler is a two-stage processing program which translates and interprets (executes) PL/I programs. It can be used in either the batch or TSO environments of the IBM System/360 Operating System.

Using the checkout compiler in a TSO environment will often enable you to check out a PL/I program in one session at the terminal. Its conversational checkout features allow you to communicate with the compiler during processing. The compiler prints messages and listings at the terminal (as requested by the TERMINAL option) and you can respond with PL/I subcommands, or PL/I statements for

immediate execution. The subcommands allow you to change compiler options, request more information, copy output files at the terminal, make temporary modifications to the PL/I program (during interpretation only), and either continue or terminate processing.

You can also communicate with the PL/I program when it is being interpreted, by using the conversational I/O feature of PL/I.

Entering a PL/I Program

The programmer uses the EDIT command to create his source program and save it as a data set. He can request EDIT to assign a line number to each line of his source program as he enters it. If line numbers are assigned, he can request the PL/I Optimizing Compiler to use them in diagnostic messages, instead of statement numbers. The programmer can use the line number to retrieve the erroneous source statement, correct the error, and invoke another compilation, all without having the complete listing displayed at the terminal.

Compiling a PL/I Program

To invoke the compiler, the programmer uses either the RUN command or the PLI command. RUN can be used as a subcommand of EDIT, allowing the user to correct errors without entering the EDIT command again. RUN causes a complete compile-load-go sequence but does not produce a permanent object program. RUN is normally used during the initial compilations to check for source language errors. When a program is debugged, the PLI command can be used to produce an object program and a full listing. The object module can be loaded for execution or linkage edited into a program library for use as a load module. Whether invoked by RUN or PLI, the PL/I Optimizing Compiler directs diagnostic messages to the terminal, in either a full or an abbreviated format. During testing, the programmer can have traces and other output generated by PL/I program checkout facilities displayed at the terminal.

Program Execution

Programs produced by the compiler can be executed in either the background or the foreground. In the foreground I/O can be directed to the terminal by allocating a PL/I file, such as SYSIN or SYSPRINT, to the terminal with the ALLOCATE command. In the background these same files can be directed to data sets or unit record devices.

Assembler Language

Like programmers who use the higher level languages, the assembler language user enters his source program statements with the EDIT command. Assembler (F) accepts free form input, but the tab setting facilities of EDIT allow the user to create a formatted listing. On request, EDIT assigns line numbers to the source statements, which are later referred to by diagnostic messages produced during assembly. Line number or context editing is always available to correct errors, modify source statements, or add comments.

Assembling the Program

When the programmer completes his source program and saves it, he invokes Assembler (F) with the RUN or ASM commands. The use of these commands requires the TSO Assembler Prompter Program Product. Operands of ASM give him control over the listing format, disposition of output, and diagnostic messages.

Assembler diagnostic messages sent to the terminal include the statement in error, if possible; both the EDIT-assigned line number and the assembler-assigned statement number; and an explanation of the error. Usually, the user will not need to have the complete listing displayed in order to obtain an error-free assembly. Using the line numbers in the diagnostic messages, the programmer can quickly locate and fix source statement errors with the edit mode subcommands.

Test Mode

When assembly completes without error, the programmer creates a load module with the LINK command, and uses the TEST command to bring it into storage. The TEST command processor uses the symbol table produced by the assembler and linkage editor, which gives the address and attributes of each symbolic name used in the source program. Before passing control to the program, TEST allows the user to establish initial values to be passed to the program as test data, and to set up breakpoints where execution is to be interrupted for displays, dumps, and other debugging activity. The user can refer to points in the program by symbolic names, absolute relative or indirect addresses.

To display storage and register contents, the programmer uses the LIST subcommand, specifying a register range or

address range, or a list of symbolic names. Special forms of the LIST subcommand provide standard formats for control blocks such as the TCB, DEB, DCB, and PSW. LIST will also provide a current map of user storage. List output can be directed to either the terminal or a data set.

Other TEST subcommands allow the programmer to load additional programs into storage, to delete or replace programs in storage, to issue GETMAIN and FREEMAIN as subcommands from the terminal, to define the location and attributes of symbols not in the symbol table, and to start and stop program execution.

Other Compilers

Any language processor designed to execute under the operating system can be invoked from a TSO terminal. A compiler, like any other program in load module form, is invoked with the CALL command. Options to control the execution of IBM compilers -- such as LOAD or NOXREF -- are entered with the CALL command, in the same form as they would be specified in the PARM field of an EXEC statement in a background job stream.

Before a language processor is invoked, the necessary input, output, and utility files must be allocated under the names expected by the processor. For the compilers invoked directly by their own commands (American National Standard COBOL, FORTRAN (G1), PL/I Optimizing Compiler and Assembler (F)), the necessary allocations are performed by initialization programs called before the compilers.

Since the ALLOCATE statements necessary for a particular compiler are always the same, it is easiest to define them in a command procedure to be used for invoking that compiler. The function of the command procedure is the same as the cataloged procedures used to invoke compilers in the background: to save the user the trouble of entering a set of unchanging statements each time the compiler is invoked. The command procedure developed in this section as an example is for the PL/I (F) compiler. Similar procedures can be defined, either by individual users or by the installation, for any processor.

A Compiler Command Procedure

Figure 12 shows a command procedure that could be used to invoke the PL/I (F) compiler. This procedure would be created with the EDIT command as a command list (CLIST) data set, under an appropriate member name, such as PLIF.

At 1 in the sample procedure is a PROC statement, defining a single positional parameter to be supplied by the user when the procedure is invoked, in this case, the name of his program. Whatever value the user specifies when calling the procedure will be filled into the following commands wherever "&NAME" appears.

Records 2 through 6 perform the data set allocations required by the PL/I compiler. Record 2 allocates the input data set containing the source program. Although this data set is probably already allocated, since the user has most likely just created it with EDIT, this ALLOCATE command will reallocate it with the DDNAME "SYSIN". This data set is always OLD, no BLOCK or SPACE values have to be supplied. The data set name will be formed from the program name supplied by the EXEC command, followed by the characters ".PLI". Two periods are necessary in the model command, since the first one indicates the following characters are to be concatenated to the supplied value. Records 3 and 4 similarly allocate and assign standard names to the data sets to hold the program listing and the object program. Since these are new data sets, the BLOCK and SPACE values must be supplied. Records 5 and 6 allocate the two utility, or temporary work, data sets the compiler needs. No data set name is specified, so a system-generated name will be assigned to them, and the data sets will automatically be deleted by a FREE command. All the other data sets will be kept and cataloged. To use the same procedure again for the same program, the user should enter DELETE commands for SYSLIN and SYSPRINT.

Record 7 invokes the PL/I (F) compiler by its load module name , and passes to it the list of options to control execution. When the compiler completes processing, the FREE command in record 8 releases all the data sets except the object module.

```
1  PROC 1 NAME
2  ALLOCATE DATASET(&NAME..PLI) FILE(SYSIN)
3  ALLOCATE DATASET(&NAME..LIST) FILE(SYSPRINT) BLOCK(125) SPACE(300,100)
4  ALLOCATE DATASET(&NAME..OBJ)FILE(SYSLIN) BLOCK(80) SPACE(250,100)
5  ALLOCATE FILE(SYSUT1) BLOCK(1024) SPACE(60,60)
6  ALLOCATE FILE(SYSUT3) BLOCK(80) SPACE(250,100)
7  CALL 'SYS1.LINKLIB(IEMAA)' 'LIST,ATR,XREF,STMT,MACRO'
8  FREE FILE(SYSUT1,SYSUT3,SYSIN,SYSPRINT)
```

Figure 12. A Command Procedure to Invoke the PL/I (F) Compiler

```
 1  exec plif 'exp' list
 2  ALLOCATE DATASET(EXP.PLI) FILE(SYSIN)
 3  ALLOCATE DATASET(EXP.LIST) FILE(SYSPRINT) BLOCK(125) SPACE(300,100)
 4  ALLOCATE DATASET(EXP.OBJ) FILE(SYSLIN) BLOCK(80) SPACE(250,100)
 5  ALLOCATE FILE(SYSUT1) BLOCK(1024) SPACE(60,60)
 6  ALLOCATE FILE(SYSUT3) BLOCK(80) SPACE(250,100)
 7  CALL 'SYS1.LINKLIB(IEMAA)' 'LIST,ATR,XREF,STMT,MACRO'
 8  FREE FILE(SYSUT1,SYSUT3,SYSIN,SYSPRINT)
 9  READY

10  allocate dataset(*) file(sysin)
11  READY

12  allocate dataset(*) file(sysout)
13  READY

14  loadgo exp.obj pl1lib
```

Figure 13. Use of a Command Procedure

Figure 13 shows how the procedure might be used from the terminal. At 1 is the EXEC command invoking the procedure. The LIST keyword on the command specifies that each command is to be printed out at the terminal as it is executed. Note that the name supplied with the EXEC command has been filled in as part of the data set name field in the ALLOCATE commands. The system continues to list commands through line 8, then notifies the user it is again ready to accept commands from the terminal with the READY message in line 9. The user enters the LOADGO command to bring his compiled object program into storage for execution.

If the procedure is a member of the command procedure library, the user can use the EXEC command implicitly, as shown in Figure 14. When the system does not find "PLIF" defined in the command library, it looks for the command procedure in the command procedure library. The individual commands are not displayed at the terminal. When the procedure completes, the READY message is displayed, and the user can load his program for execution.

```
plif exp
READY
```

Figure 14. Implicit use of Procedure

Nested Procedures

A command procedure can be made into a compile-load-go sequence -- the equivalent of the RUN command -- by using the procedure nesting and conditional execution capabilities. For instance, in Figure 13, note that the user enters two ALLOCATE commands, defining terminal input and output for execution time, and a LOADGO command to invoke his program. Like the commands used to invoke the compiler, these would normally be used every time the user wants to invoke his program, and therefore can be reasonably placed in a command procedure. This second procedure can be called from the compiler-invoking procedure, making it a compile-load-go procedure.

The procedure to load and execute the user program might be defined as shown in Figure 15, under a suitable name such as LDGO. The FREE command in record 2 is the same as the one in the PLIF procedure. It needs to be repeated here since it will not be executed in that procedure, as explained below. Records 3 and 4 allocate the terminal for any SYSIN or SYSPRINT I/O statements in the user program, and statement 5 is the LOADGO command causing the program to be brought into storage and given control.

```
1 PROC 1,NAM1
2 FREE FILE(SYSUT1,SYSUT3,SYSIN,SYSPRINT)
3 ALLOCATE DATASET(*) FILE(SYSIN)
4 ALLOCATE DATASET(*) FILE(SYSPRINT)
5 LOADGO &NAM1..OBJ PL1LIB
6 END
```

Figure 15. A Command Procedure to Invoke a User Program

It would be possible to call this procedure from the PLIF procedure by inserting a record containing:

```
EXEC LDGO '&NAME'
```

However, it would be preferable to call it only when the return code from the compiler indicates successful execution is likely, that is, no serious errors were detected during compilation. To test the compiler return code, the user inserts a WHEN statement:

```
WHEN SYSRC(LE 4) EXEC LDGO '&NAME'
```

The WHEN statement immediately follows the CALL command invoking the compiler (record 7 in Figure 12). If the compiler return code is less than or equal to four ("LE 4"), indicating that no errors, or only minor errors, were detected, the EXEC command is executed. If the return code is greater than four, the EXEC command will be ignored, the FREE command is executed, and the procedure ends. The terminal returns to command mode, and the user will probably use the LIST command to display the compiler listing, determine the errors in the source program, correct them with the EDIT command, and reinvoke the procedure for another compilation. Figure 16 shows the modified PLIF command procedure. A DELETE command has been added for the object module, since it is not executable. Figure 17 shows a use of the procedure for a successful compilation. The LIST operand is specified to display each command as it is executed.

```
PROC 1,NAME
ALLOCATE DATASET(&NAME..PLI) FILE(SYSIN)
ALLOCATE DATASET(&NAME..LIST) FILE(SYSPRINT) BLOCK(125) SPACE(300,100)
ALLOCATE DATASET(&NAME..OBJ) FILE(SYSLIN) BLOCK(80) SPACE(250,100)
ALLOCATE FILE(SYSUT1) BLOCK(1024) SPACE(60,60)
ALLOCATE FILE(SYSUT3) BLOCK(80) SPACE(250,100)
CALL 'SYS1.LINKLIB(IEMAA)' 'LIST,ATR,XREF,STMT,MACRO'
WHEN SYSRC(LE 4) EXEC LDGO '&NAME'
FREE FILE(SYSUT1,SYSUT3)
DELETE &NAME..OBJ
END
```

Figure 16. A Command Procedure for a Compile-Load-Go Sequence

```
exec plif 'derv' list
ALLOCATE DATASET(DERV.PLI) FILE(SYSIN)
ALLOCATE DATASET(DERV.LIST) FILE(SYSPRINT) BLOCK(80) SPACE(300,100)
ALLOCATE DATASET(DERV.OBJ) FILE(SYSLIN) BLOCK(80) SPACE(250,100)
ALLOCATE FILE(SYSUT1) BLOCK(1024) SPACE(60,60)
ALLOCATE FILE(SYSUT3) BLOCK(80) SPACE(250,100)
CALL 'SYS1.LINKLIB(IEMAA)' 'LIST,ATR,XREF,STMT'
WHEN SYSRC(LE 4) EXEC LDGO 'DERV'
FREE FILE(SYSUT1,SYSUT3,SYSIN,SYSPRINT)
ALLOCATE DATASET(*) FILE(SYSIN)
ALLOCATE DATASET(*) FILE(SYSPRINT)
LOADGO DERV.OBJ PL1LIB
```

Figure 17. Using a Compile-Load-Go Command Procedure

Problem Solving

To meet the needs of users who may not be professional programmers, three problem-solving languages are available as IBM Program Products with TSO: Interactive Terminal Facility (ITF); BASIC ITF: PL/I, and Code and Go FORTRAN. These languages are available as separate program products. ITF: BASIC is a simple, algebra-like language that can be quickly learned, yet it has the power to perform complex mathematical calculations. ITF: PL/I is a subset of the full PL/I language. It is a more powerful language than BASIC for subroutine handling, but is simpler than the full PL/I language, making it a good teaching tool. ITF: PL/I can be used in two ways: statements can be interpreted and executed as they are entered (desk calculator mode); or they can be collected into procedures for compilation and execution as programs or subroutines. Code and Go FORTRAN provides the full FORTRAN IV language for terminal users. It has a very fast compile-and-execute sequence, carried out entirely in main storage. Code and Go FORTRAN accepts free-form source statements, and has simplified I/O statements for terminals.

All three languages have statement-by-statement syntax checking as the programs are keyed in, and additional diagnostics are sent to the terminal for errors detected during compilation and execution phases. For the ITF: BASIC and PL/I languages, the test mode allows the user to monitor program execution with breakpoints and traces, to inspect and reset the values of variables and to modify main storage during execution. The debug facilities of FORTRAN (G) are included in Code and Go FORTRAN.

Programs in any of the three languages are created, and can be run, in edit mode. Whenever necessary, the user can use EDIT to replace or modify source statements. For small to medium-sized programs performance is better in edit mode than in command mode, since the source statements and, in the case of Code and Go FORTRAN, the object program, can be kept in main storage and do not have to be read in from auxiliary storage.

ITF: BASIC

The ITF: BASIC Program Product is based on the original BASIC language created for time sharing use at Dartmouth College. With TSO, the BASIC user logs on to the system, then enters the EDIT command. In the input mode he enters successive statements to define his problem. If the system detects a syntax error, he is notified immediately so that he can correct the faulty statement before continuing. The user can defer syntax checking until compilation. When all his statements have been entered and syntax checked, the user issues the RUN subcommand to compile and execute the program. An operand of the RUN subcommand specifies whether he wants to execute with short precision (6 significant decimal digits) or long precision (15 digits). Programs and data can be saved from one session to the next, or deleted after use.

BASIC statements are entered one to an input line, and can refer to other statements by the line number assigned by EDIT. Variables always have one- or two-character names. Arithmetic operators used in BASIC statements are +, -, /, *, and ** (exponentiation).

BASIC includes statements for defining and handling one- and two-dimensional arrays. Array references have the form A(i,j) where "A" is the array name, and "i" and "j" are variables or constants referring to the row and column of an element. Elements can contain arithmetic or character values.

A special set of statements is included to handle matrices. A BASIC matrix is always a two-dimensional array, and can contain only arithmetic values. Two matrices with the same dimensions can be multiplied, added, or subtracted, and a matrix can be inverted or transposed with built-in matrix functions.

Figure 18 shows a terminal session creating a BASIC program to calculate the infinite sum

$$\sum_{n=1}^{\infty} X^{-n}$$

to the limit of machine precision. Statements 010 and 020 write messages to the terminal, describing the input requested by statement 030. After initializing the variables, the user states the sum as in BASIC format: S = S+1/(X**N). Statement 070 increments N, and 080 is a check to see if the precision limit has been reached. If it has, control branches to statement 100, to print the results at the terminal. Note that

statement 110 uses an "image" statement to format output, while statement 130 uses the default format.

During the execution of the program, the "?" requests the user to enter the input. When the results are printed and the program terminates, the user is returned to edit mode where he saves the program for use in later sessions.

```
edit rsumx basic
INPUT
010  print 'summing 1/x**n)'
020  print 'what x'
030  input x
040  let n=0
050  s=0
060  s=s+1/(x**n)
070  n=n+1
080  if s=s+1/(x**n) then 100
090  goto 60
100  print 'number of terms:'|(n-1)
110  print using 120, s
120  :  'sum='##.##############
130  print 'last term=', 1/(x**(n-1))
140  end
150
EDIT
run
     SUMMING 1/(X**N)
     WHAT X
? 1.065
     NUMBER OF TERMS:      176
     SUM= 16.3836700000000
     LAST TERM=    1.53643E-05
save
SAVED
end
READY
```

Figure 18. ITF: BASIC Sample Session

ITF: PL/I

The ITF: PL/I Program Product is a subset of the full PL/I language, suited to problem-solving because of its simplicity and ease of use. For example, there are no arithmetic conversion rules to remember: all arithmetic data is kept in decimal floating-point format. The language is compatible with PL/I as provided by the PL/I (F) compiler, except that Interactive PL/I does not require semicolons to terminate statements, source language programs are stored with variable-length records, and some arithmetic data formats that would default to fixed-point binary in full PL/I are floating-point decimal in ITF: PL/I. A utility command, CONVERT, is provided to format ITF: PL/I source programs for submission to a batch PL/I compiler, if the user wants to create an object program.

ITF: PL/I can be used under either the EDIT or the CALC commands. Under EDIT, statements are collected into a program. When the program is complete, the RUN subcommand is used to compile and execute it. Under the CALC command, statements are interpreted and executed as they are entered. Statements are discarded as soon as they have been executed. Variables, however, are all defined as "static externals" and kept in a table in main storage, where they can be referred to by subsequent ITF: PL/I statements, or displayed at the terminal. The table of variables created during a session using the CALC command can be saved in a data set for use in later sessions.

Variables included in ITF: PL/I are scalars of either single or double precision, arrays of up to three dimensions, character and bit strings, labels, externals, and entry and return parameters. Execution control statements include DO loops, GOTO branch statements, and IF THEN ELSE conditionals. Procedures collected under the EDIT command can be saved and invoked with the CALL statement, either from another procedure or under the CALC command. Only list-directed and edit-directed stream I/O is provided, either to a file or the terminal. An appropriate set of the PL/I built-in functions is included in ITF: PL/I.

Test Facility: When a user invokes an ITF: PL/I or BASIC procedure for execution, as an option he can specify that the program is to be tested. In this case, the system allows the user to set breakpoints in the program before it is started, and to set up program traces and displays of variables. All output from the testing routines is displayed at the terminal. When the program is interrupted by a breakpoint, or when the user hits the attention key, he can display and modify variable values, modify test procedures, and then restart the program at the point of interruption. The ITF testing subcommands are a subset of the TEST subcommands available for the programming languages.

Syntax errors in an ITF: PL/I source statement are detected as soon as the statement is entered, and the user is notified to correct the statement. The user can request deferral of syntax checking to compile time. When operating under EDIT, some errors will only be detected at compile-execute time. In this case, a message is sent to the terminal, and the user is returned to the edit mode to correct the error in the source program.

```
edit div ipli
INPUT
00010   div: procedure(x,y);
00020   /* this procedure is a subroutine that finds the */
00030   /* greatest common divisor of any positive x and */
00040   /* y of six digits or less                       */
00050   x1 = max(x,y);
00060   y1 = min(x,y);
00070   if (x1 <= 0)|(y1 <= 0) then do;
00080                            put list ('invalid values');
00090                            return;
00100                            end;
00110   lab: rem = x1 - (floor(x1/y1)*y1);
00120        if rem = 0 then go to out;
00130        x1 = y1;
00140        y1 = rem;
00150        go to lab;
00160   out: put list ('the common divisor is:',y1);
00170   end
00180
EDIT
save
SAVED
end
READY

calc
CALC
call div(9,24)
THE COMMON DIVISOR IS:       3.00000E+00
end
READY
```

Figure 19. ITF: PL/I Sample Session

Sample Session: Figure 19 shows a sample terminal session using ITF: PL/I to create a procedure finding the largest common divisor of two positive numbers. "Max" and "min" in statements 50 and 60, and "floor" in statement 110 are built-in functions. Note that since no file is specified in the PUT statements, the output is sent to the terminal. At statement 180, the user entered a null line, indicating a switch from the input mode to edit mode. The SAVE subcommand stores the procedure on auxiliary storage. The user then enters CALC to go to the desk calculator terminal mode, and uses a CALL statement to invoke the procedure.

Code and Go FORTRAN

For the many problem-solvers who are familiar with the FORTRAN programming language, the Code and Go FORTRAN Program Product is available for use from the terminal. The user creates his program, and optionally has it syntax-checked, with the EDIT command. He uses the RUN subcommand to invoke the Code and Go FORTRAN compiler. The source program is converted to an object program in main storage. As soon as the object program is complete, control is passed to it. The compiler used for Code and Go FORTRAN bypasses certain object code optimization processing for greater compilation speed.

The language includes all the features of FORTRAN IV as defined in the publication IBM System/360: FORTRAN IV Language. Two extensions to the language are included for ease of use from the terminal: free-form source statements and list-directed I/O statements similar to those provided by PL/I.

Free-Form Statements: Code and Go FORTRAN does not require statements to begin in column 7. If a statement has a label, the statement can immediately follow the label. If it has no label, it can start in column 1.

A utility command (CONVERT) is available to change free-form source statements to fixed form, if a user wants to submit them to one of the batch FORTRAN compilers after developing and testing them in free form. Code and Go FORTRAN will also accept the conventional fixed format.

List-Directed I/O: The list-directed I/O facility can be used for any I/O device, but was designed especially for FORTRAN programs that read from and write to a remote terminal. List-directed I/O statements are written with an asterisk (*) in the field normally used for the FORMAT statement number. Thus, a READ statement to fill an array of five values might be coded:

```
20 READ (5,*) (A(I),I=1,5)
```

When execution reaches statement 20 in the program, the line:

```
00020
?
```

is sent to the terminal. (This prompting message is suppressed at user request or if the device is not a terminal.) The user can then enter a line such as:

```
30.7 42.85 12.3 29.1 88.43
```

to fill in the array. Input values can be separated by one or more blanks, or by a single comma. Two commas in succession indicate a value is to be skipped. A slash is used to indicate that no more values will be entered, and that any remaining variables in the list are not to be altered. Successive occurrences of the same value can be entered in the form "k*constant", as in NAMELIST input. Array A above could have been filled by the line:

```
5*30.7
```

Integer, real, literal, complex, and logical constants can be entered for list-directed READ statements. Real constants can be entered in D, E, or unspecified format. List-directed WRITE statements may not include literal constants, and real constants default to E format on output.

Sample Session: Figure 20 shows a portion of a terminal session in which a user writes a program in Code and Go FORTRAN and executes it. With the EDIT command, he specifies he is creating a new program named "VAL", written in Code and Go FORTRAN (GOFORT), and that he wants it checked for syntax errors as he enters it. READ statement 5 allows the user to enter one of the variables, and to specify how many values will be supplied for the array DELTA. Statement 10 then reads the values for DELTA. The WRITE statement will display the answers from array F at the terminal.

When the program is completely entered, the user shifts from input mode to edit mode by entering a null line. The SAVE subcommand creates a copy of the program on auxiliary storage. The RUN command invokes the CODE and Go FORTRAN compiler, which creates an object program in main storage, calls the loader to resolve external references and bring in necessary library programs, and start the program. Note that the ALOG subprogram is included in the program. The complete FORTRAN subprogram library is available.

When execution reaches statements 5 and 10, the user is prompted to supply values, and as the program completes, the answers are transmitted to the terminal. After the program terminates the user returns to the edit mode, where he could modify the source program if necessary. The saved copy of the program will be kept for the user on auxiliary storage, where it will be available in subsequent sessions.

```
READY
edit val new gofort scan
INPUT
00010  real*4 delta(10)/10*0.0/,f(9)/9*0.0/
00020  5 read(5,*) curnt,n
00030  10 read(5,*) (delta(i),i=1,n)
00040  do 20 i=1,n
00050  20 delta(i)=alog((curnt+delta(i))/curnt)
00060  do 30 i=2,n
00070  30 f(i-1)=delta(i)/delta(1)
00080  n=n-1
00090  write(6,*) (f(i),i=1,n)
00100  end
00110
EDIT
save
SAVED
run
? 00005
176.2  5
? 00010
10. , 17.1, 21.5, 37.4, 127.14
0.167791E 01  0.208565E 01 etc.
end
READY
```

Figure 20. Code and Go FORTRAN Sample Session

System Summary

This chapter introduces the major control and service routines that have been added to the MVT control program for time sharing. It identifies points where the installation can control system execution, and where modules can be modified or replaced for specialized applications.

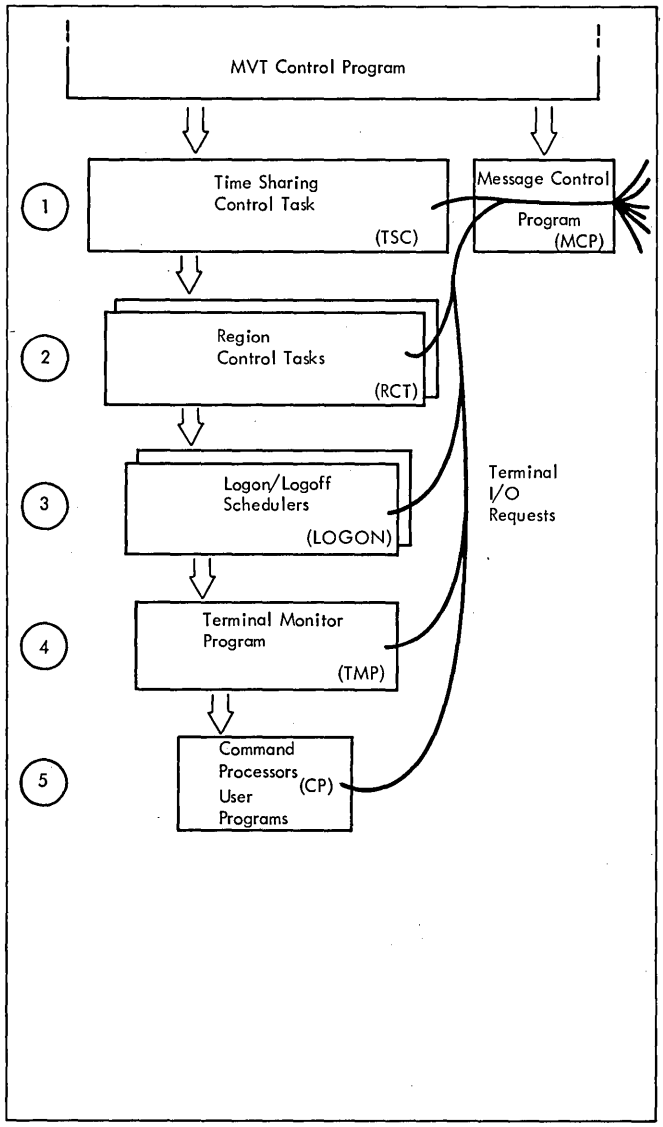

Figure 21. TSO Control Flow Diagram

Figure 21 is a generalized diagram of the flow of control through the system, showing several levels of control under the MVT control program. The portion of the system directly concerned with time sharing can be divided into five levels:

1. At the highest level are the Time Sharing Control and the TCAM Message Control Program tasks. The Time Sharing Control task handles system-wide functions such as the initialization procedures required when the operator starts time sharing, and the swapping of foreground jobs. The Message Control Program is a part of the Telecommunications Access Method (TCAM) and handles all I/O for remote terminals.

2. Below the Time Sharing Control task is a Region Control task for each foreground region. The Region Control task supervises those foreground jobs assigned to its region, including the quiescing and restoring of job activity before and after swapping.

3. The LOGON/LOGOFF Scheduler is invoked by the Region Control task whenever a user wants to log on or off the system. The LOGON routine identifies the user to the system, and defines his foreground job using parameters in the LOGON procedure, user profile, and operands of the LOGON command.

4. LOGON invokes a problem program specified by the user's LOGON procedure at the next level. This is normally the TSO Terminal Monitor Program, which handles TSO and user-supplied commands.

5. Command processors and other application programs execute at the lowest level of control.

These levels are conceptual only, and are not defined by priorities or locations in main storage. Through the course of this chapter a more precise system flow diagram will be built. However, some overall design features of the system are apparent from even the simplified picture in Figure 21:

- TSO is highly modular -- built up from small components with well-defined interfaces -- and therefore flexible and adaptable to local needs. The Terminal Monitor Program and the Message Control Program are designed to be modified or replaced by the installation for a specialized application.

- Each level of control also provides an opportunity for the system to recover from failures. For instance, abnormal termination of a command processor or other problem program is handled by the Terminal Monitor Program. Only the user who invoked the failing program is affected -- and he is given an opportunity to recover the program through the TEST facility. Users at other terminals are completely protected.

The Time Sharing Driver

Before discussing the individual control routines in greater detail, one program must be added to the control flow diagram. The Time Sharing Driver isolates in one component the decision-making algorithms for the division of system resources among all the users of the system. By passing parameters to the Driver with the START command or from the system parameter library, the installation controls the various scheduling algorithms to gain the desired performance for its job mix. These "tuning" parameters and the algorithms are discussed in the last section of this chapter.

As shown in Figure 22, the Driver has a unique relationship to the other control routines. It cannot be logically assigned to one of the control levels, but is used as a service program by all the levels from the MVT task supervisor down to the Terminal Monitor Program. The calling programs inform the Driver of events throughout the system -- time slice end, user waiting for LOGON, job waiting for input, etc. From this stream of information, the Driver maintains a current picture of the system load and activity. Based on this picture, the Driver orders actions such as swapping, changes in priority, and assignment of a user to a particular region.

The Driver component itself is completely insulated from the rest of the system by the Time Sharing Interface Program, which accepts all calls to the Driver, then passes them through a standard interface to the Driver itself. The Driver returns parameters to the Interface Program that request various actions by the other control routines. Thus, an installation can modify or replace the Driver -- effectively, provide its own system scheduler -- without modifying the system implementation programs. The operator uses the START command to specify which Driver -- the standard one or an installation-written one -- is to be used.

Control Routines

The following paragraphs discuss the functions of each of the TSO routines. Although the TCAM Message Control Program logically shares the highest level of control with the Time Sharing Control Task, it is discussed last.

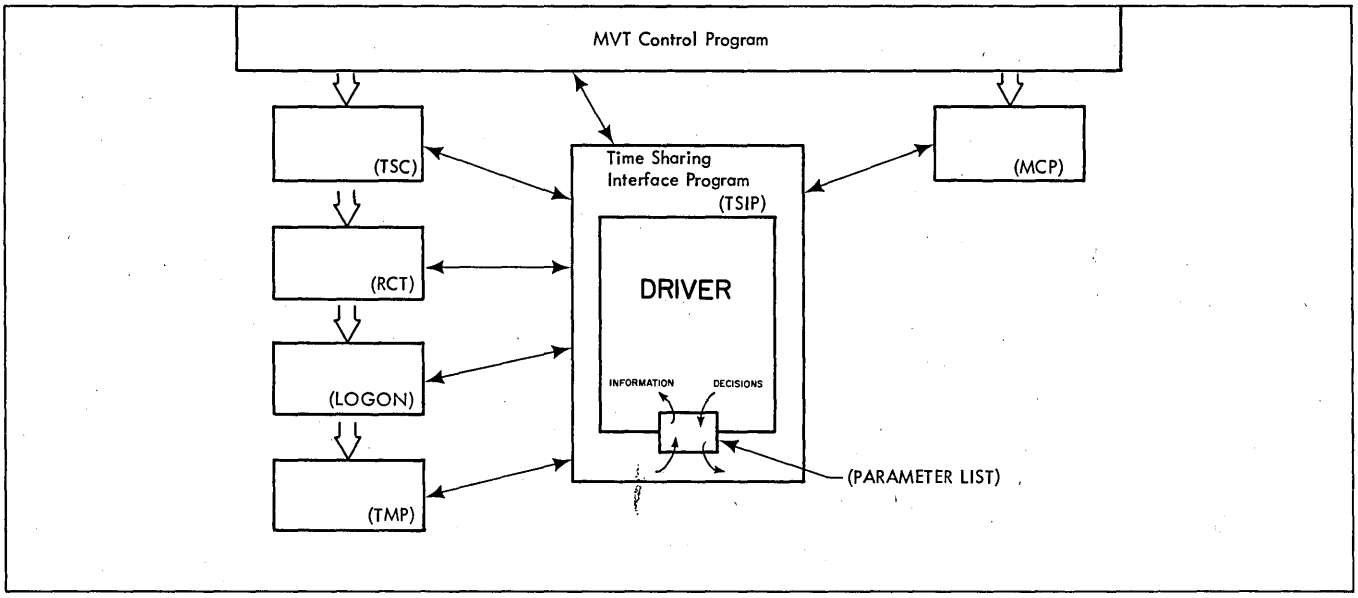

Figure 22. The Time Sharing Driver

The Time Sharing Control Task

The Time Sharing Control task, as shown in Figure 23, handles all functions affecting the entire time sharing portion of the system. This includes responding to the START, MODIFY, and STOP operator commands, and handling the swapping of foreground jobs into and out of main storage.

When the operator enters the START command for TSO, an initialization module of the Time Sharing Control task is given control. The initialization module calculates the size of the Time Sharing Control region that will be needed and obtains it from the main storage management routine of MVT. In this region, the Time Sharing Control task builds the control blocks and buffers the system will need, and invokes a Region Control task for each foreground region.

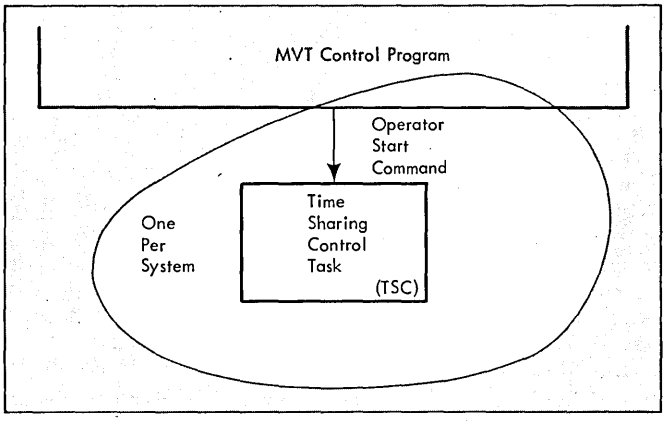

Figure 23. The Time Sharing Control Task

While the time sharing system is operating, the major function of the Time Sharing Control task is the swapping of foreground jobs into and out of main storage. Swapping is handled at this level so it can be optimized on a system-wide basis when multiple foreground regions are active. Whenever possible, an active job is not quiesced for swapping out until a channel will be free for the swap output. But in many cases when there is nothing to be gained by delaying, such as when a foreground job is waiting for input from the terminal, a swap out is scheduled whether a channel is free or not.

The Time Sharing Control task maintains an input queue and an output queue for swap requests (one of each set if parallel swapping is being used). It builds a channel program for each swap request. A program-controlled interruption (PCI) will occur near the end of each channel program. When the interruption occurs, an exit routine selects the next channel program to execute. The exit routine inserts a transfer to the next channel program at the end of the current channel program. Thus as the number of requests increases, the swap process is carried out by a never-ending channel program. Seek time is minimized by attempting to swap jobs out to the direct access area from which the last job was swapped in, or if this is not possible, by using the free space closest to the current arm position.

In determining what portion of a foreground region to swap out, the Time Sharing Control task uses a map of the foreground job created by the Region Control task. Each entry in the map identifies the starting address and length of a section of the region that the job is using. The number of entries in this map is the same for every job and is specified by the installation in the system parameter library. If there are too few entries, inactive main storage must be included (and swapped). A large number of entries cuts down on the amount of inactive storage that has to be swapped, but adds to processing overhead.

When the operator enters a STOP command to shut down the time sharing operation, the Time Sharing Control task initiates a logoff for each active user. When all users are disconnected, the Time Sharing Control task ensures that all the system resources that had been assigned to it are returned; the Time Sharing Control task then terminates, returning its main storage region to the system.

The Region Control Task

A major function of the Region Control task is quiescing and restoring foreground job activity before and after swapping. There is one Region Control task for each active foreground region, invoked by the Time Sharing Control task with an ATTACH macro instruction. Figure 24 shows a single Region Control task under the Time Sharing Control task.

Before a foreground job can be swapped out of main storage, any activity associated with it must be brought to an orderly halt, or set up to be handled by some supervisor routine that will be remaining in main storage. This includes removing control blocks associated with the job from system queues, or flagging them as inactive.

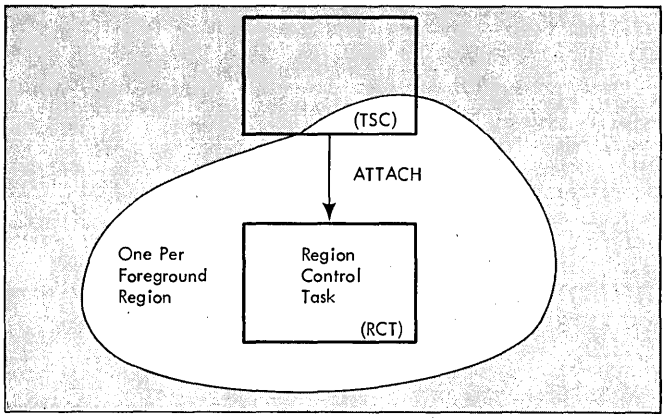

Figure 24. The Region Control Task

Quiescing of I/O activity is initiated by the Region Control task (at the request of the Driver), which issues the Purge Supervisor Call for each task associated with the foreground job. The Purge routine removes I/O requests from the I/O Supervisor's queues of pending requests if they have not yet been initiated. If a request has been started, that is, if data transfer is already taking place, it is allowed to complete before the job is marked ready for swapping. The control blocks associated with unstarted requests are stored in the foreground region where they will be swapped out of main storage along with the job.

I/O requests that address the terminal are an exception to the quiescing procedure because of their long completion time. These requests are handled through the TSO interface with TCAM and are buffered in supervisor main storage, not in the foreground region. Data can be written or read to these buffers whether the job is present in its main storage region or not.

Many control blocks, like the I/O requests mentioned above, reside in the foreground region. For background jobs, these control blocks would be created and maintained in the System Queue Area, a section of main storage set aside for this purpose during nucleus initialization. Foreground regions, however, each contain a Local System Queue Area to hold control blocks. As part of quiescing, the Region Control task removes pointers to these control blocks from system queues. The blocks can then be swapped out of main storage along with the foreground job. The only control blocks for foreground jobs that are assigned in the System Queue Area (and remain in main storage) are requests for timer interruptions, operator replies, and assignment of resources through ENQ.

When a job is swapped into main storage by the Time Sharing Control task, the Region Control task receives control to restore the I/O requests it intercepted at swap out time, and to return the control blocks associated with the job to the appropriate system queues.

LOGON/LOGOFF

The LOGON/LOGOFF Scheduler routine performs the same functions for foreground jobs that the reader/interpreter and initiator do for background jobs. When defining a foreground job, LOGON uses many of the same programs as subroutines.

When LOGON is invoked by the Region Control task, as shown in Figure 25, it is swapped into the foreground region. A copy of the LOGON/LOGOFF Scheduler for each foreground region is kept in the swap data set, reducing the amount of initialization time needed. LOGON, and all routines below it in the control flow diagram, execute from the foreground region, and are swapped in and out of main storage. LOGON first validates the user's identification and password in the User Attribute Data Set, and reads in the rest of the user profile. From the profile and any operands entered with the LOGON command, LOGON builds, in main storage, a JOB and an EXEC statement that define the foreground job. The EXEC statement names the LOGON Procedure specified by the user, and the procedure in turn specifies the name of the program to be invoked. The procedure also contains DD statements for data sets the user always wants allocated to him, and some special DD statements that save control block space for data sets he may allocate later, dynamically.

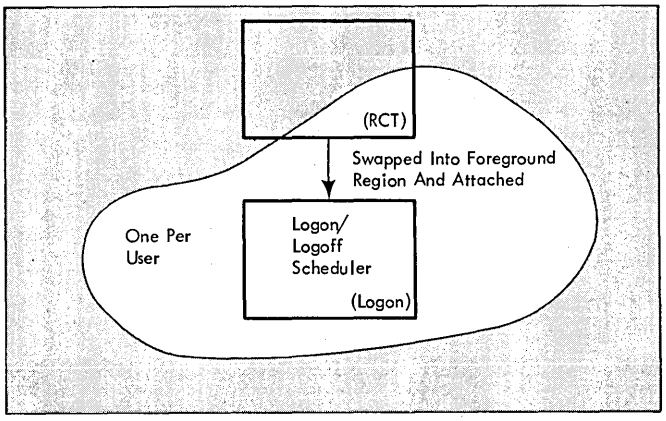

Figure 25. The LOGON/LOGOFF Scheduler

The JOB and EXEC statements built by the LOGON routine are passed to the reader/interpreter to define the resources required by the job, and then to the

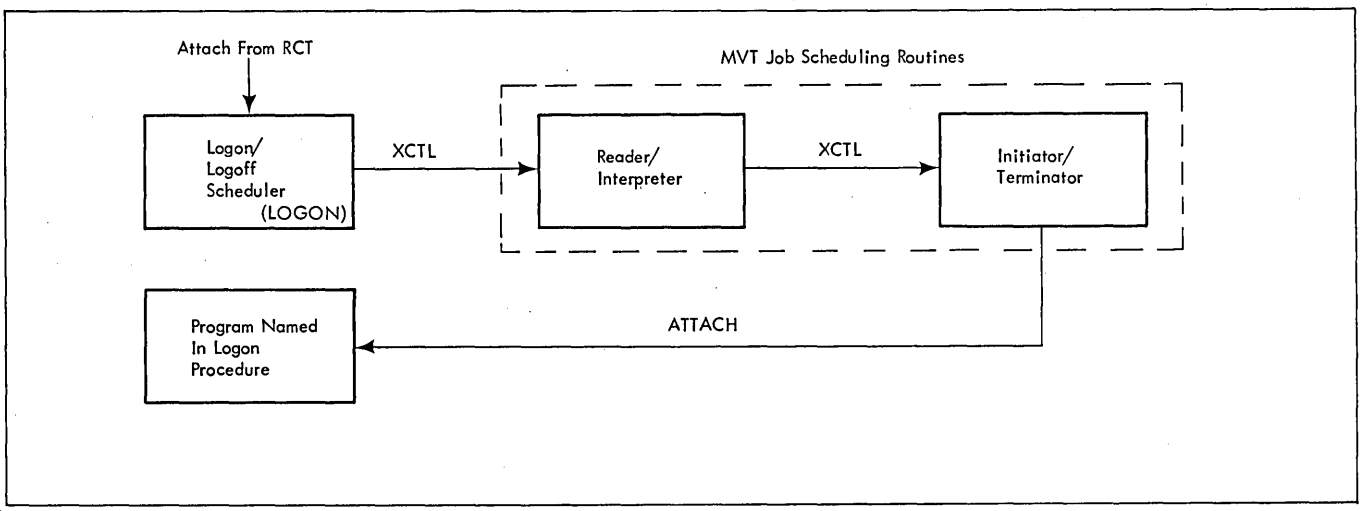

Figure 26. LOGON Linkage

initiator for allocation of the resources -- direct access storage space, main storage control blocks, etc., -- and invocation of the program. Figure 26 shows the linkage scheme used during LOGON. Use of the system reader and initiator ensures that foreground jobs are compatible with normal background jobs, appearing to the system as a job consisting of a single step.

The LOGON/LOGOFF Scheduler executes in the user's foreground region. Assignment to that region is provisional until LOGON determines the region is the correct size for the user's needs. If a larger region is appropriate, LOGON can, through the Region Control task and the Time Sharing Control task, request that the Driver assign a different region. If a region switch is made, the job information LOGON has already gathered is left in a supervisor buffer. The Driver, through the Time Sharing Control task, causes LOGON to be invoked in the new region, where processing can proceed.

The LOGON routine is also brought into a region whenever a user enters a LOGOFF command, or a second LOGON command, during a session. For logoff, the LOGON routine ensures that all resources have been returned to the system, and calls the accounting routines to update the user's statistics. A second LOGON command during a session also causes logoff processing, but it is immediately followed by re-logon. The new LOGON may request a different LOGON procedure or region size.

The Terminal Monitor Program

For users of the TSO command language, the program named in the EXEC statement of the LOGON Procedure is the Terminal Monitor Program. Users of locally-provided command systems, or terminal monitors "dedicated" to some local application, can specify these programs in the LOGON Procedure. If necessary for security reasons, user access to particular applications can be controlled through the profiles in the User Attribute Data Set.

The remainder of this discussion concerns only the IBM-supplied Terminal Monitor Program, as shown in Figure 27. Installation-written monitors must perform similar functions, and can use some or all of the service routines described below.

When the Terminal Monitor Program receives control from LOGON, it is passed a pointer to the user profile. The profile contains information to control the environment of the current session -- the user identification to append to data set names, whether the user wants to be prompted for command information, whether he wants numerical message identifiers included in messages to the terminal.

