MONITORING REMOTE TERMINALS IN A MULTIPLEXED COMPUTER SYSTEM

by

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ABSTRACT

This thesis describes a scheme for monitoring remote terminal communications lines in a multiple-user, multiplexed computer system. A software mechanism is provided to aid users in getting "on" and "off" the system smoothly via the communications lines. The system operator is provided with the ability to specify which of the system's terminal communications lines should be in use at any time. This gives the operator a great deal of control over the usage which the system will support. A mechanism is provided to automatically inform the system operator of the identification names of any defective lines as soon as such lines are detected so that these lines may be repaired as soon as possible. A design is

presented for the line-monitoring mechanism which is independent of the number of lines which are to be serviced, thus providing for flexibility in the number of terminal lines which may be attached to the system. Finally, the proposed design for the line-monitoring mechanism emphasizes a highly modular structure so that it will be possible to add new types of terminal communications lines to the realm of control of the system with a minimum amount of re-programming required.

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H. M. D.

Cambridge, Massachusetts

CONTENTS

MONITORING REMOTE TERMINALS IN A MULTIPLEXED COMPUTER SYSTEM

CHAPTER ONE

Introduction

In the design of the computer utility, means must be provided by which a large community of users may be effectively serviced. The computer utility should run continuously in much the same manner as the public utilities. Users of the utility should be provided with easy access to its facilities, and these facilities should be available to users when they need them.

The problem of monitoring remote user terminals in a computer utility can be stated briefly as follows: Given a large multi-user computer system consisting of user terminals connected to the computer via communications lines, design a line-monitoring subsystem of an operating system which allows users to get into and out of the system at their convenience. In addition, the operating system should provide the facility for the system operator to observe the condition of the communications lines at any time and to specify which lines should currently be in use.

This thesis describes the design for an answering service, the terminal line monitoring section of an operating system.

The proposed answering service provides the following services for the effective operation of the computer utility:

1. Aiding users to get into and out of the system.
2. Providing the system operator with the facility to control which communications lines should be in use at any time.
3. Aiding the system operator in the detection of malfunctioning communications lines.

In addition, the answering service provides the following properties:

1. Allowing for flexibility in the number of terminal communications lines which may be attached to the system.
2. Providing for the addition of new types of terminal communications lines with a minimum amount of reprogramming.

Let us consider why the services performed by the answering service are important. First, in a multiple-user computer utility, there is a constant turnover of users currently on the machine. New users are constantly attempting to "log in" (i.e., get on the machine) and old users are "logging out" (i.e., leaving the machine). It is therefore necessary to provide a means of aiding users to get on and off the system and, in particular, of allocating terminal communications lines to new

users and reclaiming relinquished lines from users leaving the system.

Second, by providing the system operator with the ability to specify which of the terminal communications lines should be in use at any time, the operator is given a great deal of control over the usage which the system will support. In particular, he may want to bring the system down for testing purposes, and he will be aided by having the answering service refuse to accept new users on the lines that should be placed out of use. If a certain subset of the lines should be taken out of operation for repairs, the operator merely specifies (via typewritten command at his own terminal) that the answering service should not allow any new users to log in on these lines until they are repaired.

Third, in a computer utility it is mandatory that if a malfunction should occur, it must be immediately recognized. After the answering service processes each operator request to set the configuration of communications lines which should be in use, it provides the system operator with information about the condition of these lines. If the operator is not satisfied with the reported status, he will tell the answering service not to allow any users to log in on the faulty lines until they have been repaired. The answering service itself might sometimes detect malfunctions in the operation of the communications lines. When this occurs, the answering service immediately informs the operator of those lines which are malfunctioning.

Fourth, the capacity of a computer utility should be flexible. It should be possible to add more devices as the need for these devices becomes apparent. In particular, more communications lines might be added to a given configuration so that it will be capable of supporting more user terminals. The answering service provides this flexibility in that, if it is programmed to support a particular type of communications line, it can support additional lines of that type without any reprogramming.

Fifth, the computer utility should have a modular structure so that if it is necessary to add new types of devices, the amount of reprogramming required will be minimal. If new types of communications lines are added to the system, the answering service requires only slight modification to be able to monitor these new lines. Of course, it is necessary to program a new module to handle the peculiarities of each of these lines, but these modules interface in a simple manner with the answering service, and the interfaces are very similar for each of the various types of lines.

The proposed answering service described in this thesis is being implemented as an integral part of the "Multics" system (Multiplexed Information and Computing Service) under development at Project MAC at the Massachusetts Institute of Technology. This system is a general time-sharing operating system for the computer utility. The Project MAC implementation is for the General Electric 645 computer. The reader interested in exploring Multics further should consult a group of papers

which were presented at the Fall Joint Computer Conference in 1965 as an introduction to the purposes and major design ideas of the Multics system [1, 2, 3, 4, 5, 6]. Project MAC Technical Report 30 contains a discussion of the organization of the computer utility and a description of the basic design of the Multics operating system [7]. In this thesis it is assumed that the reader is familiar with the current terminology of the computation systems field as exemplified by the terminology used in the cited references. However, every attempt is made to explain terms as they appear for the convenience of the reader.

Approach.

Chapter Two discusses the environment which the answering service operates in. Both the hardware and the software of the environment are considered.

In Chapter Three, the problem of making the communications lines ready for users to log in on is considered in detail along with an explanation of how the system operator gets logged in.

Chapter Four discusses the problems involved in managing communications lines during the logging in and logging out of users.

Chapter Five considers the control over the communications lines which is provided for the system operator by the answering service. The status types of communications lines are defined, and the method by which the system operator observes

and changes the status of particular communications lines is explained. Other topics discussed here include: the handling of disabled lines, changing the status of a line which is currently in use, the method by which commands from the system operator reach the answering service, and how the answering service actually causes a communications line to assume a particular status.

In Chapter Six, the details are given for the complete design of the answering service with the major emphasis on its modular structure.

CHAPTER TWO

Environment of the Answering Service

Before proceding with a discussion of the operation of the answering service, it is meaningful to describe the environment in which the answering service operates. In this chapter, the various portions of the computer utility with which the answering service interacts will be considered.

Features of Multiple-User System.