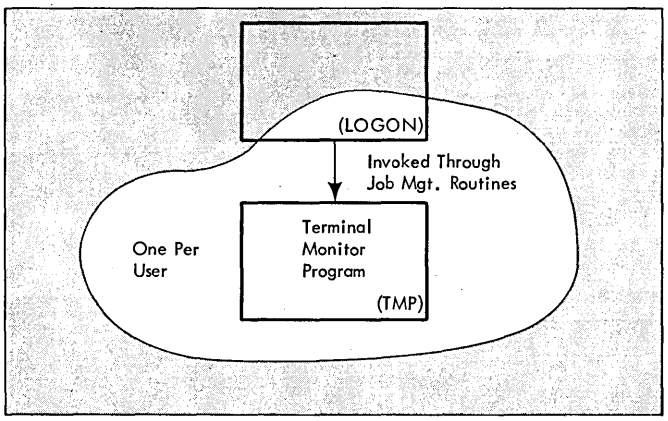

Figure 27. Terminal Monitor Program

During a session, the Terminal Monitor is called on to handle four conditions:

- A command processor or user program is completing, and a new command must be requested.
- A command processor or user program is terminating because of an error.
- The user hit the Attention key, interrupting the current program.
- A STOP operator command is forcing a LOGOFF for the user.

To invoke a command processor, the Terminal Monitor Program uses the command name to search the command library or libraries for the processor load module. When it is found, an ATTACH macro instruction is used to invoke it. When the command processor completes, the Terminal Monitor issues a DETACH for it, and writes a READY message to the terminal, indicating another command may be entered.

When a command processor or a user program invoked by a command (CALL, RUN, etc.) terminates because of an error, control is passed to a Terminal Monitor Program routine that notifies the user of the error condition and allows him to enter a new command. If the new command is TEST, abnormal termination processing (ABEND) is cancelled and control is passed to the TEST processor so the user can examine the failing program and attempt to recover. If the new command is not TEST, the failing program completes abnormal termination and the new command is processed.

When a user hits the attention key, or when an attention interruption is simulated for terminals without an attention key, the Terminal Monitor Program attention routine is given control, unless the currently executing program (a command processor or user program) has specified an attention-handling routine of its own. The Terminal Monitor Program attention routine gets a line from the terminal. If it is a program status inquiry such as TIME the Terminal Monitor Program handles the inquiry and does not cancel the interrupted program. If a new command is entered, the interrupted program is cancelled and the Terminal Monitor Program invokes the new command processor. If the user enters a null line, the interrupted program is restarted at the point of interruption although the current content of the buffers are lost.

When the operator or a control user enters the STOP command to force a user logoff, the Terminal Monitor Program terminates any program the user may have running, and returns to the LOGON routine for logoff processing and accounting.

TEST

The TEST processor is handled differently than other command processors, since it must be able to control the execution of programs (including command processors) being tested. The TEST routine executes at the same level as the Terminal Monitor Program -- receiving control via a LINK, rather than an ATTACH, macro instruction.

TEST reads successive subcommands from the terminal or a command procedure. Each subcommand requests some action -- modification of the tested program's registers or storage areas, insertion of breakpoints in the program, display of data. When the GO subcommand is encountered, the tested program is allowed to execute to the next breakpoint (an inserted SVC instruction) or to completion. When a breakpoint is encountered, TEST again receives control. It will then handle subcommands specified previously by the user, new subcommands entered from the terminal, or both. Another GO subcommand will restart the tested program.

Service Routines

The command processor service routines, as shown in Figure 28, are used by the Terminal Monitor Program, TEST, and command processors. In general, they perform services that are useful to all foreground programs, and their availability as subroutines saves repetitive coding in all the command processors. They can be called from programs written in Assembler language.

Command Analysis: Two routines are provided for analyzing input lines to the Terminal Monitor Program and command processors. The Scan routine determines if

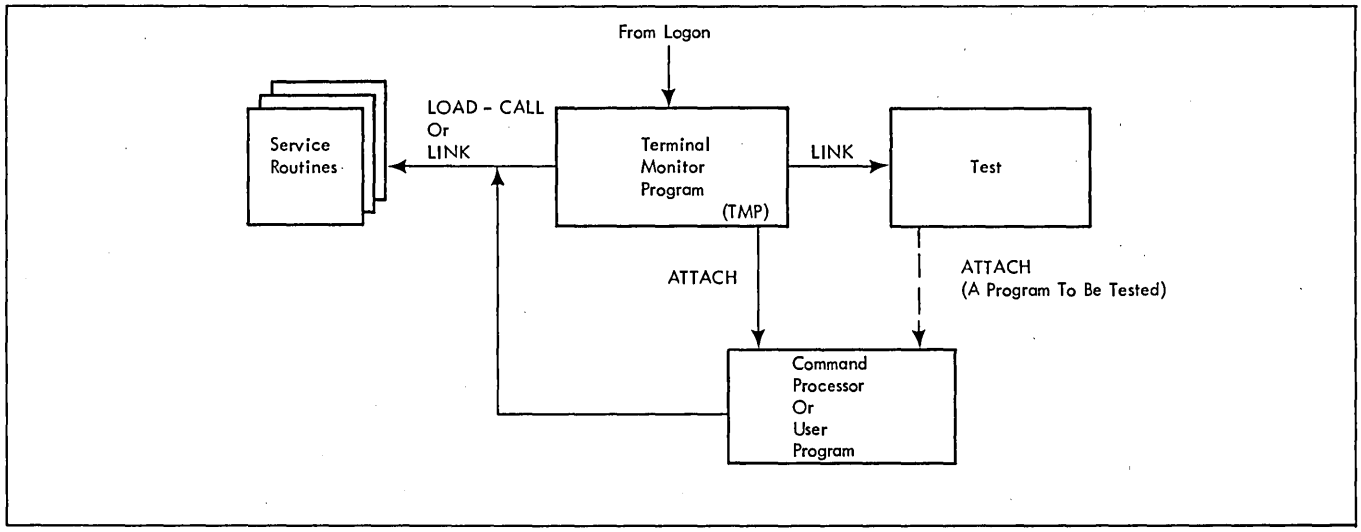

Figure 28. Service and TEST Routine

an input line contains a syntactically correct command name, and, if it does, returns it to the calling program. The Parse routine continues the analysis of a command or subcommand by comparing the line to a parameter list supplied by the calling program describing the permissible operands and default values. The Parse routine builds a new parameter list from this information, describing the options the user has selected, and returns it to the calling program.

Terminal I/O: Four service routines are provided to handle command processor input and output for the terminal. Command processors normally accept input lines containing subcommands and data from the terminal, and send messages back to the terminal. However, a command processor may be invoked from a command procedure, and in this case, the input to the command comes from an in-storage list built by one EXEC command processor from the CLIST data set that contains the procedure. To allow the command processors to be independent of the source of input, I/O is handled through the Getline, Putline, and Putget service routines.

Getline, Putline, and Putget use a push-down list to keep track of the current input source. Entries in the list represent a terminal, or an in-storage list. The in-storage list may be a command procedure or data. A fourth service routine, Stack, is provided to manipulate this list as the input source changes.

When a command processor calls Getline for a line of input, Getline checks the list of sources to determine the current source and returns one record from that source. The caller need not know whether the input came from the terminal or an in-storage buffer. Putline also checks the list of input sources before sending output from the command processor. Some types of messages, identified by a code in the message identifier, are suppressed if the current input source is not the terminal. For instance, it is not appropriate to issue a prompting message for command operand information if a command procedure is in progress. A return code to the caller indicates whether the message was issued or suppressed. Putget combines the functions of Putline and Getline -- first sending a message, then returning one record.

Dynamic Allocation: The Dynamic Allocation Interface routine handles data set allocation and manipulation for command processors. Dynamic allocation uses control block space reserved by DD DYNAM statements in the user's LOGON Procedure. These control blocks are used over and over again when different data sets are needed, but at any one time, a user can have only as many data sets allocated as he has DD statements in his LOGON Procedure. Command processors call on Dynamic Allocation to allocate data sets, to free data sets, to search the system catalog for a particular data set or group of related data sets, and to concatenate or separate groups of data sets.

In TSO a problem may arise from the multiple use of a Job File Control Block (JFCB) for an input data set. When the data set is opened, information supplied in the Data Set Control Block (DSCB) and the JFCB is used to fill any zeroed fields in the Data Control Block (DCB). The opening

routines then do a reverse merge from the DCB back into the JFCB, this time filling any zeroed fields in the JFCB. If the same data set is subsequently opened using another DCB, the opening routines will retrieve information from the JFCB for fields not specified in the DSCB or on the DD card. This information could be faulty and could cause a program failure.

Command Processors and User Programs

Although command processors vary widely in function, they have some initialization features in common. All call on the Parse routine to analyze the invoking command and prompt the user for missing or invalid operands, and all use the Dynamic Allocation routine to determine if necessary data sets are allocated and to allocate them if they are not.

At this point, some command processors call on standard system processors to carry out the function desired. For instance, the TSO COBOL Prompter sets up a standard calling sequence according to the options selected by the user, and transfers control to the American National Standard COBOL compiler to compile the user's program. Except for the special formatting of output and messages, the compiler operates exactly as it would in the background.

User-written command processors, and other programs that are not defined as command processors, should avoid using the special Terminal Monitor Program-command processor interface if they are to be compatible with the background environment. The CALL, LOADGO, and RUN commands allow control information to be passed to background-compatible programs in exactly the same format as information in the PARM field of an EXEC statement. Data set allocation can be handled by ALLOCATE commands in a command procedure used to invoke the program.

Terminal I/O

The Telecommunications Access Method, or TCAM, handles all I/O between remote terminals and jobs in the system. TCAM distinguishes between time sharing applications, with emphasis on direct control of the calling terminal, and other teleprocessing applications, where emphasis may be on queuing, formatting and routing of messages between remote terminals or between applications and remote terminals.

The Message Control Program

The Message Control Program is the TCAM controlling routine. It contains definitions and descriptions of the various terminals that can connect to the system, it has buffers for storing data going to and coming from the terminals. It transfers data between its buffers and time sharing buffers.

Most of the Message Control Program is written using a special set of macro instructions that is essentially a language suitable for defining the telecommunications network and specifying the handling of messages on the network and in the system. Macro instructions to generate a Message Control Program suitable for handling terminal I/O for time sharing are distributed with the TSO package.

The Message Control Program executes as a problem program, in a main storage region with a nonzero protection key. Normally, it has the highest priority of the problem programs in the system. It must have a higher priority then the Time Sharing Control Task.

Mixed Environment MCP's

A TSO message control program can contain more than one message handler. A message handler is a sequence of code that routes terminal I/O to the appropriate program or terminal. A mixed environment Message Control Program contains the message handler for terminal I/O for TSO and in addition one or more non-TSO message handlers.

In a mixed environment, the terminals used with TSO are allocated to the TSO message handler and the terminals used for TCAM applications to the TCAM message handlers. This is done through the macro instructions which define the message control program and through the catalogued procedure that starts the message control program.

Message Control Program Interfaces

A variety of interfaces to Terminal services are provided in TSO. The one suitable for a particular program depends on whether the program is defined as a command processor, and whether it must also be able to execute in the background environment.

A supervisor call routine, reached through the TGET and TPUT macro instructions, provides a direct route for program I/O to a remote terminal. TGET and TPUT transfer data between the calling program and a set of buffers in the Time Sharing Control Task region, that are, in turn, emptied and filled by TCAM. Through TGET and TPUT, the calling program can control deletion or insertion of terminal

control characters, and whether an output transmission is to break in on any input transmission in progress. A program using TGET and TPUT does not have to perform OPEN or CLOSE processing, and need not provide a DCB for the terminal. However, these macro instructions are available only to programs executing in the foreground.

Programs designed to be command processors can call on the Getline, Putline, and Putget service routines used by the IBM-supplied command processors for I/O. As noted earlier, these service routines have the capability to switch the input source from the terminal to a buffer in main storage, and to suppress certain types of output if the terminal is not the current input source.

The sequential access methods, BSAM (READ, WRITE, CHECK) and QSAM (GET, PUT), have been extended to call on TCAM (TGET, TPUT) when called from foreground programs for terminal I/O. This is the normal route for terminal I/O from programs that must be executable in the background as well as the foreground, or which are coded in a higher level language, such as FORTRAN or COBOL.

Programs using BSAM or QSAM to reach the terminal use the standard macro instructions or I/O statements. When the program is executed, the DD statement or ALLOCATE command defines whether the I/O is for a data set or the terminal. No recompilation is necessary to switch from one to the other, only a change in the DD statement.

Getline, Putline, Putget and the sequential access methods all issue TGET or TPUT for the caller when the I/O is for a terminal. Figure 29 shows this SVC routine handling calls from anywhere in the TSO system and passing the requests to the TCAM Message Control Program.

Multi-Terminal Message Processors

Independent of TSO, the Telecommunications Access Method includes facilities for routine messages received from remote terminals to queues for an application program, and transmitting replies generated by the applications program to queues for a terminal. In a system without TSO, such a message processing program must reside in main storage in one of the problem program regions, when it is to be available if one of the terminals in the telecommunication network sends a message that requires processing. With the addition of TSO, a terminal user logged on to TSO can execute a TCAM message processing program in a foreground region. He can do this by invoking it through the TSO command language, or by specifying it instead of the TSO Terminal Monitor Program on his LOGON procedure. The DD statements which define the process queues must be contained in the LOGON procedure. The program will be swapped in whenever needed, but will not occupy main storage space when it has no messages to process. Unlike standard foreground jobs, which are associated with a single terminal, these message processing programs can accept GET/READ, PUT/WRITE TCAM oriented input from any terminal defined to the TCAM processing queues, through the QNAMES operand of the statements on the LOGON procedure. In addition, the standard TSO terminal interfaces, can be used to interact with the terminal executing the Message Processing Program. For further information on message processing programs, see IBM System/360, TCAM Programmer's Guide and Reference Manual.

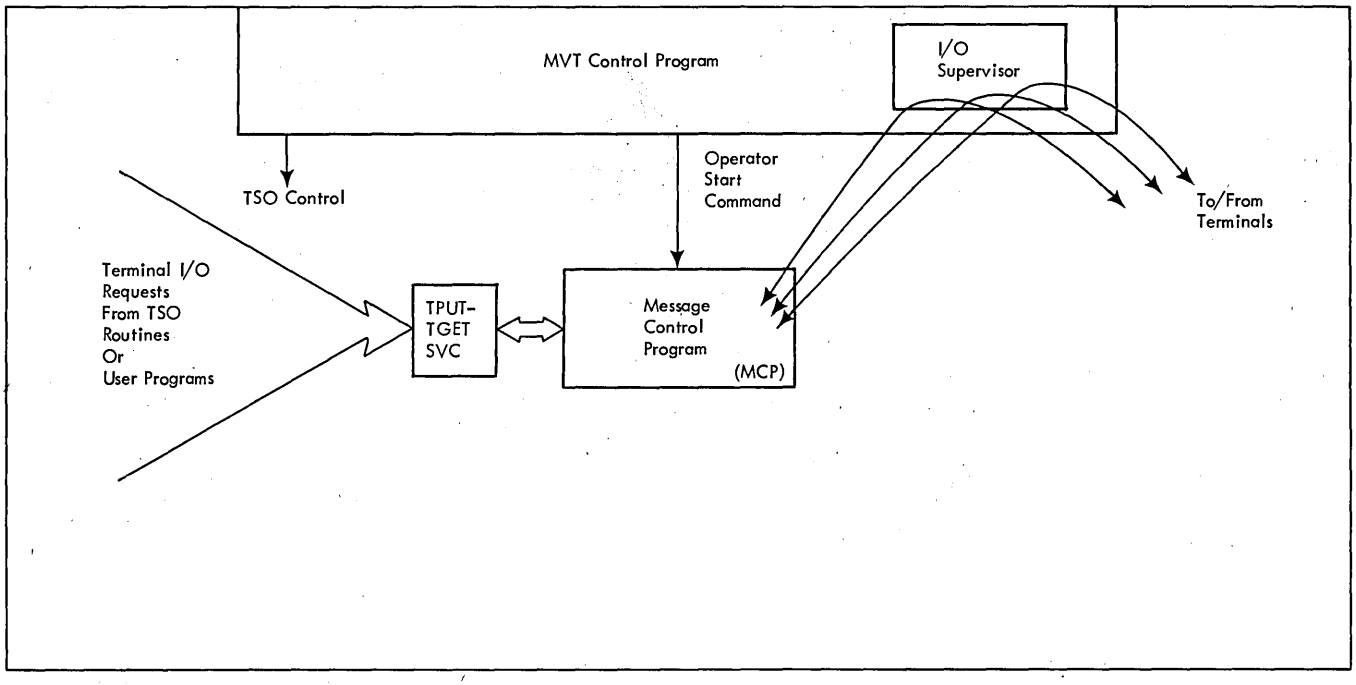

Figure 29. TCAM Message Control Program

Overview and Storage Map

Figure 30 is an overview of the complete time-sharing system as developed in the preceding sections. The picture is simplified in that it shows only one task at each level of control; there is actually one Region Control Task for each foreground region, and one LOGON-Terminal Monitor Program for each user. Many of the programs themselves are re-enterable, and can be placed in an extension to the link pack area (LPA) built when the operator starts TSO.

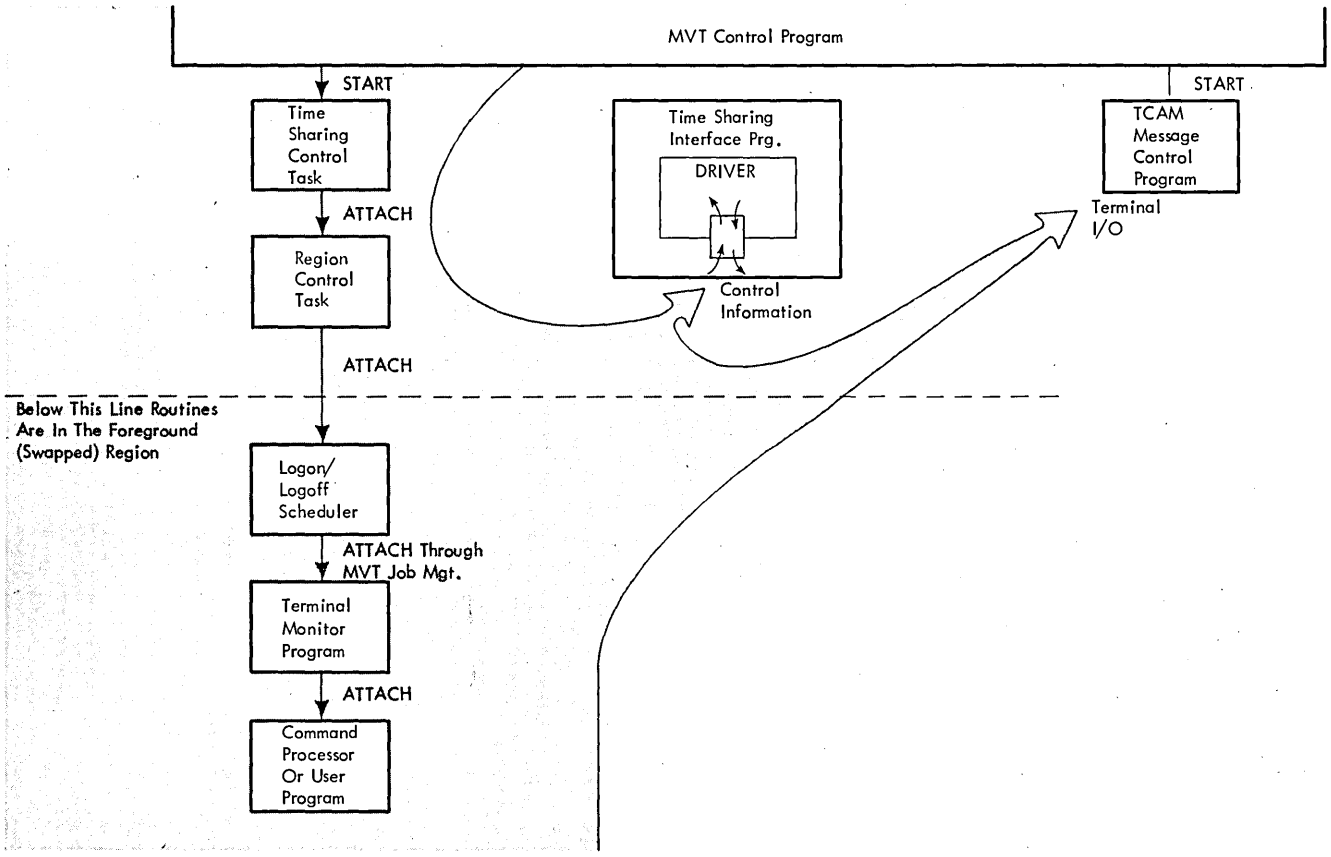

Figure 30. System Overview

Figure 31 is a map of a typical main storage layout when TSO is operating. Almost all the additional storage requirement for TSO control functions is included in the Time Sharing Control Task region. This region is not assigned until the operator enters the START TS command, so the presence of TSO in the system has no effect on MVT throughput when time sharing is not active.

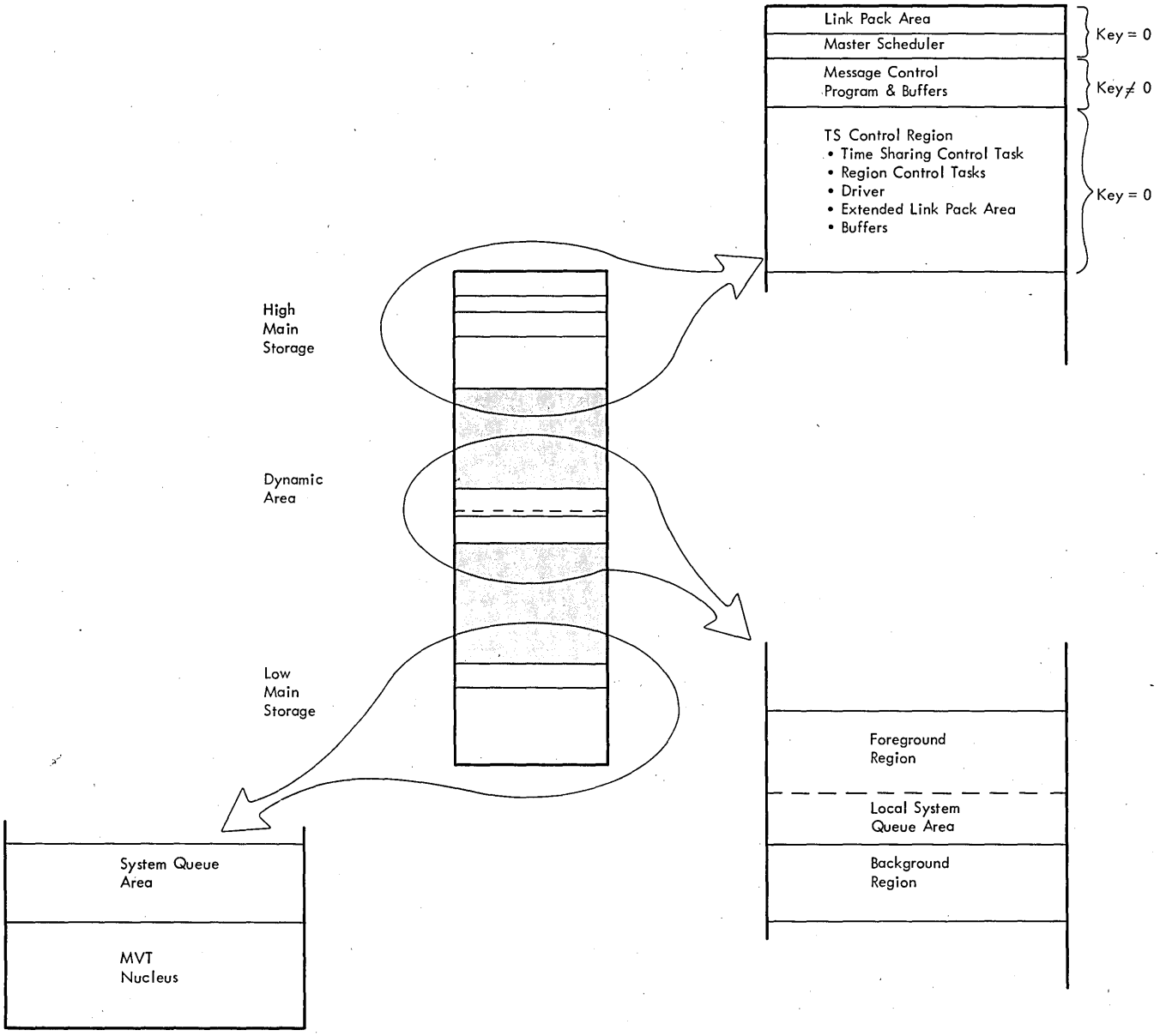

Figure 31. Typical Main Storage Map

Time Sharing Algorithms

As noted earlier in this chapter, the Time Sharing Driver is responsible for dividing the system resources -- most importantly, execution time -- among the various jobs in the system. So that this may be done effectively, the Driver is given a constant stream of information about the status of each job in the system -- whether it is ready to execute, whether it is waiting for I/O, whether it is in main storage or has been swapped out.

In a time sharing system, execution time is divided among the active foreground jobs and background jobs in brief time slices. A time slice must be long enough to perform a meaningful amount of processing, but not so long that the time between successive slices prevents quick response to conversational users. At the same time, time slices cannot be so short and frequent that system overhead for swapping and task switching becomes unreasonable.

Balancing these factors depends partly on the number and type of jobs the system is processing: a solution for one job mix is not necessarily suitable for another job mix. The Driver's time sharing algorithms -- the formulas it uses to calculate the division of execution time among the jobs in the system -- are based on several variables, many of which can be specified by the installation to tune the system for the local job mix. These variables may specify the system configuration, such as the number of foreground regions to be activated; they may request the Driver to use one of several algorithms it has for a particular calculation; or they may specify constants used in the algorithms. The variables are stored in a member of the system parameter library.

Time Slices

The Driver uses two important cycles in calculating time slices. One is the cycle of foreground jobs assigned to a region being swapped into the region, then back out to the swap data set on auxiliary storage. The average length of time to complete one cycle -- swapping each job assigned to the region into it one time -- can be controlled by the installation for each foreground region. The length of time each job gets to remain in main storage during a cycle is called the major time slice. Figure 32 shows a cycle of major time slices and the swapping of jobs between the main storage region and a swap data set.

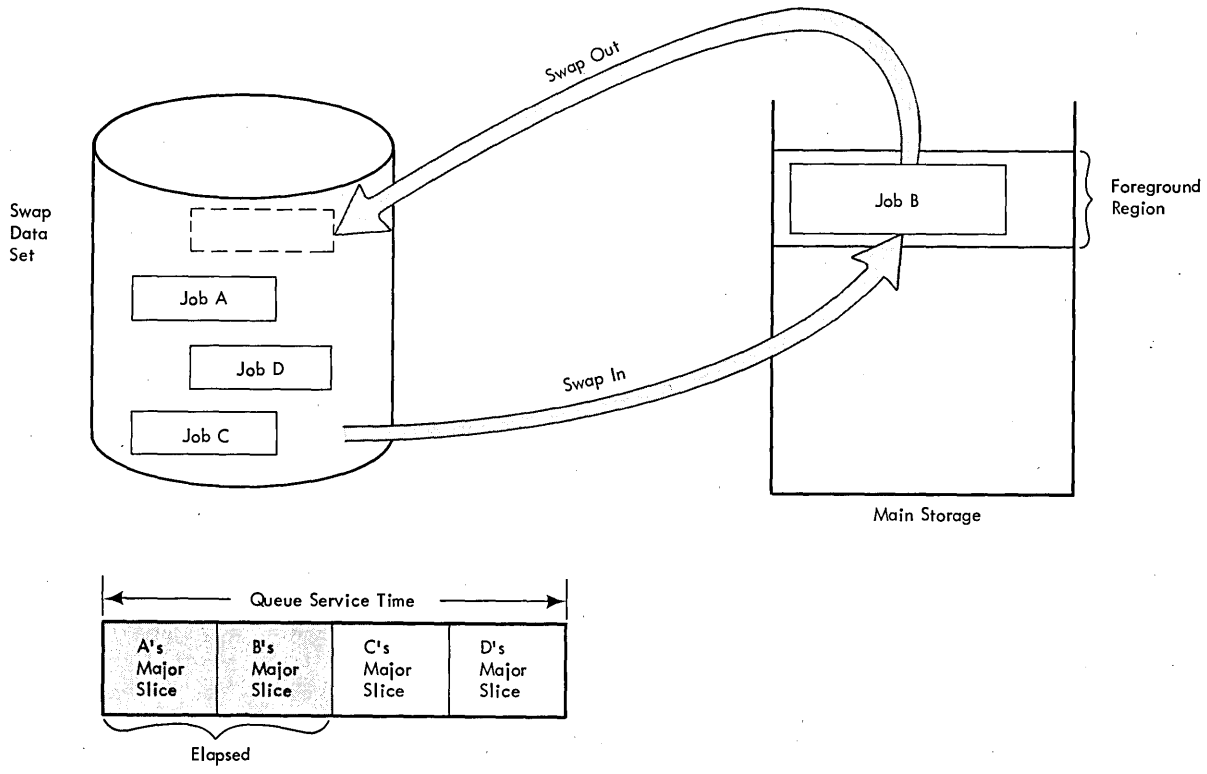

Figure 32. Queue Service Time

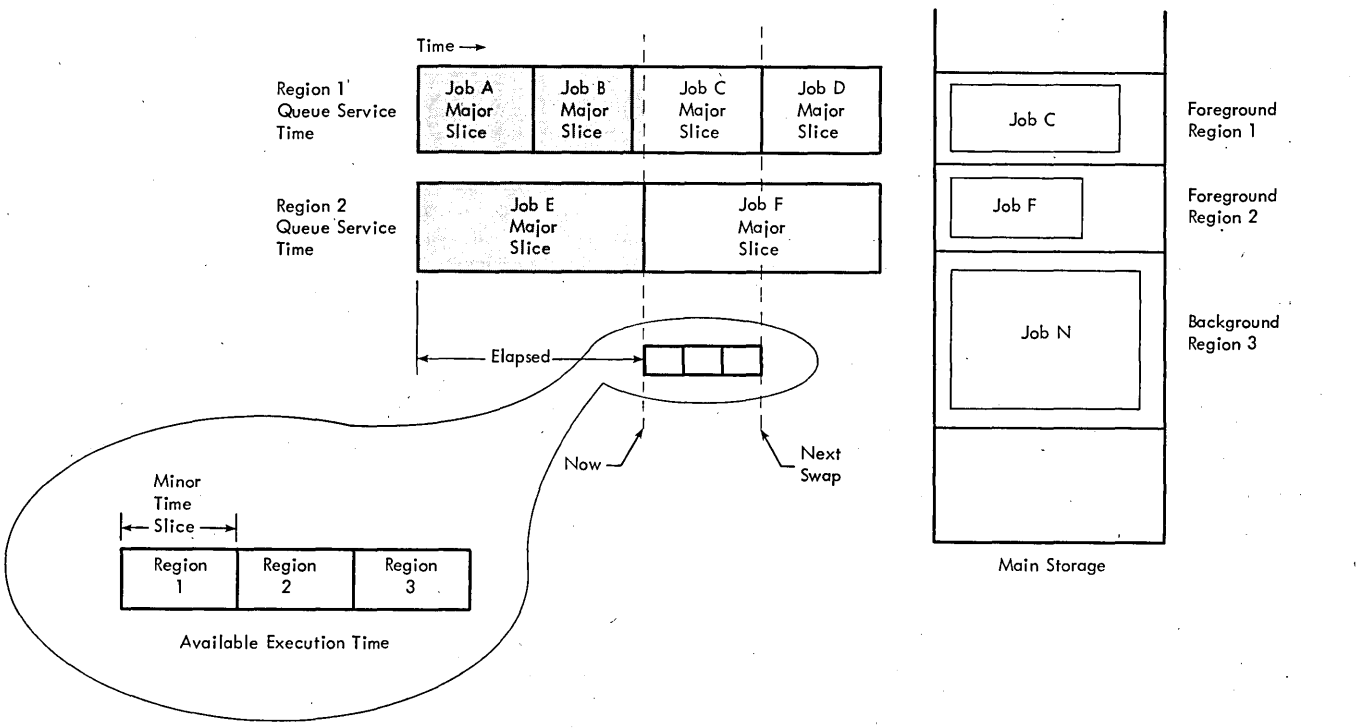

Figure 33. Minor Time Slice

The other cycle used by the Driver is the allocation of execution time to the jobs in main storage. At a particular time there are likely to be several regions containing jobs ready to execute -- one or more foreground regions containing jobs swapped in for major time slices, and some background jobs in their own regions. The Driver divides the amount of time remaining until the next scheduled swap out among the jobs than are ready to execute, resulting in a minor time slice for each. For the duration of its minor time slice, each job has the highest effective priority of the problem programs (excluding TCAM). As in batch MVT, if the job cannot execute because it is waiting for I/O or some system resource, another job runs until the higher-priority job is ready again.

Figure 33 shows the indirect relationship between major and minor time slices. A major slice is a fraction of a cycle of swaps into a foreground region, and is the length of a job's stay in main storage. The minor slice is a fraction of the time remaining before the next scheduled swap out for any region (called the available execution time), and determines how long each job will remain at the highest effective priority; that is, how much execution time the job is allotted.

Major and minor time slices can be calculated using only the number of ready jobs, and the available execution time. However, the Driver algorithms have the capability to distinguish among varying user needs to provide the best service to each foreground job. The following two sections show how the tuning variables can be used to make the calculation of time slices most efficient for varying job mixes.

Major Time Slices

Swapping a job into a foreground region from a queue of ready jobs assigned to that region is called servicing the job. The length of time used to service all ready jobs on one queue is called the queue service time. The average queue service time for each queue of foreground jobs is an installation parameter, passed to the Driver. The specified queue service time is divided by the number of ready foreground jobs on the queue, yielding a major time slice value for each job for that service cycle. As the number of jobs assigned to that queue increases, the major time slice value gets smaller. The time between services for each job remains fairly constant, which is important for conversational users expecting quick responses.

A problem may arise when a large number of users are assigned to the queue. The division of queue service time may result in a major time slice too short to perform any meaningful amount of processing for the user, and the system will be spending all

its time swapping. To avoid this condition, the installation specifies a minimum major time slice for each queue. Each job is guaranteed at least that amount of time in main storage on each cycle (provided it is ready to execute). When the minimum slice is being used, the actual queue service time will exceed the specified average queue service time.

Multiple Region Queues: To meet varying needs of users performing different kinds of processing, the installation can establish multiple service queues for each foreground region. Queue service cycles can be rotated equally among these queues, or priorities can be specified among them. Each queue is assigned its own average queue service time. The installation can also specify that a queue is to be given multiple cycles before the next queue is serviced, or that it is to be serviced until empty -- that is, until no jobs are left on the queue that are ready to run.

Assignment to queues can be based on the amount of main storage the job is using, or the degree of interaction with the terminal, or both. The amount of main storage assigned to the job is called swap load, since it is a measure of the amount of I/O necessary to swap the job in and out of storage. A swap load limit can be specified for each queue. If a job's storage needs grow beyond the limit, it is assigned to a lower queue, with a higher limit. The lower queues can be set up to receive fewer services, but longer major time slices at each service. Therefore the larger jobs will not have to be swapped so often.

The degree of interaction with the terminal is measured by the amount of processing time used by the job since its last request for I/O to the terminal. A terminal I/O request is called an interaction, and the length of execution time between interactions is called interaction time or occupancy. Very long interaction times indicate the user is not currently processing conversationally -- perhaps he is compiling a program, or executing some long-running problem program. In this case, his job does not require the quick response times provided by the higher region queues, and can be moved to a lower queue where it will receive fewer, but longer, major time slices. Each queue can be assigned an interaction time limit, to allow for this differentiation. The occupancy and swap load limits for a given queue must be higher than the next lowest queue.

Either the swap load or the interaction time limits can be suppressed when the time sharing operation is started for the day, but if both are suppressed, only one queue per foreground region is maintained. The rotation of service cycles around the queues for a region can also be made preemptive: any time a job on a higher queue becomes ready to execute; for instance, if a terminal I/O request completes, the service cycle of any lower queue is interrupted to service the job on the higher queue. This scheduling scheme tends to make responses to trivial terminal requests very fast, while lengthening somewhat the response to requests requiring a lot of processing time.

Region Assignment: The last factor involved in calculating major time slices is choosing a foreground region for the user logging on. The minimum region size needed by the user is stated in his LOGON procedure, and only those foreground regions large enough are considered.

If a choice must be made among two or more regions, the system can try to balance the workload by assigning the new user to the region with the fewest logged-on users. However, this leaves open the possibility that a group of users all requiring a lot of execution time will be assigned to one region, while another region has a preponderance of users processing conversationally. Neither group will receive the best service possible. To prevent this condition, the installation can specify that an average region activity be maintained for each foreground region. The average region activity is the number of jobs likely to be ready to execute (not waiting for terminal I/O, for instance) at the beginning of the next cycle of major time slices. A new user is then assigned to the region with the lowest region activity, which is not necessarily the region with the fewest logged-on users.

The region activity estimate is based on the number of ready jobs on the region's queues during recent major cycles. Values from more recent cycles are "weighted" in calculating the average. The weighting factor, called the region activity decay constant, is specified by the installation. Use of decay constant prevents wild fluctuations in the region activity because of a few unusual cycles, but allows gradual change to reflect changing workload.

Major Slice Variables: To summarize, the system programmer can specify the following variables affecting the major time slice calculation:

- The maximum number of users logged on.
- The number of foreground regions.

- The method for assigning users to regions.
- The number of service queues for each region.

For each region queue, the following variables can be specified:

- The average queue service time.
- The number of service cycles before advancing to the next queue.
- The minimum major time slice.
- The swap load limit.
- The interaction time limit.

Variables can be omitted or ignored, if the job mix and workload allow simplification of the algorithm. In general, the more homogeneous the job mix, the more the algorithm can be simplified, dividing time almost equally among the jobs. Remember that the major time slice determines only how long a job remains in main storage, not how much execution time it receives. Calculation of the minor time slice, which determines execution time, is discussed next.

Minor Time Slices

The minor time slice is the result of dividing the available execution time among the regions of main storage containing either a ready foreground job or a ready background job. Available execution time, in this sense, is the period from the time of the calculation until the next scheduled swap out. Whenever a major time slice expires, the calculation is repeated with the new number of ready regions.

The minor time slice is not quite equivalent to a period of execution time -- a job may have to wait for I/O or some resource during its minor time slice. In this case, control is given to another region until the waiting job is ready again. If it does not become ready before its minor time slice expires, it may wait until the next cycle of minor time slices before executing again.

All terminal jobs are assigned the same dispatching priority, so their Task Control Blocks (TCBs) are grouped together on the queue of active TCBs maintained by the operating system task supervisor. Because the dispatcher always searches this queue from the top when looking for the next task to receive control, there is an effective priority within the time-sharing TCB group based on the order in which the TCBs are found. The TSO control routines adjust this order to effect the dispatching of a task currently assigned a minor time slice. When the minor time slice of the top foreground job expires, its TCBs are moved to the bottom of the group.

The installation can adjust or weight the fraction of available execution time assigned to each ready region, or it can suppress division of the time altogether. The system operator, or a control user, specifies how many regions are active, and how much execution time, if any, is to be guaranteed to jobs running in the background regions. Three possible methods of calculating the minor time slices, called simple, even, and weighted dispatching, are described in the following paragraphs.

Simple Dispatching: In this case, the minor time slice is set equal to the available time, and assigned to the TCB at the top of the time-sharing TCB group (which will always be the job swapped in longest ago). Expressed as an algorithm:

$$MS = AT$$

where MS is the minor time slice and AT is the available execution time, or the time remaining before the next scheduled swap out.

If the operator has requested a percentage of execution time for the background regions, available time is reduced by that amount before the minor time slice is calculated. When the minor time slice expires, in this case before time for a swap out, the remaining time is assigned to TCBs representing jobs in the background regions, in whatever priority they may have. If no backgroung percentage is requested, any background jobs will receive only the execution time that the foreground jobs cannot use.

Simple dispatching is always used whenever only one foreground region is present in the system.

Even Dispatching: When more than one foreground region is defined, the installation can specify even dispatching of the foreground jobs. In this case, the available execution time is divided evenly among the ready foreground regions.

The algorithm is:

$$MS = \frac{AT}{N}$$

Where N is the number of foreground regions containing jobs ready to execute. As in simple dispatching, available time is

reduced before the calculation by any guaranteed background percentage.

The first minor time slice is assigned to the foreground job at the top of the group of time-sharing TCBs on the queue. When the minor slice expires, the TCBs associated with that job are moved to the bottom of the time-sharing group, and the next foreground job receives a minor time slice.

Weighted Dispatching: The third way the minor time slice calculation can be performed is on a weighted basis. This method allows the system to compensate for jobs that are likely to spend much of their minor time slice in the wait state, usually because of pending I/O requests. (But not for pending terminal I/O, since a job waiting for terminal I/O is not swapped in, and never becomes eligible for a minor time slice.) Under weighted dispatching, the system keeps an estimated wait time percentage for terminal job, based on averages of time spent waiting by each job during previous major time slices. Jobs with a high estimated wait time percentage tend to be I/O-bound, and will donate much of their time slices to jobs with TCBs on the queue below them. Jobs with low estimated wait time percentages tend to be compute-bound, and will use most of their minor time slice themselves. It is often desirable to assign the I/O-bound job a weighted, or longer, minor time slice to compensate for its "donation" of execution time to other jobs.

To weight the minor time slices, the system forms a sum of the estimated wait time percentages of the jobs to be assigned minor slices in the current cycle. Each job is then given a fraction of the available execution time equal to its fraction of the total estimated wait time percentages.

The algorithm is:

$$MS = \frac{\text{This job's EWT\%}}{\text{Sum of EWT\%s}} \times (AT)$$

where MS is the minor slice to be assigned to a terminal job, EWT% is the estimated wait time percentage, and AT is the available execution time for this minor slice cycle, again adjusted for any guaranteed background percentage.

As an example, consider a minor time slice calculation for two foreground regions, one containing Job A, which is expected to wait 40 percent of its minor time slice; the other containing Job B, which is expected to wait only 10 percent. The sum of the estimated wait time percentages is 50 percent. Job A gets 40/50, or 4/5, of the available execution time as its minor time slice. Job B is assigned 10/50, or 1/5, of the available execution time. However, Job B will probably be able to execute for about 40 percent of Job A's minor time slice too (while Job A is waiting for I/O), and so will end up with just under half the available execution time -- about what it would have been assigned on an equal division. Job A, however, will be able to get its I/O started, wait for it to complete, and still have some processing time left to handle the data or issue another I/O request. On an equal division of available time, its minor time slice might have expired before its first I/O request completed.

The estimation of wait time percentage is made by updating a running average of a job's wait time percentages at the end of every major time slice. In making the average, a weighting factor is used to emphasize recent usage over earlier usage. The weighting factor is called the wait time decay constant. Its purpose and function is similar to the region activity decay constant, and it can also be specified by the installation. Values appropriate for general job mixes are included in SYS1.PARMLIB.

System Implementation

This chapter is intended for the programmers and system analysts responsible for generating and maintaining a system with TSO. (The discussions assume that the reader is familiar with the System Summary chapter of this publication.) The discussions contains specific implementation information. For example, the discussion "Tailoring a Message Control Program" does not discuss the role a message control program plays in a TSO configuration, but rather provides the syntax and meaning of the macro instruction used to generate a message control program. Included are discussions of how to:

- Generate (or tailor) a Message Control Program.
- Write the cataloged procedures used by TSO.
- Specify TSO starting parameters.
- Tune the Time Sharing Driver and use TSO Trace.
- Write an installation exit from the SUBMIT command processor.
- Write an installation exit from the STATUS, OUTPUT, and CANCEL command processors.
- Write a LOGON Pre-prompt exit.

Tailoring a Message Control Program

TSO includes a standard Message Control Program (MCP) to handle terminal I/O for those installations that use TSO for all their TCAM applications. The installation must tailor the MCP to match its needs in three steps. First, it assembles three macro instructions: LINEGRP, LISTTA, and TSOMCP. The output of this assembly is a series of TCAM (Telecommunications Access Method) macro instructions which must, in turn be assembled. The output of this second assembly forms on MCP that must then be link edited into SYS1.LINKLIB.

Mixed Environment MCPs

If your installation requires a mixed environment Message Control Program, because you have TCAM applications programs, (message processing programs), you must generate your MCP using TCAM macro instructions instead of the special TSO MCP generating macro instructions. You use the TCAM macro instructions to generate an MCP containing the TSO Message Handler and any other message handlers for your particular terminal applications, and the necessary terminal I/O control blocks. The communications lines which are to be used with TSO must be dedicated to the TSO message Handler through the terminal I/O control blocks and the communications lines for TCAM applications dedicated to their message handlers. For further information, see IBM System/360 Operating System: TCAM Programmer's Guide and Reference Manual.

In addition to the standard TCAM macro instructions, there is a specialized macro instruction, the TSOMH macro instruction which expands to form a TSO Message Handler.

The TSOMH macro instruction has two operands; NOLOG which specifies a destination for non-TSO messages and CUTOFF which specifies a maximum message length. The syntax of the TSOMH macro instruction is:

```
TSOMH  [CUTOFF=integer]
       [      300     ]
```

CUTOFF=
specifies the maximum number of bytes before the remainder of the message is lost to the system. The value must be an integer between 150 and 65,535, the default is 300.

TSO-Only MCP

The following is an explanation of each step of the generation of the MCP supplied with TSO:

Step 1 - Assemble the one or more LINEGRP macro instructions each followed optionally by one or more LISTTA macro instructions, all followed by the TSOMCP macro instruction. Place the resultant output in a temporary data set that will be used as input to Step 2. The output of this assembly language source statements -- TCAM macro instructions which constitute a Message Control Program.

Step 2 - Assemble the TCAM MCP macro instructions that are generated within Step 1. The output of Step

2 is the MCP object module and is placed into a temporary data set.

Step 3 - Linkage Edit the object modules from Step 2 into SYS1.LINKLIB to create an executable MCP load module.

Figure 34 shows the Job Control Language necessary to run these steps.

LINEGRP Macro Instruction

The LINEGRP macro is used to define a line group, a group of terminals with similar characteristics, for example, a group of IBM 2741 terminals. The operands specify:

- The types of terminals in the line group. (TERM)
- The ddname of the DD statements that define the communications lines as data sets. (DDNAME)
- The number of lines, that is, physical device addresses in the line group. (LINENO)
- The number of TCAM basic units, per terminal buffer. (UNITNO)
- What translation tables are to be used to translate from the terminal code to EBCDIC. (TRANTAB)
- What character string will identify the transmission code being used when dynamic translation is required. (CODE)
- Whether the terminals in this line group are on switched or nonswitched lines. (DIAL)
- How often polled terminals are to be polled for input. (INTVL)
- What special features the terminals in this line group have -- that is, transmit or receive interruption; and for 1050, Text Timeout suppression. (FEATURE)
- The polling and addressing character of terminals in this line group, for 1050 and 2260/2265. (ADDR)
- For IBM 2260 and 2265 Display Stations the screen sizes.

```
//MCPGEN          JOB       Job card parameters
//
//STEP1           EXEC      ASMFC
//
//ASM.SYSPUNCH    DD        DSN=&&TCM,DISP=(,PASS),
//                          UNIT=SYSDA,SPACE=(CYL,(1,1))
//
//ASM.SYSIN       DD        *
                  LINEGRP
                  LISTTA
                  LINEGRP
                  TSOMCP
                  END
//
/*
//
//STEP2           EXEC      ASMFC,COND=(4,LT,STEP1.ASM)
//
//ASM.SYSPUNCH    DD        DSN=&&OBJ,DISP=(,PASS),
//                          UNIT=SYSDA,SPACE=(CYL,(1,1))
//
//ASM.SYSIN       DD        DSN=*.STEP1.ASM.SYSPUNCH,
//                          DISP=(OLD,PASS)
//
//STEP3           EXEC      PGM=LINKEDIT,COND=(4,LT,STEP2.ASM)
//
//SYSLMOD         DD        DSN=SYS1.LINKLIB(IEDQTCAM),DISP=SHR
//
//SYSPRINT        DD        SYSOUT=A
//
//SYSUT1          DD        UNIT=SYSDA,SPACE=(1024,(50,20))
//
//SYSLIB          DD        DSN=SYS1.TELCMLIB,DISP=SHR
//
//SYSLIN          DD        DSN=*.STEP2.ASM.SYSPUNCH,
//                          DISP=(OLD,PASS)
```

Figure 34. Job Stream to Tailor MCP

LINEGRP MACRO INSTRUCTION FORMAT

```
Name              Operation          Operand
(name)LINEGRP     TERM=type
                  DDNAME=ddname
                  LINENO=number
                  [UNITNO=number]
                   [TRANTAB=(table ,table...)]
                   [CODE=(string ,string...)]
                   DIAL={YES}
                        {NO }
                   [INTVL=number]
                  [FEATURE=(BREAK,  ) (ATTN,  ) (TOSUPPR)]
                           (NOBREAK,) (NOATTN,)
                   [ADDR=character string]
                   [SCRSIZE=(integer, integer)]
                   [TERMNO=(integer, integer)]
```

TERM=

Specifies the type of terminal making up this line group. Select only one of the following:

1050 -- defines a line group consisting of IBM 1050 Printer-Keyboards on either switched (dial) or non-switched (direct) lines.

2741 -- defines a line group consisting of IBM 2741 Communications-Terminals on either switched or non-switched lines.

5041 -- defines a line group consisting of both IBM 2741s and IBM 1050s. The terminals in this line group must be on switched (dial) lines.

3335 -- defines a line group consisting of Teletype Model 33 or Model 35 or both. The terminals in this line group must be on switched (dial) lines.

226L -- defines a line group consisting of IBM 2260 Display Stations connected on a local line.

226R -- defines a line group consisting of IBM 2260 Display Stations, connected on a remote line, and optionally IBM 2265 Display Stations.

2265 -- defines a line group consisting of IBM 2265 Display Stations.

DDNAME=

Specifies the ddnames of the DD statement that define the terminal lines in the line group as a data set. These DD statements are found in the cataloged procedure that is used to start the MCP.

LINENO=

Specifies the number of lines in this line group. The value is an integer between 1 and 51.

UNITNO=

Specifies the number of basic units per buffer for terminals in this line group. A basic unit is used by TCAM to construct I/O buffers. The default value is 1.

TRANTAB=

Specifies the translation tables to be used for this line group. If this parameter is omitted, all of the supplied translation tables that are valid for the terminal type specified by TERM= will be included except those marked with an asterisk.

TERM=	TRANTAB=	Comments
1050	1050	
2741	CR41	Correspondence
	EB41	EBCDIC
	BC41*	BCD
5041	1050	BCD
	BC41*	BCD
	EB41	EBCDIC
	CR41	Correspondence
3335	TTYB	TTY parity
	TTYC*	TTY non-parity
226L	EBCD	
226R	2260	
2265	2265	

*Not used as a default translation table.

Note: If more than one table is specified explicitly or implied by default, the MCP will determine the proper translation table dynamically using the CODE parameter.

CODE=

Specifies the character string used to determine the terminal character set. Each time a terminal is connected, the MCP translates the input line from that terminal, using each of the translation tables specified in the TRANTAB operand. The MCP compares the translated result with the character string specified in the CODE= operand. When the MCP finds a match, it uses the appropriate translation table with that terminal from then on.

The default is CODE=LOGON unless the TRANTAB operand specified both BC41 and EB41 (2741 BCD and 2741 EBCDIC). If both EBCDIC and BCD character sets are present in the line group, the default is CODE="LOGON.

An installation can specify a maximum of four character strings other than LOGON, but they must be eight or less characters.

DIAL=

Specifies whether the line group is a dial (switched) line group. If this parameter is omitted, YES is assumed. DIAL=NO is required for TERM=226L, 226R, 2265 and TERM=3335.

INTVL=

Specifies the poll delay intervals in seconds for polled lines. The value is an integer between 1 and 255. If this parameter is omitted, a value of two is assumed for polled lines.

FEATURE=

Specifies the special features that define this line group:

BREAK Specifies that terminals in this line group have the Transmit Interruption feature.

NOBREAK Specifies that terminals in this line group do not have the Transmit Interruption feature. This operand should be specified when any of the terminals in the line group do not have the feature.

ATTN Specifies that terminals in this line group have the Attention feature (Receive Interruption.)

NOATTN Specifies that terminals in this line group do not have the Attention Feature.

TOSUPPR For 1050 terminals, this operand specifies that the optional Text Time-out Suppression feature is present. This operand applies only to 1050 terminals and should be specified only if all 1050 terminals in a 1050 or 5041 group have the feature. When specified read inhibit rather than read commands will be used.

The following table describes the features which may be specified for the 1050, 2741, 5041, 2260 and the 3335 (TWX); where

D = Default.
A = Assumed.
I = Invalid.
O = Optional.

Feature	1050	2741	5041	3335	2260
BREAK	O	D	O	A	I
NOBREAK	D	O	D	I	A
ATTN	D	D	D	A	I
NOATTN	O	O	O	I	A
TOSUPPR	O	I	O*	I	I

*TOSUPPR is optional for the 1050 terminals in a 5041 line group. It is assumed for the 2741 terminals in the same 5041 line group.

ADDR=

Specifies the station identification character (1050) or the two byte control unit, device address (226R,2265) of the terminals in the line group. The character string should be the hexadecimal equivalent of the appropriate transmission code. Hexadecimal characters should be specified without framing characters. For example if the station identification character is "A", the correct specification is ADDR=E2, the hexadecimal equivalent of the 1050 transmission code for the character "A", not ADDR=C1, the hexadecimal equivalent of the EBCDIC character "A". To find the hexadecimal equivalent of a given character in a specific transmission code, consult the component description publications. For the 1050, only the station identification character value need be specified: the component selection character values will default to the common polling and addressing values for input and

output, respectively. 1050 multidrop is not supported.

This parameter is not valid for TERM=2741 or TERM=3335. This parameter is required for TERM=1050 or 5041. For configurations in which the addressing characters vary among the different terminals in the line group as in 2265, the addressing characters should be specified using LISTTA macro instructions (see below) rather than in the LINEGRP macro instruction.

SCRSIZE=
Specifies the screen dimensions of the display station(s) on the line. The first integer specifies the number of rows on the screen. The second integer specifies the number of characters per row. Standard IBM screen size are 12x80, 12x40, 6x49, and 15x64 non-standard sizes will be accepted but a warning will be given. The default for this parameter is (12x80).

TERMNO=
Specifies the number of terminals attached to each non-switched line, used with TERM=226R, and 2265.

LISTTA Macro

The LISTTA macro instruction specifies variations in device address (ADDR) within a line group. One or more LISTTA macro instructions can appear after each LINEGRP macro instruction. Each LISTTA macro instruction modifies one line (RLN) within a line group.

LISTTA MACRO INSTRUCTION FORMAT

Name	Operation	Operand
name	LISTTA	RLN=integer [,ADDR=(chars ,chars...)] [,SCRSIZE]

RLN
Specifies the relative line number within a line group to which the attributes specified in this macro instruction call apply. For example, RLN=1 refers to the first line in the line group.

ADDR=
Specifies the alphabetic station identification character (1050) of the terminal(s) on this line. One character string must be specified for each terminal on the line. Subparameters must be specified in the order in which polling is to take place. Each character string should be the hexadecimal equivalent of the appropriate transmission code representation for the terminal involved. Hexadecimal characters should be specified without framing characters.

Example: ADDR=(C0A1,C0A2).

For a 1050, only the station identification character value need by specified.

SCRSIZE
Specifies the screen dimensions of the display station(s) on the line. The first integer specifies the number of rows on the screen. The second integer specifies the number of characters per row. Standard IBM screen size are 12x80, 12x40, 6x49, and 15x64 non standard sizes will be accepted but a warning will be given. The default for this parameter is (12x80).

TSOMCP MACRO INSTRUCTION FORMAT

TSOMCP Macro

The TSOMCP macro instruction:

- Names the MCP, (provides the CSECT name).
- Defines the size of the TCAM basic units used to construct terminal I/O buffers.
- Specifies which TCAM trace tables will be provided.
- Specifies whether a cross-reference table will be included in the MCP.
- Specifies whether the operator can specify parameters when he starts the MCP.

Name	Operation	Operand
name	TSOMCP	[UNITSIZ=number] [TRACE=number] [DTRACE=number] [LNUITS=number] [UNITSIZ=number] [OLTEST=number] [OPTIONS=(XREF,PROMPT)]
Note: All operands are optional.		

name
Names the start of the MCP and provides the CSECT label for the generated program. This field is required.

UNITSIZ=
Specifies the size of a TCAM basic unit and must be a value between 33 and 255 inclusive. If omitted, the MCP uses a default size selected to yield the best system performance UNITSIZ should be a multiple of 8 plus 4 for efficient core usage.

TRACE=
Specifies the number of TCAM I/O trace table entries in the Message Control Program. The default value is zero. Maximum value is 65535. See IBM System/360 TCAM Programmers Guide and Reference.

DTRACE=
Specifies the number of TCAM subtask trace table entries in the Message Control Program. The default value is zero. Maximum value is 65535. See IBM System/360 TCAM Programmers Guide and Reference.

LNUNITS=
specifies the number of TCAM basic units (See IBM System/360 TCAM Programmers Guide and Reference) to be provided in the buffer pool for creating line buffers for this MCP. A maximum of 65,535 may be specified. If this operand is omitted, the system will calculate a default value using the following algorithm:

LNUNITS=
2 x (number of terminals) x (UNITNO value) or
2.5 x (number of terminals) x UNITNO for 2265/65

where,

UNITNO (as specified in each LINEGRP macro) represents the number of units per buffer for terminals defined in the associated line group. If UNITNO is omitted in the LINEGRP macro, the default value (1) is used. This means that each buffer will consist of one basic unit.

If both the LNUNITS and UNITNO keywords are defaulted, the buffer pool created will consist of 2 buffers per terminal with each buffer being one basic unit in length using PCI buffering for both input and output.

OLTEST=
Specifies the number of On-line Test procedures which can execute simultaneously. The value must be between 0 and 255. The default is 0, meaning On-line Test not supported.

OPTIONS

XREF
A cross-reference table including control blocks for each line will be included in the MCP. If this option is omitted, the cross-reference table will be excluded.

PROMPT

If PROMPT is specified, the system operator will be asked to enter parameters when TCAM is started. At that time he may enter and override some of the parameters specified when the MCP was assembled. The following TCAM parameters are ones which an installation may want to specify when it starts TCAM for TSO. The last parameter entered must be a "U" to end the prompting process. See IBM System/360 TCAM Programmer's Guide and Reference for a description of the INTRO macro instruction and the parameters which can be overridden.

KEYLEN = integer
K = integer

Specifies the size of the basic units, with which the terminal I/O buffers are constructed. This corresponds to UNITSIZ= parameter.

LNUNITS = integer
B = integer

Specifies the number of basic units which are used to build buffers, corresponds to LNUNITS. The value must be between 0 and 65,535

STARTUP
= C
S

Specifies that a "cold" start is to be performed following a shutdown of the Message Control Program or a system failure. It is required if OPTIONS=PROMPT was specified on the TSOMCP macro instruction.

CROSSRF=integer
F = integer

Specifies the number of entries in the cross reference table, a debugging aid. If OPTIONS=XREF is specified in the TSO MCP, one entry will be generated for each line. If the operator specifies fewer entries than there are simultaneously open lines, lines opened after the table is full will have no entries

TRACE = integer
T = integer

Specifies the number of TCAM I/O trace entries to be allocated, corresponds to TRACE= in the TSOMCP macro instruction.

DTRACE = integer
A = integer

Specifies the number of entries in the TCAM Dispatcher Trace Table, corresponds to DTRACE= in the TSOMCP macro. The Dispatcher Trace Table is a debugging aid that keeps a sequential record of TCAM subtasks activated by the TCAM dispatcher. One four word entry is created for each subtask activated; when the end of the table is reached, the table is wrapped around; new entries overlay the oldest entries. Maximum to be specified is 65,535: If 0 is specified, the table is not generated.

OLTEST=number
O=number

Specifies the number of On-line Test procedures that can execute simultaneously. This parameter corresponds to the OLTEST parameter of the TSOMCP macro instruction. The default is 0, which indicates that On-line Test is not supported.

CIB = integer
C = integer

Specifies the maximum number of Command Input Blocks (CIB's) that can be used at any one time in the TCAM subsystem, CIB's are the buffers used to contain operator control messages entered at the system console. Maximum that can be specified is 255; if the operand is omitted, "CIB=2" is assumed. At least two CIB's should be specified, since START uses one. If an attempt is made to enter an operator control message from the system console, and the number of CIB's specified is already in use, the message is rejected by TCAM.

Figure 35 and 36 show the MCP macro specifications for two sample systems.

The first system has:

1. 10 lines for leased, (non-switched), 2741's; all are BCD terminals and use EBCDIC character set only. All terminals in this line group have both Receive and Transmit Interrupt features.
2. 5 lines of teletype (which could be either 33 or 35).
3. The system operator will be prompted to enter TCAM parameters when he starts TCAM. At that time he can override any of the parameters specified on the TSOMCP macro, as well as other TCAM parameters. See the description of the TSOMCP macro instruction, for parameters pertinent to TSO. (The operator will always have to reply "s=cu"; STARTUP=COLD and a "u" to terminate prompting.) A Dispatcher Subtask Trace Table, useful for debugging purposes, is to be included in the MCP. It will contain 100 4 byte entries. (DTRACE=100)

The sample system shown in Figure 36 has 10 dial lines, to be used by both 1050's and 2741's. The station identification character for the 1050's is "A". Notice that it is specified in terminal transmission code, (E2) not EBCDIC (C1).

Assume there are four types of terminals in the line group.

A. Three 1050's, with Text Timeout Suppression feature, Receive and Transmit Interrupt features.

B. One 1050, with Text Timeout Suppression feature.

C. Five 2741's, Correspondence Code, Receive and Transmit Interrupt features.

D. Two 2741's, EBCDIC code.

The default is ATTN and NOBREAK.

Users at terminals in groups A and C would use the TERMINAL command to request Transmit Interrupt handling, (BREAK), the installlation could provide a special LOGON cataloged procedure for these users containing a suitable TERMINAL command as the PARM value. Users at terminals in groups B and D would not be able to cause an attention interruption during output, or while the keyboard is locked. They would use the TERMINAL command to set up simulated attention breaks by time interval when the keyboard is locked, or after a number of consecutive lines of output, when output is being sent. This also could be specified in a LOGON procedure.

```
LINEGRP     TERM=2741,DDNAME=LNGP2741,LINENO=10,         X
            TRANTAB=EB41,DIAL=NO
LINEGRP     TERM=3335,DDNAME=LNGPTWX,LINENO=5
TSOMCP      OPTIONS=PROMPT,DTRACE=100
```

Figure 35. Sample MCP

```
LINEGRP     TERM=5041,DDNAME=DIAL5041,LINENO=10,ADDR=E2, X
            FEATURE=TOSUPPR
TSOMCP
```

Figure 36. Sample MCP

Writing Cataloged Procedures for TSO

Two categories of cataloged procedures are used by TSO. The first includes procedures invoked by the system operator when he starts any of these four TSO tasks:

1. The Message Control Program (MCP).
2. The Time Sharing Control Task (TSC).
3. The Background Reader for the SUBMIT command (BRDR).
4. The TSO Trace Writer.

The second category consists of those procedures invoked each time a LOGON command is entered at a terminal. The PROC operand of the LOGON command specifies the name of the cataloged procedure which:

1. Contains the JCL statements that define the data sets available to the terminal user.
2. Specifies the name of the Terminal Monitor Program (TMP) supplied with TSO or the user-written substitute for the TMP.

Both categories of cataloged procedures must be members of SYS1.PROCLIB or members of partitioned data sets concatenated to SYS1.PROCLIB.

Message Control Program

The cataloged procedure used to start the Message Control Program specifies through the PGM= operand of the EXEC statement the MCP to be started. The MCP should be named IEDQTCAM. This name allows the MCP to run in a region smaller than MINPART and ensure that the MCP can not be canceled, that is the operator must halt it. Specify TIME=1440 to eliminate timing. Specify ROLL=(NO,NO) to preclude an attempt to Rollout the MCP. Specify DPRTY=(15,15) to insure high priority. The MCP must run at a higher priority than the TSC.

The cataloged procedure used to start the MCP also must define any terminals attached to the system as data sets. This is done through the ddnames specified in the LINEGRP macro instructions used in generating the MCP. Figure 37 shows two procedures that can be used to start the two sample MCPs generated in Figure 34.

Time Sharing Control Task

The cataloged procedure used to start the Time Sharing Control Task contains the Job Control statements defining all the system resources the TSC requires. The procedure consists of an EXEC statement and several Data Definition statements.

```
//MCP1   EXEC  PGM=IEDQTCAM,ROLL=(NO,NO),TIME=1440,DPRTY=(15,15),REGION=70K
//LNGP2741   DD UNIT=021  FIRST LINE GROUP DATA SET 2741
//           DD UNIT=022
//           DD UNIT=023
//           DD UNIT=024
//           DD UNIT=025
//           DD UNIT=026
//           DD UNIT=027
//           DD UNIT=028
//           DD UNIT=029
//           DD UNIT=02A
//LNGPTWX    DD UNIT=02B  SECOND LINE GROUP DATA SET TWX
//           DD UNIT=02C
//           DD UNIT=02D
//           DD UNIT=02E
//           DD UNIT=02F

//MCP2   EXEC  PGM=IEDQTCAM,ROLL=(NO,NO),TIME=1440,DPRTY=(15,15),REGION=66K
//DIAL5041   DD UNIT=021  LINE GROUP DATA SET
//           DD UNIT=022
//           DD UNIT=023
//           DD UNIT=024
//           DD UNIT=025
//           DD UNIT=026
//           DD UNIT=027
//           DD UNIT=028
//           DD UNIT=029
//           DD UNIT=02A
```

Figure 37. Sample MCP Start Procedures

The EXEC statement of the cataloged procedure that starts the Time Sharing Control Task, specifies:

- The TSC program name, which is IKJEAT00.
- The TSC region size. If the TSC needs a different sized region, it will obtain one.
- ROLL=(NO,NO) to preclude an attempt to Rollout the TSC region, if OPTIONS=ROLLOUT has been specified during system generation.
- DPRTY=to set a priority for the TSO. It must be lower than the MCP.

Six data sets must be defined.

- SYSPARM -- The library containing TSC initiation parameters. These parameters are discussed under "Writing TSO System Parameters".
- SYSUADS -- The User Attributes Data Set, this data set cannot be concatenated.
- SYSLBC -- The broadcast data set which contains messages from the SEND command.
- SYSWAP00 -- The swap data sets.
- IEFPDSI -- The partitioned data set containing LOGON cataloged procedures. This data set may be either SYS1.PROCLIB or a partitioned data set dedicated to LOGON procedures. A dedicated data set will speed up LOGON processing.
- SYSTSDP the TSO dump usually a tape volume.

For each of these data set definitions, DISP=SHR should be specified.

Figure 38 shows a sample cataloged procedure to start the TSC.

The data definition ddname on the DD statement defining the SWAP data set specifies whether serial or parallel swapping is to be used. The ddname is of the form

SYSWAPln

Where l indicates the level of the data set, i.e., 0 for prime, 1 for first overflow; and n is the data set number at this level.

For example, if an installation has two data sets and wants to use parallel swapping it would use SYSWAP00 and SYSWAP01 as the ddnames.

If an installation wanted to use a IBM 2301 drum for a prime swap data set and a IBM 2314 as overflow, the ddnames would be SYSWAP00 for the 2301 the prime data set, and SYSWAP10 for the 2314, the first overflow data set. If a system or TSO failure causes TSO to be restarted, you can use IMDPRDMP program to save the swap data sets before attempting to restart TSO. When invoking IMDPRDMP, the DD statements for the swap data sets should be the same as those in the TSO cataloged procedure; the //PRINTER DD statement writes to tape with chained scheduling and a large blocking factor so that the data sets are dumped quickly. The publication IBM System/360 Operating System: Service Aids, GC28-6719 shows the procedures for analyzing system failures and how to use the IMDPRDMP program to save the swap data sets.

STARTING AND STOPPING TSO

When the operator starts TSO for the day, he must:

1. Issue a START command to start the Message Control Program. The operand of the START command is the name of the cataloged procedure that provides the Job Control statements necessary to execute the MCP. For example if the cataloged procedure used to start the MCP is named TCAM, the operator will issue a START TCAM command.
2. Issue a START command to start the Time Sharing Control Task (TSC). The operand of this command names a cataloged procedure used to start the TSC. For example if the cataloged procedure used to start the TSC is named TS, the operator would issue a START TS command.

When the operator stops TSO for the day, he must:

1. Issue a STOP command to stop the Time Sharing Control Task. The operand of the STOP command must be the same as the operand that was used to start the TSC.
2. Issue a HALT command to stop the Message Control Program. If the PGM= operand of the EXEC statement in the cataloged procedure used to start the MCP is IEDQTCAM, then the MCP cannot be cancelled with a CANCEL command. If the operator cancels the MCP, the TSO must be stopped before the MCP is restarted. The MCP cannot be halted

```
//IEFPROC   EXEC  PGM=IKJEAT00,ROLL=(NO,NO),DPRTY=(13,13)
//SYSPARM   DD  DSN=SYS1.PARMLIB,DISP=SHR
//SYSUADS   DD  DSN=SYS1.UADS,DISP=SHR
//SYSLBC    DD  DSN=SYS1.BRODCAST DISP=SHR
//SYSWAP00  DD  DSN=SYS1.SWAP1,DISP=SHR
//SYSWAP01  DD  DSN=SYS1.SWAP2,DISP=SHR
//IEFPDSI   DD  DSN=SYS1.PROCLIB,DISP=SHR
```

Figure 38. Sample Cataloged Procedure to Start Time Sharing Control Task

with a HALT command unless the TSO is stopped.

DEFINING A UADS USING THE TSC PROCEDURE

When a TSO system is first started after system generation, it is necessary to construct a UADS using the ACCOUNT command. The distributed UADS contains one valid user:IBMUSER and this user is authorized to use one procedure: IKJACCNT. He should use the ALLOCATE command to define a new UADS, specifying its volume serial number, and define his UADS structure with a series of ACCOUNT command ADD subcommands. He should then log off, stop the system, and change the SYSUADS DD statement in the TSC start procedure, to point to the new UADS. If the cataloged procedure defines SYSUADS though a DSN= operand, then he need only recatalog the data set name in his system catalog.

Background Reader (BRDR)

The cataloged procedure used to start the Background Reader (BRDR) contains Job Control statements that

- Specify the program name of the Background Reader.
- Pass the Background Reader standard Reader-Interpreter parameters.
- Define required data sets.

The Background Reader, (BRDR), runs as a system task. It is started by the operator. It interprets Job Control Language passed by a terminal user with the SUBMIT command. If there is no input for the BRDR, it will relinquish its region and wait for input. Output from the BRDR is placed on SYS1.JOBQE and is queued for execution by a standard initiator. The cataloged procedure that provides the Job Control Language to start the Background Reader is similar to other reader procedures. The BRDR program name is IKJEFF40. Figure 39 shows an example of a BRDR procedure. For further information on writing system reader/interpreter cataloged procedures, see IBM System/360 Operating System: System Programmers Guide, GC28-6550.

An installation exit can gain access to and modify or delete any JCL passed by the SUBMIT command processor. The section, "Writing Installation Exits for the SUBMIT Command" describes how to write this exit.

```
//BRDR    EXEC  PGM=IKJEFF40,
//              REGION=70K,
//              PARM='READERPARM'
//IEFPDSI DD    DSN=SYS1.PROCLIB,
//              DISP=SHR
//IEFDATA DD    UNIT=SYSDA
//              SPACE= (80,(500,50),RLSE,CONTIG),
//              DCB=(BUFNO=2,LRECL=80,BLKSIZE=80,DSORG=PS,
//              RECFM=F,BUFL=80)
//IEFRDER DD    DUMMY
```

Figure 39. Sample Background Reader (BRDR) Procedure

```
//TSTRACE PROC  TRREGN=20K,        DEFAULTS:  REGION SIZE=20K
//              TRPARM=100,                    ENTRY RATE=100 ENTRIES/SEC
//              VOLCNT=20,                     VOLUME COUNT=20
//              BLKSIZE=2048                   BUFFER SIZE=2048
//*
//* DESCRIPTION OF SYMBOLIC PARAMETERS ---
//*  TRREGN  - TRACE WRITER REGION SIZE
//*  TRPARM  - AN ESTIMATE OF THE RATE AT WHICH ENTRIES WILL BE MADE
//*            INTO TRACE BUFFERS IN NUMBER OF ENTRIES PER SECONDS
//*  VOLCNT  - MAXIMUM NO. OF VOLUMES AVAILABLE FOR TRACE DATA SET
//*            PER RUN. MAXIMUM VALUE ALLOWED IS 255.
//*  BLKSIZE - SIZE OF TRACE BUFFERS. MINIMUM SIZE ALLOWED BY TRACE
//*            WRITER IS 128; MAXIMUM ALLOWED BY SYSTEM IS 32,760
//*
//IEFPROC EXEC PGM=IKJFATRC,       INVOKES INITIALIZATION MODULE
//             DPRTY=14,           PRIORITY SHOULD AT LEAST BE HIGHER
//             REGION=&TRREGN.     THAN CPU-BOUND JOBS IN THE SYSTEM
//             PARM=&TRPARM
//*
//IEFRDER DD    DSNAME=TSTRACE,    NAME OF TRACE DATA SET
//              UNIT=2400,         DATA SET CREATED ON 9-TRK TAPE(S)
//              DISP=(NEW,KEEP),
//              DCB=(BLKSIZE=&BLKSIZE),
//              VOLUME=(,,,&VOLCNT)
```

Figure 40. Sample TSO Trace Start Procedure

TSO Trace Writer

The TSO Trace Writer collects Time Sharing Driver Entry Codes and writes them out to a data set. The Trace Writer operates in its own partition and is started by the operator. A cataloged procedure distributed with TSO defines the resources needed to run TSO Trace.

The cataloged procedure used to start the TSO Trace Writer:

- Specifies the program name of the TSO Trace facility.
- Passes to the Trace Writer a parameter which controls sampling rate.
- Defines the TSO Trace output data set.

Figure 40 shows the procedure. The sample procedure specifies that the Trace Writer output data set is to be written to a 2400 tape unit. The output data set can also reside on disk. The user may specify that chained scheduling be used if trace data set is on tape. If an installation specifies in the DCB operand of the DD statement an NCP value, it must be at least three, that is,

```
DCB=(BLKSIZE=&BLKSIZE,NCP=3).
```

An installation should not include a SYSABEND or SYSUDUMP statement in the TSO TRACE cataloged procedure.

Logon Cataloged Procedure

The LOGON cataloged procedure defines the system resources that the terminal user can use. The LOGON cataloged procedure can be named in the PROC operand of the LOGON command, supplied through a user exit from the LOGON processor. This procedure:

- Defines or allows for dynamic allocation of all data sets used by the terminal user.
- Specifies which program is to be invoked after LOGON, the TMP distributed with TSO or a user written program.

The data sets defined can include the common system utility data sets, and data sets used by the compilers such as SYSUT1, SYSUT2 or even the specialized data sets used by the Assembler or the Linkage Editor.

In addition any data sets that will be allocated through the ALLOCATE command must have a corresponding DD DYNAM statement. Any data sets needed by a processing program such as a compiler or a system utility can be defined dynamically through the ALLOCATE command or through Dynamic Allocation.

The Terminal Monitor Program distributed with TSO is named IKJEFT01. If a user written TMP is to be used for a particular procedure, then its module name should be

substituted for IKJEFT01 in the PGM=operand on the EXEC statement.

The PARM operand on the EXEC statement is interpreted by the Terminal Monitor Program (TMP) as the first line of input from the terminal.

ROLL=(NO,NO) should be specified to preclude rolling out the Time Sharing Region.

REGION= is ignored

The command library, SYS1.CMDLIB, contains the command processor load modules. An installation can also load many of these modules into the TSO Link Pack Area. The command library can be concatenated to SYS1.LINKLIB or defined in the LOGON procedure as a step library.

Note: If the command library is defined in the LOGON procedure as a step library, the modules in the TSO Link Pack Area will not be used. This will degrade performance.

To concatenate SYS1.CMDLIB to SYS1.LINKLIB, use the LNKLST00 member of SYS1.PARMLIB. See IBM System/360 Operating System: System Programmer's Guide, GC28-6550 for further information about using LNKLST00.

Figure 41 shows an example of a LOGON procedure.

The sample LOGON procedure can be useful to a programmer using COBOL. Statement 1 specifies the TSO standard TMP for execution. Statement 2 defines the data set containing the HELP command messages. Statement 3 defines a utility data set used by several command processors while statement 4 defines the EDIT utility data set. Statements 5, 6, and 7 define utility data sets used by the COBOL compiler. Statement 8 defines the COBOL subroutine library. Statements 11 through 17 define data sets which can be allocated during the terminal session by the user or a program he invokes, using the ALLOCATE command. Statement 18 defines SYSPROC, an installation defined partitioned data set containing command procedures.

TSO System Parameters

When the Time Sharing Control Task initializes the TSO system, it reads a series of parameters from a member of the partitioned data set named on the SYSPARM DD statement. The SYSPARM DD statement appears in the cataloged procedure used to start the TSC. The member name is IKJPRM00 or a name supplied by the operator on the START command. There are three types of parameters.

- TSC parameters.
- Time Sharing Driver parameters.
- Parameters dealing with the allocation of terminal buffers.

All of these parameters have an effect on the size of the TSC region. The publication IBM System/360 Operating System: Storage Estimates gives formulas for assessing the effects of these parameters on region size.

The Time Sharing Control Task Parameters

The TSC parameters:

- Define the number and size of the Time Sharing regions.

```
//COPROC EXEC  PGM=IKJEFT01,ROLL=(NO,NO)                              001
//SYSHELP   DD  DSN=SYS1.HELP,DISP=SHR                                002
//SYSUT1    DD  DSN=&SYSUT1,UNIT=SYSDA,SPACE=(CYL,(10,10))            003
//SYSEDIT   DD  DSN=&EDIT,UNIT=SYSDA,SPACE=(1688,(50,20))             004
//SYSUT2    DD  DSN=&SYSUT2,UNIT=SYSDA,SPACE=(TRK,(10,5))             005
//SYSUT3    DD  DSN=&SYSUT3,UNIT=SYSDA,SPACE=(TRK,(10,5))             006
//SYSUT4    DD  DSN=&SYSUT4,UNIT=SYSDA,SPACE=(TRK,(10,5))             007
//SYSLIB    DD  DSN=SYS1.COBLIB,DISP=SHR                              008
//SYSIN     DD  TERM=TS                                               009
//SYSPRINT  DD  TERM=TS                                               010
//DD1       DD  DYNAM                                                 011
//DD2       DD  DYNAM                                                 012
//DD3       DD  DYNAM                                                 013
//DD4       DD  DYNAM                                                 014
//DD5       DD  DYNAM                                                 015
//DD6       DD  DYNAM                                                 016
//DD7       DD  DYNAM                                                 017
//SYSPROC   DD  DSN=CMDPROC,DISP=SHR                                  018
```

Figure 41. Sample LOGON Catalogued Procedure

- Specify the number of users.
- Specify whether SMF is to be used.
- Specify which DRIVER to use.
- Limit the number of tracks the SUBMIT command can use to queue jobs.
- Defines the module contents of the Time Sharing Link Pack Extension.

The contents of the Time Sharing Link Pack Area, that part of the TSC region containing reenterable modules common to different TSO applications has a direct effect on system response and overhead. The following routines are used by different users many times during an average session and should reduce loading time if included.

- The I/O Service routines -- that is GETLINE, PUTLINE, PUTGET, and STACK.
- The TMP mainline routines.
- Command Scan -- a service routine used to check the syntax of commands.
- TIME -- a routine used to get the time of day.
- PARSE -- a routine that analyzes the syntax of commands.

In addition if EDIT is being used extensively, portions of the EDIT command processor should be included.

- The Edit Mainline routines.
- INPUT subcommand processor.
- LIST subcommand processor.
- CHANGE subcommand processor.
- Implicit change processor, that is, the update function for portions of individual lines.

Driver Parameters

The DRIVER parameters specify:

1. What type of queueing service to use in a region.
2. What the cutoff points for each queue are.

For example, the SWAPLOAD/NOSWAPLOAD parameter specifies whether or not swap load will be used as a criterion for determining which queue a user will be put in. If SWAPLOAD has been specified, the MAXSWAP parameter defines the maximum swap load for each queue.

In a single region system, NOWAIT and NOACTIVITY should be specified.

The decay constant for the wait estimate (DECAYWAIT) and the activity estimate (DECAYACT) if set to 100, (that is, a decay constant of one since the value is in hundredths), will mean that the current value has a weight equal to the total prior value. This will "smooth" out the effects of excessive variations.

MINSLICE, the minimum amount of time given to a terminal user, should be set to allow a useful amount of execution time.

If PREEMPT is specified, CYCLES should be set to zero, since a higher priority queue will preempt a lower priority queue.

Buffer Control Parameters

TSO controls the allocation of terminal buffers in the TSC region. Buffers allocations are based on initial parameters specified in SYS1.PARMLIB.

The BUFSIZE= parameter specifies the size in bytes of each TSO terminal buffer.

The BUFFERS= parameter specifies the total number of TSO buffers. The remaining parameters deal with allocating the number of buffers per user when a given number of users is logged on.

TSO maintains a count of the number of allocated buffers per user, both for input and output. When the number of buffers either for input or output rises to a given level, the user is prevented from continuing until more buffers are available. If the specified maximum number of input buffers are allocated, the keyboard is locked up. If the maximum number of output buffers are allocated, the user's program is put into a wait. This level is determined by the OWAITHI value for output and the INLOCKHI value for input.

When the number of logged on users changes by the percentage specified in the USERCHGE parameter, and when the number of users falls below SLACK value,the number of buffers per user is readjusted. The number of buffers for input and output are distributed in the same ratio as specified by INLOCKHI and OWAITHI.

System Parameter Format

The format of the parameter records is:

```
parameter-owner keyword=value...
```

The possible parameter-owners are:

- TS -- parameters for the Time Sharing Control Task.
- DRIVER -- parameters for the Time Sharing Driver.
- TIOC -- parameters controlling terminal buffer allocation.

Keywords cannot be continued but may be repeated. This has the effect of continuation, as repeated keyword values are added on to those already specified. When two parameters conflict, the last value is used. Figure 42 shows an example of system parameters for a single region model 50 and for a double region model 65. Figure 43 shows the syntax and meaning of the start parameters.

PARAMETER OWNER	KEYWORD	MEANING
TS	TERMAX=nnnn	Specifies maximum number of users.
	USERS=nnnn	Specifies initial maximum number of users, defaults to TERMAX, can be changed by MODIFY command.
	REGNMAX=nn	Specifies number of TSO user regions.
	MAP=nn	Specifies the number of MAP entries, used to reduce swapping of unused storage.
	SMF=[OFF / OPT=1 / OPT=2] [,EXT={YES / NO}]	Standard SMF parameters, see MVT Job Management.
	DSPCH=cccccc	Specifies first six characters of Time Sharing Driver. Defaults to IKJEAD, driver supplied with TSO. This parameter defines the names of all four Driver modules. That is the driver supplied with TSO has four modules, IKJEAD00 to IKJEAD03.
	LPA=(module list)	List of modules to be included in Time Sharing Link Pack Extension.
	REGSIZE(nn)=(mmK, iiik)	Specifies region size (mmk) and LSQS size (iiik) for region nn. Defaults to zero.
	SUBMIT=nnnn	Specifies the maximum number of tracks in the SUBMIT command job queue. Defaults to limit set at System Generation.
DRIVER	WAIT / NOWAIT	Specifies use of wait estimate option.
	ACTIVITY / NOACTIVITY	Specifies whether Region activity estimate is to be used in assigning a user to a region. NOACTIVITY required for single region system.
	OCCUPANCY / NOOCCUPANCY	Specifies whether core occupancy estimates are to be used in queue selection.
	SWAPLOAD / NOSWAPLOAD	Specifies whether swapload is to be used in queue placement.
	AVGSERVICE / NOAVGSERVICE	Specifies average queue service time to be used.
	PRIORITY / NOPRIORITY	Specifies whether priority scheduling is to be used.
	PREEMPT/ / NOPREEMPT	Specifies whether preemptive scheduling is to be used.
	BACKGROUND=nn/ / NOBACKGROUND	Specifies a percentage of CPU time guaranteed to the background or no guaranteed time.
	DECAYWAIT=nnnn	Specifies in 100ths the decay constant for the wait estimate. Assumes WAIT specified.
	DECAYACT=nnnn	Specifies in 100ths the decay constant for the activity estimate. Assumes ACTIVITY specified.
	SUBQUEUES(n)=mmm	Specifies the number of queues for region n.

Figure 42. TSO System Parameter Syntax (Part 1 of 2)

PARAMETER OWNER	KEYWORD	MEANING
	CYCLES(n,m)=iii	Specifies the number of service cycles to be given to the mth queue of the nth region.
	MAXSWAP=(n,m)=iii	Specifies the maximum number of 1024 byte blocks which may be allowed to a user on queue m, in region n. Assumes SWAPLOAD specified.
	MAXOCCUPANCY(n, m)=iii	Specifies the maximum amount of time in 100th of a second a user on queue m in region n can reside in core.
	SERVICE(n,m)=iii	Specifies the average service time in 100ths of a second for a user on queue m in region n.
	MINSLICE(n,m)=iiii	Specifies the minimum time slice in 100th of a second to be given to a user on queue m in region n.
TIOC	BUFSIZE=nn	Specifies size of terminal buffer. Default 44.
	BUFFERS=nn	Total number of buffers.
	OWAITHI=nn	Specifies maximum number of allocated output terminal buffers per user in order to put a user program into output wait.
	INLOCKHI=nn	Specifies the maximum number of allocated input terminal buffers per user in order to lock a users keyboard.
	OWAITLO=nn	Specifies the number of allocated output buffers to bring a user out of output wait state. In other words if OWAITLO=4, when 4 or less buffers remain allocated, the user is brought out of output wait.
	INLOCKLO=nn	Specifies the number of currently allocated input buffers to unlock the terminal keyboard for input. In other words, when the number of allocated input buffers falls to or below the INLOCKLO value, the user's keyboard is unlocked.
	USERCHG=nn	Specifies percentage of change in logged on users needed to redistribute buffers and recalculate the OWAITHI and INLOCKHI numbers during slack time.
	RESVBUF=nn	Specifies the total number of terminal buffers that must be free to avoid locking all terminals to prevent input.
	SLACK=nn	Specifies number of logged on users that constitute slack time.

Figure 42. TSO System Parameter Syntax (Part 2 of 2)

```
TS       TERMAX=10 REGNMAX=1 REGSIZE(1)=(100K,8K)
TS       LPA=(IKJPTGT,IKJSCAN,IKJEF02,IKJEFT25)
TS       LPA=(IKJPARS)
DRIVER       AVGSERVICE PREEMPT SUBQUEUES(1)=3
DRIVER       CYCLES(1,1)=0
DRIVER       CYCLES(1,2)=0
DRIVER       CYCLES(1,3)=0
DRIVER       MAXOCCUPANCY(1,1)=750  MINSLICE(1,1)=150
DRIVER       MAXOCCUPANCY(1,2)=1500 MINSLICE(1,2)=750
DRIVER       MAXOCCUPANCY(1,3)=4500 MINSLICE(1,3)=4500
DRIVER       SERVICE(1,1)=150
DRIVER       SERVICE(1,2)=1500
DRIVER       SERVICE(1,3)=6000
TIOC  BUFSIZE=44
TIOC  BUFFERS=80
TIOC  OWAITHI=8
TIOC  OWAITLO=4
TIOC  INLOCKHI=4
TIOC  INLOCKLO=2
TIOC  SLACK=01
TIOC  RESVBUF=10
TIOC  USERCHG=99

TS       TERMAX=60 REGNMAX=2 REGSIZE(1)=(100K,8K) REGSIZE(2)=(100K,8K)
TS       LPA=(IKJPTGT,IKJSCAN,IKJEFT02,IKJEFT25)
TS       LPA=(IKJEBEM4,IKJEBELP,IKJEBELT,IKJEBECH,IKJEBELI)
TS       LPA=(IKJPARS)
DRIVER   WAIT
DRIVER   ACTIVITY
DRIVER   OCCUPANCY
DRIVER   AVGSERVICE
DRIVER   PREEMPT
DRIVER   DECAYWAIT=100
DRIVER   DECAYACT=100
DRIVER   SUBQUEUES(1)=3 SUBQUEUES(2)=3
DRIVER   CYCLES(1,1)=0 CYCLES(1,2)=0 CYCLES(1,3)=0
DRIVER   CYCLES(2,1)=0 CYCLES(2,2)=0 CYCLES(2,3)=0
DRIVER   MAXOCCUPANCY(1,1)=500  MINSLICE(1,1)=100
DRIVER   MAXOCCUPANCY(1,2)=1000 MINSLICE(1,2)=500
DRIVER   MAXOCCUPANCY(1,3)=3000 MINSLICE(1,3)=3000
DRIVER   MAXOCCUPANCY(2,1)=500  MINSLICE(2,1)=100
DRIVER   MAXOCCUPANCY(2,2)=1000 MINSLICE(2,2)=5000
DRIVER   MAXOCCUPANCY(2,3)=3000 MINSLICE(2,3)=3000
DRIVER   SERVICE(1,1)=1000
DRIVER   SERVICE(1,2)=1000
DRIVER   SERVICE(1,3)=6000
DRIVER   SERVICE(2,1)=100
DRIVER   SERVICE(2,2)=1000
DRIVER   SERVICE(2,3)=6000
TIOC  BUFSIZE=44
TIOC  BUFFERS=300
TIOC  OWAITHI=8
TIOC  OWAITLO=4
TIOC  INLOCKHI=4
TIOC  INLOCKLO=2
TIOC  SLACK=12
TIOC  RESVBUF=60
TIOC  USERCHG=01
```

Figure 43. Sample TSO System Parameters

Tuning the Time Sharing Driver

Tuning a TSO Time Sharing Driver is the process of specifying those values and algorithms that give a specific installation the best performance.

The time sharing algorithms discussed in the System Summary section of this publication are specified by an installation through the Driver Parameters. The syntax and meaning of these parameters are discussed under "Starting the System". This section discusses how to decide what values to specify.

Depending on the complexity of an installation, various measurements will be of value in tuning the Driver. These are:

- Think time -- the amount of time the terminal user takes to type in data, specifically, the interval between the time a READ is issued for a terminal and the time that READ is concluded.
- Swap time -- the sum of the amount of time a given user's program is being swapped in and the amount of time the user's program is being swapped out.
- Execution time -- the amount of time a given user is ready to run, i.e., the interval between when a user is restored and is quiesced.
- Response time -- the interval between a terminal user entering a command or data and the time when the system responds with output. If a user is compiling a program, response time is influenced by the particular program.

You determine such measurements through the Driver Entry Codes. The TSEVENT macro instruction is issued by system tasks to request services of the Driver or to notify the Driver of specific events. The TSEVENT macro instruction specifies an event name that is translated into a Driver Entry Code. Based on parameters specified to the Driver and on the sequence of these codes, the Driver initiates various actions.

Appendix C lists all the possible event names, the codes they generate, their meanings, and which task issues these codes. Associated with most TSEVENT macro calls is a TJID, which identifies the user to the Driver. The TJID is assigned when the user logs on.

In order to measure system performance, it is necessary to examine the sequence of these Driver Entry Codes during a Time Sharing operation. The TSO TRACE facility records all driver Entry Codes and places them on a data set for later interpretation.

Using TSO Trace

The TSO Trace Data Set Processor is a problem program that dumps the output data set from TSO Trace and produces a formatted listing. Figure 44 shows the job control language required to run the TSO Trace Data Set Processor. The example assumes that the TSO Trace Data set has been written to a tape volume with a volume serial number of TTRACE. The listing shows the parameters specified, and provides an explanation of each entry record as well as the contents of the record in hexadecimal and EBCDIC. The contents of register 1 is listed in the third column of the Trace Data Set Processor.