The main purpose of the computer utility is to provide a computing capability to a large community of users in which several of the users are currently "on" the system. The operating system of the computer utility achieves this "simultaneous" servicing of several independent users by multiplexing (i.e., sharing) its resources among them. In the Compatible Time-Sharing System (C.T.S.S.) [8] developed in 1962 at M.I.T., the programs and data of each user are kept on some secondary storage medium, and brought into the computer for a short period of time during which the system services only this user. Upon completion of the time period, the user's programs and data are placed back out on the secondary storage

medium until such time as the system has given the other users their periods of computation and is ready to service this particular user again. Thus, the effect of simultaneous operation of several independent programs is simulated by rapidly multiplexing the resources of the computer system amongst each of the programs in execution.

Although processes may be scheduled independently of each other, it is possible that certain computations in one process may need the results obtained by certain computations in another, and thus there is a need for some means of synchronizing the operation of independently scheduled processes. In the Multics system, this mechanism is provided in the Interprocess Communication Facility [7]. If one process needs the results obtained by another process, it can go "blocked" (i.e., voluntarily halt its execution) until these results are available. At this time, the process performing the required computations sends a "wakeup" (i.e., an order to schedule a process) to the blocked process to indicate that it should become active again continue its processing in light of the fact that the required computations have been performed.

In the Multics implementation, it is also possible for this parallel type of operation to occur between the various programs of a single user, collectively referred to as this user's user-process-group. For example, a process which interprets user commands from a typewriter terminal might go blocked until the process which reads lines from the typewriter has obtained the next line at which time a

wakeup is sent to the interpreting process to indicate that the next command is available.

Use of a Telephone Switching System.

Standard telephone lines (with special adapters to allow the lines to handle bit transfers) have proven sufficient for transmission of data to and from remote typewriter terminals. Thus, computer utilities such as C.T.S.S. at M.I.T. have been able to utilize existing telephone networks to provide access from remote terminals to a central computing facility.

In this type of configuration, a private branch telephone exchange (PBX) is connected to the communications lines from the computer. Remote terminals are connected to the PBX by private lines or through other switching networks. A user wishing to gain access to the computer, dials up (on a standard telephone data set such as the Bell System DATAPHONE data set 103E) the number of the computer. The dialup signal eventually reaches the PBX. The PBX attempts to find a line to the computer which is available for use. If such a line can be found, the PBX establishes a hardware connection between the line to the computer and the line to the terminal.

There are many advantages to using a switching system such as this. Among these are:

1. It is possible to have many more terminals than there are direct lines to the computer. Terminals can be conveniently located in many places

throughout the user community for easy access.

2. If a communications line to the computer is disabled, it is still possible for a user at a particular terminal to establish a line to the computer. The switching facility avoids connecting a user to a malfunctioning line, and attempts to find an available and properly functioning line to connect to this user's terminal line.

Data Sets.

The switching system is used in conjunction with standard telephone data sets. These are hardware mechanisms used for adapting telephone lines for the transmission of digitized data. Data sets also aid in controlling when the data should be sent over a line, when it should be possible to establish a line connection to the computer from a remote terminal, and when a line should be busied out so that a potential user cannot log in to the system over the line. Thus, the data sets are extremely useful in controlling the state of a communications line since the signals to the data set can be used to "ready" or "busy" the communications line it is attached to. In particular, data sets can assume states such as "automatic answer" (corresponding to "ready to accept dialups"), "busy", and "unattended" (corresponding to "will keep ringing without an answer"). The reader interested in the details of data set operation should consult reference [9].

Input/Output.

In large operating systems, all input/output operations are usually under the control of a detailed input/output software system. Ultimately, all input/output requests are serviced by a hardware input/output controller which reads and executes command words created by the software system. In order for a process to cause some input/output operation to occur, it must call the software system to create and activate these command words. To control a communications line (i.e., ready it for user dialups, or busy it out to prevent dialups from getting through to the system) calls are made to this software system to cause the data sets attached to the communications lines to assume particular states (corresponding to "ready" or "busy", etc.).

Device Assignment.

If a process wishes to perform input/output on an I/O device, it must request of the system that the device be assigned to this particular process. In this way other processes are prevented from using the device while this process is performing its I/O. When a process no longer needs a device, it relinquishes control of the device so that the device may be assigned to another process. (Note: The reader interested in further details about the Multics system should consult reference [10].)

CHAPTER THREE

System Initialization

In order to get a computer operating system running, it is necessary for the system to undergo an initialization procedure. For example, computer systems are often designed to be modular in that the number of I/O devices (and other devices) can vary from one configuration to the next. For each device it is necessary to supply certain information which must be filled into system tables so that at execution time the necessary information about each device will be available. There are many areas in a computer system which require initialization. In this chapter, the initialization needed to put the communications lines into working condition is discussed.

Logging in the System Operator.

Following system initialization, the answering service is called upon to get the system operator into the system and initialize the communications lines. At this time, the answering service is given the identification of the operator's communications

line. The answering service then calls the user-identification process to log in the system operator and informs the user-identification process of the identification of the operator's communications line. The user-identification process assigns the line to itself and proceeds to attempt to log in the operator. (Note: In order for a process to assign a line to itself, the line must currently be available for assignment, i.e., it may not be assigned to any other process. At the time the user-identification process is called, the answering service will have released the line so that the assignment may take place.) Once the operator has logged in, he is in control of the system. When the operator wants the system to accept dialup signals from user terminals, he types a command specifying over which communications lines the system should accept and respond to dialups. The processing of operator commands to the answering service is discussed in Chapter Five.

Initialization of the Communications Lines.

After the system operator is logged in, the answering service must initialize the remaining communications lines to prepare the lines to accept new user dialups. The answering service must obtain a list of all the communications lines in the current system configuration so that it may assign each of the lines to itself and thus be able to receive dialup signals from the lines. The necessary information is contained in a system configuration list which is read in during system initialization. The answering service obtains a list of all the communications lines it is to be

responsible for from this configuration list, and places this information into its own data base (where it will also store other information about each of the lines). The answering service then makes a series of calls to the system procedure responsible for assigning I/O devices to particular processes. These calls specify that each of the communications lines be assigned to the answering service. After the assignment of the lines is complete, the answering service is ready to respond to user dialups on each of the lines.

It is desirable to prevent users from dialing up over the communications lines until such time as the operator wants users to be able to get into the system. Hence, after the lines are assigned to the answering service they must be placed into a state in which it is impossible for a user to be able to dial up over the line. See Chapter Five for a discussion of how to place a communications line into a particular state.

CHAPTER FOUR

Line Monitoring During User Logins and Logouts

In this discussion, a multiple-user environment in which there is a constant turnover of new users on the machine is assumed. New users are constantly attempting to get on the machine and users who have been on the machine for a while are leaving it. The problems of line management are particularly pertinent to the logging in and logging out processes because at these times the lines are assigned to new users and de-assigned from current users. In this chapter we consider the part played by the answering service in logging users in and out of the system.

SECTION ONE: LOGGING IN A NEW USER

In order for a new user to be able to attempt to log in to the system, a sequence of both hardware and software events must occur. First, the user's "dialup" signal must propagate along a communications line from his terminal to the computer and the computer hardware must be interrupted from whatever it is doing to either process the dialup signal or in some way save the signal for

future processing. Second, software within the computer must determine what event caused the interrupt, call an appropriate software routine to process the interrupt, and eventually execute the routines which are responsible for identifying the new user. In this section, these hardware and software events are discussed in detail.

How a Dialup Interrupt Reaches the Answering Service.

When a new user dials up the following sequence of events occurs to activate the answering service:

1. Dialup signal propagates down a communications line from the user's terminal to a private branch telephone exchange (PBX).
2. The PBX makes a hardware connection between the line from the user's terminal and the line to the computer.
3. The PBX sends a ringing signal to the data set at the computer end of the line from the PBX to the computer.
4. If this data set is in the proper state, it "shakes hands" with the data set at the user's terminal and establishes the line connection from the terminal to the computer. If the data set at the computer end is not in the state in which it automatically answers dialup signals

from the terminal data set, the line connection is not established.

5. Once the line connection is established between the two data sets, a "call-received" signal is put out on the data set at the computer end of the line.
6. The input/output controller detects this signal and interrupts a processor.
7. The processor stores information about the machine state at the time the interrupt occurs, and causes a branch to the system interrupt handling routine. (Note: Until this point, all the operations have been performed by hardware. Now the system software takes over.)
8. The system interrupt handling routine examines the stored machine state to determine what caused the interrupt.
9. The system interrupt handler calls to schedule the appropriate process to handle this type of interrupt. In particular, for a dialup interrupt on a communications line, the answering service process is scheduled.

Answering Service Processing of Dialups.

When the answering service is scheduled as a result of a user dialup, it creates a user control process to identify and

log in the user. In order for the user-process-group to be able to communicate with the new user over the new user's communications line, it is necessary for the user-process-group to assign the line to itself. However, at this time the line is assigned to the answering service (see Chapter Two) and hence the answering service must release the line before the user-process-group can assign the line to itself. A problem of possession arises here which is worth noting. After the answering service releases the line there is a period of time during which the line remains unassigned before the user-process-group assigns the line to itself. It is thus possible for some other process to obtain the line before the user-process-group can do so.

To avoid this problem, it is necessary to inform the system procedure which handles I/O device assignments that when the answering service releases a line, the line should only be assigned to a specific user-process-group. Thus any other process but this user's user-process-group will be prevented from getting control of the line. This call to the system procedure which handles the line assignments is perhaps best implemented in the form of a "hold for a specific period of time" call, i.e., this line may only be assigned by this user's user-process-group over a certain period of time after which the line becomes available for assignment by any process. Thus, if the user-process-group does not, for any reason, assign the line to itself, the line is not permanently withheld from assignment to other processes.

SECTION TWO: LOGGING OUT A CURRENT USER

When a user has finished using the system, he indicates his intention to leave the system by typing a command at his terminal. This "logging out" causes any traces left by this user to be removed, i.e., any resources of the system which the user had assigned to him are released and thus made available for assignment to other users. In particular, the user's communications line is released and made available for new users for attempting to log in.

After the user-process-group logs out, its final operation is to call the interprocess communication facility to schedule the answering service. The answering service interprets this as meaning that this user is finished using the system and that his communications line is available for reassignment to other users. The answering service reassigns the line to itself so that it will be able to receive dialup signals from new users over this line. Finally, any traces left by this user-process-group in the answering service's data base are deleted by the answering service since this information is no longer needed for the answering service to manage the communications line.

A user may log out of the system willingly by typing the appropriate command at his terminal, or he may be automatically logged out by the system. The latter case occurs, for example, when a user's time-allotment runs out and the system therefore logs him out because he is no longer entitled to use its

facilities. However, regardless of how a user is logged out, his logging out procedure will be executed and it will return to the answering service. Thus the answering service is informed of all user logouts in the same manner, and its processing of them is identical.

CHAPTER FIVE

Operator Control of the Communications Lines

During the operation of the system, the system operator may want to specify that only a certain subset of the communications lines should be in operation, i.e., the answering service should respond to dialup interrupts from certain lines and not from others. In particular, the operator will specify an initial configuration of active lines following answering service initialization, and he will specify that all of the lines should be busied out at system shutdown time when no further users are to be able to attempt to log in to the system. Since the answering service is the system module concerned with managing the communication line, it is appropriate to provide it with an interface with the system operator to enable the operator to control the status of the communications lines. In this chapter, the details of this interface and the method with which the answering service sets the status of the communications lines will be discussed.

Status of a Communications Line.

Before the system initialization routine makes its initial call to the answering service to initialize the communications lines, the lines are not as yet assigned to the answering service and hence a user cannot successfully dial up and log in to the system. Once the lines have been assigned to it, the answering service maintains them in one of four possible types of status. These status types reflect whether the line is currently in use, ready to be used, operational but not available for use, or not operational, and are indicated by status switches for the line in the answering service's data base. These status types are:

1. "active" - The line is in use by someone using the system and is currently assigned to that user's user-process-group. No other user may successfully dial up on this line until this user has relinquished control over it by logging out.
2. "on-hook" - The line is not currently in use. It is assigned to the answering service which is ready to create a user-process-group for anyone who dials up on this line so that he may attempt to log in to the system.
3. "off-hook" - The line is not currently in use. It is assigned to the answering service which will not accept dialups on this line and hence

no user may log in on this line.