TSO TRACE is a started task which operates in its own region. All Driver Entry Codes are recorded in buffers which are then written to a data set. This data set can be listed by the TSO Trace Data Set Processor or can be analyzed by a user written program. The section of this publication Writing Cataloged Procedures for TSO, discusses how to define the TS Trace data set and specify parameters required by TSO Trace. Figure 45 shows the format of the TSO Trace data set.

The PARM value on the EXEC statement specifies what entries will be listed. All "G" type records will be listed regardless of the parameters. The individual keyword parameters should be enclosed in apostrophes and separated by commas. The keyword parameters and their syntax are:

```
//TTRDUMP  JOB    ,MSGLEVEL=1
//STEP     EXEC   PGM=IKJFATRP,PARM='CODES=STD'
//SYSPRINT DD     SYSOUT=A
//TRACEDD  DD     DSN=TSTRACE,VOL=SCR=TTRACE,UNIT=2400
```

Figure 44. Sample Job System to Run TSO Trace Data Set Processor

Entry Type	When Produced	Description of Contents
'A'	When the trace writer is started.	Word 1 X'FFFFFFFD' Word 2 # of 3-word entries per record Word 3 Time of Day in timer units
'B'	When the trace writer is stopped.	Word 1 X'FFFFFFFE' Word 2 Date in packed decimal 00YYDDDS Word 3 Time of Day in timer units
'C'	When information was lost (volume switching, low sampling rate, etc.	Word 1 X'FFFFFFFF' Word 2 Number of entries lost Word 3 Time of Day in timer units of the first lost entry
'D'	Normal entry (contains words 1-3 of the DPA).	Word 1 Bytes 1-2 TJID or 0 Byte 3 Reserved (X'00') Byte 4 Entry code Word 2 Contents of register 1 on entry to TSIP Word 3 Time of Day in timer units
'E'	Following a normal entry with entry code 0 (TMP entry).	Words 1-2 Command name Word 3 Unpredictable
'F'	Following a normal entry with entry code 25 (LOGON establishes PSCB).	Bytes 1-7 USERID Bytes 8-12 Unpredictable
'G'	Following a normal entry with entry code 44 (FE Serviceability)	Diagnostic data (There will be 2^{n+1} 3-word groups of data available. The value of n is contained in bits 5-7 of word 2 of the normal entry.

Figure 45. Format of the TS Trace Data Set

CODES
specifies which class of entry codes are to be included in the listing. The subparameters, S,T and D represent 'System' codes, 'Terminal I/O' codes, and "Dispatcher" codes, respectively. The listing, therefore, will contain only those entry codes belonging to the class, or classes, specified. Appendix C lists the Entry Code classes. These subparameters may be written in any order, but must not contain delimiters nor embedded blanks. If the CODES parameter is omitted, all non-dispatcher entries will be listed, i.e., CODES=ST is the default option.

TJID=XXX[- YYY]
specifies that only entries associated with the TJID specified by the number XXX are to be listed. If YYY is also given, all entries associated with TJID's in the range XXX to YYY, inclusive, are listed. If the value given for XXX is zero, all entries will be listed. (This is also the default if the 'TJID' parameter is not specified.) Both numbers XXX and YYY must be specified as decimal digits. The maximum length of each number is three digits.

CLOCK=XXXXXXX[- YYYYYYY]
indicates that no entry before time XXXXXXX (relative to the starting time of the first entry) is to be included in the listing. If -YYYYYYY is specified no entry after that time is listed. Both numbers must be specified as decimal digits and given the time in seconds. The maximum length of each number is seven digits.

Writing Installation Exits for the Submit Command

A user exit from the SUBMIT command allows an installation to:

- Verify a jobname.
- Verify a userid.
- Send a message to the terminal and optionally request a reply.
- Cancel a SUBMIT request.

The TSO SUBMIT command allows a terminal user to initiate a background job. A description of the syntax and use of the SUBMIT command is found in IBM System/360 Operating System; Time Sharing Option, Command Language.

The SUBMIT command processor writes the contents of a user specified data set consisting of Job Control Language statements, (JCL), and input data, onto a logical extension of SYS1.JOBQE. The size of this extension is limited at system generation time by the SUBMITQ operand of the TSO OPTION macro. Size can be further limited by the SUBMIT parameter which the Time Sharing Control Task reads from SYS1.PARMLIB when the operator issues a START TS command.

Any authorized terminal user can submit a background job, but no jobs will be scheduled if the operator has not issued a START BRDR command.

An installation can control foreground initiated background jobs through an installation written SUBMIT exit routine. Through the routine an installation can:

- Delete, modify, or insert statements.
- Request that a message be displayed at the terminal and optionally request a reply.

The routine must be linkage edited as an independent module, given the name IKJEFF10, and cataloged in SYS1.LINKLIB. The SUBMIT command processor invokes the user written exit when the first JOB statement is read. Return codes in register 15 control subsequent calls. The return codes are:

0 - continue -- that is process the current statement and read the next.

4 - reinvoke the exit for another statement -- that is process the current statement and invoke the exit for the next statement.

8 - display a message at the terminal and invoke the exit.

12 - display a message at the terminal, obtain a response, and invoke the exit. (If the user has specified NOPROMPT, this will cause the SUBMIT processor to abort.)

16 - abort.

Upon entry to the user written exit routine, register 1 contains the address of a list of six fullwords.

1st word - address of the current statement.

If zero, entry is to get a statement (return code from previous call was 4). To delete the current statement, zero out the first word.

2nd word - address of a message to be displayed on terminal.

If non-zero, return code from previous call was 8 or 12. The exit may free the buffer. If zero, no message, the return code was 0, 4, or this is the first call.

3rd word - address of response.

If the exit return code from the previous call was 12, SUBMIT will free the buffer. The format of both the message and the response is LLtext where LL is a two byte length field containing one length of the text, maximum length 82 bytes.

4th word - address of USERID.

The USERID is 8 characters left justified padded with blanks.

5th word - address of control switches.

Byte 0 specifies under what conditions SUBMIT will call the exit.

Byte	Bit	Meaning
0	0	Call for JOB card
	1	Exec
	2	DD
	3	Command
	4	Null
	5	Reserved
	6	Reserved
	7	Reserved

Byte 1 if non-zero contains the card column where the operand field begins. For example, if the operand field

begins in column 16, byte 1 contains hex 10.

Byte 2. Specifies what the current statement is.

Byte	Bit	
2	0	JOB statement
	1	EXEC
	2	DD
	3	command
	4	null
	5	operand to be continued
	6	statement to be continued
	7	statement continuation

If bit 5 is on, bit 6 must be on, but bit 6 can be on and bit 5 off.

Byte 3 is unused.

6th word - for exit's use.

The first time SUBMIT calls the exit, the 6th word is initialized to zeros. The exit can use the word for counters or switches. The value is not changed between calls.

Writing Installation Exits for the Output, Status and Cancel Commands

An installation can write a user exit for the OUTPUT, CANCEL, and STATUS commands. The exit routine is common to all three command processors and is named IKJEFF53. An TSO supplied module performs jobname verification if a user exit is not supplied. The parameters and the return codes have the same format and meaning for all three command processors. The user exit determines which command processor is invoking it from a parameter. The parameters are passed through a standard linkage with register one containing the address of a list seven of fullwords.

Word 1 -- contains the address of the jobname.

Word 2 -- contains the address of the length of the jobname.

Word 3 -- contains the address of the userid.

Word 4 -- contains the address of the length of the userid.

Word 5 -- contains the address of a message to be issued to the terminal user. The format of one message is LLtext where LL is a two byte field containing the length of the entire message, maximum length 82 bytes. If 0, the exit is being entered to create a message.

Word 6 -- contains the address of a response from the terminal user. The format of the response is LLtext where LL is a two byte field containing the length of the entire message, maximum length 82 bytes.

Word 7 -- contains the address of the command code.

Command codes are:

0 = STATUS command.
4 = CANCEL command.
8 = OUTPUT command.

Return codes are passed in register 15 and are defined as:

0 = Valid job name, continue processing.

4 = Display message, get response, and call exit again. If the terminal use has specified NOPROMPT on his LOGON command, the command will abort and a message will be issued to the terminal.

8 = Display message and call exit again.

12 = Invalid jobname, cancel request.

16 = Abort

WRITING A LOGON PRE-PROMPT EXIT

A user-written exit, cataloged in SYS1.LINKLIB can specify most of the values to be determined from the LOGON command or from prompting by the LOGON command processor. These include:

- The userid.
- The password.
- An account character string -- that is the value specified in the ACCT operand.
- A procedure name -- that is the name of a cataloged procedure usually specified in the PROC operand.
- A region size.
- A series of 80 byte card images of Job Control Language (JCL) to be used instead of the JOB and EXEC statements

normally constructed by the LOGON processor.

- Portions of the Protected Step Control Block.

- The contents of the User Profile Table.

- The contents of the Environment Control Table.

In addition, the exit can:

- Read but not change the Event Control Block which will be posted if the exit terminates due to a CANCEL request.

- Read but not change the completion code from the last step executed from the terminal logging on.

The parameters passed are defined in the PL/I procedure in Figure 46. The variables declared as either BIT or CHAR, VARYING are passed as String Dope Vectors. For a definition of String Dope Vectors see IBM System/360 Operating System: PL/I-F Programmer's Guide, GC28-6594. The exit may be written in any language but since parameters are passed as String Dope Vectors, they can be manipulated directly in PL/I. The exit must be Linkage Edited and cataloged in SYS1.LINKLIB with a entry point name which processes standard Operating System parameters and the module must be named IKJEFLD.

LOGON passes 16 parameters to the user exit. They are of three types:

1. Character Strings defined in PL/I as CHAR VARYING.

2. Bit Strings defined in PL/I as BIT VARYING.

3. Fullwords defined in PL/I as BINARY FIXED (31).

The parameters passed can be given any name in the user written exit procedure but their meaning is determined by the order in which they appear. The following explanation of the parameters uses the names defined in the PL/I procedure in Figure 46.

CONTROL SWITCHES -- a bit string that specifies what actions the exit has taken. The various bit switches are:

UADS FAIL -- if this bit is equal to one, on entry to the pre-prompt exit, then there was an unsuccessful ENQ on the UADS entry for the specified userid.

REGION FAIL -- if this bit is equal to one on entry to the pre-prompt exit, the region size specified in the LOGON REGION operand was too large to be satisfied. The exit can specify a different region size.

FAIL -- if this bit is equal to one on entry to the pre-prompt exit, the procedure was invoked because of an unsuccessful attempt to obtain an unspecified system resource.

CANCEL -- if this bit is equal to one upon return from the pre-prompt exit, the LOGON processor will cancel the attempted log on. No message will be issued to the terminal user, so the pre-prompt exit must issue any needed message.

DONT PROMPT -- if this bit is equal to one on return from the procedure, the LOGON processor will not prompt the terminal user for any necessary LOGON operand values but will use the values specified by the pre-prompt exit. These include:

- Userid.
- Password.
- Accounting string.
- Procedure name.
- Region size.

EXIT UADS -- if this bit equals one on return from the pre-prompt exit, the LOGON processor will not reference the UADS but will take all character strings and bit strings from the procedure. DON'T PROMPT must be set to one if this bit is set to one.

EXIT JCL -- if this bit is equal to one on return from the pre-prompt exit, the pre-prompt exit has supplied Job Control Language (JCL) that is to be used instead of the JOB and EXEC statements constructed normally by the LOGON processor.

EXIT PSCB -- if this bit is equal to one on return from the pre-prompt exit, the LOGON processor will use the PSCB accounting string returned by the user but will not write it to the UADS at LOGOFF time.

EXIT ATTR1 -- if this bit is equal to one on return from the pre-prompt exit, the LOGON

processor will use the PSCBATR1 string provided by the exit and will not write it into the UADS at LOGOFF time.

EXIT ATTR2 -- if this bit is equal to one on return from the pre-prompt exit, the LOGON processor will use the PSCBATR2 string returned by the pre-prompt exit and will not write it into the UADS at LOGOFF time.

EXIT GROUP -- if this bit is equal to one on return from the pre-prompt exit, the LOGON processor will use the PSCBGPNM string returned by the exit procedure, but will not write it to the UADS at LOGOFF time.

EXIT UPT -- if this bit is equal to one on exit from the pre-prompt exit, the LOGON processor will use the UPT string returned by the exit procedure, but will not be written to the UADS at LOGOFF time.

NO ENQ UADS -- if this bit equals one and the DONT PROMPT and EXIT UADS bits are both one, the LOGON processor will not ENQ on the UADS entry for the specified user.

If both DONT PROMPT and EXIT UADS are equal to one then

- EXIT PSCB
- EXIT ATTR1
- EXIT ATTR2
- EXIT GROUP
- EXIT UPT

also must be equal to one.

TERMINAL INPUT LINE -- this parameter contains the first line entered from the terminal.

The values for the next five parameters must be specified if the DONT PROMPT bit is set to one.

USERID -- used to return a userid to the LOGON processor.

PASSWORD -- used to return a password to the LOGON processor.

ACCOUNT -- used to return an accounting string to the LOGON processor.

PROCEDURE -- used to return the name of a cataloged procedure containing JCL to define the resources needed by the terminal job.

REGION SIZE -- used to return to the LOGON processor a region size for the terminal job.

JCL -- used to provide Job Control statements that define terminal job resources instead the JOB and EXEC statement constructed by the LOGON processor.

The next six parameters must have values specified by the pre-prompt exit if EXIT UADS is set to one by the pre-prompt exit.

PSCB -- used by the exit procedure to set a value for the PSCB accounting string.

FIRST ATTRIBUTE -- used to return a value for the PSCBATR1 string.

SECOND ATTRIBUTE -- used to return a value for the PSCBATR2 string.

GENERIC GROUP -- used to return a value for the PSCBGPNM.

UPT -- used to return a value for the UPT.

ECT -- used to return a value for the Environment Control Table (ECT).

The last two parameters cannot be altered by the pre-prompt exit but may be read.

ECB -- the Event Control Block (ECB) for the exit procedure.

COMPLETION CODE -- this fullword contains the completion code for the last job step of the last job executed from this terminal.

For the format of the Protected Step Control Block (PSCB), the User Profile Table (UPT), and the Environment Control Table (ECT) see the publication IBM System/360 Operating System: System Control Blocks.

```
USEREXIT:      PROCEDURE
               ( CONTROL_SWITCHES,
                 TERMINAL_INPUT_LINE,
                 USERID,
                 PASSWORD,
                 ACCOUNT,
                 PROCEDURE,
                 REGION_SIZE,
                 JCL,
                 PSCB,
                 FIRST_ATTRIBUTES,
                 SECOND_ATTRIBUTE,
                 GENERIC_GROUP,
                 UPT,
                 ECT,
                 ECB,COMPLETION_CODE) ;
         DECLARE
            CONTROL_SWITCHES BIT (*) VARYING,
             UADS_FAIL   BIT (1) DEFINED CONTROL_SWITCHES POSITION (1),
             REGION_FAIL BIT (1) DEFINED CONTROL_SWITCHES POSITION (2),
             CANCEL      BIT (1) DEFINED CONTROL_SWITCHES POSITION (3),
             DONT_PROMPT BIT (1) DEFINED CONTROL_SWITCHES POSITION (4),
             EXIT_UADS   BIT (1) DEFINED CONTROL_SWITCHES POSITION (5),
             EXIT_JCL    BIT (1) DEFINED CONTROL_SWITCHES POSITION (6),
             EXIT_PSCB   BIT (1) DEFINED CONTROL_SWITCHES POSITION (7),
             EXIT_ATTR1  BIT (1) DEFINED CONTROL_SWITCHES POSITION (8),
             EXIT_ATTR2  BIT (1) DEFINED CONTROL_SWITCHES POSITION (9),
             EXIT_GROUP  BIT (1) DEFINED CONTROL_SWITCHES POSITION (10),
             EXIT_UPT    BIT (1) DEFINED CONTROL_SWITCHES POSITION (11),
             NO_ENQ_USERID BIT (1) DEFINED CONTROL_SWITCHES POSITION (12);
    DECLARE TERMINAL_INPUT_LINE CHAR  (*)  VARYING;
    DECLARE USERID              CHAR (*)   VARYING;
    DECLARE PASSWORD            CHAR (*)   VARYING;
    DECLARE ACCOUNT             CHAR (*)   VARYING;
    DECLARE PROCEDURE           CHAR (*)   VARYING;
    DECLARE REGION_SIZE         BINARY FIXED (31);
    DECLARE JCL                 CHAR (*)   VARYING;
    DECLARE PSCB                BIT (*)    VARYING;
    DECLARE FIRST_ATTRIBUTE     BIT (*)   VARYING;
    DECLARE SECOND_ATTRIBUTE    BIT (*)   VARYING;
    DECLARE GENERIC_GROUP       CHAR (*)   VARYING;
    DECLARE UPT                 BIT  (*)   VARYING;
    DECLARE ECT                 BIT  (*)   VARYING;
    DECLARE  CP_ABEND           BIT (1) DEFINED ECT POSITION (1);
    DECLARE  CP_RETURN-CODE     BIT (24) DEFINED ECT POSITION (8);
    DECLARE  IO_WORD_AREA_ADDR  BIT (32) DEFINED ECT
                                   POSITION (33);
    DECLARE  NOSEC_LEVEL_MSG    BIT (1)  DEFINED ECT POSITION (65);
    DECLARE SEC_LEVEL_MSG_ADDR  BIT (24) DEFINED ECT POSITION (73);
    DECLARE COMMAND_NAME        CHAR (8) DEFINED ECT POSITION (97);
    DECLARE SUBCOMMAND_NAME     CHAR (8) DEFINED ECT POSITION (161);
    DECLARE NO_MAIL_SWITCH      BIT (1) DEFINED ECT POSITION (228);
    DECLARE NO_NOTICE_SWITCH    BIT (1) DEFINED ECT POSITION (229);
    DECLARE ECB                 BINARY FIXED  (31);
    DECLARE COMPLETION_CODE     BINARY FIXED  (31);
```

Figure 46. Portion of Sample PL/I Logon Pre-Prompt Exit

The estimates included in this chapter are intended for planning purposes only. None of these estimates have been verified, and they are subject to change. Verified estimates will appear in the publication IBM System/360 Operating System: Storage Estimates, GC28-6551, when they are available.

This chapter contains three sections: main storage requirements, sample configurations, and auxiliary storage considerations. All figures in this chapter are decimal, and "K" represents a factor of 1024.

Main Storage Requirements

The main storage requirement for TSO is divided into four major parts:

- An addition to the MVT basic fixed requirement.
- The TCAM Message Control Program requirement.
- The Time Sharing Control region requirement.
- The foreground regions in which users' programs are executed.

Only the first of these requirements has any effect on the batch environment if time sharing is not active. Storage for the TCAM, Time Sharing Control, and froeground regions is obtained from the dynamic area when the operator starts time-sharing operations. This storage is returned to the dynamic area when time sharing is stopped, and is again available for batch processing.

MVT BASIC FIXED REQUIREMENT

The main storage basic fixed requirement for an MVT system is for:

- The nucleus.
- The Master Scheduler Region.
- The Link Pack Area (LPA).
- The System Queue Area (SQA).

Storage for the basic fixed requirement is allocated by the Nucleus Initialization Program (NIP) when the system is started and does not normally vary while the system is running.

Nucleus

Including TSO at system generation adds approximately 3K to the size of the resident MVT nucleus, for a total requirement of about 45K. In addition, communication lines, like other I/O devices, require 40 bytes each in the nucleus for control blocks.

Master Scheduler Region

The master scheduler region is increased by approximately 4K to handle new or extended operator commands for the time-haring environment, and for extended error recovery. The total requirement is about 16K.

Link Pack Area

One small TSO module is added to the required MVT link pack area list of resident modules. The minimum link pack area size remains 10K. If the standard MVT resident reenterable load module and resident SVC lists are used at system generation, the LPA requirement is about 54K. If space is available, an additional 16K of SVC modules for time sharing are appropriate for the resident list, for a total LPA size of 70K.

Additional resident reenterable load modules for time sharing are placed in an extension to the link pack area allocated in the Time Sharing Control region, and are resident only when time sharing is active. The size of this extension, called the Time Sharing Link Pack Area (TSLPA), is discussed with the Time Sharing Control Region requirement.

System Queue Area

During time-sharing operations, use of the system queue area is kept to a minimum by placing as many control blocks as possible into a local system queue area (LSQA) defined in each foreground region. Control blocks in the local SQA are swapped in and out of main storage along with the foreground job they apply to.

Some control blocks associated with foreground jobs, such as queue elements for named data sets and operator reply queue elements, must remain in main storage while the job is swapped out. Space for these control blocks, and for all control blocks associated with the tasks supervising the time-sharing operation must be allocated

from the system queue area. These requirements must be considered when setting SQA size at system generation or at nucleus initialization.

MESSAGE CONTROL PROGRAM REQUIREMENT

The size of the TCAM Message Control Program region depends largely on what options are selected and what hardware is present on the teleprocessing network. In addition to the minimum requirement for the Message Control Program routines, there are requirements for each defined line group, each additional terminal type, and for each permitted user. If teleprocessing applications other than TSO are present, additional routines to handle different buffering and queuing techniques will be needed.

In a system with TSO as the only teleprocessing application, with three terminal types and two line groups, the Message Control Program requirement is expected to be about 46K plus 800 bytes for each possible concurrent user. Although the Message Control Program executes in a problem program region, the region may be smaller than the normal minimum problem program region size (MINPART).

TIME SHARING CONTROL REGION REQUIREMENT

The Time Sharing Control region must provide space for programs for the Time Sharing Control Task, Region Control Tasks, several resident SVC routines, the time sharing extension to the link pack area, and various control blocks. Some of the control blocks are repeated for each foreground region, for each swap data set, or for each time sharing user. An initialization routine brought in when the operator starts time sharing analyzes the time-sharing parameters supplied by the installation, calculates the region size requirement, and obtains the region from the dynamic area.

Using a buffer length of 40 bytes, and assuming eight buffers per time-sharing user, a TSO configuration with two IBM 2314 swap data sets, one foreground region, and 20 users would require a time sharing control region of about 87K. A larger configuration, with two 2301 swap data sets and two 2314 swap data sets, four foreground regions, and 100 users would require about 117K for the time sharing control region.

DYNAMIC AREA REQUIREMENTS

The SEND operator command, like several others already in the MVT configuration, obtains and uses an 12K operator command region from the dynamic area when the operator enters it. This area is freed when processing of the command is completed.

When it is active, the time sharing trace facility requires a 20K region from the dynamic area.

FOREGROUND REGION REQUIREMENT

The foreground region contains the programs invoked by the terminal user. Space must be provided in the foreground region for the local system queue area (LSQA) and for four main storage subpools used for control blocks for the command system.

The subpools defined are:

- Subpool 0--4K.
- Subpool 1--4K.
- Subpool 78--2K.
- Subpool 251--2K.

The minimum foreground region size is 72K, and all IBM-supplied command processors except some of the language processors can execute in this region.

Auxiliary Storage Requirements

The major additions to the system auxiliary storage requirements for TSO are for the swap data sets and new or larger system libraries and data sets. The installation must also consider the direct access storage needs of the individual terminal users, and make allowances for these in the size of the system catalog and password data sets.

SWAP DATA SETS

A swap data set is divided into swap allocation units, each of which consists of a device-dependent number of 2K records. To avoid space fragmentation, space in the swap data set is always assigned in integral swap allocation units. Figure 47 shows the sizes of allocation units for various swap devices.

Device	Type	Allocation Unit	Size
2301	Drum Storage	1 track	18K
2303	Drum Storage	4 tracks	18K
2305-1	Fixed Head Storage	4 tracks	44K
2305-2	Fixed Head Storage	4 tracks	52K
2311	Disk Storage	1 cylinder	32K
2314	Direct Access Storage	1/2 cylinder	64K
3330	Disk Storage	3 tracks	32K

Figure 47. Swap Allocation Unit Sizes

For a system with one foreground region, the maximum necessary swap space can be calculated by the algorithm:

Swap Space = (R/A)•(U+2)

where:

R is the size of the region.

A is the size of an allocation unit, as shown in Figure 47, (R/A is rounded up to an integer).

U is the number of concurrent foreground jobs.

For instance, a system with one foreground region of 120K, an IBM 2314 swap device, and 30 possible users would have a maximum swap data set space requirement of:

(120/64)•(30+2) = 2•32 = 64 allocation unit
or 32 cylinders

In this case, the number of allocation units required to hold a complete foreground region is two, and the number of users plus two is 32.

If TSO runs out of swap space, no message is issued, and the system may loop, so allow sufficient space.

SYSTEM LIBRARIES AND DATA SETS

The additions to system libraries for TSO are expected to be (with the increments expressed in 2311 tracks):

- SYS1.LINKLIB--30 tracks.
- SYS1.SVCLIB--20 tracks.
- SYS1.MACLIB--60 tracks.

Two new libraries, SYS1.CMDLIB (command library) and SYS1.HELPLIB (HELP data set), are expected to be smaller than 220 IBM 2311 tracks each.

The size of the User Attribute Data Set, a partitioned data set with a member for each user identification, depends on the number of password-identification-account number-procedure name combinations defined for each user. A simple identification structure for a single user with a single value at each level requires about 200 bytes of storage space.

Typical time-sharing usage also requires more space for the system catalog and password data sets than batch usage. All user data sets are cataloged as a default, and read-only password protection is recommended at least for system data sets. This type of protection does not cause any performance degradation when the data sets are accessed for reading.

Appendix A: TSO Commands

The commands available to terminal users of the Time Sharing Option are listed below, grouped according to function. Installations may give other names to these commands by assigning aliases to the respective members in the system command library. No IBM-supplied command names include numerals, allowing installations to ensure uniqueness in locally named commands.

Data Management

ALLOCATE
define and allocate a new or old data set.

CONVERT
convert source programs written in Code and Go FORTRAN or Interactive PL/I to standard format FORTRAN or PL/I.

COPY
duplicate a sequential or partitioned data set, or a member of a partitioned data set, optionally modifying such characteristics as blocking factor.[1]

DELETE
delete and uncatalog one or more data sets or members.

EDIT
invoke the edit mode or input mode to modify or create a data set; provide an interface to the language syntax checkers and processors.

FORMAT
format a data set for printing according to embedded controls.[1]

FREE
release a data set.

LIST
display at the terminal all or part of one or more data sets, optionally re-arranging information in the records.[1]

LISTALC
display at the terminal the names and characteristics of currently active (allocated) data sets.

LISTBC
display at their terminal any system notices or messages from other users.

LISTCAT
display at the terminal the names and characteristics of a group of data sets indexed together in the system catalog.

LISTDS
display at the terminal the characteristics of one or more specified data sets.

MERGE
copy all or part of one data set or member into another.[1]

PROTECT
assign or modify password protection to a data set.

RENAME
change the name of a data set or member, or assign an alias to a member.

Language Processors

ASM
invoke the prompter for[1] the Assembler (F).

CALC
invoke the Interactive PL/I processor for desk calculator mode.[1]

COBOL
invoke the American National Standard COBOL compiler.[1]

FORT
invoke the FORTRAN (G1) compiler.[1]

RUN BASIC
invoke the ITF: BASIC compiler and execution control routines.[1]

RUN GOFORT
invoke the Code and Go FORTRAN compiler and execution control routines.[1]

RUN IPLI
invoke the ITF: PL/I compiler and execution control routines.[1]

PLI
invoke the PL/I Optimizing compiler.[1]

PLIC
invoke the PL/I Checkout Compiler.[1]

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[1] IBM Program Products. See Appendix B.

Program Control

CALL
invoke a specified program which exists in load module form.

LINK
invoke the Linkage Editor to create a load module from one or more object and load modules.

LOADGO
invoke the Loader to process a specified object module, bring it into storage, and give it control.

RUN
invoke a user program in source program form, first compiling it, then calling the Loader to bring it into storage and give it control.

TEST
control the execution of a program, interrupting it at pre-specified points for debugging activity.

Remote Job Entry

Note: Use of these commands requires authorization in the user profile.

CANCEL
cancel a job previously submitted for background execution.

OUTPUT
direct SYSOUT data sets and system messages from submitted jobs to the terminal or a specified data set.

STATUS
display information at the terminal on the status of a job previously submitted for background execution.

SUBMIT
submit a data set containing job control language for one or more jobs for interpretation and execution in the background.

System Control

Note: Use of these commands requires authorization in the user profile.

ACCOUNT
add or modify user profiles in the User Attribute Data Set.

OPERATOR
invoke the operator mode, allowing the user to enter system commands from his terminal.

Session Control

EXEC
invoke a command procedure.

HELP
display at the terminal information on command function and syntax.

LOGON
start a terminal session.

LOGOFF
end a terminal session.

PROFILE
specify special characters for line editing; lock out and accept messages from other users.

SEND
direct a message to the system operator or to another user.

TERMINAL
specify the conditions under which an attention interruption is to be simulated, for terminals without attention keys; and define other terminal-dependent characteristics.

TIME
display at the terminal the amount of time expended during the current session or the current program.

Appendix B: Program Products

The following is a list of the IBM Program Products available for use with TSO. Program Products are available from IBM for a license fee. Program Product Design Objectives for each of the Program Products are available from your local IBM representative.

- Interactive Terminal Facility (ITF): PL/I and BASIC.
  A problem-solving language processor. See the following publications: IBM System/360 Operating System Time Sharing Option: Interactive Terminal Facility: PL/I and BASIC Design Objectives, GC28-6822. ITF: PL/I General Information, GC28-6827. ITF: BASIC General Information, GC28-6828.

- Code and Go FORTRAN.
  A FORTRAN compiler designed for a fast compile-execute sequence. See the publications: Code and Go FORTRAN Design Objectives, GC28-6823. FORTRAN Program Products for OS and OS with TSO, General Information, GC28-6824.

- FORTRAN IV (G1).
  A version of FORTRAN IV providing specific support for the terminal environment. See the publications: FORTRAN IV (G1) Processor Design Objectives, GC28-6845. FORTRAN Program Products for OS and OS with TSO, General Information, GC28-6824.

- TSO FORTRAN Prompter.
  An initialization routine to prompt the user for options, and invoke the FORTRAN IV (G1) Processor. See the publications: TSO FORTRAN Prompter Design Objectives, GC28-6843. FORTRAN Program Products for OS and OS with TSO, General Information, GC28-6824.

- FORTRAN IV Library (Mod 1).
  Execution-time routines for list-directed I/O, PAUSE, and STOP capability, for use with either Code and Go FORTRAN or FORTRAN IV (G1). See the publications: FORTRAN IV Library (Mod 1) Design Objectives, GC28-6844. FORTRAN Program Products for OS and OS with TSO, General Information, GC28-6824.

- American National Standard Full COBOL Version 3.
  A version of the American National Standard COBOL compiler modified for the terminal environment. See the publication: American National Standard (ANS) Full COBOL Compiler Version 3 Design Objectives, GC28-6406.

- TSO COBOL Prompter.
  An initialization routine to prompt the user for options, and invoke the American National Standard Full COBOL Version 3 Compiler. See the publication: TSO COBOL Prompter Design Objectives, GC28-6404.

- PL/I Optimizing Compiler.
  A PL/I compiler designed for compilation of efficient object programs, incorporating a prompter routine allowing invocation from the terminal. See the publications: PL/I Optimizing Compiler Design Objectives, GC33-0013. PL/I Optimizing Compiler, General Information, GC33-0001.

- OS PL/I Resident Library.
  A subroutine library for use during the linkage editing of programs produced by the PL/I Optimizing Compiler. See the publication: OS PL/I Resident Library Design Objectives, GC33-0014.

- OS PL/I Transient Library.
  A subroutine library for use during the execution of programs produced by the PL/I Optimizing Compiler. See the publication: OS PL/I Transient Library Design Objectives, GC33-0015.

- TSO Assembler Prompter.
  An initialization routine to prompt the user for options and invoke the Assembler (F). See the publication: TSO Assembler Prompter Design Objectives, GC26-3734.

- TSO Data Utilities: COPY, FORMAT, LIST, MERGE.
  A set of commands and EDIT subcommands to manipulate data sets and format text. See the publication: TSO Data Utilities: COPY, FORMAT, LIST, MERGE Design Objectives, GC28-6750.

Appendix C: Driver Entry Codes

Entry Code Table (Part 1 of 4)

Event Name (Entry Code)	Calling Routine (CLASS)	Reason for Entry	Input Register 0	Input Register 1
PPMODE (0)	Problem Program (S)	Command about to be processed		Address of 8-character command name. Bit 0 0 - Ended 1 - Beginning
TSLICE (1)	TSC Timer Exit Routine (S)	Time slice has expired	0	NA
TERMWAIT (2)	TGET/TPUT (T)	User is waiting for terminal I/O. Swap him out.	TJID	Bit 0 0: input 1: output Bytes 3 and 4: number of free buffers.
NIOWAIT (3)	Region Control Tasks (S)	All user's tasks are in non-I/O Wait.	TJID	NA
USERRDY (4)	DEQUEUE, Terminal Handler, TSLIH, WTOR (S,T)	Swapped out user ready to run.	TJID	NA
RUSRTRMW (5)	Region Control Task (S)	Restored user is still in non-I/O Wait. Swap him out.	TJID	NA
REQSTNC (6)	Enqueue (S)	User is setting must complete for owned resources.		Estimated must complete time.
RELMC (7)	Dequeue (S)	User is no longer in must complete status.		
DISPLAC (8)	TS Dispatcher (D)	A task switch has taken place resulting in a background task being dispatched.		
DISPSYS (9)	TS Dispatcher (D)	A task switch has taken place resulting in a system task being dispatched.		

Entry Code Table (Part 2 of 4)

Event Name (Entry Code)	Calling Routine (CLASS)	Reason for Entry	Input	
			Register 0	Register 1
DISPTS (10)	TS Dispatcher (D)	A task switch has taken place resulting in a new time-sharing task being dispatched.	TJID	
DISPWAIT (11)	TS Dispatcher (D)	A task switch has taken place resulting in a system Wait.		
QSCEST (12)	Region Control Task (S)	Quiesce is started	TJID	
QSCECMP (13)	Region Control Task (S)	Quiesce is complete	TJID	Number of FBQEs
SWOUTST (14)	Time Sharing Control Task (SWAP) (S)	Swap out Start	TJID	
SWOUTCMP (15)	Time Sharing Control Task (SWAP) (S)	Swap out complete	TJID	
SWINST (16)	Time Sharing Control Task (SWAP) (S)	Swap in started	TJID	
SWINCMP (17)	Time Sharing Control Task (SWAP) (S)	Swap in complete	TJID	
RSTORST (18)	Region Control Task (S)	Restore is started	TJID	
RSTORCMP (19)	Region Control Task (S)	Restore is complete	TJID	
(20)	Reserved			
(21)	Reserved			
(22)	Reserved			
(23)	Reserved			
(24)	Reserved			
LOGACCT (25)	LOGON (S)	Pass Logon information for accounting purposes		Address of accounting information
CHGTOD (26)	Timer SLIH (S)	Time of day must be altered	0	TOD change in 52 M value sec Timer units Bit 0 0 - positive value 1 - negative value

Entry Code Table (Part 3 of 4)

Event Name (Entry Code)	Calling Routine (CLASS)	Reason for Entry	Input Register 0	Input Register 1
SPRGNSZ (27)	Timer Sharing Control Task, Region Control Task (S)	Specify size region for specific region	0	Region number Required region size
(28)	Reserved			
LOGOFF (29)	End of Task (S)	TJID is to be released. Region can be released.	TJID	
LOGON (30)	LOGON (S)	Hook user into selected region	TJID	Region ID
REQRGNID (31)	Time Sharing Control Task, Logon (S)	Obtain region ID appropriate to size	TJID	Region size
SWINERR (32)	RCT and Time Sharing Control Task (SWAP) (S)	Swap in failed	TJID	Bit 0 0: LOGON image 1: Not LOGON image
SWOTERR (33)	Time Sharing Control Task (SWAP) (S)	Swap out failed. No room on SWAP data set	TJID	
TGETPUT (34)	TGET, TPUT (T)	TGET was satisfied; TPUT was satisfied	TJID	Bit 0: 0 - TGET 1 - TPUT For TGET, Bit 1: 0 - all data transfered 1 - partial transfer Bytes 3 and 4: Characters transferred
ATTN (35)	Terminal Handler (T) Attention	Attention (not line delete)		Sign bit: 0 - No exit 1 - Exit
IOERROR (36)	Terminal Handler HANG UP(T)	Permanent I/O Error Terminal disconnected	TJID	

Entry Code Table (Part 4 of 4)

Event Name (Entry Code)	Calling Routine (CLASS)	Reason for Entry	Input Register 0	Input Register 1
TERMDSCN (37)	Terminal Handler LOGOFF (T)	Disconnect terminal logically from TSO	TJID	
(38)	Reserved			
(39)	Reserved			
RGNFAIL (40)	Time Sharing Control Task Region Control Task (S)	Region failed		Region ID
DONTSWAP (41)	Transient Area Handler (S)	Do not swap out user	TJID	
OKSWAP (42)	Transient Area Handler (S)	Allow swap out of user	TJID	
UPDATACC (43)	LOGOFF (S)	Update accounting information for user logging off	TJID	
FEDIAG (44)	Serviceability (S)	FE diagnostics recorded in TSO TRACE data set	0	Bit 0: 0 Bits 1-4: Diagnostic Identifier Bits 5-7: n when $2^{(n+1)}$ equals number of entries Bits 8-31: address of data to be recorded.
ENQWAIT (45)	Enqueue (S)	User in enqueue WAIT. Swap him out.		

Note: On entry to the Time Sharing Driver, Register 0 contains either:

1) 0 - shown in one table as 0.
2) A specific TJID - shown in one table as TJID.
3) The TJID of the current tasks - shown in the table as blank.

Appendix D: Terminal Messages Requiring Installation Action

The following section contains those TSO terminal messages that are generated for the terminal user but that require the operator to perform certain diagnostic measures before calling IBM for programming support. The messages are not listed by message number but are listed alphabetically according to message text; the additional messages associated with each initial message are listed alphabetically under each message. The KEY indicate at the left of the message denotes the appropriate operator response for the message he responses are listed in numeric order following the list of messages.

KEY	MESSAGE
	DATA SET dsname NOT ALLOCATED, DATA SET NOT ON VOLUME+ CATALOG INFORMATION INCORRECT
	DATA SET dsname NOT ALLOCATED, SYSTEM OR INSTALLATION ERROR+ CATALOG ERROR CODE 14 CATALOG ERROR CODE 1C CATALOG I/O ERROR
20	ERROR IN CONCATENATING {LIBRARY} DATA SETS {INPUT }
9	DADSM ERROR CODE 4704
10	DADSM ERROR CODE 4708
16	DADSM ERROR CODE 470C
20	DADSM ERROR CODE 4710
20	DADSM ERROR CODE 4718
20	DADSM ERROR CODE 4730
12	DADSM ERROR CODE 4734
20	DYNAMIC ALLOCATION ERROR CODE 004
20	DYNAMIC ALLOCATION ERROR CODE 008
5	DYNAMIC ALLOCATION ERROR CODE 104
5	DYNAMIC ALLOCATION ERROR CODE 108
5	DYNAMIC ALLOCATION ERROR CODE 10C
6	DYNAMIC ALLOCATION ERROR CODE 208
20	DYNAMIC ALLOCATION ERROR CODE 268
20	DYNAMIC ALLOCATION ERROR CODE 304
20	DYNAMIC ALLOCATION ERROR CODE 308
20	DYNAMIC ALLOCATION ERROR CODE 30C
20	DYNAMIC ALLOCATION ERROR CODE 310
20	DYNAMIC ALLOCATION ERROR CODE 314
20	DYNAMIC ALLOCATION ERROR CODE 318
20	DYNAMIC ALLOCATION ERROR CODE 31C
20	DYNAMIC ALLOCATION ERROR CODE 320
20	DYNAMIC ALLOCATION ERROR CODE 324
20	DYNAMIC ALLOCATION ERROR CODE 328
20	DYNAMIC ALLOCATION ERROR CODE 338
20	DYNAMIC ALLOCATION ERROR CODE 33C
20	DYNAMIC ALLOCATION ERROR CODE 340
20	DYNAMIC ALLOCATION ERROR CODE 344
20	DYNAMIC ALLOCATION ERROR CODE 350
20	DYNAMIC ALLOCATION ERROR CODE 358
20	DYNAMIC ALLOCATION ERROR CODE 40C
20	DYNAMIC ALLOCATION ERROR CODE 408
20	DYNAMIC ALLOCATION ERROR CODE 410
20	DYNAMIC ALLOCATION ERROR CODE 414
20	DYNAMIC ALLOCATION ERROR CODE 418
20	DYNAMIC ALLOCATION ERROR CODE 420
20	DYNAMIC ALLOCATION ERROR CODE 424
17	DYNAMIC ALLOCATION ERROR CODE 504
	COMMAND SYSTEM ERROR+
20	DEVTYPE FAILED xx FOR DDNAME ddname
20	TIOT SEARCH FAILED FOR DDNAME ddname
10	OBTAIN ERROR CODE 8 FOR DATA SET dsname
12	OBTAIN ERROR CODE 12 FOR DATA SET dsname
16	BLDL I/O ERROR
21	OBTAIN ERROR CODE 12 FOR FORMAT 4 DSCB
20	PARSE ERROR CODE xx
20	DEFAULT ERROR CODE xx
20	SCAN ERROR CODE xx
20	DAIR ERROR CODE xx
20	PUTLINE ERROR CODE xx
20	GETLINE ERROR CODE xx
20	PUTGET ERROR CODE xx
20	STACK ERROR CODE xx
6	OUTPUT QUEUE ERROR
20	SVC 98 RETURN CODE xx

```
      DATA SET dsname NOT ALLOCATED+
 8      INVALID UNIT IN USER ATTRIBUTE DATA SET

      USER ATTRIBUTE DATA SET NOT USABLE+
22      CANNOT OPEN DATA SET
16      BLDL I/O ERROR
16      STOW I/O ERROR
14      I/O SYNAD ERROR synadinfo
16      BACKSPACE ERROR   4

      DATA SET dsname NOT USABLE+
16      BLDL FAILED, PERMANENT I/O ERROR IN DIRECTORY
14      I/O SYNAD ERROR synadinfo
10      OBTAIN ERROR CODE   8
21      OBTAIN ERROR CODE  12
22      CANNOT OPEN DATA SET
16      BLDL I/O ERROR
20      XDAP WRITE FAILED IN TEN TRIES
15      OPEN ERROR CODE xxxx
15      ABEND CODE xxx
16      BLDL ERROR CODE xxx

 6    JOB QUEUE I/O ERROR

      CAN NOT COPY INTO DATA SET dsname+
14      I/O SYNAD ERROR synadinfo
16      STOW I/O ERROR

      DATA SET dsname CANNOT BE RESOLVED, SYSTEM ERROR+
20      DEFAULT ERROR CODE xx
 3      CATALOG ERROR CODE  14
 4      CATALOG ERROR CODE  1C

      ERROR WRITING DATA SET dsname, MEMBER AND ALL MEMBERS
      FOLLOWING NOT COPIED+
14      I/O SYNAD ERROR synadinfo

      INPUT DIRECTORY ERROR, CANNOT COPY DATA SET dsname+
14      I/O SYNAD ERROR synadinfo

      MEMBER member CANNOT BE COPIED+
14      I/O SYNAD ERROR synadinfo

      UNABLE TO COMPLETE UPDATE OF OUTPUT DIRECTORY+
16      INPUT DIRECTORY ENTRY xxxx INCONSISTENCIES FOUND

      {UTILITY DATA SET}
      {DATA SET dsname } CANNOT BE RESOLVED, SYSTEM ERROR+
20      DAIR ERROR CODE xx
 2      LOCATE ERROR CODE   1
 4      LOCATE ERROR CODE  24
20      DEFAULT ERROR CODE xx

19    SYSTEM FAILED, ALL USERS TERMINATED

19    SYSTEM FAILURE, PLEASE LOGON AGAIN

      UNABLE TO DELETE DATA SET dsname+
11      SCRATCH ERROR CODE   4
17      SCRATCH ERROR CODE   6
16      STOW ERROR CODE  16

      SYSTEM ERROR+

       {UTILITY DATA SET}
20     {DATA SET dsname }NOT UNALLOCATED, DYNAMIC ALLOCATION ERROR CODE xx
```

```
20       DATA SET dsname NOT UNALLOCATED, CATALOG ERROR CODE xx

       function NOT AVAILABLE FOR language+
20       PROGRAM NO LONGER USABLE

       FILE SYSPROC NOT USABLE+
22       CANNOT OPEN DATA SET
14       I/O SYNAD ERROR synadinfo
16       FIND ERROR

       HELP DATA SET NOT USABLE+
22       CANNOT OPEN DATA SET
16       FIND I/O ERROR
14       I/O SYNAD ERROR synadinfo

       CONTROL STATEMENT DATA SET NOT USABLE+
14       I/O SYNAD ERROR
22       OPEN ERROR

                                 {LIBRARY}
20       ERROR IN CONCATENATING, {INPUT  } DATA SETS

       HISTORY NOT AVAILABLE+
 2       LOCATE ERROR CODE   4
 4       LOCATE ERROR CODE  24
21       I/O ERROR DURING OBTAIN, CODE  12
11       DATA SET NOT ON VOLUME

       MEMBERS NOT AVAILABLE+
16       DIRECTORY STRUCTURE ERROR
16       I/O SYNAD ERROR DURING DIRECTORY SEARCH synadinfo

       BROADCAST DATA SET NOT USABLE+
14       I/O SYNAD ERROR
22       CANNOT OPEN DATA SET

22     BROADCAST DATA SET NOT USABLE, CANNOT OPEN DATA SET

       BROADCAST DATA SET NOT ALLOCATED, DATA SET NOT ON VOLUME+
 1       CATALOG INFORMATION INCORRECT

14     BROADCAST DATA SET NOT USABLE, I/O SYNAD ERROR

       BROADCAST DATA SET NOT ALLOCATED, SYSTEM ERROR+
 2       CATALOG ERROR CODE   4
 3       CATALOG ERROR CODE  14
 4       CATALOG ERROR CODE  1C
20       DYNAMIC ALLOCATION ERROR CODE   004
20       DYNAMIC ALLOCATION ERROR CODE   008
 5       DYNAMIC ALLOCATION ERROR CODE   104
 5       DYNAMIC ALLOCATION ERROR CODE   108
 5       DYNAMIC ALLOCATION ERROR CODE   10C
 6       DYNAMIC ALLOCATION ERROR CODE   208
20       DYNAMIC ALLOCATION ERROR CODE   210
 7       DYNAMIC ALLOCATION ERROR CODE   214
 8       DYNAMIC ALLOCATION ERROR CODE   21C
20       DYNAMIC ALLOCATION ERROR CODE   268
20       DYNAMIC ALLOCATION ERROR CODE   308
20       DYNAMIC ALLOCATION ERROR CODE   30C
20       DYNAMIC ALLOCATION ERROR CODE   310
20       DYNAMIC ALLOCATION ERROR CODE   314
20       DYNAMIC ALLOCATION ERROR CODE   318
20       DYNAMIC ALLOCATION ERROR CODE   31C
20       DYNAMIC ALLOCATION ERROR CODE   320
20       DYNAMIC ALLOCATION ERROR CODE   324
20       DYNAMIC ALLOCATION ERROR CODE   328
20       DYNAMIC ALLOCATION ERROR CODE   338
20       DYNAMIC ALLOCATION ERROR CODE   33C
```

```
20       DYNAMIC ALLOCATION ERROR CODE   340
20       DYNAMIC ALLOCATION ERROR CODE   344
20       DYNAMIC ALLOCATION ERROR CODE   350
20       DYNAMIC ALLOCATION ERROR CODE   358
20       DYNAMIC ALLOCATION ERROR CODE   408
20       DYNAMIC ALLOCATION ERROR CODE   40C
20       DYNAMIC ALLOCATION ERROR CODE   410
20       DYNAMIC ALLOCATION ERROR CODE   414
20       DYNAMIC ALLOCATION ERROR CODE   418
20       DYNAMIC ALLOCATION ERROR CODE   420
20       DYNAMIC ALLOCATION ERROR CODE   424
20       DYNAMIC ALLOCATION ERROR CODE   504
 9       DYNAMIC ALLOCATION ERROR CODE  4704
10       DYNAMIC ALLOCATION ERROR CODE  4708
16       DYNAMIC ALLOCATION ERROR CODE  470C
20       DYNAMIC ALLOCATION ERROR CODE  4710
20       DYNAMIC ALLOCATION ERROR CODE  4714
20       DYNAMIC ALLOCATION ERROR CODE  4718
20       DYNAMIC ALLOCATION ERROR CODE  4730
20       DYNAMIC ALLOCATION ERROR CODE  4734
13       DYNAMIC ALLOCATION ERROR CODE  4738

     {MEMBERS              }
     {HISTORY AND MEMBERS  }
     {HISTORY              }NOT AVAILABLE+
21     I/O ERROR DURING OBTAIN, CODE 12

     UNABLE TO LIST CATALOG+
 4     I/O ERROR DURING LOCATE CODE 24
 2     LOCATE ERROR CODE 4

     DATA SET ATTRIBUTES NOT AVAILABLE+
21     OBTAIN ERROR CODE 12
10     OBTAIN ERROR CODE 8

     DIRECTORY INFORMATION NOT AVAILABLE+
16     I/O ERROR DURING BLDL

     COMPLETE VOLUME LIST NOT AVAILABLE+
 6     JFCB EXTENSION NOT AVAILABLE
 2     LOCATE ERROR CODE 4
 4     LOCATE ERROR CODE 24

     LABEL INFORMATION NOT AVAILABLE+
10     OBTAIN ERROR CODE 8
21     OBTAIN ERROR CODE 12

     userid LOGGED OFF TSO AT hh: ON month day, year+
 5     I/O ERROR ON JOB QUEUE
20     ALLOCATION UNSUCCESSFUL
21     OBTAIN ERROR
20     SYSTEM ERROR
20     STEPLIB DATA SET COULD NOT BE OPENED
20     JOBLIB DATA SET COULD NOT BE OPENED
 6     NOT ENOUGH JOB QUEUE SPACE TO EXECUTE LOGON

20   ATTENTION IGNORED, SYSTEM ERROR, LOGON RESUMED

20   LOGON TERMINATED, SYSTEM ERROR

20   LOGON TERMINATED, routine ERROR xxx

20   LOGON FAILED

20   ABEND WHILE PROCESSING BROADCAST MESSAGES, LOGON PROCEEDING

     UNABLE TO RENAME DATA SET dsname+
10     RENAME ERROR CODE   4
```

```
10        RENAME ERROR CODE   8
 2        CATALOG ERROR CODE   4
 3        CATALOG ERROR CODE 16
 4        CATALOG ERROR CODE  1C
16        STOW ERROR CODE xx
16        BLDL ERROR CODE xx

10      NOT ENOUGH DIRECT ACCESS SPACE TO CONTAIN ALL RECORDS+
15        SYSTEM ABEND CODE code

        UNABLE TO PROTECT DATA SET+
23        I/O ERROR IN PASSWORD DATA SET

        UNABLE TO MODIFY PROTECTION FLAGS OF DATA SET dsname+
21        I/O ERROR WHILE UPDATING SECURITY FLAGS

        DATA SET RENAMED BUT dsname STILL CATALOGED+
 2        CATALOG ERROR CODE   4
 3        CATALOG ERROR CODE  16
 4        CATALOG ERROR CODE  1C

24      NO SPACE IN DIRECTORY FOR ALIAS

        UNABLE TO CATALOG, dsname+
 2        CATALOG ERROR CODE   4
 3        CATALOG ERROR CODE  16
 4        CATALOG ERROR CODE  1C

        INPUT DATA SET dsname NOT USABLE+
14        I/O SYNAD ERROR synadinfo
15        INPUT OPEN ERROR CODE xxx

        OUTPUT DATA SET FOR JOB jobname NOT USABLE+
14        SYNAD ERROR synadinfo
15        OPEN ERROR CODE xxx
10        NOT ENOUGH DIRECT ACCESS SPACE

        UNABLE TO QUALIFY dsname+
 2        DEFAULT ERROR CODE xx   LOCATE CODE   4
 4                                LOCATE CODE  24
20        DEFAULT ERROR CODE xx

        PRINT DATA SET NOT USABLE+
20        PERMANENT I/O ERROR
22        CANNOT OPEN DATA SET

        SYMBOL ADDRESS NOT AVAILABLE, SYSTEM ERROR+
14        I/O SYNAD ERROR synadinfo
22        CANNOT OPEN DATA SET, DDNAME ddname

        {command name    } ENDED DUE TO AN ERROR
        {subcommand name}
19        USER ABEND CODE IS code
19        COMPLETION CODE IS code
19        SYSTEM ABEND CODE IS code
19        LINK TO SUBCOMMAND FAILED
19        INSUFFICIENT STORAGE
19        SYSTEM CODE code INSUFFICIENT STORAGE
19        SYSTEM CODE code PERMANENT ERROR DURING BLDL
19        SYSTEM CODE code GETMAIN FAILURE
19        SYSTEM CODE code LINK FAILURE
19        SYSTEM CODE code ATTACH FAILURE
19        SYSTEM CODE code
```

```
        subcomm FAILED+
          ABEND CODE SYSTEM = code
          ABEND CODE SYSTEM = code IC = addr
          INSTR IMAGE = image
20        LINK TO PARSE FAILED
20        LOAD FAILED
20        ATTACH FAILED
20        OPEN FAILED
20        LINK TO SYM FAILED
20        LINK TO DAIR FAILED
20        LINK TO SCAN FAILED
20        XCTL FAILED
20        LINK TO DEFAULT FAILED
20        GETMAIN ERROR CODE xxx

        subcommand FAILED, COMMAND SYSTEM ERROR+
20        PARSE ERROR CODE xx
20        DAIR ERROR CODE xx
20        GETLINE ERROR CODE xx
20        PUTLINE ERROR CODE xx
20        PUTGET ERROR CODE xx

        UNABLE TO LOAD PROGRAM+
22        OPEN ERROR
16        BLDL ERROR CODE xx
```