4. "disabled" - The state of the line is uncertain. The answering service is not able to maintain this line in proper operational status. An inventory of disabled lines is maintained by the answering service and the system operator has access to this information. Whenever a line is classed as disabled the system operator is automatically informed and he sees that it is serviced.

When the answering service receives a call from the system operator to set (or reset) the configuration of communications lines, it first checks the status switches in the answering service's data base to see which of the above status types is applicable for each line. From this information it is able to avoid attempting to put a line "on-hook" if it is already "on-hook" and similarly for the other status types.

Observing the Status of a Communications Line.

It is desirable for the system operator to be able to interrogate the status of a communications line during the course of operation of the system. For example, the operator might be informed by some user that a particular line is not functioning properly, so he interrogates the status of the line to determine if the answering service has classified the line as "disabled"

(if the operator does find trouble with a line that is not "disabled", he will call the answering service and inform it that the line is to be classed as "disabled" until such time as it can be repaired). The operator should at any time be able to determine which of the communications lines is in each particular state. For example, he might want to know how many of the lines are "on-hook", i.e., how many of the lines are available for new users to attempt to dial up on. If the operator finds that this number is too small, he may want to specify that more lines be placed into the "on-hook" state. A later section of this chapter explains how a call from the system operator to interrogate the status of a communications line reaches the answering service, and how the answering service actually supplies this information to the operator.

Changing the Status of a Communications Line.

Just as it is desirable for the system operator to be able to interrogate the status of a line, it is also important for him to be able to change the state of a line. When it becomes necessary to scale up (or down) the number of lines over which users may log into the system, the operator will type a command at his terminal specifying the desired change in configuration and the answering service will perform the change for him and return information to him indicating the new status of the lines. The method with which the answering service causes the status of a communications line to be changed is discussed in a later section of this chapter.

Setting the Configuration of Lines.

The operator, in his capacity as one in charge of the resources of the system, should, in particular, be in control of the communications lines at all times. When the system is brought up, it is the operator who sets the initial configuration of lines. He decides which particular subset of all the lines should be operative for accepting new user dialups. This decision is based on such criteria as what the system is to be used for in the immediate future and what the anticipated demand upon the system is for this particular application. In particular, if the system is to be used for some demonstration which requires the complete attention of all its resources, the operator might want to specify that only a certain terminal should accept dialups and that all the others should not.

When it is time to shut down the system, the operator issues a shutdown command at his terminal which results in all the users being automatically logged out. After this occurs he logs out and the answering service receives the logout signal. In order to prevent new users from being able to dial up before the operator logs out, the operator specifies that all of the communications lines be placed into the "off-hook" status. Thus as each user logs out his line is immediately busied so that a new user attempting to dial up on this line is not able to do so.

Besides setting the configuration of lines at system initialization time and system shutdown time, it is sometimes

desirable to reset the configuration during the operation of the system to reflect changes in anticipated usage. To scale up (or down) the number of lines which respond to dialups, the operator first examines the current status of the lines and decides what modifications to make to the current configuration to achieve his desired configuration. He then types a command describing the desired modifications, or alternatively, he may describe the desired configuration and the answering service will make the appropriate modifications to the current configuration. In the latter case, the answering service checks the status switches for the lines in its data base and decides which lines must have their status changed in order to achieve the desired configuration.

Disabling a Communications Line.

It is to be assumed that malfunctions in the operation of the communications lines will occur and there are several ways in which these malfunctions may be detected. If a user has trouble with his terminal he might suspect that either the system, his terminal, or his communications line is malfunctioning. He informs the system operator of his problems and eventually the trouble may be traced to the communications line. In such a case, the system operator interrogates the status of the line via the answering service and if the line is not classed as "disabled" he informs the answering service that the line should be reclassed as "disabled" until it is repaired.

During the operation of the answering service

routines, it may become apparent that a particular line is not functioning properly. In this case the answering service classifies the line as "disabled" and immediately informs the system operator that the line has been so classed. The operator sees that the line is repaired and then informs the answering service that it should once again ready itself to receive user dialups over that line.

When the answering service classifies a line as "disabled" it attempts to put the line into the "off-hook" state so that the line appears busy to new users attempting to dial up. This prevents new users from being connected to a malfunctioning line, by the switching network. Unfortunately, it is not always possible to place a "disabled" line "off-hook".

In general, the answering service calls routines which are more intimately tied in with the I/O system and these routines are the ones most likely to detect malfunctions in the lines. These routines therefore interface with a set of test and diagnostic routines because they are close to the malfunction. However, the answering service does not operate at such an intimate level with the I/O system and hence when it detects trouble with the lines it merely informs the system operator that a line is malfunctioning.

Changing the Status of an "Active" Line.

If a communications line is currently in the "active" status, i.e., it is currently in use by some system user, the answering service can only regain control of the line if this user logs

out and sends a return signal to the answering service. If the system operator specifies that a particular line should be placed into any status other than "active", and the line is currently in the "active" status, then the answering service cannot perform the operator's request. The problem here is that the answering service is not a privileged routine. Its line management functions do not require that it have immediate access to the privileged routines and tables in the system and thus it is unable to perform functions such as forcing a user to log out of the system. Thus, in the case that a communications line is "active" some special provisions must be made for changing the status of the line is response to an operator configuration request.

In the case that the system is in operation and the operator wants to scale down the number of lines over which dialups are to be accepted by the answering service, the operator specifies that certain "on-hook" lines should be placed "off-hook" and he may also specify that certain "active" lines should be placed "off-hook". In order to perform the operator's request (even though it cannot be performed immediately) the answering service, upon noting that a particular line is "active" sets a switch for this line indicating that as soon as the user on this line logs out, the line should be placed "off-hook". Thus the operator's request is preserved until such time as it can be performed by the answering service. There are times, however, when the operator's request is more pressing and must be serviced immediately. This occurs,

for example, at system shutdown time when the operator wants the system brought down immediately without having to wait for users to log out when they care to do so. The operator circumvents this problem by making two calls. One call is made to the answering service to place all the communications lines "off-hook" as soon as possible and another is made to the system routine responsible for automatically logging out a user. Thus, any lines which are in the "active" status do not cause a problem here. The switches are set for each of these lines to indicate that they should be placed "off-hook" as soon as logout return signals are received from the users on these lines. The return signals, however, follow shortly because the automatic logout mechanism was triggered by the system operator.

How System Operator Commands Reach the Answering Service.

When the operator wants to observe the status of a communications line, or when he wants to change the status of a line, he types a command to his own command language interpreter. Contained within the command language interpreter is a set of routines to process each of the commands which he may type. Since the information which is specified in the operator command is to be read by the answering service, it must be deposited in a segment which the operator's command language interpreter shares with the answering service. After depositing the command information in the shared segment, the operator's command processor wakes up the answering service. The answering service becomes active,

determines that it was activated to process an operator command, reads the information from the shared segment and performs the appropriate processing. If the operator's request was to observe the status of a line, the answering service looks at the switches for the line in its data base, deposits the status information in the shared segment, and wakes up the system operator's command procedure. The command procedure reads the information in the shared segment and types it out at the operator's terminal. (Note: Other solutions to the above problem can be worked out. In particular, in some cases it might be possible for the operator's command procedure to read the status information directly from the answering service's data base thus eliminating the need for the shared segment.)

How the Answering Service Sets the Status of a Line.

When the operator's command is to set the configuration of the communications lines, the answering service calls appropriate routines within the input/output system to place each line into the specified status. As mentioned in a previous section, the answering service first examines the status of the communications lines as indicated by the status switches in its data base to determine what status changes must occur to achieve the desired configuration. It then calls appropriate modules within the input/output system depending upon the type of the communications line whose status is to be changed. These modules then call the general software interface module which manages the input/output controller. The

input/output controller is the hardware device which manages all Of the system's input output devices and, in particular, the communications lines. The control commands to the input/output controller from its software interface module contains all the information needed to make the input/output controller perform the appropriate operation to the communications line.

CHAPTER SIX

Design Proposal

In Chapters Two, Three, and Four, the operation of the answering service has been described in detail. In this chapter, a modular design is proposed for the answering service which delegates responsibilities to a small group of interacting procedures.

The Procedures of the Answering Service.

The functions of line-monitoring during the logging in and logging out of users is handled by the answering service procedure. Its responsibilities include logging in the system operator, initialization of the communications lines, and aiding in the assignment of communications lines to new users logging into the system and reclaiming communications lines from users logging out.

The functions of providing for operation control over the status of the communications lines are handled by the communications line management module. Its responsibilities include processing commands from the system operator to observe and

change the status of particular communications lines, handling commands from the system operator to set the configuration of communications lines which should be in use at any time, and automatically informing the system operator of any lines which appear to be malfunctioning.

The answering service procedure and the communications line management module together perform all of the line-monitoring operations of the answering service. However, these procedures should operate independently of the types of lines which they monitor since their functions are not intimately involved with the details of the operator of the particular types of lines. Thus it is necessary to provide a set of procedures which will interface with the line-monitoring procedures of the answering service and will make the appropriate calls to the input/output system to observe and set the states of the communications lines.

These procedures are called communications line interface modules and there exists a separate module of this nature for each different types of communications line under answering service control.

Flow of Control in the Answering Service.

To see how these various procedures of the answering service interact to perform the line-monitoring functions, let us consider the actions performed within the answering service in the initialization of the communications lines.

After the answering service procedure has aided the

system operator in logging in to the system, it calls the communications line management module to initialize the communications lines. The communications line management module reads a system-provided configuration list to obtain the identification names of each of the communications lines in the current system configuration and the line type of each of these lines. It calls the system process responsible for assigning I/O devices to assign all of the communications lines to the answering service. The communications line management module then makes a series of calls to the appropriate communications line interface modules to place all of the communications lines in the "off-hook" state (to prevent users from dialing up on these lines until the operator wants them to do so). The communications line interface modules are programmed to handle the peculiarities of each type of communications line and they make the calls to the I/O system to put each line into the "off-hook" state. (Note: The meaning of "off-hook" may differ for different types of communications lines. In particular, for one type of line it may be possible to put the line into a "busy" state to prevent dialup interrupts from reaching the answering service, whereas for another type of line this busy state may not exist and "off-hook" for this line would be simulated by no response from the answering service to user dialups on this line.)

As each line is placed into the "off-hook" state, the communications line interface module returns status information to the communications line management module. When all of the

lines have been placed "off-hook", the communications line management module returns status information to the answering service to indicate that the communications lines have been initialized.

The answering service then informs the interprocess communication facility of the system that should a dialup interrupt come from any of the communications lines, the answering service should be immediately awakened. The initialization of the communications lines is now complete.

Modular Structure of the Answering Service.

There are two basic reasons underlying the choice of a modular structure for the answering service. First, the line-monitoring functions performed by the answering service can be logically divided into two categories:

1. Aiding in line assignment to new users. The main interface of the answering service with the system to perform this function is the system procedure responsible for I/O device assignment.
2. Setting and observing the status of the communications lines. The main interface of the answering service with the system to perform this function is with the system process which controls the hardware input/output controller.

It is therefore possible to break the answering service down into several smaller modules each of which can be programmed

independently of the others with only minor interfacing required. This facilitates a more rapid implementation of the answering service.

Second, it is desirable to require a minimal amount of reprogramming in the event that a new type of communications line is to be installed on the system. By creating a separate communications line interface module to handle the peculiarities of each type of line, it is thus not necessary to make modifications throughout the answering service in order to place this new type of line under answering service control; it is merely necessary to program a new communications line interface module for this type of line. Deletion of an old type of line from answering service control is trivial with this modular structure. It is merely necessary to delete the appropriate communications line interface module for this particular type of line.