KEY Explanation

1. If the data set was deleted by a utility program that was also supposed to update the catalog, but the catalog was not updated, do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Execute the IEHLIST system utility program to obtain a list of the catalog and a list of the volume table of contents (specifying the FORMAT option) of the associated volume, and save the resulting output.
   - Execute the IEHPROGM system utility program to uncatalog the data set.

2. If the necessary control volume is mounted and the error persists, do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Execute the IEHLIST system utility program to obtain a list of the catalog, and save the resulting output.

3. If sufficient space exists in all necessary control volumes, do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Execute the IEHLIST system utility program to obtain a printed copy of the catalog, and save the resulting output.

4. Do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.

- Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
- Execute the IEHLIST system utility program to obtain a printed copy of the catalog, and save the resulting output.

5. Do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF of local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Execute the IMCJQDMP system utility program to obtain a printed copy of the job queue, and save the resulting output. IMCJQDMP - specify JOBNAME or TOTAL option.

6. If sufficient space exists in the SYS1.SYSJOBQE data set, do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Execute the IMCJQDMP service aid program to obtain a formatted copy of the contents of the SYS1.SYSJOBQE data set, and save the resulting output, specifying the total option.
   - Execute the IMDSADMP service aid program, specifying the TYPE=HI option, to write the contents of main storage to a tape volume. After restarting the system, execute the IMDPRDMP service aid program, specifying the GO statement, to print a main storage dump from the dump tape produced by the IMDSADMP service aid program. (If a tape is not available, execute the IMDSADMP service aid program, specifying the TYPE=LO option, to directly print a main storage dump.) Save the resulting dump output.

7. If the devices of the type indicated in the User Attribute Data Set for use by this user are actually online, do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Execute the IMDSADMP service aid program, specifying the TYPE=HI option, to write the contents of main storage to a tape volume. After restarting the system, execute the IMDPRDMP service aid program, specifying the GO statement, to print a main storage dump from the dump tape produced by the IMASADMP service aid program. (If a tape is not available, execute the IMDSADMP service aid program, specifying the TYPE=LO option, to directly print a main storage dump.) Save the resulting dump output.
   - Have the person in the installation authorized to use the ACCOUNT command issue the command with the LIST subcommand to list the attributes of the user having trouble.

8. If the device of the type indicated in the User Attribute Data Set for use by this user were actually included in the system at system generation time, do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resluting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Have the system generation output available from Stage I and Stage II.
   - Have the person in the installation authorized to use the ACCOUNT command issue the command with the LIST subcommand to list the attributes of the user having trouble.

9. If no uncataloged data set has the same name as the new data set being created by the user, do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Execute the IEHLIST system utility program to obtain a list of the entire catalog and a list of the volume table of contents (specifying the FORMAT option) of all online direct access volumes, and save the resulting output.

10. If space exists in the volume table of contents of all online volumes, do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Execute the IEHLIST system utility program to obtain a list of the volume table of contents (specifying the FORMAT option) of all online direct access volumes.

11. Do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Execute the IHELIST system utility program ot obtain a list of the volume table of contents of the associated volume.

12. If there are no DOS volumes online, do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Execute the IEHLIST system utility program to obtain a list of the volume table of contents (specifying the DUMP option) of all online direct access volumes.

13. If the directory space requested is not larger than the first extent, do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.

14. Do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.
   - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
   - Execute the IEHLIST system utility program to obtain a printed copy of the catalog, and save the resulting output.

15. Do the following before calling IBM for programming support:

   - Retain the console sheet and instruct the terminal user to retain the terminal listing.

- Consult the 'System Completion Codes' section of this publication for the associated error code, and respond as indicated after the statement 'If the problem recurs, do the following before calling IBM for programming support' in the Programmer Response for that code; however, do not obtain a storage dump and do not specify MSGLEVEL=(1,1) in the JOB statement, even if so requested.

16. Do the following before calling IBM for programming support:

    - Retain the console sheet and instruct the terminal user to retain the terminal listing.
    - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
    - Execute the IEHLIST system utility program to obtain a printed copy of the directory of the data set.

17. If the required volume is mounted, do the following before calling IBM for programming support:

    - Retain the console sheet and instruct the terminal user to retain the terminal listing.
    - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
    - Execute the IEHLIST system utility program to obtain a list of the catalog, and save the resulting output.
    - Execute the IMDSADMP service aid program, specifying the TYPE=HI option, to write the contents of main storage to a tape volume. After restarting the system, execute the IMDPRDMP service aid program, specifying the GO statement, to print a main storage dump from the dump tape procued by the IMASADMP service aid program. (If a tape is not available, execute the IMDSADMP service aid program, specifying the TYPE=LO option, to directly print a main storage dump.) Save the resulting dump output.

18. Do the following before calling IBM for programming support:

    - Execute the IMDPRDMP service aid program to print the TSO dump data set and the SWAP data sets.

19. Do the following before calling IBM for programming support:

    - Inform the user that if a subcommand was being processed, any further information must be obtained from the user; that is, the user should:

      1) Use the ALLOCATE command to allocate a SYSOUT data set with the FILE name of SYSUDUMP.
      2) Repeat the error situation.
      3) Strike the 'return' key after receiving the message 'xxxxxx ENDED DUE TO ERROR+'.
      4) Use the FREE command to free the FILE named SYSUDUMP.
      5) Retain the terminal listing.

    - Retain the SYSOUT listing containing the dump output.

20. Do the following before calling IBM for programming support:

    - Retain the console sheet and instruct the terminal user to retain the terminal listing.
    - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.

21. Do the following before calling IBM for programming support:

    - Retain the console sheet and instruct the terminal user to retain the terminal listing.
    - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
    - Execute the IEHDASDR system utility program to obtain a list of the volume table of contents (VTOC) of the associated volume.

22. If the file is already allocated do the following before calling IBM for programming support:

    - Retain the console sheet and instruct the terminal user to retain the terminal listing.
    - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.

    If the file is not allocated and you are currently logged on, use the ALLOCATE command to allocate the data set.

23. Do the following before calling IBM for programming support:

    - Retain the console sheet and instruct the terminal user to retain the terminal listing.
    - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
    - Execute the IEHDASDR system utility program to obtain a printed copy of the Master Password Data Set.

24. If sufficient space exists in the directory do the following before calling IBM for programming support:

    - Retain the console sheet and instruct the terminal user to retain the terminal listing.
    - Execute the IMAPTFLS service aid program to obtain a list of all members with a PTF or local fix, and save the resulting output. Execute the program against the SYS1.LINKLIB data set, the SYS1.SVCLIB data set, and the command library.
    - Execute the IEHLIST system utility program to obtain a printed copy of the directory of the data set.

Appendix E: Message Control Program Assembly Diagnostic

IKJ5410I LINEGRP MACRO MUST PRECEDE TSOMCP MACRO

Explanation: Processing of a LINEGRP macro has been terminated because it followed a TSOCMP macro. All LINEGRP macros must precede the TSOMCP macro.

IKJ54102I MORE THAN 63 LINEGRP MACROS

Explanation: Too many LINEGRP macros were issued. The user should check to see if theer are two or more line groups with the same attributes which could be combined into one line group. Another possible solution could be combining 1050 and 2741 line groups into a 5041 line group.

IKJ54103I REQUIRED OPERAND(S) NOT SPECIFIED

Explanation: Processing of this macro has been terminated because one or more required operands were omitted.

IKJ54104I xxxx INVALID FOR yyyy OPERAND

Explanation: The value (xxxx) of the indicated operand (yyyy) is invalid as specified. The user should reread the description of this operand and determine the permissable values.

IKJ54105I TRANTAB=xxxx INVALID FOR THIS TERMINAL TYPE

Explanation: The indicated translate table was ignored because it is not compatible with the terminal type specified in the TERM operand.

IKJ54106I CODE OPERAND SHOULD BE SPECIFIED ONLY IF MORE THAN ONE TRANSLATE TABLE IS SPECIFIED

Explanation: The CODE operand has been ignored because less than two translate tables are being used in the line group.

IKJ54107I CODE OPERAND CONTAINS MORE THAN 4 SUBLIST OPERANDS

Explanation: Too many suboperands were specified in the CODE operand sublist. The user should reread the description of this operand to be sure he understands dynamic translation. If not, he should omit this operand so that the default values will be used.

IKJ54108I CODE SUBOPERAND TOO LONG

Explanation: Each suboperand of the CODE operand must be less than 9 characters.

IKJ54109I DIAL OPERAND NOT CONSISTANT WITH TERM OPERAND

Explanation: The terminal type specified in the TERM operand cannot be supported on the type of network (switched or non-switched) specified by the DIAL operand.

IKJ54110I xxxx OPERAND OUT OF RANGE, DEFAULT VALUE USED

Explanation: The value of the indicated operand is outside the valid limits. The default value has been used instead. The user should consult the description of this operand to determine the value limits and the default value used.

IKJ54111I xxxx OPERAND CONTAINS TOO MANY SUBLIST OPERANDS

Explanation: The indicated operand was not processed because it contained too many sublist operands.

IKJ54112I SUBLIST OPERAND yy OF FEATURE OPERAND IS INVALID

Explanation: The indicated sublist operand (1, 2, or 3) of the FEATURE operand has been ignored because it is not valid for the terminal type specified in the TERM operand.

IKJ54114I xxxx OPERAND NOT ALLOWED FOR THIS TERMINAL TYPE

Explanation: The indicated operand has been ignored because it is not allowed with the terminal type specified in the TERM operand of the LINEGRP macro.

IKJ54115I TERMNO OPERAND REFERENCES NON-EXISTENT LINE(S)

Explanation: The TERMNO operand refers to more lines than exist for this line group. In other words, the number of sublist operands in the TERMNO operand is greater than the vaue of the LINENO operand. The extra TERMNO sublist operands have been ignored.

IKJ54116I SCREEN OPERAND MUST BE A TWO-OPERAND SUBLIST

Explanation: The SCREEN operand has been ignored because it is not a sublist with two suboperands. The default values (12,80) have been assumed.

IKJ54117I NON-STANDARD SCREEN DIMENSIONS -- ACCEPTED

Explanation: This message is a warning that the screen dimensions specified do not correspond to standard IBM screen sizes. The values specified have been accepted, however.

IKJ54118I ADDR OPERAND INCORRECT LENGTH -- IGNORED

Explanation: ADDR operand of incorrect length has been ignored. For a 1050 terminal, the length must be two, for 2260/65 the length must be four.

IKJ54119I ADDR OPERAND SHOULD BE SPECIFIED FOR THIS TERMINAL TYPE

Explanation: The ADDR operand was omitted and the terminal type specified in the TERM operand requires addressing characters which can only be specified in this LINEGRP macro. Note that this warning message cannot be provided in the case of 2260/65 line groups. Omission of the ADDR operand can be valid in the LINEGRP macros of these line groups since the addressing characters may be specified in the LISTTA macro. Omission of necessary addressing characters from a LISTTA macro will be documented by message IKJ54128I.

IKJ54120I LISTTA MACRO OUT OF ORDER -- IGNORED

Explanation: A LISTTA macro must follow the LINEGRP macro to which it refers and precede the TSOMCP macro.

IKJ54121I RLN OPERAND MISSING OR INVALID

Explanation: Processing of the LISTTA macro has been terminated because the RLN operand is missing or invalid.

IKJ54122I RLN OPERAND REFERS TO NON-EXISTENT LINE

Explanation: Processing of the LISTTA macro has been terminated because the value of the RLN operand exceeds the value of the LINENO operand of the previous LINEGRP macro.

IKJ54123I LISTTA MACRO NOT ALLOWED WITH TERMINAL TYPE OF PREVIOUS LINEGRP

Explanation: The TERM operand of the previous LINEGRP macro specified a terminal type which doesn't permit LISTTA macros to be issued for the line group. This LISTTA macro was therefore ignored.

IKJ54124I ADDR OPERAND REFERS TO NON-EXISTENT TERMINAL(S)

Explanation: The number of suboperands in the ADDR operand sublist of the LISTTA macro is greater than the number of terminals specified or defaulted by the TERMNO operand of the previous LINEGRP macro. The ADDR operand has been ignored. The user should recheck his specifications for the ADDR and RLN operands in the LISTTA macro and the TERMNO operand in the previous LINEGRP macro.

IKJ54125I MORE THAN ONE TSOMCP MACRO CALL ISSUED

Explanation: Processing of this TSOMCP macro was terminated because it was not the first TSOMCP macro in the assembly. Only one TSOMCP macro call is allowed for each generation of an MCP.

IKJ54126I NO LINEGRP MACRO ISSUED BEFORE TSOMCP MACRO

Explanation: Processing of this macro was terminated because no LINEGRP macro had been issued previously in the assembly. At least one LINEGRP macro must precede the TSOMCP macro.

IKJ54127I SERIOUS ERROR IN PREVIOUS MACRO CALL PREVENTS FURTHER GENERATION

Explanation: One or more serious errors in previous LINEGRP or LISTTA macros has occurred, causing MCP generation to be bypassed. See error messages printed in the listing prior to this one.

IKJ54128I ADDRESSING CHARACTERS OMITTED FOR TERMINAL(S) IN LINE GROUP xx

Explanation: The TSOMCP macro has discovered a terminal whose type requires addressing characters, but for which none were specified in previous LINEGRP or LISTTA macros. The error message indicates the relative number (xx) of the line group in which the error exists.

Appendix F: Glossary

address stop: A capability at the system console to specify an address which when fetched causes a halt in processing.

attributes, user: A characteristic; for instance, attributes of data include record length, record format, data set name, associated device type and volume identification, use, creation date, etc. See also UADS.

attention interruption: An interruption of instruction execution caused by a remote terminal user hitting the attention key. See also "simulated attention."

attention exit routine: A routine that receives control when an attention interruption is received by the system.

attention key: A function key on remote terminals that causes an interruption of execution by the CPU.

background: The environment in which jobs submitted through the SUBMIT command or SYSIN are executed. One job step at a time is assigned to a region of main storage, and remains in storage to completion. Opposed to "foreground."

background job: A job entered through the SUBMIT command or SYSIN.

Background Reader: A system task started by the operator to process foreground-initiated background jobs. Output is identical to the normal reader/interpreter output.

BASIC: An algebra-like language used for problem solving by engineers, scientists, and others who may not be professional programmers.

batch processing: In TSO, describing the processing of one job step at a time in a region; so called because jobs are submitted in a group or "batch".

break: See "receive interruption."

breakpoint: A point within an executing program where execution is to be interrupted for debugging activity. It is similar to the address stop capability at the system console.

Broadcast Data Set: A system data set containing messages and notices from the system operator, administrators, and other users.

central processing unit (CPU): A unit of a computing system that processes data by executing predefined sequences of instructions, such as add, subtract, multiply, and divide instructions.

character-deletion character: A character within a line of terminal input specifying that it and the immediately preceding character are to be removed from the line by a scanning and editing routine.

Code and Go FORTRAN: A version of FORTRAN IV for rapid compilation and execution of programs.

command: Under TSO, a command is a request from a remote terminal for the execution of a particular program, called a command processor. The command processor is in a command library under the command name. Any subsequent commands processed directly by that command processor are called subcommands.

command language: The set of commands, subcommands, and operands recognized by TSO.

command library: A partitioned data set consisting of command processor programs. A user command library can be concatenated to the system command library.

command mode: The entry mode immediately following LOGON, or following completion of a command processor. In command mode the system is ready to accept any command in the command libraries.

command procedure: A data set or a member of a partitioned data set containing TSO commands, to be performed sequentially by the EXEC command.

command processor (CP): A problem program executed as the result of entering a command at the terminal. Any problem program can be defined as a command processor by assigning a command name to the program and including the program in a command library.

communication line: Any medium, such as a wire or a telephone circuit, that connects a remote terminal with a computer.

component: In teleprocessing, one or more input/output devices attached to a single control unit, and together making up one remote terminal.

context editing: A method of editing a line data set without using line numbers. To refer to a particular line, all or part of the contents of that line are specified.

control terminal: Any terminal at which a user authorized to enter commands affecting TSO operation is logged on.

conversational: Describing a program or a system that carries on a dialog with a remote terminal user, alternately accepting input and then responding to the input quickly enough for the user to maintain his train of thought.

Conversational Remote Job Entry (CRJE): An operating system component for entering job control language statements from a remote terminal, and causing the scheduling and execution of the jobs described. The terminal user is prompted for missing operands or corrections.

CP: See "command processor."

CPU time: The amount of time devoted by the central processing unit to the execution of instructions.

current line pointer: A pointer maintained by the Edit command processor that indicates the line of a line data set with which a user is currently working. A terminal user can refer to the value of the current line pointer by entering an asterisk (*) with EDIT subcommands.

DAIR: See "Dynamic Allocation Interface Routine."

data base: A data set or a collection of related data sets for simultaneous use by many users, often accessed through simple languages and/or specialized terminals; for instance, a master inventory file in an online ordering system.

Data Set Extension (DSE): A control block containing control information for each of a terminal user's data sets.

DCA: See "Driver Control Area."

DCARE: See "Driver Control Area Region Extension."

debug: To detect, locate, and remove mistakes from a routine.

decay constant: A weighting factor used in calculating the duration of a job's next time slice based on its use of previous time slices. Recent time slices are weighted more heavily than earlier time slices.

dedication: Describing the assignment of a system resource -- an I/O device, a program, or a whole system -- to one application or purpose.

default value: The choice among exclusive alternatives made by the system when no explicit choice is specified by the user.

delimiter: A character that groups or separates the words or values in a line of input.

dial-up terminal: A terminal on a switched network.

Driver Control Area (DCA): A control block representing the current state of the time-sharing system, with a section for each time-sharing region; maintained by the Driver.

Driver Control Area Region Extension (DCARE): A section of the Driver Control Area representing a time-sharing region.

Driver Parameter Area: A parameter list containing information for the time sharing Driver.

DSE: See "Data Set Extension."

Dynamic Allocation Interface Routine (DAIR): A service routine that performs various data management functions for CPs.

dynamic data set definition: The process of defining a data set and allocating auxiliary storage space for it during job step execution rather than before job step execution.

edit mode: Under the EDIT command an entry mode that accepts successive subcommands suitable for modifying an existing line data set.

foreground: Describing the environment in which programs invoked by commands are executed. Programs are swapped in and out of main storage as necessary to efficiently utilize main storage contrast with "background."

foreground-initiated background job: A job submitted from a remote terminal for scheduling and execution in the background environment.

foreground job: Any job executing in a foreground region, such as a command processor or a terminal user's program. Also called a "terminal job."

function key: A terminal key, such as the attention key, that causes the transmission of a signal not associated with a character. Detection of the signal usually

causes the system to perform some predefined function for the user.

GETLINE: A service routine used by command processors to obtain input. GETLINE passes successive lines from the source indicated by the current input stack element: the terminal, or an in-storage list.

input mode: Under the EDIT command an entry mode that accepts successive line of input for a line data set. The lines are not checked for the presence of subcommands.

input stack: A push-down list of sources of input for GETLINE. Possible sources are the terminal or an in-storage list.

in-storage list: A chain of input lines in main storage, such as commands in an EXEC procedure, that are used in place of terminal input.

interaction: A basic unit used to record system activity, consisting of acceptance of a line of terminal input, processing of the line, and response, if any. Interactions are recorded when a user task starts its wait for a line of terminal input.

interaction time: The duration of an interaction.

ITF: BASIC: A simple, algebra-like language designed for ease of use at a terminal.

ITF: PL/I: A conversational subset of PL/I designed for ease of use at the terminal.

job:

1. In the background environment, a collection of related problem programs, identified in the input stream by a JOB statement followed by one or more EXEC and DD statements.

2. In the foreground environment, the processing done on behalf of one user from LOGON to LOGOFF -- one terminal session.

keyword: A command operand that consists of a specific character string (such as FORTLIB or PRINT) and optionally a parenthesized value.

line data set: A data set with logical records that are printable lines.

line deletion character: A terminal character that specifies that it and all preceding characters are to be deleted from a line of terminal input.

line number: A number associated with a line in a line data set, which can be used to refer to the line.

line number editing: A mode of operation under the EDIT command in which lines to be modified are referred to by line number.

linkage editor: A program that produces a load module from one or more object and load modules.

Link Pack Area (LPA): An area of main storage containing reenterable routines from system libraries. Their presence in main storage saves loading time when one is needed.

Link Pack Area Extension: An extension of the Link Pack Area containing system routines used only when TSO is operating. It is loaded when TSO is started by the operator.

loader: A program that converts object programs into executable form and loads them into main storage for execution.

Local System Queue Area (LSQA): A portion of the foreground (swapped) region used for control blocks that are to be swapped out along with a terminal job.

logon exit: An optional installation routine entered at user LOGON for accounting purposes.

LPA: See "Link Pack Area."

LSQA: See "Local System Queue Area."

main storage: All addressable storage from which instructions may be executed and from which data can be loaded into registers.

major time slice: The period of time for which a terminal job is swapped into main storage.

master scheduler: A control program routine that responds to operator commands and initiates the requested actions.

MCP: See "Message Control Program."

message: In telecommunications, a combination of characters and symbols transmitted from one point to another on a network.

Message Control Program (MCP): A series of TCAM routines which identify the teleprocessing network to the system, establish the line controls required for the various kinds of terminals and modes of connection, and control the handling and routing of messages in accordance with the users' (including TSO's) requirements.

Message Handler (MH): A sequence of instructions in the Message Control Program that examines and processes control information in message headers and performs the functions necessary to prepare the message segments for forwarding to their destinations.

message switching: A system application that accepts, stores, and routes messages.

MH: See "Message Handler."

minor time slice: The period(s) of time during a major slice in which the tasks associated with a user have the highest priority for execution.

MPP: See "Message Processing Program."

MVT: Multiprogramming with a variable number of tasks. The operating system control program that supervises the concurrent execution of a variable number of tasks in main storage, and allocates system resources among them.

network: In teleprocessing, a number of communication lines connecting a computer with remote terminals.

non-I/O wait condition: A user program wait condition not caused by an I/O operation -- ENQ, WTOR, etc. A foreground job is not swapped in while such a condition is outstanding.

non-switched line: A connection between a remote terminal and a computer that does not have to be established by dialing.

nucleus: That portion of the control program that is permanently resident in main storage. The time-sharing portion of the nucleus is resident only when time sharing is active.

offline: Pertaining to resources with which the CPU has no direct communication or control.

online: Pertaining to resources with which the CPU has direct communication or control.

operands: In the TSO command language, information entered with a command name to define the data on which a command processor operates and to control the execution of the command processor. Some operands are positional, identified by their sequence in the command input line, others are identified by keywords.

parse: To analyze the operands entered with a command and build a parameter list for the command processor from the information.

password: A one- to eight-character symbol assigned to a user that he can be required to supply at LOGON. The password is confidential, as opposed to the user identification. Users can also assign passwords to data sets.

priority: A rank assigned to a task that determines its precedence in receiving system resources. All tasks associated with time-sharing users are assigned the same dispatching priority, by which they are grouped together on the queue of all tasks in the system. Within the subgroup of tasks associated with a single user, a second time sharing priority is assigned, to establish precedence within the subgroup. A CHAP (Change Priority) macro instruction by a user task affects only the time sharing priority.

problem program: A program which executes in the problem state, is restricted from executing privileged instructions, and executes from main storage with a non-zero protection key.

processor:

1. A problem program performing some fixed function on input, such as a compiler or the linkage editor.
2. See Central Processing Unit (CPU).

prompting: A system function that helps a terminal user by requesting him to supply operands necessary to continue processing.

PUTLINE: A service routine that sends output to the terminal. PUTLINE selectively puts out messages according to whether or not a user has suppressed prompting or is executing a command procedure.

quiesce: To bring a program to a halt in such a way that it can be swapped out of main storage. This includes removing its I/O requests from the channel queues and taking most of its control blocks out of system chains.

RCT: See "Region Control Task."

read-only: A type of access to data that allows it to be read, but not modified.

real-time: Describing a system application in which response to input is fast enough to affect subsequent input -- such as a process control system or a computer assisted instruction system.

real priority: "Dispatching priority" is preferred, see "priority."

receive interruption: The interruption of a transmission to a terminal by a higher priority transmission from the terminal. Also called a "break."

region: An area of main storage allocated to a job step and assigned a unique storage protection key. Time sharing jobs share regions. Each job occupies a region briefly, then is swapped out to auxiliary storage and another job is swapped into the vacated main storage area for execution. The jobs are swapped in and out until they are completed.

Region Control Task (RCT): The control program routine handling quiesce/restore and LOGON/LOGOFF. There is one RCT for each active foreground region.

Region Queue Element: A Region Queue Element represents each of several service queues for a time-sharing region. Information in it is used to allocate time among the users on the queue.

Remote Job Entry: Submission of JCL statements and data from a remote terminal, causing the jobs described to be scheduled and executed as though encountered in the input job stream.

remote terminal: An input/output control unit and one or more input/output devices usually attached to a system through an IBM 2700-series telecommunications control unit. It may or may not be physically remote from the system.

response time: The time between the end of a block of user input and the display of the first character of system response at the terminal.

reverse break: See "transmit interruption."

self-defining delimiter: Any character appearing in the first position of certain character strings in the TSO command language. A repetition of the character within the string is interpreted as a delimiter.

separator: A delimiter used to separate multiple fields in an input line to the system.

session time: The elapsed real time from LOGON to LOGOFF.

simulated attention: A function that allows terminals without attention keys to interrupt processing. The terminal is queried for a specified character string meaning "attention" after every "n" seconds of uninterrupted execution or after every "n" lines of consecutive output.

SMF: See "System Management Facilities."

STACK: A service routine that manipulates the input stack.

STAE (Specify Task Asynchronous Exit): A macro instruction specifying a routine to receive control in the event of the issuing task's abnormal termination (ABEND).

STAI (Subtask ABEND Intercept): A keyword of the ATTACH macro instruction specifying a routine to receive control after the abnormal termination of a daughter task.

swap: To write an image of a foreground jobs's main storage region to auxiliary storage, and to read in another job's main storage image into the region.

Swap Allocation Unit: An arbitrary unit of auxiliary storage space into which a swap data set is divided, and by which it is allocated.

swap data set: A data set dedicated to the swapping operation.

Swap Data Set Control Block: A control block describing a swap data set, containing a DCB, a space queue, and device dependent control information.

swap in: The process of reading an image of a terminal job's main storage region from a swap data set into the appropriate main storage locations.

swap out: The process of writing an image of a terminal job's main storage region from main storage to a swap data set.

switched: Describing a connection established by dialing between a remote terminal and a computer.

syntax checker: A program that tests source statements in a programming language for violations of that language's syntax.

System Management Facilities (SMF): An optional control program feature that provides the means for gathering and recording information that can be used to evaluate system uage.

System Queue Area (SQA): A main storage area reserved for control blocks and tables maintained by the control program.

system resource: Any facility of the computing system that may be allocated to a task.

TCAM: See "Telecommunications Access Method."

Telecommunications Access Method (TCAM): A generalized terminal I/O support package, providing application program independence of terminal characteristics.

Telecommunications Control Unit (TCU): An input/output control unit that addresses messages to and receives messages from a number of remote terminals.

teleprocessing: Entering data to or controlling processing by a system via a remote device that performs the necessary format conversions and controls the rate of transmission.

terminal: See "remote terminal."

terminal I/O wait: The condition of a task which cannot continue processing until a message is received from a terminal, i.e., a TGET has been issued.

terminal job: A foreground job, a session from LOGON to LOGOFF. Also used to refer to the main storage region assigned to a user and associated system control blocks.

Terminal Job Identification (TJID): A two-byte identification assigned to each terminal job.

Terminal Monitor Program (TMP): A program that accepts and interprets commands from the terminal, and causes the appropriate command processors to be scheduled and executed.

terminal user: See "user."

TGET: An I/O macro instruction used by problem programs to obtain a line of input from the terminal.

think time: During a terminal session, the elapsed time from the end of a line of system output to the terminal until the end-of-block of a line of input.

time sharing: A method of using a computing system that allows a number of users to execute programs concurrently and to interact with the programs during execution.

Time Sharing Control Task (TSC): A TSO system task that handles system initialization, allocation of time-shared regions, swapping, and general control of the time-sharing operation.

Time Sharing Driver: A TSO addition to the Dispatcher that determines which task is to execute next.

Time Sharing Interface Area: A TSO control block used for communication between the Driver and the Time Sharing Interface Program.

Time Sharing Interface Program (TSIP): This routine receives control from the SVC first level interruption handler when the TSIP SVC is detected, or by direct branch from some routines. It passes control to the Driver, and on return, initiates the actions specified.

Time Sharing Option (TSO): An option of the operating system providing conversational time sharing from remote terminals.

time sharing priority: A ranking within the group of tasks associated with a single user, used to determine their precedence in receiving system resources. See "priority."

time slice: A segment of time allocated to a terminal job. See "major time slice" and minor time slice."

TJID: See "Terminal Job Identification."

TMP: See "Terminal Monitor Program."

transaction: See "Interaction."

transmission code: A code for sending information over communications lines.

transmit interruption: The interruption of a transmission from a terminal by a higher priority transmission to the terminal. Also called a "reverse break."

trivial response: A response from the system to a request for processing that should require only one time slice; e.g., a syntax check of one FORTRAN statement.

TSC: See "Time Sharing Control Task."

TS Dispatcher: A section of the TSIP executed as part of the operating system dispatcher. It looks in TSIA for any work requested by the Driver, and, if there is any, initiates the work before returning to the Dispatcher.

tuning: The process of adjusting system control variables such as the number of service queues per time sharing region, the percentage of time for background execution, the number of permitted foreground users, etc., to make the system divide its resources most efficiently for the workload.

type-in time: The time between a READ to a terminal and the end of the input transmission. See "Think Time."

type-out time: The time between a WRITE to a terminal and the next READ.

user: Under TSO, anyone with an entry in the User Attribute Data Set; anyone eligible to log on.

User Attribute Data Set (UADS): A partitioned data set with a member for each authorized system user. Each member contains the appropriate passwords, user identifications, account numbers, LOGON Procedure names, and user characteristics defining the user profile.

USERID: See "User Identification."

user identification (USERID): A one- to eight-character symbol identifying each system user.

User Main Storage Map: A map of the allocated storage in a user's region, built by the RCT, and used to determine how much of the region needs to be swapped.

User Profile Table: A table of user attributes kept for each active user, built by Logon from information in the LOGON command, the UADS, and the Logon procedure.

verification: A mode of operation under the EDIT command in which all subcommands are acknowledged and any textual changes are displayed as they are made.

Index

Indexes to systems reference library manuals are consolidated in the publication IBM System/360 Operating System: Systems Reference Library Master Index, Order No. GC28-6644. For additional information about any subject listed below, refer to other publications listed for the same subject in the Master Index.

Where more than one page reference is given, the major reference is first.

GC28-6698-3

System/360 OS TSO Guide (S360-36) Printed in U.S.A. GC28-6698-3

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IBM Technical Newsletter

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IBM System/360 Operating System:
Time Sharing Option Guide

This Technical Newsletter, applies to release 20.1 of IBM System/360 Operating System, provides replacement pages for the subject publication. These replacement pages remain in effect for subsequent releases unless specifically altered. Pages to be inserted and/or removed are:

7,8
11-14
23,24
33-36
39-42
53,54
61-72
77,78
81,82
87-92,92.1
95,96

A change to the text or a change to an illustration is indicated by a vertical line to the left of the change.

Summary of Amendments

Provides new information about the PL/I Checkout Compiler, MCP Generation macro instructions, EDIT facilities, Background reader, UADS construction, the Broadcast data set.

Note: Please file this cover letter at the back of the manual to provide a record of changes.

IBM Corporation, Programming Systems Publications, P.O. Box 390, Poughkeepsie, N.Y. 12602

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Release 20.1 GC28-6698-2

Item	Description
System Implementation	A section has been added describing the techniques used in implementing a TSO system. This section consists of discussions of: Generating a Message Control Program Writing Cataloged Procedures Used With TSO Specifying TSO System Parameters Tuning the Time Sharing Driver Writing Installation Exits for: The SUBMIT Command The OUTPUT, STATUS, and CANCEL Commands The LOGON Command
Storage Estimates	Most of the information in the Storage Estimates section, including the sample TSO configuration, has been deleted and moved to the publication IBM System/360 Operating System Storage Estimates GC28-6551.
Driver Entry Codes	An appendix has been added containing the format and meaning of the TSEVENT macro instructions used to notify the Time Sharing Driver of system events.
Terminal Messages Requiring Installation Action	An appendix has been added containing messages which when received at a terminal requires the installation to take certain actions.
Message Control Program Assembly Error Messages	An appendix has been added containing the text of error messages generated by the macro instructions used to generate the Message Control Program.

Release 20.1 GC28-6698-3

Item	Description	Areas Affected
TMP Step Library	A discussion of the advantages of concatenating Command Library to SYS1.LINKLIB, the Linkage Library.	20,74
OS PL/I Checkout Compiler	A discussion of the uses and facilities of the Checkout Compiler.	35-36
2260,2265	The macro instructions for generating the MCP have additional operands for 2260 and 2265 support.	63-69

Release 20.1 (GC28-6698-3 MODIFIED BY TNL GN28-2497

Item	Description	Areas Affected
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Restrictions to Foreground Programs	Tape and multivolume data sets are not supported by most Command Processors and cannot be dynamically allocated.	14
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Using a Terminal

A terminal session is designed to be an uncomplicated process for a terminal user: he identifies himself to the system and then issues commands to request work from the system. As the session progresses, the user has a variety of aids available at the terminal which he can use if he encounters any difficulties.

Commands specifically tailored to an installation's needs can be written and added to the command language or used to replace IBM-supplied commands.

Starting and Stopping a Terminal Session

When the user has some work to perform with the system, he dials the system number if he has a terminal on a switched line, or he turns the power on if he has a terminal on a non-switched line. A switched line is one in which the connection between the computer and a terminal is established by dialing the system's number from the terminal. A non-switched line is one with a connection between the computer and the terminal. With an IBM 2741 terminal or an IBM 1050 terminal, the system responds by unlocking the keyboard. In any case, the user identifies himself by entering "LOGON" and one or more of the following fields:

- A user identification, for example, the user's name or initials, which the system will use to identify his programs and data sets.
- A password assigned by his installation, usually known only to the user and the system manager.
- An account number, which defines the account in which his system usage totals are to be accumulated.
- A LOGON procedure name, which identifies a cataloged procedure that specifies what system resources he will be using.

The user may omit the last three fields if the system manager has defined only one account number and LOGON procedure for him and no password is used.

The LOGON processor verifies that the user is an authorized TSO user, then checks the password, if it is required, and account number in a record it keeps of user attributes, called the User Attribute Data Set (UADS). From the attributes, the LOGON command operands, and a LOGON cataloged procedure, the system builds a user profile, which is used to control the processing of his job. The system assigns the user's job to a time-sharing (foreground) region of main storage and allocates other resources, such as auxiliary storage space and user data sets according to the LOGON procedure.

LOGON marks the start of a terminal session. When the user completes his work, he enters "LOGOFF" to end the session. The system then updates his job's system use totals, releases resources allocated to it, and releases the terminal from TSO. A session is also terminated any time the terminal user enters LOGON to start a new session. In this case, the old session is terminated and a new one is begun; the terminal is not released in the process.

Working at the Terminal

The user enters commands to define and execute his work at the terminal. He enters a command by typing a command name, such as EDIT and possibly some additional operands. The system finds the appropriate command processor--a load module in a command library--and brings it into the foreground region assigned to the user for execution. For example, in response to entering the EDIT command, the system brings in the EDIT command processor, the data handling routine used to create and update data sets.

If a user does not enter all the operands associated with a particular command name, default values are assumed where possible. If necessary operands are missing, the system prompts the user for them with a message such as "ENTER DATA SET NAME." The user can reply with the missing value, or enter a question mark for a further explanation of what the system needs. If the user chooses, he can specify that prompting messages be suppressed.

A terminal user can also receive assistance through the HELP facility. He can request information regarding the syntax, operands, or function of any command, subcommand, or operand. If he enters HELP followed by a command name, he receives an explanation of the command and the operands required with it. HELP followed by a subcommand name furnishes an explanation of the subcommand if you are working with the command at that time. Entering HELP by itself returns a description of the command language, a list of the commands, and an explanation of how to use HELP to obtain further information.

During a typical session, the user enters a series of commands to define and perform his work. If the sequence is one that is used often, he can store the sequence in a data set and then execute the sequence whenever he needs it by entering the EXEC command.

The commands provided with the system handle data and program entry, program invocation in either the foreground or the background, program testing, data management, and session and system control. IBM Program Products are available to support problem solving, data manipulation, and text formatting, to provide terminal-oriented language processors, and to make these processors more convenient to use from the terminal.

System Configurations

TSO is an extension of the MVT configuration of the control program on System/360 Models 50 through 195, or System/370 Models 155 and 165. TSO also operates with the Model 65 Multiprocessing (M65MP) configuration. The minimum machine configuration for System/360 models must include 384K of main storage, the required I/O devices for MVT, plus at least one each of the following:

- A terminal (IBM 1050, 2741, 2260 Local or Remote, 2265, or Teletype[1] Model 33 or 35 KSR and ASR).
- A transmission control unit (IBM 2701, 2702, or 2703), unless all terminals are locally attached 2260 Display Stations.
- Sufficient direct access storage space (IBM 2301, 2311, 2303, 2305, 2314, or 3330) for command libraries and system data sets.
- Sufficient direct access storage space to swap data sets.

In a System/360 with 384K of main storage, TSO is, in effect, a "dedicated" time sharing system. In other words, with 384K the system can run as a time sharing system or as a batch job processing system, but not both at the same time. To run both time sharing and batch jobs concurrently or to execute on M65MP or System/370 models, at least 512K of main storage is required. At least 128K of main storage is required for system generation.

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[1]Trademark of Teletype Corporation, Skokie, Illinois.

Terminals

Some remote terminals suitable for interactive applications have keyboards for entering input data and either typewriter-like printers or display screens. A remote terminal incorporates or is attached to a control unit. The control unit is in turn connected to the system by either of two ways:

- Through a device such as a data set to a dialed (switched) line to the system.
- Through either a direct or a leased line to the system.

At the computer site the communication line connects to a Transmission Control Unit, which in turn is attached to one of the computer system's multiplexor channels. The IBM 2260 Display Station can be an exception to this general configuration. Its control unit, the IBM 2848 Display Control, can be attached directly to a multiplexor or selector channel. This mode of operation is called local attachment.