CHAPTER SEVEN

Summary

In Chapters Three, Four, Five, and Six, we have discussed the design of an answering service made up of a small group of interfacing procedures. These procedures are intended to handle the following line-monitoring problems in the computer utility:

1. Aiding users to log in and out of the system. Because of the turnover of users who are currently on the system in a computer utility, it is necessary to provide a mechanism for assigning the available communications lines to new users and reclaiming control of lines relinquished by users leaving the system.
2. Operator control over the communications lines. The system operator should have the ability to specify that a certain subset of the communications lines should be in use at any given time. This

gives the operator a great deal of control over the usage which the system will support.

3. Aiding the system operator in the detection of malfunctioning communications lines. In the computer utility, as in the public utility, it is necessary to repair any malfunctions as quickly as possible so that normal service may be restored to the user community.
4. Allowing for flexibility in the number of terminal communications lines which are attachable to the system. The demands upon the computer utility may increase with time and it is therefore necessary to provide a framework which makes addition of new terminal communications lines both possible and easy to implement.
5. Providing for the addition of new types of terminal communications lines with a minimum amount of reprogramming. In the computer utility, as in any other utility, improvements in technology may result in the need for a new type of service. In particular, in the computer utility it might be necessary to add new types of terminal communications lines to the realm of control of the utility. The computer utility should be designed in such a manner as to make it possible

to add new types of lines without having to do any major redesign work of the utility.

To solve these problems, a modularly structured answering service has been designed. To aid users in logging in and out of the system an answering service procedure is included in the design. It aids in the assignment of communications lines to new users and the reclaiming of communications lines from users leaving the system.

To provide the system operator with the ability to control the usage and status of the communications lines and detect malfunctions in the operation of the lines, a communications line management module and several communications line interface modules have been provided. These modules make calls which result in hardware signals being sent by the hardware input/output controller to the communications lines to either set or observe the status of the lines.

To make the answering service flexible in the number of terminals which it can support, it has been designed independently of the number of lines it is to monitor in any particular configuration. At system initialization time, the answering service obtains all the information it needs to know about the communications lines and places this information into its own variable size data base. From this point on it assumes control over the lines regardless of how many lines there are.

Finally, to provide for deletion of old types of lines and

addition of new types of lines to its realm of control, the answering service has been designed in a modular manner. In particular, independent communications lines interface modules have been provided to handle the peculiarities of each type of line. Deleting an old type of line from answering service control merely requires deleting the appropriate communications line interface module. Addition requires programming a new communications line interface module to interface in a simple manner with the line-monitoring modules of the answering service. The procedures of the answering service provide a workable mechanism for solving the line-monitoring problems in the computer utility. In addition, the modularity of the design of the answering service provides a convenient structure for the addition of new procedures to handle further line monitoring problems as these problems become apparent.

APPENDICES

The following three documents will soon be published as sections of the Multics System-Programmers Manual (Project MAC internal documentation). The reader who finds some of the terminology unfamiliar should consult the overview sections of reference [10]. These documents describe the Multics implementation of the answering service in detail.

APPENDIX A

D R A F T
3/23/67

Identification

Overview of the Answering Service
H. M. Deitel

Purpose

The Answering Service is a system process which monitors the GIOC channels from which a user may log in to Multics. Included in the Answering Service are an Answering Service Procedure, a Communications Line Management Module, several Data Set Interface Modules, and a Dedicated Line Interface Module. This section describes the functions of each of these modules and the relationships between them. Detailed descriptions will be found in the remaining sections of BQ.2.

Operation

Following system initialization, the Answering Service is created by the System Control Procedure. Its first task is to create a user-process-group for the System Operator. It calls the User Identification Subsystem in this user-process-group which proceeds to log the System Operator in to Multics. The Answering Service then allocates to itself all of the communications lines from which users may attempt to log in, and creates event channels to signal dialup interrupts on

each of the allocated lines. It then calls the wait entry of the Wait Coordinator to await a command from the System Operator Specifying the initial configuration of active lines, i.e., the particular subset of all the communications lines from which the Answering Service is to accept "dialup" and "turn-on" interrupts and ultimately allow users to attempt to log in to Multics. Once the initial configuration of lines is set, the Answering Service is prepared to handle incoming interrupt signals from these lines.

In attempting to gain access to Multics, a potential user dials up on a DATAPHONE data set (or turns on some device attached to a dedicated line with or without data sets). The resulting interrupt causes the Answering Service to wake up and proceed to determine from which line the interrupt came. The Answering Service then creates a user-process-group for this user, creates an event channel to receive a return signal from this user-process-group, and calls the User Identification Subsystem in this process-group informing it of the communications line over which it is to attempt to log in the user. Upon successfully logging in, the user proceeds to utilize the system. When he is finished using the system, he types the "logout" command which eventually causes his user-process-group to send a return signal to the Answering Service. The Answering Service destroys this user-process-group and reallocates the communications line to itself. It then calls wait to await further wakeups.

While Multics is running, the System Operator may want to reset the configuration of active communications lines, and at system shutdown time he specifies that no lines should be active. To set the configuration, the System Operator types a command specifying either the number of lines of each type which should be active, or the Registry File Names of particular lines and whether these lines should be active or not active. The Answering Service sends calls to the GIM to "activate" or "deactivate" particular lines until the desired configuration of lines is achieved, and then calls wait to await further wakeups. At system shutdown time, the Answering Service returns to the System Control Procedure instead of calling wait.

Modular Structure

In order to facilitate the incorporation of new (or deletion of old) types of communications lines, the Answering Service has a modular structure with separate modules to handle the peculiarities of each type of line. The Answering Service Procedure creates and destroys user-process-groups in response to user dialups and Overseer returns, respectively. The Communications Line Management Module handles allocation of the communications lines to the Answering Service Process at system initialization time, and sees that commands from the System Operator to set the configuration of active lines result in a series of calls to the appropriate Communications Line Interface Modules. The Communications Line Interface Modules (i.e., the Data Set Interface Modules and the Dedicated Line Interface Module) are informed by the Communications Line Management Module

of the device index of a particular line, and that they are to either "activate" or "deactivate" the line. They call the GIM informing it of the device index the line and particular parameters which are necessary for the GIM to perform the desired operation on the line.

The system-programmer deletes a certain type of line from the realm of Answering Service control by deleting the appropriate Communications Line Interface Module and by making some minor deletions in the Communications Line Management Module. To add a new type of line, the system-programmer programs a new Communications Line Interface Module and makes some minor additions to the Communications Line Management Module. In either case, no further modifications to any other parts of the Answering Service are necessary.

The Answering Service Procedure

The Answering Service Procedure is first called by the System Control Procedure following system initialization. It creates a user-process-group for the System Operator so that he may log in to the system. It then calls the Communications Line Management Module which proceeds to allocate to the Answering Service Process all of the communications lines listed in the Communications Line Table. This table is read into the system as a part of the System Configuration List and is placed in the File System hierarchy in such a manner as to be easily accessible by the Answering Service

Process. It contains a listing of all those communications lines in the current Multics configuration from which the Answering Service may expect users to attempt to log in, and their associated Registry File Names. There is also an entry for each line specifying the line type of that line so that the Answering Service will know which Communications Line Interface Module to call in order to "activate" or "deactivate" that line. The Communications Line Management Module reads the entries in the Communications Line Table at the time that it initially allocates all the communications lines to the Answering Service Process. At this time it creates an entry for each of the lines in the Answering Service Data Base, and fills in the Registry File Name and line type of each line. Both the Answering Service Procedure and the Communications Line Management Module use the Answering Service Data Base. The Communications Line Management Module utilizes status switches for each line in the table to indicate the current operational status (such as "active") of that particular line. The Answering Service Procedure utilizes the table in its interfacing with the Interprocess Communication Facility for the storage of information necessary in the creation of event channels, and for determining information about an event (such as what communications line is allocated to a user-process-group which just sent a return signal to the Answering Service via the Interprocess Communication Facility.

After the allocation of the communications lines is completed, the Answering Service Procedure creates a separate event channel to signal a dialup interrupt on each of the allocated lines. It then calls the wait entry in the Wait Coordinator to await a command from the System Operator specifying the initial configuration of active lines. It is important to note here that immediately after the Communications Line Management Module allocates each line to the Answering Service Process, it calls the appropriate Communications Line Interface Module for that particular type of line to "inactivate" that line. This is to assure that no users can successfully dialup the Answering Service before the System Operator specifies the initial configuration of active lines. The System Operator may choose to "activate" any number of the communications lines in his initial specification.

When a dialup (or "turn-on") interrupt occurs, the Answering Service Procedure determines which line caused the interrupt and creates a user-process-group for this new user. It calls the Reserver to deallocate the line so that the new user-process-group is able to capture control of the line. It then creates an event channel to signal the return of this user-process-group to the Answering Service. Finally, it calls the User Identification Subsystem in this process-group informing it of the line over which it is to attempt to log in this new user, and it then calls wait.

When a user-process-group returns, the Answering Service Procedure determines which user-process-group returned and thus over which line this user-process-group was communicating. It then calls the Reserver to allocate the line to the Answering Service Process once again in order to recapture control over the line, and hence allow other users to attempt to dial up over this line. The Answering Service Procedure then calls Process Control to destroy this user-process-group since it is no longer needed. Finally, if it is the System Operator's user-process-group which returns, and all other lines are not in use, the Answering Service Procedure returns control to the System Control Procedure. Otherwise, it calls wait. This First situation occurs at system shutdown time.

The Communications Line Management Module

During Answering Service Initialization, the Communications Line Management Module is called by the Answering Service Procedure to allocate all of the lines listed in the Communications Line Table to the Answering Service Process. It obtains the Registry File Name of each line from the table and calls the allocate entry of the Reserver specifying these Registry File Names. The Reserver returns the device index of each line as the line is allocated. The device index of a line is used in calls to the GIM by the Communications Line Interface Modules to inform the GIM to "activate" or "inactivate" a line. The Communications Line Management Module fills the device indices into the Answering Service Data Base and sets the status switches to

indicate that the lines just allocated are all "inactive". As it sets the switches for each line, the Communications Line Management Module calls the appropriate Communications Line Interface Module to make the lines "inactive" to assure that no users may dial up until The System Operator has given the command to set the initial configuration of active lines. The Communications Line Management Module then calls wait expecting the next wakeup to the Answering Service Process to be from the System Operator in order to set the initial configuration of active lines.

Status of a Communications Line

Before the System Control Process makes its initial call to the Answering Service, the communications lines have not as yet been allocated to the Answering Service Process (or any other process, for that matter) and hence a user cannot successfully dial up and log in to Multics. Once the communications lines have been allocated to it, the Answering Service Process maintains each line in one of four possible types of status. These status types reflect whether the line is currently in use, ready to be used, or cannot be used until made ready, and are indicated by the status switches for the line in the Answering Service Data Base. These status types are:

1- "active" - The line is in use by someone using the system and is currently allocated to that user's user-process-group. No other user may successfully dial up on this line until this user has relinquished control over it by logging out.

2- "on-hook" - The line is not currently in use. It is allocated to the Answering Service Process which is ready to create a user-process-group for anyone who dials up on this line so that he may attempt to log in to the system.

3- "off-hook" - The line is not currently in use. It is allocated to the Answering Service Process which will not accept dial ups on this line and hence no user may log in on this line. If this communications line has data sets, then the Answering Service will put the data sets into the busy state. If this line is a dedicated line without data sets, then the Answering Service will be awakened by interrupts from it, which it will ignore.

4- "disabled" - The state of this line is uncertain. The Answering Service is not able to maintain this line in proper operational status. An inventory of disabled lines is maintained by the Answering Service and the System Operator has access to this information. When System Operator notes that a line is disabled, he sees that it will be serviced.

When the Answering Service Process receives a call from the System Operator to set (or reset) the configuration of active lines, it will first check the status switches in the Answering Service Data Base to see which of the above status types is applicable for each line. From this information it is able to avoid attempting to put a line "on-hook" if it is already "on-hook" and similarly for the other status types. If a line is currently in the active status and the System Operator has requested this line to be made "inactive" (i.e., placed in the "off-hook" state), then the Answering Service waits until a return signal is received from the user-process-group in control of this line before it proceeds to place the line "off-hook". The status switches in the Answering Service Data Base have many other important functions. These will be discussed in the remaining sections of BQ.2.