TSO uses the Telecommunications Access Method (TCAM) for terminal access. TSO provides terminal handling programs for the following terminals:

- IBM 2741 Communication Terminal.
- IBM 1050 Printer-Keyboard.
- Teletype[1] Model 33 and 35 KSR and ASR. (Paper tape is not supported for Teletype[1].)
- IBM 2260 and 2265 Display Stations.

The IBM 2741 Receive Interruption Feature and the Transmit Interruption Feature are recommended for use with the 2741. These features are described in the publication IBM 2741 Communications Terminal. The Transmit Interrupt, Receive Interrupt, and Text-Timeout Suppression features are recommended for use with the IBM 1050. 1050 multidrop is not supported. These features are described in the publication IBM 1050 System Summary. Note that some of these features are not available through the IBM 2701 Data Adapter Unit.[2]

Transmission Control Unit

TSO requires at least one of the following transmission control units to handle terminal communications:

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[2]Terminals which are equivalent to those explicitly supported may also function satisfactorily. The customer is responsible for establishing equivalency. IBM assumes no responsibility for the impact that any changes to the IBM-supplied products or programs may have on such terminals.

- IBM 2701 Data Adapter Unit.
- IBM 2702 Transmission Control.
- IBM 2703 Transmission Control.

The Terminal Interruption Features are recommended for use with the 2702 and 2703 transmission control units and must be present if the terminals are to use the features. These units are described in the following publications:

- IBM 2701 Data Adapter Unit, Component Description.
- IBM System/360 Component Description, IBM 2702 Transmission Control.
- IBM 2703 Transmission Control, Component Description.

Swap Data Set Devices

The process of copying images back and forth between main and auxiliary storage is called swapping. Writing an image to auxiliary storage is a swap out; reading one into main storage is a swap in. The pre-formatted data sets into which jobs are written are called swap data sets. A swap data set is divided into swap allocation units, each of which consists of a device-dependent number of 2048-byte records. An integral number of swap allocation units, not necessarily contiguous, are assigned to each job to contain the swapped out image of the job.

If there is more than one foreground region, they share the available swap data sets, but the cycle of swapping for each region is essentially independent of other regions. However, the system avoids queuing on swap data sets if possible.

TSO requires sufficient storage capacity on one or more of the following for swap data sets:

- IBM 2301 Drum Storage.
- IBM 2303 Drum Storage.
- IBM 2305 Fixed Head Storage, Model 1 or 2.
- IBM 2314 Direct Access Storage Facility.
- IBM 3330 Disk Storage Facility.

See the Storage Estimates section of this publication for information on swap data set sizes.

The record overflow feature is required for the devices used to store the swap data sets. One or more data sets on any of the above devices can be used for swap data sets.

The direct access storage space required for the swapped data may be divided among the devices listed above in either of two ways. The user may specify that swapped data be distributed serially among a hierarchy of data sets, or he may specify parallel distribution of data onto two devices. With serial distribution, the first data set in the hierarchy is filled with swapped data, and then the next data set in the hierarchy is used. For example, a drum, because of its higher access speed, could be assigned as the first unit in the hierarchy, with a 2314 assigned to receive any overflow of swapped data.

With the parallel distribution scheme, two devices are used concurrently to receive swap data sets. The exact order in which data sets are written on either of the devices is determined by the system, based on the I/O activity taking place in the channel at the time of a swap out. For example, if the two data sets are on devices on separate channels, swap performance improves substantially.

Before a terminal job can be swapped out of main storage, activity associated with the job must be brought to an orderly halt. The halt must be performed in such a way that the job is not aware of it, and information must be saved to restart the job when its next time slice is scheduled. The orderly suspension of a job's activity before a swap out is called quiescing the job. Quiescing includes the removal of the majority of the control blocks associated with the job from the system queues so they can be written to the swap data set along with the contents of the main storage region assigned to the job.

The Relationship of TSO to the Operating System

For the data processing center, TSO is compatible with operating system standard formats and services, while providing the flexibility needed for various time sharing and terminal-based applications.

TSO is not necessarily intended to be used as a dedicated time-sharing system, that is, a system on which only time-sharing operations take place. TSO augments the facilities already available with the operating system: batch processing, teleprocessing, and other data processing activities can take place concurrently on the same system.

Once an installation has generated a system that includes TSO, time sharing operations can be started and stopped at any time by the system console operator. The operator can specify how many regions

of main storage are to be assigned to time sharing users. Each region can serve many users, whose programs are swapped back and forth between main and auxiliary storage. Time sharing, or foreground operations, can take place concurrently with batch or background operations. (Background jobs are not swapped.) If the user chooses, he can dedicate his system to time sharing and run only foreground jobs. If there are periods when TSO is not needed in the system, time sharing operations can be stopped, and the system will then process background jobs in the usual way with MVT and TCAM.

Terminal communications are handled by the Telecommunications Access Method (TCAM) through an interface that allows the use of standard sequential access method I/O statements and macro instructions.

All of the MVT facilities are available to a background job. Foreground jobs can use most of the operating system access methods for data set access (e.g., BSAM, QSAM, BDAM etc.). All devices available to these access methods are usable by foreground jobs. A detailed list of restrictions is in the "Restrictions and Limitations" section of this manual.

Execution of Background Jobs from the Terminal

In addition to the foreground execution of programs, TSO allows jobs to be submitted for execution in the background, or batch, portion of the system. If his installation authorizes it, a user can submit a background job at his terminal, be notified of the job's status, and then receive results of the job at the terminal. If he chooses, he can specify that the output of his job be produced at the computing center, rather than at the terminal.

Foreground-Background Compatibility

Because time sharing is carried out within the framework of MVT job and task management, the foreground and background environments are compatible. TSO uses the same data formats, programming conventions, and access methods as the rest of the operating system. The programming languages and service programs available with TSO are compatible with their background counterparts.

The TSO command language is also generally compatible with the Conversational Remote Job Entry (CRJE) command language. Programs can be developed in the foreground and stored in background libraries. These programs are compatible with other operating system programs. Most problem programs can be executed in either the background or the foreground without revision or recompilation.

Restrictions and Limitations

Certain facilities are unavailable to foreground jobs, although they remain available to background jobs. These include:

- The BTAM and QTAM telecommunications access methods.
- The Graphics Access Method (GAM).
- The EXCP equivalents of the BTAM, QTAM, and GAM access methods.
- Main storage requests for hierarchy 1 (all foreground requests for main storage are allocated to hierarchy 0).
- Use of Job Control Language in the foreground for other than single-step jobs (the TSO command language is used to provide the equivalent of multi-step jobs).
- Checkpoint/Restart Facility (foreground requests for checkpoint are ignored).
- Rollout/Rollin Option.
- TESTRAN Facility.
- Multivolume or tape data sets are not supported by most Command Processors and cannot be allocated dynamically.

SVC numbers 92 through 102 (decimal) are added to the system for TSO. The following SVCs can be issued by problem programs in the foreground region:

- SVC 93--TGET/TPUT (execute terminal I/O).
- SVC 94--STCC (specify terminal control characteristics).
- SVC 95--TSEVENT (notify the supervisor of an event).
- SVC 96--STAX (specify a terminal attention exit).
- SVC 97--Breakpoint (used by TEST command).
- SVC 98--PROTECT (protect a data set with a password).
- SVC 99--Dynamic Allocation (of a data set).

One input line from the terminal normally becomes one record in the data set. Because of this equivalency between records and lines at the terminal, data sets created by EDIT are called line data sets. On request, EDIT appends a line number to each record of the data set as it is entered.

Entry Modes for EDIT

Depending on the type of work the user is doing with his data set, he uses one of two entry modes provided by EDIT (some other modes specifically for particular programming languages are discussed later). The input mode allows rapid entry of successive lines of input for the data set. The edit mode allows subcommands to be entered to modify, insert, or delete lines.

Input Mode

In input mode, the user enters successive lines of input. The lines are normally appended at the end of the data set, although the user can request they be inserted at some other point. The only subcommand recognized in the input mode is the null line (hitting the return key with no preceding characters), which requests transfer to the edit mode.

Services available in the input mode include translation of lowercase letters to uppercase, translation of tab characters to a series of blanks, and interpretation of the character-delete and line-delete characters. If line numbers are being assigned to each line, the user may request each new number be typed out by the system at the beginning of each input line. If line numbers are not being assigned, the user can request prompting for each new line by an underscore. If no prompting is requested, lines are entered one after another, with no intervening response from the system. Programming language syntax checkers can be requested to process input lines as they are entered.

Edit Mode

In edit mode, the user enters subcommands to point to particular records of the data set, to modify or renumber records, to add and delete records, to control editing of input, or to compile and execute a program.

Whenever the terminal is in edit mode, the user is considered to be positioned at a particular record, or line, of the data set. The EDIT command processor maintains a current line pointer to keep track of the user's position. In general, the current line pointer, which can be referred to in subcommands by an asterisk (*), is positioned at the last line referred to, entered, changed, or printed. Using the subcommands provided, the user can move the current line pointer to any record in the data set.

For line-numbered data sets, specifying a line number as an operand of a subcommand moves the pointer to that record before the action requested by the subcommand is carried out. This method of operation is called line number editing.

Another method of repositioning the current line pointer is called context editing. A set of subcommands is provided to reposition the current line pointer without reference to line numbers. The user can move the pointer up or down a specified number of lines, or request the system to find a line with a particular series of characters in it, and move the pointer to it.

Modifying Data Sets

The most common use of the EDIT command for existing data sets is the addition, deletion, or modification of records. The INSERT and DELETE subcommands handle single or multiple record insertions and deletions. The CHANGE subcommand allows the user to replace one character string with another, not necessarily of the same length.

Data Set Management Commands

To allow the user to manage his data stored on auxiliary storage devices, a set of data set utility commands is included in the TSO command language. All user data is kept in standard operating system data sets, and as a default, data sets used by foreground programs are entered in the system catalog, reducing the amount of information the user must supply about the data set from the terminal when he refers to it.

The LISTCAT and LISTDS commands retrieve information from the system catalog for the user. He can find out what data sets are currently allocated to him, and what the attributes of the data sets are. The RENAME command can assign a new data set name to an existing data set, or add an alias name to a partitioned data set member. The DELETE command removes a data set from the catalog, and frees the auxiliary storage space it occupies.

The PROTECT command is the facility to assign password protection to data sets. Protection can be assigned for read access or for write and delete access. Multiple passwords can be assigned to a single data set.

The ALLOCATE and FREE commands invoke the dynamic data set allocation routines from the terminal. A user who wants to run a program that requires one or more data sets not currently allocated to his foreground job enters ALLOCATE commands to have the data sets assigned. The FREE command is used to release the data sets assigned by ALLOCATE. The ALLOCATE command can also be used to find data sets not in the system catalog, and to control the size of new data sets and the volumes to which they are assigned.

TSO Data Utilities

The TSO Data Utilities Program Product is available to augment the data entry and data set management commands by providing a text-formatting capability and data set utilities for terminal users. The product provides four commands:

- FORMAT, to format textual information into pages.
- LIST, to display all or part of a data set at the terminal.
- COPY, to copy a data set.
- MERGE, to merge all or part of one data set into another.

The FORMAT and MERGE commands can also be used as subcommands of EDIT (EDIT incorporates a less powerful listing capability). The COPY and MERGE commands can be used for access to ASCII tape data sets. See the publication IBM System/360: Planning for the Use of Information Interchange Standards, GC28-6756, for details.

Text-Handling

The EDIT, FORMAT, and LIST commands provide a facility for the entry, editing, storage, and output of text. With the EDIT command, the terminal user creates a data set with the type qualifier TEXT, and enters the material line-by-line. If his terminal has both uppercase and lowercase letters, the material will not be translated to uppercase letters, but will be saved just as entered. The user can specify what tab settings he wants to use, and the system will convert tabs in the material into strings of blanks of the proper length. The use of line numbers is optional.

The user formats the data set by inserting format control records into it. A format control record is entered as a separate line in the data set, starting with a period in the first position, followed by a control word (or a two-character abbreviation). The EDIT processor does not interpret the controls; they are retained in the data set for interpretation later by the FORMAT processor. The controls allow the user to:

- Print a heading on each page.
- Center lines of text between margins.
- Control the amount of space for all four margins on the page.
- Control line spacing.
- Justify left and right margins of the text.
- Number pages of output consecutively.
- Halt printing when desired.
- Print multiple copies of selected pages.

The FORMAT processor scans the data set for the format controls and inserts blanks, carrier return characters, headings, and page numbers as needed. At the user's option, the output can be formatted for a terminal or saved in a data set for deferred printing, either on the terminal (with the LIST command) or on a high-speed printer. Either an all-capitals or an uppercase and lowercase print chain can be used on the printer.

Data Set Manipulation

The COPY, LIST, and MERGE commands allow the terminal user to move information between data sets and to display data sets at the terminal.

The COPY command will duplicate sequential or partitioned data sets or a member of a partitioned data set. While doing so, it can resequence or change the record length, blocksize, or record format as requested. The MERGE command will copy all or part of one data set or member into another data set and will resequence the record numbers in the target data set if requested. Both these commands will process tape data sets in ASCII format. Tape devices must be allocated to a user in his LOGON procedure.

The LIST command displays all or part of a data set at the terminal. The user can request that fields within records be rearranged for output, and line numbers can be suppressed or included.

```
22 link query load(commands(query)) coblib
   READY

23 query
   3288540
   3288540 PAWL SPRING (4-INCH) 13 DOZ ON HAND        7 ORDER POINT
   READY
```

Figure 9. A Terminal Session Creating a COBOL Program (Part 2 of 2)

FORTRAN

Two versions of FORTRAN IV with special support for the foreground environment are available as Program Products to TSO users:

- Code and Go FORTRAN.
- FORTRAN IV (G1).

Both processors can also be used in the background environment. Two additional Program Products are available to complement the processors:

- FORTRAN IV Library (Mod I), for use with either processor to provide list-directed input/output support, ASCII data set handling, and PAUSE and STOP output to the terminal.
- TSO FORTRAN Prompter, which allows the terminal user to invoke the FORTRAN IV (G1) processor with the FORT or RUN commands.

A FORTRAN programmer can also invoke the FORTRAN (E), (G), or (H) processors with the CALL command, but not with the RUN or FORT commands. The user is responsible for allocating the data sets needed by these compilers, and for specifying the compiler options. The prompter performs these services for the FORTRAN IV (G1) compiler, which also has output specially formatted for the terminal.

Code and Go FORTRAN is optimized for a fast compile-and-execute sequence, carried out entirely within main storage for small- to medium-sized programs. This makes it a useful tool for problem-solvers. It accepts free-form source statements, and has simplified I/O statements for addressing the terminal. However, no permanent object program is produced, and some execution speed is sacrificed for fast compilation. Whenever the programmer needs to link separately compiled programs and subroutines, when he is working with very large programs, or when he wants to produce an object program he can save, he will use the FORTRAN (G1) compiler. He may develop and test his program with Code and Go FORTRAN, and then compile it a last time with the FORT command. The TSO CONVERT command will change free form source statements to fixed form or vice versa. Code and Go FORTRAN is discussed in greater detail in the chapter "Problem Solving."

Entering the Source Program

The programmer uses the EDIT command to create a source program. An operand of the EDIT command informs the syntax checker what FORTRAN compiler is going to be used. As the program source statements are entered, the FORTRAN syntax checker processes each line, interrupting the input sequence if it detects an error. Figure 10 shows a syntax checker diagnostic response and the user action to correct the error. The first CHANGE subcommand inserts a left parenthesis, the second, a right parenthesis.

Compiling a FORTRAN Program

When the programmer finishes entering the source program, he saves his data set with the SAVE subcommand, and switches to command mode to enter the FORT command, or stays in edit mode and uses the RUN subcommand. Operands of FORT allow him to specify various compiler options: whether or not a listing is to be produced, the contents of the listing, where it is to be printed or stored, whether or not an object program is to be produced, and whether diagnostics are to be sent to the terminal. All operands except the input data set name can default to standard values.

```
      .
      .
00030  30 format (f10.3)
00040  12 read (2,30) a(i),i=1,5
) REQUIRED FOR IMPLIED DO
EDIT
change / a/ (a/
change /5/5)/
list *
00040  12 read (2,30) (A(I),I=1,5)


INPUT
           do 50 i=1,5
      .
      .
```

Figure 10. FORTRAN Syntax Checker Diagnostic

As the compiler processes the program, it may find program organization errors that were not detected by the syntax checker on a statement-by-statement basis. Compiler diagnostic messages are sent to the terminal, along with the statement in error, and a pointer to the field in error, if possible. Figure 11 is an example of compiler output to the terminal during a single compilation. The number preceding the source statement is the line number assigned by EDIT when the source program was entered. The line number allows the programmer to use the edit mode subcommands to correct the statement quickly, without listing the entire source program.

```
G1 COMPILER ENTERED
000170  30  FORMAT (I6)
                  $
01)  IGI006I  DUPLICATE LABEL
SOURCE ANALYZED
PROGRAM NAME=MAIN
*001 DIAGNOSTICS GENERATED,
     HIGHEST SEVERITY CODE IS 8
READY
```

Figure 11. Sample of FORTRAN compiler Output

When the program compiles successfully, the programmer can print an error-free listing, and use the LOADGO command to load his program for execution.

Testing FORTRAN Programs

The FORTRAN programmer has two testing facilities: The debug facility of the FORTRAN language, and the TSO test mode.

The debug facility of FORTRAN (G1) allows the programmer to monitor program execution from his terminal. Output from the debug statements such as TRACE and DISPLAY is sent to the terminal, unless directed elsewhere with the UNIT option of the DEBUG statement. DUMP and PDUMP output also goes to the terminal. Execution of the program can be synchronized with the terminal by inserting READ statements in the debug packets, forcing the program to wait for the user to allow it to continue. Since FORTRAN debug statements are grouped together in the source program, they can be easily deleted with EDIT subcommands when testing is completed.

The test mode is also available for FORTRAN programmers. Using an object program listing and storage map produced by the compiler, the programmer can insert breakpoints to interrupt execution of his program, list and modify variable values in main storage, and control program flow. Some knowledge of System/360 instruction formats and hexadecimal notation is helpful in using test mode.

PL/I

The PL/I programmer can use the following language processors from the terminal:

- ITF: PL/I.
- PL/I Optimizing Compiler.
- PL/I (F) Compiler.
- PL/I Checkout Compiler.

The ITF: PL/I Program Product is a subset of PL/I designed for solving problems at the terminal. It is provided by a compiler that offers two types of processing: a rapid compile-and-execute sequence for small- to medium-sized programs, or line-by-line interpretation and execution of PL/I statements as they are entered. ITF: PL/I does not produce a permanent object program. ITF: PL/I is described in the chapter, "Problem Solving."

The PL/I Optimizing Compiler, an IBM Program Product, is a language processor for use in either the background or the foreground environment. For the foreground environment, the compiler incorporates a prompter, which allows the user to invoke it with the PLI or RUN commands. Compiler options allow the user to request diagnostics and listings formatted for the terminal, or to request termination of compilation if syntax errors are found.

The PL/I programmer can also use the PL/I (F) compiler from the terminal, but no special prompting or output format is available. The F-level syntax checker can be used to scan source statements as they are entered or to scan complete programs. The PL/I (F) compiler cannot be invoked with the PLI or PLIC commands, but an example of a command procedure that uses the CALL command for the PL/I (F) processor is given in the last section of this chapter.

The PL/I Optimizing Compiler implements a more comprehensive subset of PL/I than previous compilers and offers a choice of fast compilation, optimization for speed of object program execution, or optimization for minimum object program size. A subroutine library is required during linkage editing of a compiler output module. A second library is required for execution of the object program. Each library is available as an IBM Program Product:

- OS PL/I Resident Library.
- OS PL/I Transient Library.

The PL/I Checkout Compiler is a two-stage processing program which translates and interprets (executes) PL/I programs. It can be used in either the batch or TSO environments of the IBM System/360 Operating System.

Using the checkout compiler in a TSO environment will often enable you to check out a PL/I program in one session at the terminal. Its conversational checkout features allow you to communicate with the compiler during processing. The compiler prints messages and listings at the terminal (as requested by the TERMINAL option) and you can respond with PL/I subcommands, or PL/I statements for

immediate execution. The subcommands allow you to change compiler options, request more information, copy output files at the terminal, make temporary modifications to the PL/I program (during interpretation only), and either continue or terminate processing.

You can also communicate with the PL/I program when it is being interpreted, by using the conversational I/O feature of PL/I.

Entering a PL/I Program

The programmer uses the EDIT command to create his source program and save it as a data set. He can request EDIT to assign a line number to each line of his source program as he enters it. If line numbers are assigned, he can request the PL/I Optimizing Compiler to use them in diagnostic messages, instead of statement numbers. The programmer can use the line number to retrieve the erroneous source statement, correct the error, and invoke another compilation, all without having the complete listing displayed at the terminal.

Compiling a PL/I Program

To invoke the compiler, the programmer uses either the RUN, the PLIC, or the PLI command. RUN can be used as a subcommand of EDIT, allowing the user to correct errors without entering the EDIT command again. RUN causes a complete compile-load-go sequence but does not produce a permanent object program. RUN is normally used during the initial compilations to check for source language errors. When a program is debugged, the PLI command can be used to produce an object program and a full listing. The object module can be loaded for execution or linkage edited into a program library for use as a load module. Whether invoked by RUN or PLI, the PL/I Optimizing Compiler directs diagnostic messages to the terminal, in either a full or an abbreviated format. During testing, the programmer can have traces and other output generated by PL/I program checkout facilities displayed at the terminal.

Program Execution

Programs produced by the compiler can be executed in either the background or the foreground. In the foreground I/O can be directed to the terminal by allocating a PL/I file, such as SYSIN or SYSPRINT, to the terminal with the ALLOCATE command. In the background these same files can be directed to data sets or unit record devices.

Assembler Language

Like programmers who use the higher level languages, the assembler language user enters his source program statements with the EDIT command. Assembler (F) accepts free form input, but the tab setting facilities of EDIT allow the user to create a formatted listing. On request, EDIT assigns line numbers to the source statements, which are later referred to by diagnostic messages produced during assembly. Line number or context editing is always available to correct errors, modify source statements, or add comments.

Assembling the Program

When the programmer completes his source program and saves it, he invokes Assembler (F) with the RUN or ASM commands. The use of these commands requires the TSO Assembler Prompter Program Product. Operands of ASM give him control over the listing format, disposition of output, and diagnostic messages.

Assembler diagnostic messages sent to the terminal include the statement in error, if possible; both the EDIT-assigned line number and the assembler-assigned statement number; and an explanation of the error. Usually, the user will not need to have the complete listing displayed in order to obtain an error-free assembly. Using the line numbers in the diagnostic messages, the programmer can quickly locate and fix source statement errors with the edit mode subcommands.

Test Mode

When assembly completes without error, the programmer creates a load module with the LINK command, and uses the TEST command to bring it into storage. The TEST command processor uses the symbol table produced by the assembler and linkage editor, which gives the address and attributes of each symbolic name used in the source program. Before passing control to the program, TEST allows the user to establish initial values to be passed to the program as test data, and to set up breakpoints where execution is to be interrupted for displays, dumps, and other debugging activity. The user can refer to points in the program by symbolic names, absolute relative or indirect addresses.

To display storage and register contents, the programmer uses the LIST subcommand, specifying a register range or

```
1 PROC 1,NAM1
2 FREE FILE(SYSUT1,SYSUT3,SYSIN,SYSPRINT)
3 ALLOCATE DATASET(*) FILE(SYSIN)
4 ALLOCATE DATASET(*) FILE(SYSPRINT)
5 LOADGO &NAM1..OBJ PL1LIB
6 END
```

Figure 15. A Command Procedure to Invoke a User Program

It would be possible to call this procedure from the PLIF procedure by inserting a record containing:

```
EXEC LDGO '&NAME'
```

However, it would be preferable to call it only when the return code from the compiler indicates successful execution is likely, that is, no serious errors were detected during compilation. To test the compiler return code, the user inserts a WHEN statement:

```
WHEN SYSRC(LE 4) EXEC LDGO '&NAME'
```

The WHEN statement immediately follows the CALL command invoking the compiler (record 7 in Figure 12). If the compiler return code is less than or equal to four ("LE 4"), indicating that no errors, or only minor errors, were detected, the EXEC command is executed. If the return code is greater than four, the EXEC command will be ignored, the FREE command is executed, and the procedure ends. The terminal returns to command mode, and the user will probably use the LIST command to display the compiler listing, determine the errors in the source program, correct them with the EDIT command, and reinvoke the procedure for another compilation. Figure 16 shows the modified PLIF command procedure. A DELETE command has been added for the object module, since it is not executable. Figure 17 shows a use of the procedure for a successful compilation. The LIST operand is specified to display each command as it is executed.

```
PROC 1,NAME
ALLOCATE DATASET(&NAME..PLI) FILE(SYSIN)
ALLOCATE DATASET(&NAME..LIST) FILE(SYSPRINT) BLOCK(125) SPACE(300,100)
ALLOCATE DATASET(&NAME..OBJ) FILE(SYSLIN) BLOCK(80) SPACE(250,100)
ALLOCATE FILE(SYSUT1) BLOCK(1024) SPACE(60,60)
ALLOCATE FILE(SYSUT3) BLOCK(80) SPACE(250,100)
CALL 'SYS1.LINKLIB(IEMAA)' 'LIST,ATR,XREF,STMT,MACRO'
WHEN SYSRC(LE 4) EXEC LDGO '&NAME.'
FREE FILE(SYSUT1,SYSUT3)
DELETE &NAME..OBJ
END
```

Figure 16. A Command Procedure for a Compile-Load-Go Sequence

```
exec plif 'derv' list
ALLOCATE DATASET(DERV.PLI) FILE(SYSIN)
ALLOCATE DATASET(DERV.LIST) FILE(SYSPRINT) BLOCK(80) SPACE(300,100)
ALLOCATE DATASET(DERV.OBJ) FILE(SYSLIN) BLOCK(80) SPACE(250,100)
ALLOCATE FILE(SYSUT1) BLOCK(1024) SPACE(60,60)
ALLOCATE FILE(SYSUT3) BLOCK(80) SPACE(250,100)
CALL 'SYS1.LINKLIB(IEMAA)' 'LIST,ATR,XREF,STMT'
WHEN SYSRC(LE 4) EXEC LDGO 'DERV'
FREE FILE(SYSUT1,SYSUT3,SYSIN,SYSPRINT)
ALLOCATE DATASET(*) FILE(SYSIN)
ALLOCATE DATASET(*) FILE(SYSPRINT)
LOADGO DERV.OBJ PL1LIB
```

Figure 17. Using a Compile-Load-Go Command Procedure

Problem Solving

To meet the needs of users who may not be professional programmers, three problem-solving languages are available as IBM Program Products with TSO: Interactive Terminal Facility (ITF); BASIC ITF: PL/I, and Code and Go FORTRAN. These languages are available as separate program products. ITF: BASIC is a simple, algebra-like language that can be quickly learned, yet it has the power to perform complex mathematical calculations. ITF: PL/I is a subset of the full PL/I language. It is a more powerful language than BASIC for subroutine handling, but is simpler than the full PL/I language, making it a good teaching tool. ITF: PL/I can be used in two ways: statements can be interpreted and executed as they are entered (desk calculator mode); or they can be collected into procedures for compilation and execution as programs or subroutines. Code and Go FORTRAN provides the full FORTRAN IV language for terminal users. It has a very fast compile-and-execute sequence, carried out entirely in main storage. Code and Go FORTRAN accepts free-form source statements, and has simplified I/O statements for terminals.

All three languages have statement-by-statement syntax checking as the programs are keyed in, and additional diagnostics are sent to the terminal for errors detected during compilation and execution phases. For the ITF: BASIC and PL/I languages, the test mode allows the user to monitor program execution with breakpoints and traces, to inspect and reset the values of variables and to modify main storage during execution. The debug facilities of FORTRAN (G) are included in Code and Go FORTRAN.

Programs in any of the three languages are created, and can be run, in edit mode. Whenever necessary, the user can use EDIT to replace or modify source statements. For small to medium-sized programs performance is better in edit mode than in command mode, since the source statements and, in the case of Code and Go FORTRAN, the object program, can be kept in main storage and do not have to be read in from auxiliary storage.

ITF: BASIC

The ITF: BASIC Program Product is based on the original BASIC language created for time sharing use at Dartmouth College. With TSO, the BASIC user logs on to the system, then enters the EDIT command. In the input mode he enters successive statements to define his problem. If the system detects a syntax error, he is notified immediately so that he can correct the faulty statement before continuing. The user can defer syntax checking until compilation. When all his statements have been entered and syntax checked, the user issues the RUN subcommand to compile and execute the program. An operand of the RUN subcommand specifies whether he wants to execute with short precision (6 significant decimal digits) or long precision (15 digits). Programs and data can be saved from one session to the next, or deleted after use.

BASIC statements are entered one to an input line, and can refer to other statements by the line number assigned by EDIT. Variables always have one- or two-character names. Arithmetic operators used in BASIC statements are +, -, /, *, and ** (exponentiation).

BASIC includes statements for defining and handling one- and two-dimensional arrays. Array references have the form A(i,j) where "A" is the array name, and "i" and "j" are variables or constants referring to the row and column of an element. Elements can contain arithmetic or character values.

A special set of statements is included to handle matrices. A BASIC matrix is always a two-dimensional array, and can contain only arithmetic values. Two matrices with the same dimensions can be multiplied, added, or subtracted, and a matrix can be inverted or transposed with built-in matrix functions.

Figure 18 shows a terminal session creating a BASIC program to calculate the infinite sum

$$\sum_{n=1}^{\infty} X^{-n}$$

to the limit of machine precision. Statements 010 and 020 write messages to the terminal, describing the input requested by statement 030. After initializing the variables, the user states the sum as in BASIC format: S = S+1/(X**N). Statement 070 increments N, and 080 is a check to see if the precision limit has been reached. If it has, control branches to statement 100, to print the results at the terminal. Note that

statement 110 uses an "image" statement to format output, while statement 130 uses the default format.

During the execution of the program, the "?" requests the user to enter the input. When the results are printed and the program terminates, the user is returned to edit mode where he saves the program for use in later sessions.

```
edit rsumx basic
INPUT
010  print 'summing 1/(x**n)'
020  print 'what x'
030  input x
040  let n=0
050  s=0
060  s=s+1/(x**n)
070  n=n+1
080  if s=s+1/(x**n) then 100
090  goto 60
100  print 'number of terms:'|(n-1)
110  print using 120, s
120  :  'sum='##.##############
130  print 'last term=', 1/(x**(n-1))
140  end
150
EDIT
run
     SUMMING 1/(X**N)
     WHAT X
? 1.065
     NUMBER OF TERMS:       176
     SUM= 16.3836700000000
     LAST TERM=     1.53643E-05
save
SAVED
end
READY
```

Figure 18. ITF: BASIC Sample Session

ITF: PL/I

The ITF: PL/I Program Product is a subset of the full PL/I language, suited to problem-solving because of its simplicity and ease of use. For example, there are no arithmetic conversion rules to remember: all arithmetic data is kept in decimal floating-point format. The language is compatible with PL/I as provided by the PL/I (F) compiler, except that Interactive PL/I does not require semicolons to terminate statements, source language programs are stored with variable-length records, and some arithmetic data formats that would default to fixed-point binary in full PL/I are floating-point decimal in ITF: PL/I. A utility command, CONVERT, is provided to format ITF: PL/I source programs for submission to a batch PL/I compiler, if the user wants to create an object program.

ITF: PL/I can be used under either the EDIT or the CALC commands. Under EDIT, statements are collected into a program. When the program is complete, the RUN subcommand is used to compile and execute it. Under the CALC command, statements are interpreted and executed as they are entered. Statements are discarded as soon as they have been executed. Variables, however, are all defined as "static externals" and kept in a table in main storage, where they can be referred to by subsequent ITF: PL/I statements, or displayed at the terminal. The table of variables created during a session using the CALC command can be saved in a data set for use in later sessions.

Variables included in ITF: PL/I are scalars of either single or double precision, arrays of up to three dimensions, character and bit strings, labels, externals, and entry and return parameters. Execution control statements include DO loops, GOTO branch statements, and IF THEN ELSE conditionals. Procedures collected under the EDIT command can be saved and invoked with the CALL statement, either from another procedure or under the CALC command. Only list-directed and edit-directed stream I/O is provided, either to a file or the terminal. An appropriate set of the PL/I built-in functions is included in ITF: PL/I.

Test Facility: When a user invokes an ITF: PL/I or BASIC procedure for execution, as an option he can specify that the program is to be tested. In this case, the system allows the user to set breakpoints in the program before it is started, and to set up program traces and displays of variables. All output from the testing routines is displayed at the terminal. When the program is interrupted by a breakpoint, or when the user hits the attention key, he can display and modify variable values, modify test procedures, and then restart the program at the point of interruption. The ITF testing subcommands are a subset of the TEST subcommands available for the programming languages.

Syntax errors in an ITF: PL/I source statement are detected as soon as the statement is entered, and the user is notified to correct the statement. The user can request deferral of syntax checking to compile time. When operating under EDIT, some errors will only be detected at compile-execute time. In this case, a message is sent to the terminal, and the user is returned to the edit mode to correct the error in the source program.

```
edit div ipli
INPUT
00010    div: procedure(x,y);
00020    /* this procedure is a subroutine that finds the */
00030    /* greatest common divisor of any positive x and */
00040    /* y of six digits or less                       */
00050    x1 = max(x,y);
00060    y1 = min(x,y);
00070    if (x1 <= 0)|(y1 <= 0) then do;
00080                             put list ('invalid values');
00090                             return;
00100                             end;
00110    lab: rem = x1 - (floor(x1/y1)*y1);
00120         if rem = 0 then go to out;
00130         x1 = y1;
00140         y1 = rem;
00150         go to lab;
00160    out: put list ('the common divisor is:',y1);
00170    end
00180
EDIT
save
SAVED
end
READY

calc
CALC
call div(9,24)
THE COMMON DIVISOR IS:       3.00000E+00
end
READY
```

Figure 19. ITF: PL/I Sample Session

Sample Session: Figure 19 shows a sample terminal session using ITF: PL/I to create a procedure finding the largest common divisor of two positive numbers. "Max" and "min" in statements 50 and 60, and "floor" in statement 110 are built-in functions. Note that since no file is specified in the PUT statements, the output is sent to the terminal. At statement 180, the user entered a null line, indicating a switch from the input mode to edit mode. The SAVE subcommand stores the procedure on auxiliary storage. The user then enters CALC to go to the desk calculator terminal mode, and uses a CALL statement to invoke the procedure.

Code and Go FORTRAN

For the many problem-solvers who are familiar with the FORTRAN programming language, the Code and Go FORTRAN Program Product is available for use from the terminal. The user creates his program, and optionally has it syntax-checked, with the EDIT command. He uses the RUN subcommand to invoke the Code and Go FORTRAN compiler. The source program is converted to an object program in main storage. As soon as the object program is complete, control is passed to it. The compiler used for Code and Go FORTRAN bypasses certain object code optimization processing for greater compilation speed.

The language includes all the features of FORTRAN IV as defined in the publication IBM System/360: FORTRAN IV Language. Two extensions to the language are included for ease of use from the terminal: free-form source statements and list-directed I/O statements similar to those provided by PL/I.

Free-Form Statements: Code and Go FORTRAN does not require statements to begin in column 7. If a statement has a label, the statement can immediately follow the label. If it has no label, it can start in column 1.

A utility command (CONVERT) is available to change free-form source statements to fixed form, if a user wants to submit them to one of the batch FORTRAN compilers after developing and testing them in free form. Code and Go FORTRAN will also accept the conventional fixed format.

control characters, and whether an output transmission is to break in on any input transmission in progress. A program using TGET and TPUT does not have to perform OPEN or CLOSE processing, and need not provide a DCB for the terminal. However, these macro instructions are available only to programs executing in the foreground.

Programs designed to be command processors can call on the Getline, Putline, and Putget service routines used by the IBM-supplied command processors for I/O. As noted earlier, these service routines have the capability to switch the input source from the terminal to a buffer in main storage, and to suppress certain types of output if the terminal is not the current input source.

The sequential access methods, BSAM (READ, WRITE, CHECK) and QSAM (GET, PUT), have been extended to issue TGET, TPUT when called from foreground programs for terminal I/O. This is the normal route for terminal I/O from programs that must be executable in the background as well as the foreground, or which are coded in a higher level language, such as FORTRAN or COBOL.

Programs using BSAM or QSAM to reach the terminal use the standard macro instructions or I/O statements. When the program is executed, the DD statement or ALLOCATE command defines whether the I/O is for a data set or the terminal. No recompilation is necessary to switch from one to the other, only a change in the DD statement.

Getline, Putline, Putget and the sequential access methods all issue TGET or TPUT for the caller when the I/O is for a terminal. Figure 29 shows this SVC routine handling calls from a TSO user region and passing the requests to the TCAM Message Control Program.

Multi-Terminal Message Processors

Independent of TSO, the Telecommunications Access Method includes facilities for routine messages received from remote terminals to queues for an application program, and transmitting replies generated by the applications program to queues for a terminal. In a system without TSO, such a message processing program must reside in main storage in one of the problem program regions, when it is to be available if one of the terminals in the telecommunication network sends a message that requires processing. With the addition of TSO, a terminal user logged on to TSO can execute a TCAM message processing program in a foreground region. He can do this by invoking it through the TSO command language, or by specifying it instead of the TSO Terminal Monitor Program on his LOGON procedure. The DD statements which define the process queues must be contained in the LOGON procedure. The program will be swapped in whenever needed, but will not occupy main storage space when it has no messages to process. Unlike standard foreground jobs, which are associated with a single terminal, these message processing programs can handle GET/READ, PUT/WRITE TCAM oriented input/output from any terminal defined to the TCAM processing queues, through the QNAME operand of the statements on the LOGON procedure. In addition, the standard TSO terminal interfaces, can be used to interact with the terminal executing the Message Processing Program. For further information on message processing programs, see IBM System/360, TCAM Programmer's Guide and Reference Manual.

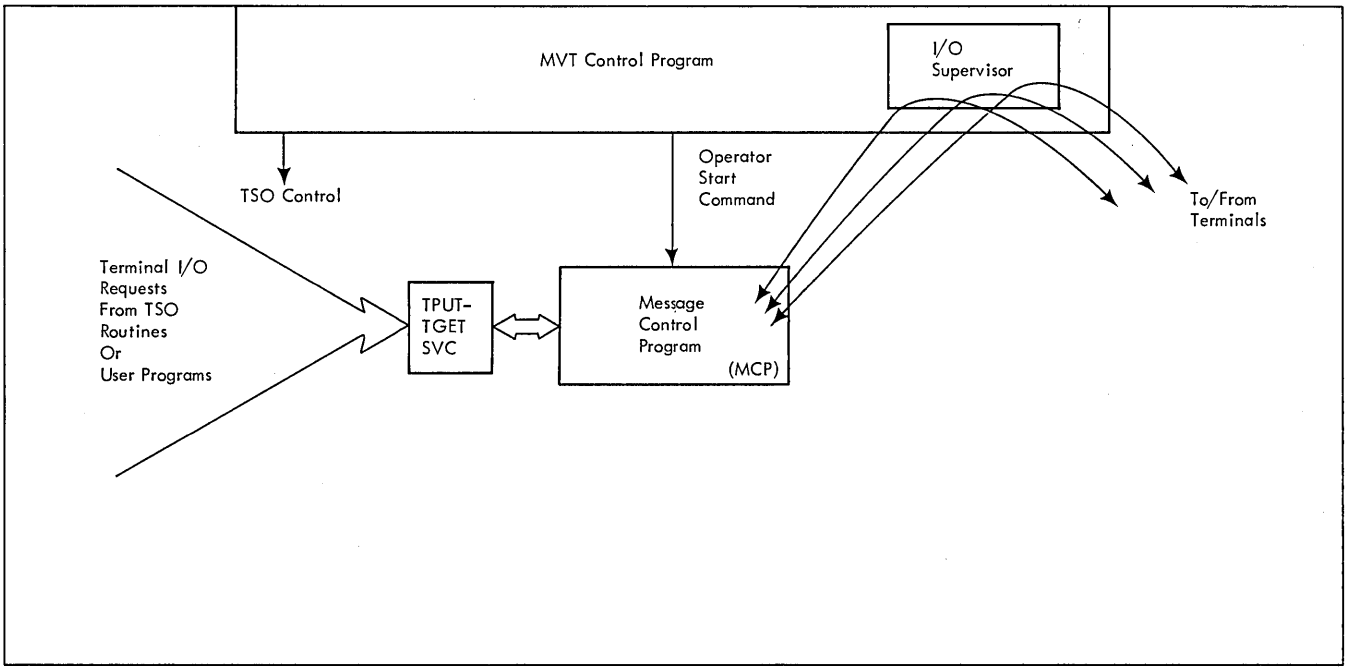

Figure 29. TCAM Message Control Program

reduced before the calculation by any guaranteed background percentage.

The first minor time slice is assigned to the foreground job at the top of the group of time-sharing TCBs on the queue. When the minor slice expires, the TCBs associated with that job are moved to the bottom of the time-sharing group, and the next foreground job receives a minor time slice.

Weighted Dispatching: The third way the minor time slice calculation can be performed is on a weighted basis. This method allows the system to compensate for jobs that are likely to spend much of their minor time slice in the wait state, usually because of pending I/O requests. (But not for pending terminal I/O, since a job waiting for terminal I/O is not swapped in, and never becomes eligible for a minor time slice.) Under weighted dispatching, the system keeps an estimated wait time percentage for terminal job, based on averages of time spent waiting by each job during previous major time slices. Jobs with a high estimated wait time percentage tend to be I/O-bound, and will donate much of their time slices to jobs with TCBs on the queue below them. Jobs with low estimated wait time percentages tend to be compute-bound, and will use most of their minor time slice themselves. It is often desirable to assign the I/O-bound job a weighted, or longer, minor time slice to compensate for its "donation" of execution time to other jobs.

To weight the minor time slices, the system forms a sum of the estimated wait time percentages of the jobs to be assigned minor slices in the current cycle. Each job is then given a fraction of the available execution time equal to its fraction of the total estimated wait time percentages.

The algorithm is:

$$MS = \frac{\text{This job's EWT\%}}{\text{Sum of EWT\%s}} \times (AT)$$

where MS is the minor slice to be assigned to a terminal job, EWT% is the estimated wait time percentage, and AT is the available execution time for this minor slice cycle, again adjusted for any guaranteed background percentage.

As an example, consider a minor time slice calculation for two foreground regions, one containing Job A, which is expected to wait 40 percent of its minor time slice; the other containing Job B, which is expected to wait only 10 percent. The sum of the estimated wait time percentages is 50 percent. Job A gets 40/50, or 4/5, of the available execution time as its minor time slice. Job B is assigned 10/50, or 1/5, of the available execution time. However, Job B will probably be able to execute for about 40 percent of Job A's minor time slice too (while Job A is waiting for I/O), and so will end up with just under half the available execution time -- about what it would have been assigned on an equal division. Job A, however, will be able to get its I/O started, wait for it to complete, and still have some processing time left to handle the data or issue another I/O request. On an equal division of available time, its minor time slice might have expired before its first I/O request completed.

The estimation of wait time percentage is made by updating a running average of a job's wait time percentages at the end of every major time slice. In making the average, a weighting factor is used to emphasize recent usage over earlier usage. The weighting factor is called the wait time decay constant. Its purpose and function is similar to the region activity decay constant, and it can also be specified by the installation. Values appropriate for general job mixes are included in SYS1.PARMLIB.

System Implementation

This chapter is intended for the programmers and system analysts responsible for generating and maintaining a system with TSO. (The discussions assume that the reader is familiar with the System Summary chapter of this publication.) The discussions contains specific implementation information. For example, the discussion "Tailoring a Message Control Program" does not discuss the role a message control program plays in a TSO configuration, but rather provides the syntax and meaning of the macro instruction used to generate a message control program. Included are discussions of how to:

- Generate (or tailor) a Message Control Program.
- Write the cataloged procedures used by TSO.
- Specify TSO starting parameters.
- Tune the Time Sharing Driver and use TSO Trace.
- Write an installation exit from the SUBMIT command processor.
- Write an installation exit from the STATUS, OUTPUT, and CANCEL command processors.
- Write a LOGON Pre-prompt exit.

Tailoring a Message Control Program

TSO includes a standard Message Control Program (MCP) to handle terminal I/O for those installations that use TSO for all their TCAM applications. The installation must tailor the MCP to match its needs in three steps. First, it assembles three macro instructions: LINEGRP, LISTTA, and TSOMCP. The output of this assembly is a series of TCAM (Telecommunications Access Method) macro instructions which must, in turn be assembled. The output of this second assembly forms on MCP that must then be link edited into SYS1.LINKLIB.

Mixed Environment MCPs

If your installation requires a mixed environment Message Control Program, because you have TCAM applications programs, (message processing programs), you must generate your MCP using TCAM macro instructions instead of the special TSO MCP generating macro instructions. You use the TCAM macro instructions to generate an MCP containing the TSO Message Handler and any other message handlers for your particular terminal applications, and the necessary terminal I/O control blocks. The communications lines which are to be used with TSO must be dedicated to the TSO message Handler through the terminal I/O control blocks and the communications lines for TCAM applications dedicated to their message handlers. For further information, see IBM System/360 Operating System: TCAM Programmer's Guide and Reference Manual.

In addition to the standard TCAM macro instructions, there is a specialized macro instruction, the TSOMH macro instruction which expands to form a TSO Message Handler.

The TSOMH macro instruction has one operand CUTOFF which specifies a maximum input message length. The syntax of the TSOMH macro instruction is:

```
TSOMH  [CUTOFF=integer]
       [      300     ]
```

CUTOFF=
specifies the maximum number of bytes before the remainder of the message is lost to the system. The value must be an integer between 150 and 65,535, the default is 300.

TSO-Only MCP

The following is an explanation of each step of the generation of the MCP supplied with TSO:

Step 1 - Assemble the one or more LINEGRP macro instructions each followed optionally by one or more LISTTA macro instructions, all followed by the TSOMCP macro instruction. Place the resultant output in a temporary data set that will be used as input to Step 2. The output of this assembly language source statements -- TCAM macro instructions which constitute a Message Control Program.

Step 2 - Assemble the TCAM MCP macro instructions that are generated within Step 1. The output of Step

2 is the MCP object module and is placed into a temporary data set.

Step 3 - Linkage Edit the object modules from Step 2 into SYS1.LINKLIB to create an executable MCP load module.

Figure 34 shows the Job Control Language necessary to run these steps.

LINEGRP Macro Instruction

The LINEGRP macro is used to define a line group, a group of terminals with similar characteristics, for example, a group of IBM 2741 terminals. The operands specify:

- The types of terminals in the line group. (TERM)
- The ddname of the DD statements that define the communications lines as data sets. (DDNAME)
- The number of lines, that is, physical device addresses in the line group. (LINENO)
- The number of TCAM basic units, per terminal buffer. (UNITNO)
- What translation tables are to be used to translate from the terminal code to EBCDIC. (TRANTAB)
- What character string will identify the transmission code being used when dynamic translation is required. (CODE)
- Whether the terminals in this line group are on switched or nonswitched lines. (DIAL)
- How often polled terminals are to be polled for input. (INTVL)
- What special features the terminals in this line group have -- that is, transmit or receive interruption; and for 1050, Text Timeout suppression. (FEATURE)
- The polling and addressing character of terminals in this line group, for 1050 and 2260/2265. (ADDR)
- For IBM 2260 and 2265 Display Stations the screen sizes.

```
//MCPGEN          JOB       Job card parameters
//
//STEP1           EXEC      ASMFC
//
//ASM.SYSPUNCH    DD        DSN=&&TCM,DISP=(,PASS),
//                          UNIT=SYSDA,SPACE=(CYL,(1,1))
//
//ASM.SYSIN       DD        *
                  LINEGRP
                  LISTTA
                  LINEGRP
                  TSOMCP
                  END
//*
//STEP2           EXEC      ASMFC,COND=(4,LT,STEP1.ASM)
//
//ASM.SYSPUNCH    DD        DSN=&&OBJ,DISP=(,PASS),
//                          UNIT=SYSDA,SPACE=(CYL,(1,1))
//
//ASM.SYSIN       DD        DSN=*.STEP1.ASM.SYSPUNCH,
//                          DISP=(OLD,PASS)
//
//STEP3           EXEC      PGM=LINKEDIT,COND=(4,LT,STEP2.ASM)
//
//SYSLMOD         DD        DSN=SYS1.LINKLIB(IEDQTCAM),DISP=SHR
//
//SYSPRINT        DD        SYSOUT=A
//
//SYSUT1          DD        UNIT=SYSDA,SPACE=(1024,(50,20))
//
//SYSLIB          DD        DSN=SYS1.TELCMLIB,DISP=SHR
//
//SYSLIN          DD        DSN=*.STEP2.ASM.SYSPUNCH,
//                          DISP=(OLD,PASS)
```

Figure 34. Job Stream to Tailor MCP

LINEGRP MACRO INSTRUCTION FORMAT

```
Name              Operation          Operand
(name)LINEGRP     TERM=type
                  DDNAME=ddname
                  LINENO=number
                  [UNITNO=number]
                   [TRANTAB=(table ,table...)]
                   [CODE=(string ,string...)]
                  [DIAL={YES}]
                        {NO }
                   [INTVL=number]
                  [FEATURE=(BREAK, )(ATTN, )(TOSUPPR)]
                           (NOBREAK,)(NOATTN,)
                   [ADDR=character string]
                   [SCREEN=(integer, integer)]
                   [TERMNO=(integer, integer)]
```

TERM=

Specifies the type of terminal making up this line group. Select only one of the following:

1050 -- defines a line group consisting of IBM 1050 Printer-Keyboards on either switched (dial) or non-switched (direct) lines.

2741 -- defines a line group consisting of IBM 2741 Communications-Terminals on either switched or non-switched lines.

5041 -- defines a line group consisting of both IBM 2741s and IBM 1050s. The terminals in this line group must be on switched (dial) lines.

3335 -- defines a line group consisting of Teletype Model 33 or Model 35 or both. The terminals in this line group must be on switched (dial) lines.

226L -- defines a line group consisting of IBM 2260 Display Stations connected on a local line.

226R -- defines a line group consisting of IBM 2260 Display Stations, connected on a remote line, and optionally IBM 2265 Display Stations.

2265 -- defines a line group consisting of IBM 2265 Display Stations.

DDNAME=

Specifies the ddnames of the DD statement that define the terminal lines in the line group as a data set. These DD statements are found in the cataloged procedure that is used to start the MCP.

LINENO=

Specifies the number of lines in this line group. The value is an integer between 1 and 51.

UNITNO=

Specifies the number of basic units per buffer for terminals in this line group. A basic unit is used by TCAM to construct I/O buffers. The default value is 1.

TRANTAB=

Specifies the translation tables to be used for this line group. If this parameter is omitted, all of the supplied translation tables that are valid for the terminal type specified by TERM= will be included except those marked with an asterisk.

TERM=	TRANTAB=	Comments
1050	1050	
2741	CR41	Correspondence
	EB41	EBCDIC
	BC41*	BCD
5041	1050	BCD
	BC41*	BCD
	EB41	EBCDIC
	CR41	Correspondence
3335	TTYB	TTY parity
	TTYC*	TTY non-parity
226L	EBCD	
226R	2260	
2265	2265	

*Not used as a default translation table.

Note: If more than one table is specified explicitly or implied by default, the MCP will determine the proper translation table dynamically using the CODE parameter.

CODE=

Specifies the character string used to determine the terminal character set. Each time a terminal is connected, the MCP translates the input line from that terminal, using each of the translation tables specified in the TRANTAB operand. The MCP compares the translated result with the character string specified in the CODE= operand. When the MCP finds a match, it uses the appropriate translation table with that terminal from then on.

The default is CODE=LOGON unless the TRANTAB operand specified both BC41 and EB41 (2741 BCD and 2741 EBCDIC). If both EBCDIC and BCD character sets are present in the line group, the default is CODE="LOGON.

An installation can specify a maximum of four character strings other than LOGON, but they must be eight or less characters.

DIAL=

Specifies whether the line group is a dial (switched) line group. If this parameter is omitted, YES is assumed. DIAL=NO is required for TERM=226L, 226R, 2265.

INTVL=

Specifies the poll delay intervals in seconds for polled lines. The value is an integer between 1 and 255. If this parameter is omitted, a value of two is assumed for polled lines.

FEATURE=

Specifies the special features that define this line group:

BREAK Specifies that terminals in this line group have the Transmit Interruption feature.

NOBREAK Specifies that terminals in this line group do not have the Transmit Interruption feature. This operand should be specified when any of the terminals in the line group do not have the feature.

ATTN Specifies that terminals in this line group have the Attention feature (Receive Interruption.)

NOATTN Specifies that terminals in this line group do not have the Attention Feature.

TCSUPPR For 1050 terminals, this operand specifies that the optional Text Time-out Suppression feature is present. This operand applies only to 1050 terminals and should be specified only if all 1050 terminals in a 1050 or 5041 group have the feature. When specified read inhibit rather than read commands will be used.

The following table describes the features which may be specified for the 1050, 2741, 5041, 2260 and the 3335 (TWX); where

D = Default.
A = Assumed.
I = Invalid.
O = Optional.

Feature	1050	2741	5041	3335	2260
BREAK	O	D	O	A	I
NOBREAK	D	O	D	I	A
ATTN	D	D	D	A	I
NOATTN	O	O	O	I	A
TCSUPPR	O	A	O*	A	I

*TOSUPPR is optional for the 1050 terminals in a 5041 line group. It is assumed for the 2741 terminals in the same 5041 line group.

ADDR=

Specifies the station identification character (1050) or the two byte control unit, device address (226R,2265) of the terminals in the line group. The character string should be the hexadecimal equivalent of the appropriate transmission code. Hexadecimal characters should be specified without framing characters. For example if the station identification character is "A", the correct specification is ADDR=E2, the hexadecimal equivalent of the 1050 transmission code for the character "A", not ADDR=C1, the hexadecimal equivalent of the EBCDIC character "A". To find the hexadecimal equivalent of a given character in a specific transmission code, consult the component description publications. For the 1050, only the station identification character value need be specified: the component selection character values will default to the common polling and addressing values for input and

output, respectively. 1050 multidrop is not supported.

This parameter is not valid for TERM=2741 or TERM=3335. This parameter is required for TERM=1050 or 5041. For configurations in which the addressing characters vary among the different terminals in the line group as in 2260, the addressing characters should be specified using LISTTA macro instructions (see below) rather than in the LINEGRP macro instruction.

SCREEN
Specifies the screen dimensions of the display station(s) on the line. The first integer specifies the number of rows on the screen. The second integer specifies the number of characters per row. Standard IBM screen size are 12x80, 12x40, 6x40, and 15x64 non-standard sizes will be accepted but a warning will be given. The default for this parameter is (12x80).

TERMNO=
Specifies the number of terminals attached to each non-switched line, used with TERM=226R, and 2265.

Each subparameter specifies the number for the corresponding relative line number. The relative line number within a group refers to the order in which lines are defined in the MCP start cataloged procedure.

LISTTA Macro

The LISTTA macro instruction specifies variations in device address (ADDR) within a line group. One or more LISTTA macro instructions can appear after each LINEGRP macro instruction. Each LISTTA macro instruction modifies one line (RLN) within a line group.

LISTTA MACRO INSTRUCTION FORMAT

Name	Operation	Operand
name	LISTTA	RLN=integer [,ADDR=(chars ,chars...)] [,SCREEN]

RLN
Specifies the relative line number within a line group to which the attributes specified in this macro instruction call apply. The relative line number within a group refers to the order in which lines are defined in the MCP start cataloged procedure. For example, RLN=1 refers to the line in the line group defined by the first DD statement.

ADDR=
Specifies the alphabetic station identification character (1050) or two byte control unit and device address (2260 and 2225) of the terminal(s) on this line. One character string must be specified for each terminal on the line. Subparameters must be specified in the order in which polling is to take place. Each character string should be the hexadecimal equivalent of the appropriate transmission code representation for the terminal involved. Hexadecimal characters should be specified without framing characters.

Example: ADDR=(A0A1,A0A2). For a 2848 Model 2, with two 2260 Display Stations.

For a 1050, only the station identification character value need be specified. 1050 multidrop is not supported.

SCREEN
Specifies the screen dimensions of the display station(s) on the line. The first integer specifies the number of rows on the screen. The second integer specifies the number of characters per row. Standard IBM screen size are 12x80, 12x40, 6x40, and 15x64 non standard sizes will be accepted but a warning will be given. The default for this parameter is (12x80).

TSOMCP MACRO INSTRUCTION FORMAT

TSOMCP Macro

The TSOMCP macro instruction:

- Names the MCP, (provides the CSECT name).
- Defines the size of the TCAM basic units used to construct terminal I/O buffers.
- Specifies which TCAM trace tables will be provided.
- Specifies whether a cross-reference table will be included in the MCP.
- Specifies whether the operator can specify parameters when he starts the MCP.

Name	Operation	Operand
name	TSOMCP	[UNITSIZ=number] [TRACE=number] [DTRACE=number] [LNUITS=number] [OLTEST=number] [OPTIONS=(XREF,PROMPT)]
Note: All operands are optional.		

name
Names the start of the MCP and provides a CSECT label for the generated program. This field is required.

UNITSIZ=
Specifies the size of a TCAM basic unit and must be a value between 38 and 255 inclusive. If omitted, the MCP uses a default size of 44. UNITSIZ should be a multiple of 8, plus 4 for efficient core usage.

TRACE=
Specifies the number of TCAM I/O trace table entries in the Message Control Program. The default value is zero. Maximum value is 65535. See IBM System/360 TCAM Programmers Guide and Reference.

DTRACE=
Specifies the number of TCAM subtask trace table entries in the Message Control Program. The default value is zero. Maximum value is 65535. See IBM System/360 TCAM Programmers Guide and Reference.

LNUNITS=
specifies the number of TCAM basic units (See IBM System/360 TCAM Programmers Guide and Reference) to be provided in the buffer pool for creating line buffers for this MCP. A maximum of 65,535 may be specified. If this operand is omitted, the system will calculate a default value using the following algorithm:

LNUNITS=
2 x (number of terminals) x (UNITNO value) or
2.5 x (number of terminals) x UNITNO for 2265/65

where,

UNITNO (as specified in each LINEGRP macro) represents the number of units per buffer for terminals defined in the associated line group. If UNITNO is omitted in the LINEGRP macro, the default value (1) is used. This means that each buffer will consist of one basic unit.

If both the LNUNITS and UNITNO keywords are defaulted, the buffer pool created will consist of 2 buffers per terminal with each buffer being one basic unit in length. (PCI buffering is used for both input and output.)

OLTEST=
Specifies the number of On-line Test procedures which can execute simultaneously. The value must be between 0 and 255. The default is 0, meaning On-line Test not supported.

OPTIONS

XREF
A cross-reference table including control blocks for each line will be included in the MCP. If this option is omitted, the cross-reference table will be excluded.

PROMPT

If PROMPT is specified, the system operator will be asked tc enter parameters when TCAM is started. At that time he may enter and override some of the parameters specified when the MCP was assembled. The following TCAM parameters are ones which an installation may want to specify when it starts TCAM for TSO. The last parameter entered must be a "U" to end the prompting process. See IBM System/360 TCAM Programmer's Guide and Reference for a description of the INTRO macro instruction and the parameters which can be overridden.

KEYLEN = integer
K = integer

Specifies the size of the basic units, with which the terminal I/O buffers are constructed. This corresponds to UNITSIZ= parameter.

LNUNITS = integer
B = integer

Specifies the number of basic units which are used to build buffers, corresponds to LNUNITS. The value must be between 0 and 65,535

STARTUP
= C
S

Specifies that a "cold" start is to be performed following a shutdown of the Message Control Program or a system failure. It is required if OPTIONS=PROMPT was specified on the TSOMCP macro instruction.

CROSSRF=integer
F = integer

Specifies the number of entries in the cross reference table, a debugging aid. If OPTIONS=XREF is specified in the TSO MCP, one entry will be generated for each line. If the operator specifies fewer entries than there are simultaneously open lines, lines opened after the table is full will have no entries

TRACE = integer
T = integer

Specifies the number of TCAM I/O trace entries to be allocated, corresponds to TRACE= in the TSOMCP macro instruction.

DTRACE = integer
A = integer

Specifies the number of entries in the TCAM Dispatcher Trace Table, corresponds to DTRACE= in the TSOMCP macro. The Dispatcher Trace Table is a debugging aid that keeps a sequential record of TCAM subtasks activated by the TCAM dispatcher. One four word entry is created for each subtask activated; when the end of the table is reached, the table is wrapped around; new entries overlay the oldest entries. Maximum to be specified is 65,535: If 0 is specified, the table is not generated.

OLTEST=number
O=number

Specifies the number of On-line Test procedures that can execute simultaneously. This parameter corresponds to the OLTEST parameter of the TSOMCP macro instruction. The default is 0, which indicates that On-line Test is not supported.

CIB = integer
C = integer

Specifies the maximum number of Command Input Blocks (CIB's) that can be used at any one time in the TCAM subsystem, CIB's are the buffers used to contain operator control messages entered at the system console. Maximum that can be specified is 255; if the operand is omitted, "CIB=2" is assumed. At least two CIB's should be specified, since START uses one. If an attempt is made to enter an operator control message from the system console, and the number of CIB's specified is already in use, the message is rejected by TCAM.

Figure 35 and 36 show the MCP macro specifications for two sample systems.

The first system has:

1. 10 lines for leased, (non-switched), 2741's; all are BCD terminals and use EBCDIC character set only. All terminals in this line group have both Receive and Transmit Interrupt features.
2. 5 lines of teletype (which could be either 33 or 35).

3. The system operator will be prompted to enter TCAM parameters when he starts TCAM. At that time he can override any of the parameters specified on the TSOMCP macro, as well as other TCAM parameters. See the description of the TSOMCP macro instruction, for parameters pertinent to TSO. (The operator will always

have to reply "s=c,u"; STARTUP=COLD and a "u" to terminate prompting.) A Dispatcher Subtask Trace Table, useful for debugging purposes, is to be included in the MCP. It will contain 100 4 byte entries. (DTRACE=100)

The sample system shown in Figure 36 has 10 dial lines, to be used by both 1050's and 2741's. The station identification character for the 1050's is "A". Notice that it is specified in terminal transmission code, (E2) not EBCDIC (C1).

Assume there are four types of terminals in the line group.

A. Three 1050's, with Text Timeout Suppression feature, Receive and Transmit Interrupt features.

B. One 1050, with Text Timeout Suppression feature.

C. Five 2741's, Correspondence Code, Receive and Transmit Interrupt features.

D. Two 2741's, EBCDIC code.

The default is ATTN and NOBREAK.

Users at terminals in groups A and C would use the TERMINAL command to request Transmit Interrupt handling, (BREAK), the installlation could provide a special LOGON cataloged procedure for these users containing a suitable TERMINAL command as the PARM value. Users at terminals in groups B and D would not be able to cause an attention interruption during output, or while the keyboard is locked. They would use the TERMINAL command to set up simulated attention breaks by time interval when the keyboard is locked, or after a number of consecutive lines of output, when output is being sent. This also could be specified in a LOGON procedure.

```
LINEGRP     TERM=2741,DDNAME=LNGP2741,LINENO=10,          X
            TRANTAB=EB41,DIAL=NO
LINEGRP     TERM=3335,DDNAME=LNGPTWX,LINENO=5
TSOMCP      OPTIONS=PROMPT,DTRACE=100
```

Figure 35. Sample MCP

```
LINEGRP     TERM=5041,DDNAME=DIAL5041,LINENO=10,ADDR=E2, X
            FEATURE=TOSUPPR
TSOMCP
```

Figure 36. Sample MCP

Writing Cataloged Procedures for TSO

Two categories of cataloged procedures are used by TSO. The first includes procedures invoked by the system operator when he starts any of these four TSO tasks:

1. The Message Control Program (MCP).
2. The Time Sharing Control Task (TSC).
3. The Background Reader for the SUBMIT command (BRDR).
4. The TSO Trace Writer.

The second category consists of those procedures invoked each time a LOGON command is entered at a terminal. The PROC operand of the LOGON command specifies the name of the cataloged procedure which:

1. Contains the JCL statements that define the data sets available to the terminal user.

2. Specifies the name of the Terminal Monitor Program (TMP) supplied with TSO or the user-written substitute for the TMP.

Both categories of cataloged procedures must be members of SYS1.PROCLIB or members of partitioned data sets concatenated to SYS1.PROCLIB.

Message Control Program

The cataloged procedure used to start the Message Control Program specifies through the PGM= operand of the EXEC statement the MCP to be started. The MCP should be named IEDQTCAM. This name allows the MCP to run in a region smaller than MINPART and ensure that the MCP can not be canceled, that is the operator must halt it. Specify TIME=1440 to eliminate timing. Specify ROLL=(NO,NO) to preclude an attempt to Rollout the MCP. Specify DPRTY=(15,15) to insure high priority. The MCP must run at a higher priority than the TSC.

The cataloged procedure used to start the MCP also must define any terminals attached to the system as data sets. This is done through the ddnames specified in the LINEGRP macro instructions used in generating the MCP. Figure 37 shows two procedures that can be used to start the two sample MCPs generated in Figure 35 and 36.

Time Sharing Control Task

The cataloged procedure used to start the Time Sharing Control Task contains the Job Control statements defining all the system resources the TSC requires. The procedure consists of an EXEC statement and several Data Definition statements.

```
//MCP1   EXEC  PGM=IEDQTCAM,ROLL=(NO,NO),TIME=1440,DPRTY=(15,15),REGION=70K
//LNGP2741   DD UNIT=021  FIRST LINE GROUP DATA SET 2741
//            DD UNIT=022
//            DD UNIT=023
//            DD UNIT=024
//            DD UNIT=025
//            DD UNIT=026
//            DD UNIT=027
//            DD UNIT=028
//            DD UNIT=029
//            DD UNIT=02A
//LNGPTWX    DD UNIT=02B  SECOND LINE GROUP DATA SET TWX
//            DD UNIT=02C
//            DD UNIT=02D
//            DD UNIT=02E
//            DD UNIT=02F

//MCP2   EXEC  PGM=IEDQTCAM,ROLL=(NO,NO),TIME=1440,DPRTY=(15,15),REGION=66K
//DIAL5041   DD UNIT=021  LINE GROUP DATA SET
//            DD UNIT=022
//            DD UNIT=023
//            DD UNIT=024
//            DD UNIT=025
//            DD UNIT=026
//            DD UNIT=027
//            DD UNIT=028
//            DD UNIT=029
//            DD UNIT=02A
```

Figure 37. Sample MCP Start Procedures

The EXEC statement of the cataloged procedure that starts the Time Sharing Control Task, specifies:

- The TSC program name, which is IKJEAT00.
- The TSC region size. If the TSC needs a different sized region, it will obtain one.
- ROLL=(NO,NO) to preclude an attempt to Rollout the TSC region, if OPTIONS=ROLLOUT has been specified during system generation.
- DPRTY=to set a priority for the TSO. It must be lower than the MCP.

Six data sets must be defined.

- SYSPARM -- The library containing TSC initiation parameters. These parameters are discussed under "Writing TSO System Parameters".
- SYSUADS -- The User Attributes Data Set, this data set cannot be concatenated.
- SYSLBC -- The broadcast data set which contains messages from the SEND command and a list of valid users should not be password protected.
- SYSWAP00 -- The swap data sets.
- IEFPDSI -- The partitioned data set containing LOGON cataloged procedures. This data set may be either SYS1.PROCLIB or a partitioned data set dedicated to LOGON procedures. A dedicated data set will speed up LOGON processing.
- SYSTSDP the TSO dump usually a tape volume.

For each of these data set definitions, DISP=SHR should be specified.

Figure 38 shows a sample cataloged procedure to start the TSC.

The data definition ddname on the DD statement defining the SWAP data set specifies whether serial or parallel swapping is to be used. The ddname is of the form

SYSWAPln

Where l indicates the level of the data set, i.e., 0 for prime, 1 for first overflow; and n is the data set number at this level.

For example, if an installation has two data sets and wants to use parallel swapping it would use SYSWAP00 and SYSWAP01 as the ddnames.

If an installation wanted to use a IBM 2301 drum for a prime swap data set and a IBM 2314 as overflow, the ddnames would be SYSWAP00 for the 2301 the prime data set, and SYSWAP10 for the 2314, the first overflow data set. If a system or TSO failure causes TSO to be restarted, you can use IMDPRDMP program to save the swap data sets before attempting to restart TSO. When invoking IMDPRDMP, the DD statements for the swap data sets should be the same as those in the TSO cataloged procedure; the //PRINTER DD statement writes to tape with chained scheduling and a large blocking factor so that the data sets are dumped quickly. The publication IBM System/360 Operating System: Service Aids GC28-6719 shows the procedures for analyzing system failures and how to use the IMDPRDMP program to save the swap data sets.

STARTING AND STOPPING TSO

When the operator starts TSO for the day, he must:

1. Issue a START command to start the Message Control Program. The operand of the START command is the name of the cataloged procedure that provides the Job Control statements necessary to execute the MCP. For example if the cataloged procedure used to start the MCP is named TCAM, the operator will issue a START TCAM command.
2. Issue a START command to start the Time Sharing Control Task (TSC). The operand of this command names a cataloged procedure used to start the TSC. For example if the cataloged procedure used to start the TSC is named TS, the operator would issue a START TS command.

When the operator stops TSO for the day, he must:

1. Issue a STOP command to stop the Time Sharing Control Task. The operand of the STOP command must be the same as the operand that was used to start the TSC.
2. Issue a HALT command to stop the Message Control Program. If the PGM= operand of the EXEC statement in the cataloged procedure used to start the MCP is IEDQTCAM, then the MCP cannot be cancelled with a CANCEL command. If the operator cancels the MCP, the TSO must be stopped before the MCP is

```
//IEFPROC   EXEC  PGM=IKJEAT00,ROLL=(NO,NO),DPRTY=(13,13)
//SYSPARM   DD  DSN=SYS1.PARMLIB,DISP=SHR
//SYSUADS   DD  DSN=SYS1.UADS,DISP=SHR
//SYSLBC    DD  DSN=SYS1.BRODCAST DISP=SHR
//SYSWAP00  DD  DSN=SYS1.SWAP1,DISP=SHR
//SYSWAP01  DD  DSN=SYS1.SWAP2,DISP=SHR
//IEFPDSI   DD  DSN=SYS1.PROCLIB,DISP=SHR
```

Figure 38. Sample Cataloged Procedure to Start Time Sharing Control Task

restarted. The MCP cannot be halted with a HALT command unless the TSO is stopped.

DEFINING A UADS USING THE TSC PROCEDURE

When a TSO system is first started after system generation, it is necessary to construct a UADS using the ACCOUNT command. The distributed UADS contains one valid user:IBMUSER and this user is authorized to use one procedure: IKJACCNT. He should use the ALLOCATE command to define a new UADS with a file name of SYSUADS and a data set name other than SYS1.UADS, specifying its volume serial number, and define his UADS structure with a series of ACCOUNT command ADD subcommands. He should then log off, stop the system, and change the SYSUADS DD statement in the TSC start procedure, to point to the new UADS. If the cataloged procedure defines SYSUADS though a DSN= operand, then he need only rename the data set.

Background Reader (BRDR)

The cataloged procedure used to start the Background Reader (BRDR) contains Job Control statements that

- Specify the program name of the Background Reader.
- Pass the Background Reader standard Reader-Interpreter parameters.
- Define required data sets.

The Background Reader, (BRDR), runs as a system task. It is started by the operator. It interprets Job Control Language passed by a terminal user with the SUBMIT command. If there is no input for the BRDR, it will relinquish its region and wait for input. Output from the BRDR is placed on SYS1.SYSJOBQE and is queued for execution by a standard initiator. The cataloged procedure that provides the Job Control Language to start the Background Reader is similar to other reader procedures. The BRDR program name is IKJEFF40. Figure 39 shows an example of a BRDR procedure. For further information on writing system reader/interpreter cataloged procedures, see IBM System/360 Operating System: System Programmers Guide, GC28-6550.

An installation exit can gain access to and modify or delete any JCL passed by the SUBMIT command processor. The section, "Writing Installation Exits for the SUBMIT Command" describes how to write this exit.

```
//BRDR    EXEC  PGM=IKJEFF40,
//              REGION=70K,
//              PARM='READERPARM'
//IEFPDSI DD    DSN=SYS1.PROCLIB,
//              DISP=SHR
//IEFDATA DD    UNIT=SYSDA
//              SPACE= (80,(500,50),RLSE,CONTIG),
//              DCB=(BUFNO=2,LRECL=80,BLKSIZE=80,DSORG=PS,
//              RECFM=F,BUFL=80)
//IEFRDER DD    DUMMY
```

Figure 39. Sample Background Reader (BRDR) Procedure

PARAMETER OWNER	KEYWORD	MEANING
TS	TERMAX=nnnn	Specifies maximum number of users.
	USERS=nnnn	Specifies initial maximum number of users, defaults to TERMAX, can be changed by MODIFY command.
	REGNMAX=nn	Specifies number of TSO user regions.
	MAP=nn	Specifies the number of MAP entries, used to reduce swapping of unused storage.
	SMF=[OFF / OPT=1 / OPT=2] [,EXT=(YES / NO)]	Standard SMF parameters, see MVT Job Management.
	DSPCH=cccccc	Specifies first six characters of Time Sharing Driver. Defaults to IKJEAD, driver supplied with TSO. This parameter defines the names of all four Driver modules. That is the driver supplied with TSO has four modules, IKJEAD00 to IKJEAD03.
	LPA=(module list)	List of modules to be included in Time Sharing Link Pack Extension.
	REGSIZE(nn)=(mmK, iiik)	Specifies region size (mmk) and LSQS size (iiik) for region nn. Defaults to zero.
	SUBMIT=nnnn	Specifies the maximum number of tracks in the SUBMIT command job queue. Defaults to limit set at System Generation.
	DUMP=[DUMP / NODUMP]	Specifies whether the SYSTSDP DD statement is in the START TSO procedure and the TSO dump facility will be used.
DRIVER	WAIT / NOWAIT	Specifies use of wait estimate option.
	ACTIVITY / NOACTIVITY	Specifies whether Region activity estimate is to be used in assigning a user to a region. NOACTIVITY required for single region system.
	OCCUPANCY / NOOCCUPANCY	Specifies whether core occupancy estimates are to be used in queue selection.
	SWAPLOAD / NOSWAPLOAD	Specifies whether swapload is to be used in queue placement.
	AVGSERVICE / NOAVGSERVICE	Specifies average queue service time to be used.
	PRIORITY / NOPRIORITY	Specifies whether priority scheduling is to be used.
	PREEMPT/ / NOPREEMPT	Specifies whether preemptive scheduling is to be used
	BACKGROUND=nn/ / NOBACKGROUND	Specifies a percentage of CPU time guaranteed to the background or no guaranteed time.
	DECAYWAIT=nnnn	Specifies in 100ths the decay constant for the wait estimate. Assumes WAIT specified.

Figure 42. TSO System Parameter Syntax (Part 1 of 2)

PARAMETER OWNER	KEYWORD	MEANING
	DECAYACT=nnnn	Specifies in 100ths the decay constant for the activity estimate. Assumes ACTIVITY specified.
	SUBQUEUES(n)=mmm	Specifies the number of queues for region n.
	CYCLES(n,m)=iii	Specifies the number of service cycles to be given to the mth queue of the nth region.
	MAXSWAP=(n,m)=iii	Specifies the maximum number of 1024 byte blocks which may be allowed to a user on queue m, in region n. Assumes SWAPLOAD specified.
	MAXOCCUPANCY(n, m)=iii	Specifies the maximum amount of time in 100th of a second a user on queue m in region n can reside in core.
	SERVICE(n,m)=iii	Specifies the average service time in 100ths of a second for a user on queue m in region n.
	MINSLICE(n,m)=iiii	Specifies the minimum time slice in 100th of a second to be given to a user on queue m in region n.
TIOC	BUFSIZE=nn	Specifies size of terminal buffer. Default 44.
	BUFFERS=nn	Total number of buffers.
	OWAITHI=nn	Specifies maximum number of allocated output terminal buffers per user in order to put a user program into output wait.
	INLOCKHI=nn	Specifies the maximum number of allocated input terminal buffers per user in order to lock a users keyboard.
	OWAITLO=nn	Specifies the number of allocated output buffers to bring a user out of output wait state. In other words if OWAITLO=4, when 4 or less buffers remain allocated, the user is brought out of output wait.
	INLOCKLO=nn	Specifies the number of currently allocated input buffers to unlock the terminal keyboard for input. In other words, when the number of allocated input buffers falls to or below the INLOCKLO value, the user's keyboard is unlocked.
	USERCHG=nn	Specifies percentage of change in logged on users needed to redistribute buffers and recalculate the OWAITHI and INLOCKHI numbers during slack time.
	RESVBUF=nn	Specifies the total number of terminal buffers that must be free to avoid locking all terminals to prevent input.
	SLACK=nn	Specifies number of logged on users that constitute slack time.

Figure 42. TSO System Parameter Syntax (Part 2 of 2)

Entry Type	When Produced	Description of Contents
'A'	When the trace writer is started.	Word 1 X'FFFFFFFD' Word 2 # of 3-word entries per record Word 3 Time of Day in timer units
'B'	When the trace writer is stopped.	Word 1 X'FFFFFFFE' Word 2 Date in packed decimal 00YYDDDS Word 3 Time of Day in timer units
'C'	When information was lost (volume switching, low sampling rate, etc.	Word 1 X'FFFFFFFF' Word 2 Number of entries lost Word 3 Time of Day in timer units of the first lost entry
'D'	Normal entry (contains words 1-3 of the DPA).	Word 1 Bytes 1-2 TJID or 0 Byte 3 Reserved (X'00') Byte 4 Entry code Word 2 Contents of register 1 on entry to TSIP Word 3 Time of Day in timer units
'E'	Following a normal entry with entry code 0 (TMP entry).	Words 1-2 Command name Word 3 Unpredictable
'F'	Following a normal entry with entry code 25 (LOGON establishes PSCB).	Bytes 1-7 USERID Bytes 8-12 Unpredictable
'G'	Following a normal entry with entry code 44 (FE Serviceability)	Diagnostic data (There will be2 +[1] 3-word groups of data available. The value of n is contained in bits 5-7 of word 2 of the normal entry.

Figure 45. Format of the TS Trace Data Set

CODES
specifies which class of entry codes are to be included in the listing. The subparameters, S,T and D represent 'System' codes, 'Terminal I/O' codes, and "Dispatcher" codes, respectively. The listing, therefore, will contain only those entry codes belonging to the class, or classes, specified. Appendix C lists the Entry Code classes. These subparameters may be written in any order, but must not contain delimiters nor embedded blanks. If the CODES parameter is omitted, all non-dispatcher entries will be listed, i.e., CODES=ST is the default option.

TJID=XXX[- YYY]
specifies that only entries associated with the TJID specified by the number XXX are to be listed. If YYY is also given, all entries associated with TJID's in the range XXX to YYY, inclusive, are listed. If the value given for XXX is zero, all entries will be listed. (This is also the default if the 'TJID' parameter is not specified.) Both numbers XXX and YYY must be specified as decimal digits. The maximum length of each number is three digits.

CLOCK=XXXXXXX[- YYYYYYY]
indicates that nc entry before time XXXXXXX (relative to the starting time of the first entry) is to be included in the listing. If -YYYYYYY is specified no entry after that time is listed. Both numbers must be specified as decimal digits and given the time in seconds. The maximum length of each number is seven digits.

Writing Installation Exits for the Submit Command

A user exit from the SUBMIT command allows an installation to:

- Verify a jobname.
- Verify a userid.
- Send a message to the terminal and optionally request a reply.
- Cancel a SUBMIT request.

The TSO SUBMIT command allows a terminal user to initiate a background job. A description of the syntax and use of the SUBMIT command is found in IBM System/360 Operating System; Time Sharing Option, Command Language.

The SUBMIT command processor writes the contents of a user specified data set consisting of Job Control Language statements, (JCL), and input data, onto a logical extension of SYS1.SYSJOBQE. The size of this extension is limited at system generation time by the SUBMITQ operand of the TSO OPTION macro. Size can be further limited by the SUBMIT parameter which the Time Sharing Control Task reads from SYS1.PARMLIB when the operator issues a START TS command.

Any authorized terminal user can submit a background job, but no jobs will be scheduled if the operator has not issued a START BRDR command.

An installation can control foreground initiated background jobs through an installation written SUBMIT exit routine. Through the routine an installation can:

- Delete, modify, or insert statements.
- Request that a message be displayed at the terminal and optionally request a reply.

The routine must be linkage edited as an independent module, given the name IKJEFF10, and cataloged in SYS1.LINKLIB. The SUBMIT command processor invokes the user written exit when the first JOB statement is read. Return codes in register 15 control subsequent calls. The return codes are:

0 - continue -- that is process the current statement and read the next.

4 - reinvoke the exit for another statement -- that is process the current statement and invoke the exit for the next statement.

8 - display a message at the terminal and invoke the exit.

12 - display a message at the terminal, obtain a response, and invoke the exit. (If the user has specified NOPROMPT, this will cause the SUBMIT processor to abort.)

16 - abort.

Upon entry to the user written exit routine, register 1 contains the address of a list of six fullwords.

1st word - address of the current statement.

If zero, entry is to get a statement (return code from previous call was 4). To delete the current statement, zero out the first word.

2nd word - address of a message to be displayed on terminal.

If non-zero, return code from previous call was 8 or 12. The exit may free the buffer. If zero, no message, the return code was 0, 4, or this is the first call.

3rd word - address of response.

If the exit return code from the previous call was 12, SUBMIT will free the buffer. The format of both the message and the response is LLtext where LL is a two byte length field containing one length of the text, maximum length 82 bytes.

4th word - address of USERID.

The USERID is 8 characters left justified padded with blanks.

5th word - address of control switches.

Byte 0 specifies under what conditions SUBMIT will call the exit.

Byte	Bit	Meaning
0	0	Call for JOB card
	1	Exec
	2	DD
	3	Command
	4	Null
	5	Reserved
	6	Reserved
	7	Reserved

Byte 1 if non-zero contains the card column where the operand field begins. For example, if the operand field

Storage Estimates

The estimates included in this chapter are intended for planning purposes only. None of these estimates have been verified, and they are subject to change. Verified estimates will appear in the publication IBM System/360 Operating System: Storage Estimates, GC28-6551, when they are available.

This chapter contains three sections: main storage requirements, sample configurations, and auxiliary storage considerations. All figures in this chapter are decimal, and "K" represents a factor of 1024.

Main Storage Requirements

The main storage requirement for TSO is divided into four major parts:

- An addition to the MVT basic fixed requirement.
- The TCAM Message Control Program requirement.
- The Time Sharing Control region requirement.
- The foreground regions in which users' programs are executed.

Only the first of these requirements has any effect on the batch environment if time sharing is not active. Storage for the TCAM, Time Sharing Control, and froeground regions is obtained from the dynamic area when the operator starts time-sharing operations. This storage is returned to the dynamic area when time sharing is stopped, and is again available for batch processing.

MVT BASIC FIXED REQUIREMENT

The main storage basic fixed requirement for an MVT system is for:

- The nucleus.
- The Master Scheduler Region.
- The Link Pack Area (LPA).
- The System Queue Area (SQA).

Storage for the basic fixed requirement is allocated by the Nucleus Initialization Program (NIP) when the system is started and does not normally vary while the system is running.

Nucleus

Including TSO at system generation adds approximately 3K to the size of the resident MVT nucleus, for a total requirement of about 45K. In addition, communication lines, like other I/O devices, require 40 bytes each in the nucleus for control blocks.

Master Scheduler Region

The master scheduler region is increased by approximately 4K to handle new or extended operator commands for the time-haring environment, and for extended error recovery. The total requirement is about 16K.

Link Pack Area

One small TSO module is added to the required MVT link pack area list of resident modules. The minimum link pack area size remains 10K. If the standard MVT resident reenterable load module and resident SVC lists are used at system generation, the LPA requirement is about 54K. If space is available, an additional 16K of SVC modules for time sharing are appropriate for the resident list, for a total LPA size of 70K.

Additional resident reenterable load modules for time sharing are placed in an extension to the link pack area allocated in the Time Sharing Control region, and are resident only when time sharing is active. The size of this extension, called the Time Sharing Link Pack Area (TSLPA), is discussed with the Time Sharing Control Region requirement.

System Queue Area

During time-sharing operations, use of the system queue area is kept to a minimum by placing as many control blocks as possible into a local system queue area (LSQA) defined in each foreground region. Control blocks in the local SQA are swapped in and out of main storage along with the foreground job they apply to.

Some control blocks associated with foreground jobs, such as queue elements for named data sets and operator reply queue elements, must remain in main storage while the job is swapped out. Space for these control blocks, and for all control blocks associated with the tasks supervising the time-sharing operation must be allocated

from the system queue area. These requirements must be considered when setting SQA size at system generation or at nucleus initialization.

MESSAGE CONTROL PROGRAM REQUIREMENT

The size of the TCAM Message Control Program region depends largely on what options are selected and what hardware is present on the teleprocessing network. In addition to the minimum requirement for the Message Control Program routines, there are requirements for each defined line group, each additional terminal type, and for each permitted user. If teleprocessing applications other than TSO are present, additional routines to handle different buffering and queuing techniques will be needed.

In a system with TSO as the only teleprocessing application, with three terminal types and two line groups, the Message Control Program requirement is expected to be about 52K plus 800 bytes for each possible concurrent user. Although the Message Control Program executes in a problem program region, the region may be smaller than the normal minimum problem program region size (MINPART).

TIME SHARING CONTROL REGION REQUIREMENT

The Time Sharing Control region must provide space for programs for the Time Sharing Control Task, Region Control Tasks, several resident SVC routines, the time sharing extension to the link pack area, and various control blocks. Some of the control blocks are repeated for each foreground region, for each swap data set, or for each time sharing user. An initialization routine brought in when the operator starts time sharing analyzes the time-sharing parameters supplied by the installation, calculates the region size requirement, and obtains the region from the dynamic area.

Using a buffer length of 40 bytes, and assuming eight buffers per time-sharing user, a TSO configuration with two IBM 2314 swap data sets, one foreground region, and 20 users would require a time sharing control region of about 87K. A larger configuration, with two 2301 swap data sets and two 2314 swap data sets, four foreground regions, and 100 users would require about 117K for the time sharing control region.

DYNAMIC AREA REQUIREMENTS

The SEND operator command, like several others already in the MVT configuration, obtains and uses an 12K operator command region from the dynamic area when the operator enters it. This area is freed when processing of the command is completed.

When it is active, the time sharing trace facility requires a 20K region from the dynamic area.

FOREGROUND REGION REQUIREMENT

The foreground region contains the programs invoked by the terminal user. Space must be provided in the foreground region for the local system queue area (LSQA) and for four main storage subpools used for control blocks for the command system.

The subpools defined are:

- Subpool 0--4K.
- Subpool 1--4K.
- Subpool 78--2K.
- Subpool 251--2K.

The minimum foreground region size is 72K, and all IBM-supplied command processors except some of the language processors can execute in this region.

Auxiliary Storage Requirements

The major additions to the system auxiliary storage requirements for TSO are for the swap data sets and new or larger system libraries and data sets. The installation must also consider the direct access storage needs of the individual terminal users, and make allowances for these in the size of the system catalog and password data sets.

SWAP DATA SETS

A swap data set is divided into swap allocation units, each of which consists of a device-dependent number of 2K records. To avoid space fragmentation, space in the swap data set is always assigned in integral swap allocation units. Figure 47 shows the sizes of allocation units for various swap devices.

Device	Type	Allocation Unit	Size
2301	Drum Storage	1 track	18K
2303	Drum Storage	4 tracks	18K
2305-1	Fixed Head Storage	4 tracks	44K
2305-2	Fixed Head Storage	4 tracks	52K
2314	Direct Access Storage	1/2 cylinder	64K
3330	Disk Storage	3 tracks	32K

Figure 47. Swap Allocation Unit Sizes

For a system with one foreground region, the maximum necessary swap space can be calculated by the algorithm:

Swap Space = (R/A)•(U+2)

where:

R is the size of the region.

A is the size of an allocation unit, as shown in Figure 47, (R/A is rounded up to an integer).

U is the number of concurrent foreground jobs.

For instance, a system with one foreground region of 120K, an IBM 2314 swap device, and 30 possible users would have a maximum swap data set space requirement of:

(120/64)•(30+2) = 2•32 = 64 allocation unit
or 32 cylinders

In this case, the number of allocation units required to hold a complete foreground region is two, and the number of users plus two is 32.

If TSO runs out of swap space, no message is issued, and the system may loop, so allow sufficient space.

SYSTEM LIBRARIES AND DATA SETS

The additions to system libraries for TSO are expected to be (with the increments expressed in 2311 tracks):

- SYS1.LINKLIB--30 tracks.
- SYS1.SVCLIB--20 tracks.
- SYS1.MACLIB--60 tracks.

Two new libraries, SYS1.CMDLIB (command library) and SYS1.HELPLIB (HELP data set), are expected to be smaller than 220 IBM 2311 tracks each.

The size of the User Attribute Data Set, a partitioned data set with a member for each user identification, depends on the number of password-identification-account number-procedure name combinations defined for each user. A simple identification structure for a single user with a single value at each level requires about 200 bytes of storage space.

Typical time-sharing usage also requires more space for the system catalog and password data sets than batch usage. All user data sets are cataloged as a default, and read-only password protection is recommended at least for system data sets. This type of protection does not cause any performance degradation when the data sets are accessed for reading.

Appendix A: TSO Commands

The commands available to terminal users of the Time Sharing Option are listed below, grouped according to function. Installations may give other names to these commands by assigning aliases to the respective members in the system command library. No IBM-supplied command names include numerals, allowing installations to ensure uniqueness in locally named commands.

Data Management

ALLOCATE
define and allocate a new or old data set.

CONVERT
convert source programs written in Code and Go FORTRAN or Interactive PL/I to standard format FORTRAN or PL/I.

COPY
duplicate a sequential or partitioned data set, or a member of a partitioned data set, optionally modifying such characteristics as blocking factor.[1]

DELETE
delete and uncatalog one or more data sets or members.

EDIT
invoke the edit mode or input mode to modify or create a data set; provide an interface to the language syntax checkers and processors.

FORMAT
format a data set for printing according to embedded controls.[1]

FREE
release a data set.

LIST
display at the terminal all or part of one or more data sets, optionally re-arranging information in the records.[1]

LISTALC
display at the terminal the names and characteristics of currently active (allocated) data sets.

LISTBC
display at their terminal any system notices or messages from other users.

LISTCAT
display at the terminal the names and characteristics of a group of data sets indexed together in the system catalog.

LISTDS
display at the terminal the characteristics of one or more specified data sets.

MERGE
copy all or part of one data set or member into another.[1]

PROTECT
assign or modify password protection to a data set.

RENAME
change the name of a data set or member, or assign an alias to a member.

Language Processors

ASM
invoke the prompter for[1] the Assembler (F).

CALC
invoke the Interactive PL/I processor for desk calculator mode.[1]

COBOL
invoke the American National Standard COBOL compiler.[1]

FORT
invoke the FORTRAN (G1) compiler.[1]

RUN BASIC
invoke the ITF: BASIC compiler and execution control routines.[1]

RUN GOFORT
invoke the Code and Go FORTRAN compiler and execution control routines.[1]

RUN IPLI
invoke the ITF: PL/I compiler and execution control routines.[1]

PLI
invoke the PL/I Optimizing compiler.[1]

PLIC
invoke the PL/I Checkout Compiler.[1]

---

[1]IBM Program Products. See Appendix B.

Program Control

CALL
invoke a specified program which exists in load module form.

LINK
invoke the Linkage Editor to create a load module from one or more object and load modules.

LOADGO
invoke the Loader to process a specified object module, bring it into storage, and give it control.

RUN
invoke a user program in source program form, first compiling it, then calling the Loader to bring it into storage and give it control.

TEST
control the execution of a program, interrupting it at pre-specified points for debugging activity.

Remote Job Entry

Note: Use of these commands requires authorization in the user profile.

CANCEL
cancel a job previously submitted for background execution.

OUTPUT
direct SYSOUT data sets and system messages from submitted jobs to the terminal or a specified data set.

STATUS
display information at the terminal on the status of a job previously submitted for background execution.

SUBMIT
submit a data set containing job control language for one or more jobs for interpretation and execution in the background.

System Control

Note: Use of these commands requires authorization in the user profile.

ACCOUNT
add or modify user profiles in the User Attribute Data Set.

OPERATOR
invoke the operator mode, allowing the user to enter system commands from his terminal.

Session Control

EXEC
invoke a command procedure.

HELP
display at the terminal information on command function and syntax.

LOGON
start a terminal session.

LOGOFF
end a terminal session.

PROFILE
specify special characters for line editing; lock out and accept messages from other users.

SEND
direct a message to the system operator or to another user.

TERMINAL
specify the conditions under which an attention interruption is to be simulated, for terminals without attention keys; and define other terminal-dependent characteristics.

TIME
display at the terminal the amount of time expended during the current session or the current program.

Appendix B: Program Products

The following is a list of the IBM Program Products available for use with TSO. Program Products are available from IBM for a license fee. Program Product Design Objectives for each of the Program Products are available from your local IBM representative.

- Interactive Terminal Facility (ITF): PL/I and BASIC.
  A problem-solving language processor. See the following publications: IBM System/360 Operating System Time Sharing Option:
  Interactive Terminal Facility: PL/I and BASIC Design Objectives, GC28-6822.
  ITF: PL/I General Information, GC28-6827.
  ITF: BASIC General Information, GC28-6828.

- Code and Go FORTRAN.
  A FORTRAN compiler designed for a fast compile-execute sequence. See the publications:
  Code and Go FORTRAN Design Objectives, GC28-6823.
  FORTRAN Program Products for OS and OS with TSO, General Information, GC28-6824.

- FORTRAN IV (G1).
  A version of FORTRAN IV providing specific support for the terminal environment. See the publications:
  FORTRAN IV (G1) Processor Design Objectives, GC28-6845.
  FORTRAN Program Products for OS and OS with TSO, General Information, GC28-6824.

- TSO FORTRAN Prompter.
  An initialization routine to prompt the user for options, and invoke the FORTRAN IV (G1) Processor. See the publications:
  TSO FORTRAN Prompter Design Objectives, GC28-6843.
  FORTRAN Program Products for OS and OS with TSO, General Information, GC28-6824.

- FORTRAN IV Library (Mod 1).
  Execution-time routines for list-directed I/O, PAUSE, and STOP capability, for use with either Code and Go FORTRAN or FORTRAN IV (G1). See the publications:
  FORTRAN IV Library (Mod 1) Design Objectives, GC28-6844.
  FORTRAN Program Products for OS and OS with TSO, General Information, GC28-6824.

- American National Standard Full COBOL Version 3.
  A version of the American National Standard COBOL compiler modified for the terminal environment. See the publication:
  American National Standard (ANS) Full COBOL Compiler Version 3 Design Objectives, GC28-6406.

- TSO COBOL Prompter.
  An initialization routine to prompt the user for options, and invoke the American National Standard Full COBOL Version 3 Compiler. See the publication:
  TSO COBOL Prompter Design Objectives, GC28-6404.

- PL/I Optimizing Compiler.
  A PL/I compiler designed for compilation of efficient object programs, incorporating a prompter routine allowing invocation from the terminal. See the publications:
  PL/I Optimizing Compiler Design Objectives, GC33-0013.
  PL/I Optimizing Compiler, General Information, GC33-0001.

- PL/I Checkout Compiler
  A PL/I compiler designed to simplify the task of testing and debugging programs, incorporating a prompter routine allowing invocation from the terminal. See the publications:
  PL/I Checkout Compiler Design Objectives, GC33-0028.
  PL/I Checkout Compiler, General Information, GC33-0003.

- OS PL/I Resident Library.
  A subroutine library for use during the linkage editing of programs produced by the PL/I Optimizing Compiler. See the publication:
  OS PL/I Resident Library Design Objectives, GC33-0014.

- OS PL/I Transient Library.
  A subroutine library for use during the execution of programs produced by the PL/I Optimizing Compiler. See the publication:
  OS PL/I Transient Library Design Objectives, GC33-0015.

- TSO Assembler Prompter.
  An initialization routine to prompt the user for options and invoke the Assembler (F). See the publication:

TSO Assembler Prompter Design Objectives, GC26-3734.	
• TSO Data Utilities: COPY, FORMAT, LIST, MERGE.	A set of commands and EDIT subcommands to manipulate data sets and format text. See the publication: TSO Data Utilities: COPY, FORMAT, LIST, MERGE Design Objectives, GC28-6750.

Entry Code Table (Part 3 of 4)

Event Name (Entry Code)	Calling Routine (CLASS)	Reason for Entry	Input Register 0	Input Register 1
SPRGNSZ (27)	Timer Sharing Control Task, Region Control Task (S)	Specify size region for specific region	0	Region number Required region size
(28)	Reserved			
LOGOFF (29)	End of Task (S)	TJID is to be released. Region can be released.	TJID	
LOGON (30)	LOGON (S)	Hook user into selected region	TJID	Region ID
REQRGNID (31)	Time Sharing Control Task, Logon (S)	Obtain region ID appropriate to size	TJID	Region size
SWINERR (32)	RCT and Time Sharing Control Task (SWAP) (S)	Swap in failed	TJID	Bit 0 0: LOGON image 1: Not LOGON image
SWOTERR (33)	Time Sharing Control Task (SWAP) (S)	Swap out failed. No room on SWAP data set	TJID	
TGETPUT (34)	TGET, TPUT (T)	TGET was satisfied; TPUT was satisfied	TJID	Bit 0: 0 - TGET 1 - TPUT For TGET, Bit 1: 0 - all data transfered 1 - partial transfer Bytes 3 and 4: Characters transferred
ATTN (35)	Terminal Handler (T) Attention	Attention (not line delete)		Sign bit: 0 - No exit 1 - Exit
IOERROR (36)	Terminal Handler HANG UP(T)	Permanent I/O Error Terminal disconnected	TJID	

Entry Code Table (Part 4 of 4)

Event Name (Entry Code)	Calling Routine (CLASS)	Reason for Entry	Input Register 0	Input Register 1
TERMDSCN (37)	Terminal Handler LOGOFF (T)	Disconnect terminal logically from TSO	TJID	
(38)	Reserved			
(39)	Reserved			
RGNFAIL (40)	Time Sharing Control Task Region Control Task (S)	Region failed		Region ID
DONTSWAP (41)	Transient Area Handler (S)	Do not swap out user	TJID	
OKSWAP (42)	Transient Area Handler (S)	Allow swap out of user	TJID	
UPDATACC (43)	LOGOFF (S)	Update accounting information for user logging off	TJID	
FEDIAG (44)	Serviceability (S)	FE diagnostics recorded in TSO TRACE data set	0	Bit 0: 0 Bits 1-4: Diagnostic Identifier Bits 5-7: n when 2(n+1) equals number of entries Bits 8-31: address of data to be recorded.
ENQWAIT (45)	Enqueue (S)	User in enqueue WAIT. Swap him out.		

Note: On entry to the Time Sharing Driver, Register 0 contains either:

1) 0 - shown in one table as 0.
2) A specific TJID - shown in one table as TJID.
3) The TJID of the current tasks - shown in the table as blank.

CLASS refers to the TSO Trace Data Set Processor CODES parameter.

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Order No. GC28-6698-3

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IBM Technical Newsletter

File No. S360-20 (OS Release 20.6)

Base Publ. No. GC28-6698-3

This Newsletter No. GN28-2502

Date: September 1, 1971

Previous Newsletter Nos. GN28-2497

IBM System/360 Operating System:
Time Sharing Option Guide

This Technical Newsletter, applies to release 20.6 of IBM System/360 Operating System, provides replacement pages for the subject publication. These replacement pages remain in effect for subsequent releases unless specifically altered. Pages to be inserted and/or removed are:

Cover,2
Summary of Amendments
15,16,16.1
47,48,48.1
71,72
75-78,78.1
87,88

A change to the text or a change to an illustration is indicated by a vertical line to the left of the change.

Summary of Amendments

The TSC start parameters and the operator START command have been changed. The specifications for the swap data set definitions have changed.

Note: Please file this cover letter at the back of the manual to provide a record of changes.

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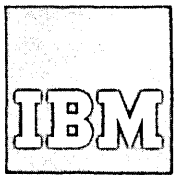
File No. S360-20
Order No. GC28-6698-3

OS



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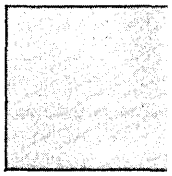
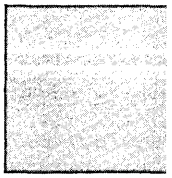
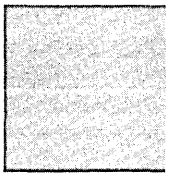
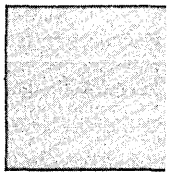
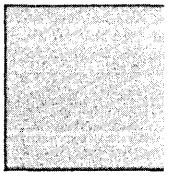
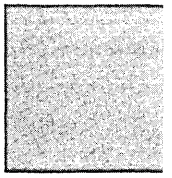
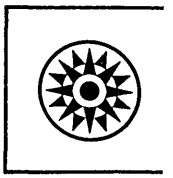
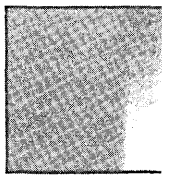
IBM System/360 Operating System:

Time Sharing Option Guide

Fourth Edition (June, 1971)

This is a major revision of, and obsoletes, GC28-6698-2. Changes or additions to the text and illustrations are indicated by a vertical line to the left of the change.

This edition with Technical Newsletters GN28-2497 and GN28-2502 applies to release 20.6, of IBM System/360 Operating System, and to all subsequent releases until otherwise indicated in new editions or Technical Newsletters. Changes are continually made to the information herein; before using this publication in connection with the operation of IBM systems, refer to the latest IBM System/360 SRL Newsletter, Order No. GN20-0360, for the editions that are applicable and current.

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SUMMARY OF AMENDMENTS
FOR GC28-6698-3
OS RELEASE 20.6

TSC START PARAMETERS

Programming Change

Two new parameters; TSCREGSZ and DUMP have been added. TSCREGSZ allows an installation to specify a size for the TSC region. DUMP reserves the swap data sets so they are not initialized during a restart.

START COMMAND

Programming Change

Most of the TSC start parameters can be altered by the operator using the START command.

MISCELLANEOUS CHANGES

Swap Data Sets

Swap data sets must begin on a cylinder boundary. Parallel data sets must reside on the same device types.

- SVC 100--Submit a job to the background.
- SVC 102--AQCTL -- used by TCAM to communicate with problem programs.

Of these, only SVC 98--PROTECT--can be issued by programs executing in the background. SVCs 92 (TCB EXCP) and 101 (TCAM-TSO Communication) are used only by supervisor programs.

Including TSO in a system adds no restrictions to programs executed in the background. For example, other teleprocessing applications can be run simultaneously.

System Control

The management of an installation can shift most of the responsibility for controlling the time sharing system from the operator at the system console to users at remote terminals, called control terminals. A control terminal user can alter the system configuration to meet changing work loads. For instance, he can assign an extra region of main storage to time sharing operations during peak periods, and then release it to be used for batch operations during slack periods. Such changes require no shutdown of TSO and are not noticed by the users of other regions. Even the starting and stopping of TSO operations is accomplished without shutting down the system or affecting background operations.

Job Definition and Scheduling

To the operating system, each terminal session from LOGON to LOGOFF is one terminal job, corresponding to a single step batch job. The job control statements that define a terminal job are stored in the LOGON procedure used to begin the session. The "EXEC" JCL statement in the LOGON procedure identifies the program the user wants loaded into his region for execution. The program may be the TSO-provided command language handler or an installation provided application program.

An important feature of TSO is the dynamic allocation of data sets for time sharing users. A user may defer definition of his data sets until he requires them. During LOGON processing, any data sets named on Data Definition (DD) statements in the procedure are allocated to the terminal job. Any data sets requiring volume mounting by the operator, must be defined here. The procedure also includes dynamic DD statements (similar to a DD DUMMY), which reserve control block space for data sets the user may allocate during the session. The dynamic allocation facility allows data sets to be created, deleted, concatenated, or separated without previous allocation at the beginning of the job step.

Tuning the Time Sharing System

In a time sharing system, execution time is divided among the active foreground jobs and background jobs in brief time slices. A time slice must be long enough to perform a meaningful amount of processing, but not so long that the time between successive slices prevents quick response to conversational users. At the same time, time slices cannot be so short and frequent that system overhead for swapping and task switching becomes excessive. Balancing these factors depends on the number and type of jobs the system is processing. A solution for one job mix is not necessarily suitable for another job mix. The TSO time sharing algorithms -- the formulas used to calculate the division of time among jobs -- are based on several variables, most of which can be specified by the installation to tune the system for their particular workload. Most of the tuning variables such as the number of foreground regions and the maximum number of users, can be set or modified by the system operator or a user at a control terminal whenever the system is running. Others are specified as parameters in SYS1.PARMLIB. These parameters are used when the operator starts the time sharing operations.

The time sharing algorithms are described in detail in the "System Summary" section of this manual. They are implemented by a subroutine called Time Sharing Driver. The Driver makes decisions about system functions such as swapping and task switching. An installation may experiment with other time sharing algorithms by modifying or replacing the driver, and specifying use of the new Driver in the SYS1.PARMLIB parameters used when the operator starts time sharing operations.

Execution time may also be affected by the choice of modules to be included in the Link Pack Area (LPA) extension in the Time Sharing Control task (TSC) region. The size of the LPA extension and the amount of main storage dynamically allocated by the driver are major factors in determining the size of the TSC region. The installation may let the TSC calculate its own region size or may specify a TSC region size, either in the SYS1.PARMLIB or on the START command, to compensate for additional main storage requirements created during tuning.

Monitoring System Use and Performance

By extending the services of the system to many concurrent users, TSO makes the operating system more useful to more people. However, installation management's job of monitoring system use and performance becomes more complex. Three tools are provided to help management maintain a clear picture of what the system is doing.

System Management Facilities (SMF): The SMF Option can be used with TSO. Both the data collection and dynamic control facilities are extended to the foreground environment.

With the data collection facility, records describing both the system environment and individual user activity are written to the SMF data sets in a format similar to that used for background records. The system environment data includes:

- Machine configuration.
- Resource status.
- Library management information.

This information is recorded whenever time-sharing operations are started, modified, or stopped by an operator. The user data includes:

- I/O device use.
- Data set use.
- Main storage used.
- Time resident in main storage.
- Time actually spent executing.

The user data is recorded at LOGON and LOGOFF and during a terminal session whenever a user changes the status of his data sets with the dynamic allocation facility. The information on the use of data sets is particularly useful to the installation for controlling the use of secondary storage in the time-sharing environment.

The SMF dynamic control exits give the installation access control program information at key points during the processing of jobs, including foreground jobs. The step initiation and termination exits are taken, if present, when a user begins or ends a terminal session. These routines can record information and control processing for foreground jobs just as they do for background jobs. SMF is discussed in detail in the publication IBM System/360 Operating System: System Management Facilities, GC28-6712.

An additional installation exit, separate from the SMF dynamic control exits, is provided from the routine handling user LOGON. This exit allows the installation to establish its own user verification and control procedures, independent of those supplied with the system. The section of this publication Writing a Logon Pre-prompt Installation Exits describes the parameters passed and what actions the exit may take.

MONITOR Command: The MONITOR command allows the operator to watch the changing workload on the system over a period of time. In addition to the job initiation, data set, and volume information formerly available with the DISPLAY command, he can request notification of time-sharing users logging on and off the system. The DISPLAY command now gives the system workload at a particular point in time, and has been extended to include information relative to the time-sharing environment, such as the number of foreground regions and the number of active terminals. Both MONITOR and DISPLAY, like other operator commands concerned with the time-sharing operation, are available to a control user at a remote terminal as well as the system operator at the console.

TSO Trace Program: The TSO Trace Writer Program provides a detailed history of what the system does over a period of time. The Trace Program records a stream of information that all components of the system are continuously passing to the Time Sharing Driver. The Driver uses this information in its calculations of resource allocation. When the operator starts the Trace Program, it intercepts these event signals and records them with a time stamp in a data set. Typical events recorded are "job requesting terminal input" and "swap completed." The TSO Trace Data Set Processor can be used at a later time to format and print out the information recorded by the Trace Program. The Trace Data Set Processor can be requested to list only those events associated with a particular component of the system, such as the dispatcher, or to list only those events associated with a particular terminal or set of terminals. Using this information, system management can determine how well the system is responding to the workload and make adjustments to the tuning variables if necessary.

System Security

The need for adequate data and program protection is increased in the time-sharing environment, where many persons are simultaneously using the system. The system itself must be protected against unauthorized users. Each user's programs and data must be protected against accidental destruction by other users. Confidential data must be safeguarded against unauthorized access.

User Verification

Any user starting a terminal session is required to supply a user identification recognized by the system; that is, one that

The Time Sharing Control Task

The Time Sharing Control task, as shown in Figure 23, handles all functions affecting the entire time sharing portion of the system. This includes responding to the START, MODIFY, and STOP operator commands, and handling the swapping of foreground jobs into and out of main storage.

When the operator enters the START command for TSO, an initialization module of the Time Sharing Control task is given control. The initialization module calculates the size of the Time Sharing Control region that will be needed and obtains it from the main storage management routine of MVT. In this region, the Time Sharing Control task builds the control blocks and buffers the system will need, and invokes a Region Control task for each foreground region.

The installation may override the calculated TSC region size by specifying the size it wants in SYS1.PARMLIB or on the START command. This may be necessary if an installation written driver has greater main storage requirements than the driver supplied with TSO.

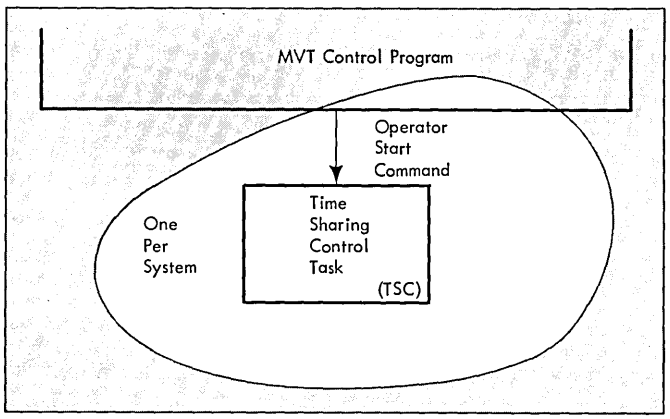

Figure 23. The Time Sharing Control Task

While the time sharing system is operating, the major function of the Time Sharing Control task is the swapping of foreground jobs into and out of main storage. Swapping is handled at this level so it can be optimized on a system-wide basis when multiple foreground regions are active. Whenever possible, an active job is not quiesced for swapping out until a channel will be free for the swap output. But in many cases when there is nothing to be gained by delaying, such as when a foreground job is waiting for input from the terminal, a swap out is scheduled whether a channel is free or not.

The Time Sharing Control task maintains an input queue and an output queue for swap requests (one of each set if parallel swapping is being used). It builds a channel program for each swap request. A program-controlled interruption (PCI) will occur near the end of each channel program. When the interruption occurs, an exit routine selects the next channel program to execute. The exit routine inserts a transfer to the next channel program at the end of the current channel program. Thus as the number of requests increases, the swap process is carried out by a never-ending channel program. Seek time is minimized by attempting to swap jobs out to the direct access area from which the last job was swapped in, or if this is not possible, by using the free space closest to the current arm position.

In determining what portion of a foreground region to swap out, the Time Sharing Control task uses a map of the foreground job created by the Region Control task. Each entry in the map identifies the starting address and length of a section of the region that the job is using. The number of entries in this map is the same for every job and is specified by the installation in the system parameter library. If there are too few entries, inactive main storage must be included (and swapped). A large number of entries cuts down on the amount of inactive storage that has to be swapped, but adds to processing overhead.

When the operator enters a STOP command to shut down the time sharing operation, the Time Sharing Control task initiates a logoff for each active user. When all users are disconnected, the Time Sharing Control task ensures that all the system resources that had been assigned to it are returned; the Time Sharing Control task then terminates, returning its main storage region to the system.

If any users cannot be logged off, the Time Sharing Control task cannot terminate. The operator is given the facility to "force" TSO to terminate even if it appears that normal STOP processing cannot be completed. For further information on "forced STOP" see Messages and Codes, message IKJ024D.

The Region Control Task

A major function of the Region Control task is quiescing and restoring foreground job activity before and after swapping. There is one Region Control task for each active foreground region, invoked by the Time Sharing Control task with an ATTACH macro instruction. Figure 24 shows a single Region Control task under the Time Sharing Control task.

Before a foreground job can be swapped out of main storage, any activity associated with it must be brought to an orderly halt, or set up to be handled by some supervisor routine that will be remaining in main storage. This includes removing control blocks associated with the job from system queues, or flagging them as inactive.

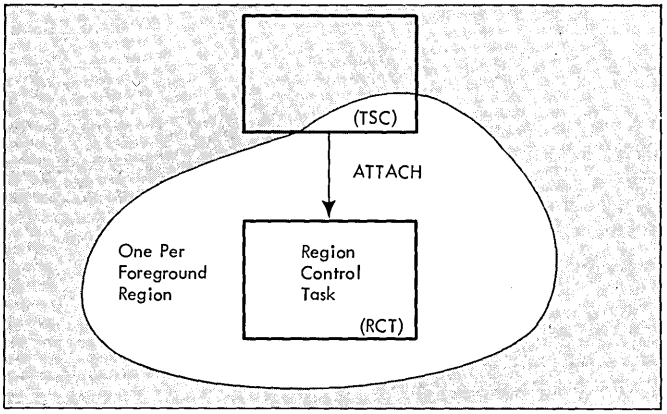

Figure 24. The Region Control Task

Quiescing of I/O activity is initiated by the Region Control task (at the request of the Driver), which issues the Purge Supervisor Call for each task associated with the foreground job. The Purge routine removes I/O requests from the I/O Supervisor's queues of pending requests if they have not yet been initiated. If a request has been started, that is, if data transfer is already taking place, it is allowed to complete before the job is marked ready for swapping. The control blocks associated with unstarted requests are stored in the foreground region where they will be swapped out of main storage along with the job.

I/O requests that address the terminal are an exception to the quiescing procedure because of their long completion time. These requests are handled through the TSO interface with TCAM and are buffered in supervisor main storage, not in the foreground region. Data can be written or read to these buffers whether the job is present in its main storage region or not.

Many control blocks, like the I/O requests mentioned above, reside in the foreground region. For background jobs, these control blocks would be created and maintained in the System Queue Area, a section of main storage set aside for this purpose during nucleus initialization. Foreground regions, however, each contain a Local System Queue Area to hold control blocks. As part of quiescing, the Region Control task removes pointers to these control blocks from system queues. The blocks can then be swapped out of main storage along with the foreground job. The only control blocks for foreground jobs that are assigned in the System Queue Area (and remain in main storage) are requests for timer interruptions, operator replies, and assignment of resources through ENQ.

When a job is swapped into main storage by the Time Sharing Control task, the Region Control task receives control to restore the I/O requests it intercepted at swap out time, and to return the control blocks associated with the job to the appropriate system queues.

LOGON/LOGOFF

The LOGON/LOGOFF Scheduler routine performs the same functions for foreground jobs that the reader/interpreter and initiator do for background jobs. When defining a foreground job, LOGON uses many of the same programs as subroutines.

When LOGON is invoked by the Region Control task, as shown in Figure 25, it is swapped into the foreground region. A copy of the LOGON/LOGOFF Scheduler for each foreground region is kept in the swap data set, reducing the amount of initialization time needed. LOGON, and all routines below it in the control flow diagram, execute from the foreground region, and are swapped in and out of main storage. LOGON first validates the user's identification and password in the User Attribute Data Set, and reads in the rest of the user profile. From the profile and any operands entered with the LOGON command, LOGON builds, in main storage, a JOB and an EXEC statement that define the foreground job. The EXEC statement names the LOGON Procedure specified by the user, and the procedure in turn specifies the name of the program to be invoked. The procedure also contains DD statements for data sets the user always wants allocated to him, and some special DD statements that save control block space for data sets he may allocate later, dynamically.

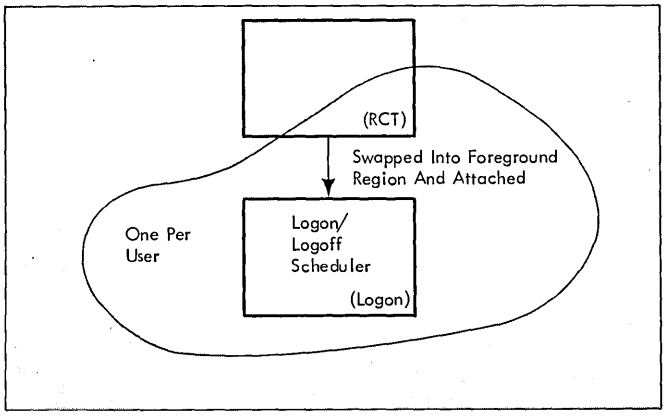

Figure 25. The LOGON/LOGOFF Scheduler

The JOB and EXEC statements built by the LOGON routine are passed to the reader/interpreter to define the resources required by the job, and then to the

The EXEC statement of the cataloged procedure that starts the Time Sharing Control Task, specifies:

- The TSC program name, which is IKJEAT00.
- The TSC region size. If the TSC needs a different sized region, it will obtain one.
- ROLL=(NO,NO) to preclude an attempt to Rollout the TSC region, if OPTIONS=ROLLOUT has been specified during system generation.
- DPRTY=to set a priority for the TSO. It must be lower than the MCP.

Five data sets must be defined.

- SYSPARM -- The library containing TSC initiation parameters. These parameters are discussed under "Writing TSO System Parameters".
- SYSUADS -- The User Attributes Data Set, this data set cannot be concatenated.
- SYSLBC -- The broadcast data set which contains messages from the SEND command and a list of valid users should not be password protected.
- SYSWAP00 -- The swap data sets.
- IEFPDSI -- The partitioned data set containing LOGON cataloged procedures. This data set may be either SYS1.PROCLIB or a partitioned data set dedicated to LOGON procedures. A dedicated data set will speed up LOGON processing.

If an installation uses the TSO dump, SYSTSDP, the TSO dump data set,usually a tape volume,should also be defined.

For each of these data set definitions, DISP=SHR should be specified.

Figure 38 shows a sample cataloged procedure to start the TSC.

The data definition ddname on the DD statement defining the SWAP data set specifies whether serial or parallel swapping is to be used. The ddname is of the form

SYSWAPln

Where l indicates the level of the data set, i.e., 0 for prime, 1 for first overflow; and n is the data set number at this level.

For example, if an installation has two data sets and wants to use parallel swapping it would use SYSWAP00 and SYSWAP01 as the ddnames.

If an installation wanted to use an IBM 2301 drum for a prime swap data set and an IBM 2314 as overflow, the ddnames would be SYSWAP00 for the 2301 the prime data set, and SYSWAP10 for the 2314, the first overflow data set. Parallel units must be of the same device type. A swap data set must begin on a cylinder boundary.

If a system or TSO failure causes TSO to be restarted, you can use IMDPRDMP program to save the swap data sets before attempting to restart TSO. When invoking IMDPRDMP, the DD statements for the swap data sets should be the same as those in the TSO cataloged procedure; the //PRINTER DD statement writes to tape with chained scheduling and a large blocking factor so that the data sets are dumped quickly. The publication IBM System/360 Operating System: Service Aids GC28-6719 shows the procedures for analyzing system failures and how to use the IMDPRDMP program to save the swap data sets.

STARTING AND STOPPING TSO

When the operator starts TSO for the day, he must:

1. Issue a START command to start the Message Control Program. The operand of the START command is the name of the cataloged procedure that provides the Job Control statements necessary to execute the MCP. For example if the cataloged procedure used to start the MCP is named TCAM, the operator will issue a START TCAM command.
2. Issue a START command to start the Time Sharing Control Task (TSC). The operand of this command names a cataloged procedure used to start the TSC. For example if the cataloged procedure used to start the TSC is named TS, the operator would issue a START TS command.

When the operator stops TSO for the day, he must:

1. Issue a STOP command to stop the Time Sharing Control Task. The operand of the STOP command must be the same as the operand that was used to start the TSC.
2. Issue a HALT command to stop the Message Control Program. If the PGM= operand of the EXEC statement in the cataloged procedure used to start the MCP is IEDQTCAM, then the MCP cannot

```
//IEFPROC   EXEC  PGM=IKJEAT00,ROLL=(NO,NO),DPRTY=(13,13)
//SYSPARM   DD  DSN=SYS1.PARMLIB,DISP=SHR
//SYSUADS   DD  DSN=SYS1.UADS,DISP=SHR
//SYSLBC    DD  DSN=SYS1.BRODCAST DISP=SHR
//SYSWAP00  DD  DSN=SYS1.SWAP1,DISP=SHR
//SYSWAP01  DD  DSN=SYS1.SWAP2,DISP=SHR
//IEFPDSI   DD  DSN=SYS1.PROCLIB,DISP=SHR
//SYSTSDP   DD  UNIT=2400,VOL=SER=TSODUMP,DISP=(,KEEP)
```

Figure 38. Sample Cataloged Procedure to Start Time Sharing Control Task

be cancelled with a CANCEL command. If the operator cancels the MCP, the TSO must be stopped before the MCP is restarted. The MCP cannot be halted with a HALT command unless the TSO is stopped.

- Specify the program name of the Background Reader.
- Pass the Background Reader standard Reader-Interpreter parameters.
- Define required data sets.

DEFINING A UADS USING THE TSC PROCEDURE

When a TSO system is first started after system generation, it is necessary to construct a UADS using the ACCOUNT command. The distributed UADS contains one valid user:IBMUSER and this user is authorized to use one procedure: IKJACCNT. He should use the ALLOCATE command to define a new UADS with a file name of SYSUADS and a data set name other than SYS1.UADS, specifying its volume serial number, and define his UADS structure with a series of ACCOUNT command ADD subcommands. He should then log off, stop the system, and change the SYSUADS DD statement in the TSC start procedure, to point to the new UADS. If the cataloged procedure defines SYSUADS though a DSN= operand, then he need only rename the data set.

Background Reader (BRDR)

The cataloged procedure used to start the Background Reader (BRDR) contains Job Control statements that:

The Background Reader, (BRDR), runs as a system task. It is started by the operator. It interprets Job Control Language passed by a terminal user with the SUBMIT command. If there is no input for the BRDR, it will relinquish its region and wait for input. Output from the BRDR is placed on SYS1.SYSJOBQE and is queued for execution by a standard initiator. The cataloged procedure that provides the Job Control Language to start the Background Reader is similar to other reader procedures. The BRDR program name is IKJEFF40. Figure 39 shows an example of a BRDR procedure. For further information on writing system reader/interpreter cataloged procedures, see IBM System/360 Operating System: System Programmers Guide, GC28-6550.

An installation exit can gain access to and modify or delete any JCL passed by the SUBMIT command processor. The section, "Writing Installation Exits for the SUBMIT Command" describes how to write this exit.

```
//BRDR    EXEC  PGM=IKJEFF40,
//              REGION=70K,
//              PARM='READERPARM'
//IEFPDSI DD    DSN=SYS1.PROCLIB,
//              DISP=SHR
//IEFDATA DD    UNIT=SYSDA
//              SPACE= (80,(500,50),RLSE,CONTIG),
//              DCB=(BUFNO=2,LRECL=80,BLKSIZE=80,DSORG=PS,
//              RECFM=F,EUFL=80)
//IEFRDER DD    DUMMY
```

Figure 39. Sample Background Reader (BRDR) Procedure

- Specify the number of users.
- Specify whether SMF is to be used.
- Specify which DRIVER to use.
- Limit the number of tracks the SUBMIT command can use to queue jobs.
- Defines the module contents of the Time Sharing Link Pack Extension.

Notes:

- All parameters except LPA and DUMP/NODUMP may be overridden on the START command.
- USERS, SMF, REGSIZE(n), and SUBMIT may be changed by a MODIFY command.
- TERMAX, REGNMAX, and MAP must be specified either in the SYS1.PARMLIB or on the START command to start TSO.

The contents of the Time Sharing Link Pack Area, that part of the TSC region containing reenterable modules common to different TSO applications has a direct effect on system response and overhead. The following routines are used by different users many times during an average session and should reduce loading time if included.

- The I/O Service routines -- that is GETLINE, PUTLINE, PUTGET, and STACK.
- The TMP mainline routines.
- Command Scan -- a service routine used to check the syntax of commands.
- TIME -- a routine used to get the time of day.
- PARSE -- a routine that analyzes the syntax of commands.

In addition if EDIT is being used extensively, portions of the EDIT command processor should be included.

- The Edit Mainline routines.
- INPUT subcommand processor.
- LIST subcommand processor.
- CHANGE subcommand processor.
- Implicit change processor, that is, the update function for portions of individual lines.

Driver Parameters

The DRIVER parameters specify:

1. What type of queueing service to use in a region.
2. What the cutoff points for each queue are.

For example, the SWAPLOAD/NOSWAPLOAD parameter specifies whether or not swap load will be used as a criterion for determining which queue a user will be put in. If SWAPLOAD has been specified, the MAXSWAP parameter defines the maximum swap load for each queue.

In a single region system, NOWAIT and NOACTIVITY should be specified.

The decay constant for the wait estimate (DECAYWAIT) and the activity estimate (DECAYACT) if set to 100, (that is, a decay constant of one since the value is in hundredths), will mean that the current value has a weight equal to the total prior value. This will "smooth" out the effects of excessive variations.

MINSLICE, the minimum amount of time given to a terminal user, should be set to allow a useful amount of execution time.

If PREEMPT is specified, CYCLES should be set to zero, since a higher priority queue will preempt a lower priority queue.

Buffer Control Parameters

TSO controls the allocation of terminal buffers in the TSC region. Buffers allocations are based on initial parameters specified in SYS1.PARMLIB.

The BUFSIZE= parameter specifies the size in bytes of each TSO terminal buffer.

The BUFFERS= parameter specifies the total number of TSO buffers. The remaining parameters deal with allocating the number of buffers per user when a given number of users is logged on.

TSO maintains a count of the number of allocated buffers per user, both for input and output. When the number of buffers either for input or output rises to a given level, the user is prevented from continuing until more buffers are available. If the specified maximum number of input buffers are allocated, the keyboard is locked up. If the maximum number of output buffers are allocated, the user's program is put into a wait. This level is determined by the OWAITHI value for output and the INLOCKHI value for input.

When the number of logged on users changes by the percentage specified in the

USERCHGE parameter, and when the number of users falls below SLACK value,the number of buffers per user is readjusted. The number of buffers for input and output are distributed in the same ratio as specified by INLOCKHI and OWAITHI.

System Parameter Format

The format of the parameter records is:

```
parameter-owner keyword=value...
```

The possible parameter-owners are:

- TS -- parameters for the Time Sharing Control Task.
- DRIVER -- parameters for the Time Sharing Driver.
- TIOC -- parameters controlling terminal buffer allocation.

Keywords cannot be continued but may be repeated. This has the effect of continuation, as repeated keyword values are added on to those already specified. When two parameters conflict, the last value is used. Figure 42 shows an example of system parameters for a single region model 50 and for a double region model 65. Figure 43 shows the syntax and meaning of the start parameters.

PARAMETER OWNER	KEYWORD	MEANING
TS	TERMAX=nnnn	Specifies the maximum number of terminals the installation wants to support. Must be less than 10000.
	REGNMAX=nn	Specifies the maximum number of TSO user regions. Must be between 1 and 14 inclusive.
	MAP=nnnn	Specifies the number of entries in the User Main Storage Map for each user. Entry describes area to be swapped. Used to reduce swapping of unused storage.
	USERS=nnnn	Specifies the initial maximum number of users the system will allow to log on. Must be between 0 and the value specified on TERMAX. If nnnn greater than TERMAX, TERMAX value will be used. Defaults to TERMAX.
	SMF=([OFF / OPT=1 / OPT=2] [,EXT=[YES / NO]])	Standard SMF foreground parameters, See System Management Facilities, GC28-6712.
	DSPCH=cccccc	Specifies first six characters of Time Sharing Driver. Defines names of all four driver modules. Last two characters must be 00 to 03. Defaults to IKJEAD, the driver supplied with TSO.
	LPA=(module list)	List of modules to be included in Time Sharing Link Pack Extension.
	REGSIZE(n)= (nnnnnK,xxxxxK)	Specifies the time sharing region number and size of that region. n is the region number and nnnnnK its size. xxxxxK is size of Local System Queue Area (LSQA). LSQA must be smaller than region size but greater than zero. n must be between 1 and REGNMAX. nnnnn and xxxxx are number of contiguous 1024 byte areas wanted, should be even, and their sum may range from 0 to 16382. Odd numbers specified will be rounded up to next higher even number.
	SUBMIT=nnn	Specifies maximum number of tracks in SUBMIT command job queue. Defaults to limit set at system generation.
	TSCREGSZ=nnnnnK	Specifies amount of main storage to be allocated to Time Sharing Control Task region. nnnnn is number of contiguous 1024 byte areas desired, must be even, and may not be more than 16382. An odd number will be rounded up to next higher even number. If not specified in either SYS1.PARMLIB or in START command, Time Sharing Control Task will calculate its own region size.
	DUMP=[DUMP / NODUMP]	DUMP indicates that swap units are to be marked reserved. Necessary if a SWAP dump to be taken.

Figure 42. TSO System Parameter Syntax (Part 1 of 3)

PARAMETER OWNER	KEYWORD	MEANING
DRIVER	WAIT NOWAIT	Specifies use of wait estimate option.
	ACTIVITY NOACTIVITY	Specifies whether Region activity estimate is to be used in assigning a user to a region. NOACTIVITY required for single region system.
	OCCUPANCY NOOCCUPANCY	Specifies whether core occupancy estimates are to be used in queue selection.
	SWAPLOAD NOSWAPLOAD	Specifies whether swapload is to be used in queue placement.
	AVGSERVICE NOAVGSERVICE	Specifies average queue service time to be used.
	PRIORITY NOPRIORITY	Specifies whether priority scheduling is to be used.
	PREEMPT NOPREEMPT	Specifies whether preemptive scheduling is to be used.
	BACKGROUND=nn NOBACKGROUND	Specifies a percentage of CPU time guaranteed to the background or no guaranteed time.
	DECAYWAIT=nnnn	Specifies in 100ths the decay constant for the wait estimate. Assumes WAIT specified.
	DECAYACT=nnnn	Specifies in 100ths the decay constant for the activity estimate. Assumes ACTIVITY specified.
	SUBQUEUES(n)=mmm	Specifies the number of queues for region n.
	CYCLES(n,m)=iii	Specifies the number of service cycles to be given to the mth queue of the nth region.
	MAXSWAP=(n,m)=iii	Specifies the maximum number of 1024 byte blocks which may be allowed to a user on queue m, in region n. Assumes SWAPLOAD specified.
	MAXOCCUPANCY(n, m)=iii	Specifies the maximum amount of time in 100th of a second a user on queue m in region n can reside in core.
	SERVICE(n,m)=iii	Specifies the average service time in 100ths of a second for a user on queue m in region n.
	MINSLICE(n,m)=iiii	Specifies the minimum time slice in 100th of a second to be given to a user on queue m in region n.

Figure 42. TSO System Parameter Syntax (Part 2 of 3)

PARAMETER OWNER	KEYWORD	MEANING
TIOC	BUFSIZE=nn	Specifies size of terminal buffer. Default 44.
	BUFFERS=nn	Total number of buffers.
	OWAITHI=nn	Specifies maximum number of allocated output terminal buffers per user in order to put a user program into output wait.
	INLOCKHI=nn	Specifies the maximum number of allocated input terminal buffers per user in order to lock a users keyboard.
	OWAITLO=nn	Specifies the number of allocated output buffers to bring a user out of output wait state. In other words if OWAITLO=4, when 4 or less buffers remain allocated, the user is brought out of output wait.
	INLOCKLO=nn	Specifies the number of currently allocated input buffers to unlock the terminal keyboard for input. In other words, when the number of allocated input buffers falls to or below the INLOCKLO value, the user's keyboard is unlocked.
	USERCHG=nn	Specifies percentage of change in logged on users needed to redistribute buffers and recalculate the OWAITHI and INLOCKHI numbers during slack time.
	RESVBUF=nn	Specifies the total number of terminal buffers that must be free to avoid locking all terminals to prevent input.
	SLACK=nn	Specifies number of logged on users that constitute slack time.

Storage Estimates

The estimates included in this chapter are intended for planning purposes only. None of these estimates have been verified, and they are subject to change. Verified estimates will appear in the publication IBM System/360 Operating System: Storage Estimates, GC28-6551, when they are available.

This chapter contains three sections: main storage requirements, sample configurations, and auxiliary storage considerations. All figures in this chapter are decimal, and "K" represents a factor of 1024.

Main Storage Requirements

The main storage requirement for TSO is divided into four major parts:

- An addition to the MVT basic fixed requirement.
- The TCAM Message Control Program requirement.
- The Time Sharing Control region requirement.
- The foreground regions in which users' programs are executed.

Only the first of these requirements has any effect on the batch environment if time sharing is not active. Storage for the TCAM, Time Sharing Control, and froeground regions is obtained from the dynamic area when the operator starts time-sharing operations. This storage is returned to the dynamic area when time sharing is stopped, and is again available for batch processing.

MVT BASIC FIXED REQUIREMENT

The main storage basic fixed requirement for an MVT system is for:

- The nucleus.
- The Master Scheduler Region.
- The Link Pack Area (LPA).
- The System Queue Area (SQA).

Storage for the basic fixed requirement is allocated by the Nucleus Initialization Program (NIP) when the system is started and does not normally vary while the system is running.

Nucleus

Including TSO at system generation adds approximately 3K to the size of the resident MVT nucleus, for a total requirement of about 45K. In addition, communication lines, like other I/O devices, require 40 bytes each in the nucleus for control blocks.

Master Scheduler Region

The master scheduler region is increased by approximately 4K to handle new or extended operator commands for the time-haring environment, and for extended error recovery. The total requirement is about 16K.

Link Pack Area

One small TSO module is added to the required MVT link pack area list of resident modules. The minimum link pack area size remains 10K. If the standard MVT resident reenterable load module and resident SVC lists are used at system generation, the LPA requirement is about 54K. If space is available, an additional 16K of SVC modules for time sharing are appropriate for the resident list, for a total LPA size of 70K.

Additional resident reenterable load modules for time sharing are placed in an extension to the link pack area allocated in the Time Sharing Control region, and are resident only when time sharing is active. The size of this extension, called the Time Sharing Link Pack Area (TSLPA), is discussed with the Time Sharing Control Region requirement.

System Queue Area

During time-sharing operations, use of the system queue area is kept to a minimum by placing as many control blocks as possible into a local system queue area (LSQA) defined in each foreground region. Control blocks in the local SQA are swapped in and out of main storage along with the foreground job they apply to.

Some control blocks associated with foreground jobs, such as queue elements for named data sets and operator reply queue elements, must remain in main storage while the job is swapped out. Space for these control blocks, and for all control blocks associated with the tasks supervising the time-sharing operation must be allocated

from the system queue area. These requirements must be considered when setting SQA size at system generation or at nucleus initialization.

MESSAGE CONTROL PROGRAM REQUIREMENT

The size of the TCAM Message Control Program region depends largely on what options are selected and what hardware is present on the teleprocessing network. In addition to the minimum requirement for the Message Control Program routines, there are requirements for each defined line group, each additional terminal type, and for each permitted user. If teleprocessing applications other than TSO are present, additional routines to handle different buffering and queuing techniques will be needed.

In a system with TSO as the only teleprocessing application, with three terminal types and two line groups, the Message Control Program requirement is expected to be about 52K plus 800 bytes for each possible concurrent user. Although the Message Control Program executes in a problem program region, the region may be smaller than the normal minimum problem program region size (MINPART).

TIME SHARING CONTROL REGION REQUIREMENT

The Time Sharing Control region must provide space for programs for the Time Sharing Control Task, Region Control Tasks, several resident SVC routines, the Time Sharing Driver, the time sharing extension to the link pack area, and various control blocks. Some of the control blocks are repeated for each foreground region, for each swap data set, or for each time sharing user. An initialization routine brought in when the operator starts time sharing analyzes the time-sharing parameters supplied by the installation, calculates the region size requirement, and obtains the region from the dynamic area.

The installation may override the calculated TSC region size either in SYS1.PARMLIB or on the START command. This may be necessary if an installation written driver has greater main storage requirements than the driver supplied with TSO.

Using a buffer length of 40 bytes, and assuming eight buffers per time-sharing user, a TSO configuration with two IBM 2314 swap data sets, one foreground region, and 20 users would require a time sharing control region of about 87K. A larger configuration, with two 2301 swap data sets and two 2314 swap data sets, four foreground regions, and 100 users would require about 117K for the time sharing control region.

DYNAMIC AREA REQUIREMENTS

The SEND operator command, like several others already in the MVT configuration, obtains and uses an 12K operator command region from the dynamic area when the operator enters it. This area is freed when processing of the command is completed.

When it is active, the time sharing trace facility requires a 20K region from the dynamic area.

FOREGROUND REGION REQUIREMENT

The foreground region contains the programs invoked by the terminal user. Space must be provided in the foreground region for the local system queue area (LSQA) and for four main storage subpools used for control blocks for the command system.

The subpools defined are:

- Subpool 0--4K.
- Subpool 1--4K.
- Subpool 78--2K.
- Subpool 251--2K.

The minimum foreground region size is 72K, and all IBM-supplied command processors except some of the language processors can execute in this region.

AUXILIARY STORAGE REQUIREMENTS

The major additions to the system auxiliary storage requirements for TSO are for the swap data sets and new or larger system libraries and data sets. The installation must also consider the direct access storage needs of the individual terminal users, and make allowances for these in the size of the system catalog and password data sets.

SWAP DATA SETS

A swap data set is divided into swap allocation units, each of which consists of a device-dependent number of 2K records. To avoid space fragmentation, space in the swap data set is always assigned in integral swap allocation units. Figure 47 shows the sizes of allocation units for various swap devices.