Types of Communications Lines

The Answering Service monitors those GIOC channels from which a

user may log into the system. Each of these falls into one of the following three types of line:

1 - dedicated line without data sets - This consists of a communications line running directly from the GIOC to a terminal device. There are no DATAPHONE data sets attached to the line, and hence a user does not actually dial up over such a line. Instead, he causes an interrupt to occur (which will eventually wake up the Answering Service) by merely turning on the power switch at his terminal.

2 - dedicated line with data sets - This consists of a communications line running from the GIOC to a terminal device with a data set on each end of the line. At the GIOC end there is a data set adapter between the data set and the GIOC. Over this type of line, the user also causes an interrupt to occur by turning on the power switch at his terminal. This interrupt also causes the Answering Service to wake up.

3 - lines with data sets and a PBX switchboard - On the GIOC side of the PBX, there is a fixed number of lines to the GIOC. On the opposite side of the PBX, there can be any number of lines running into the PBX from remote terminals. A user wishing to gain access to the system dials a special telephone number which is unique to his

type of terminal device and communication line types. There may be many terminals of this same type on the terminal side of the PBX and on the GIOC side there may be many lines to the GIOC which are prepared to handle this type of device and line combination. When the user dials his particular telephone number, the PBX will hunt around the GIOC lines until it finds one for this particular telephone number, i.e., until it finds a line which is assigned to handle this users device and line combination. If it finds such a line it connects the line to the terminal with the line to the GIOC and a dialup interrupt occurs eventually waking up the Answering Service. It is possible that a user may dial an improper number and hence an improper connection might be made. In this case the Answering Service creates a user-process-group for this user which attempts to log him in. The Device Manager Process in this process-group runs tests to determine if a proper connection exists. It finds that an improper connection has been made and proceeds to log out this user-process-group so that this user is able to attempt to make a proper connection for his type of terminal.

The Communications Line Interface Modules

Ultimately, all input/output requests are serviced by the General

Input/Output Controller (GIOC). The actions performed by the GIOC are specified in lists of command words which are created by calls to the GIOC Interface Module (GIM). The content of these command words is, in general, different for each type of I/O device (including communications lines) to be serviced. To perform the functions of creating and activating these lists of command words, there is, in the Answering Service Process, a separate Communications Line Interface Module for each type of line which the Answering Service monitors. These modules call the GIM to cause Data Channel words (DCW's) and Connect Channel Words (CCW's) to be created and activated. The information regarding the formatting of these command words is contained in the GIM's Class Driving Tables (CDT's). The tables are tailored to the individual devices and will be described in detail in the sections of BQ.2 describing the various Communications Line Interface Modules. Hence, the Communications Line Interface Modules are responsible for causing the particular types of lines (via the GIOC) to perform the desired action such as assuming the "on-hook" status, etc.

The Communications Line Interface Modules will be called by the Communications Line Management Module which will supply the device index of the line, the desired operation to be performed, and any other pertinent information which is necessary to build an appropriate call to the GIM.

APPENDIX B

D R A F T
4/21/67

Identification

Answering Service Procedure
H. M. Deitel

Purpose

The Answering Service Procedure is a subroutine within the Answering Service Process. Its functions include creating a user-process-group to log in the System Operator following system initialization, responding to dialups from user terminals by creating user-process-groups to log in the new users, and responding to return signals from user-process-groups (indicating that the user has logged out) by destroying the user-process-group and reclaiming control over the communications line so that some other user may dial up on the returned line.

Answering Service Initialization

Following system initialization, the Answering Service Procedure is called by the System Control Procedure to create a user-process-group for the System Operator, and to create event channels so that the Answering Service Process will be awakened by user dialups and operator commands. The Answering Service Procedure calls Process Control to create a user-process-group for the System Operator. It then calls the Interprocess Communication Facility to create an event channel to signal the return of the Operator's user-process-group to the Answering Service Process. It then calls the user-identification-subsystem in this

user-process-group informing it of the Registry File Name of the Operator's terminal (this information was given to the Answering Service Procedure by the System Control Procedure). The user-identification-subsystem contains the user-in procedure which validates that this user is indeed a valid System Operator and proceeds to log him in to the system.

The Answering Service Procedure then calls the Communications Line Management Module to allocate all of the lines listed in the Communications Line Table to the Answering Service Process. The Communications Line Table is read in at the same time as the System Configuration List. It contains a listing of the Registry File Names of each of the communications lines in the current system configuration, and the type for each line (such as a line for 1050's, a line for model 37 teletypes, etc.). The table is read into the file system hierarchy in such a way as to be easily accessible by the Answering Service Process. In particular, the table resides in the user ring for easy access.

The Answering Service Process maintains a data base called the Answering Service Data Base. This table contains all the information about the communications lines, including Registry File Names, line types, and interprocess communication information such as event channel id's, etc. As each line is initially allocated to the Answering Service Process, a switch is

set for this line in the Answering Service Data Base indicating that the line is currently in the "off-hook" state, i.e., the line appears busy to new users attempting to dial up and hence no new users may log in to the system. This is done to prevent new users from getting on the system before the System Operator actually authorizes that users should be allowed on the system. The Communications Line Management Module actually performs the allocation and initialization of the communications lines. To insure that each particular line assumes the appropriate state, the Communications Line Management Module calls the appropriate Communications Line Interface Module which in turn calls the GIM to put the line into the appropriate state. This is explained in detail in MSPM section BQ.2.02.

After the communications lines have been allocated to the Answering Service Process, the Answering Service Procedure calls the Interprocess Communication Facility to create event channels to signal dialups on each of the allocated lines. This insures that when a user dials up from a terminal, the resulting interrupt causes the Answering Service Process to wake up. Additional event channels are created to signal commands from the System Operator to the Answering Service Process. See MSPM section BQ.2.02 for a detailed summary of these commands.

After creating all the necessary event channels, the Answering Service Procedure returns control to the System Control Procedure informing

it of the configuration of the communications lines. This informs the System Control Procedure that the Answering Service Process has allocated the communications lines to itself and that it is awaiting a wakeup from the System Operator specifying the initial configuration of communications lines which should be in the "on-hook" state, namely those communications lines over which the Answering Service Process will accept user dialups and hence those lines over which users may attempt to log in to the system. The Operator command to set the configuration of "on-hook" lines is processed by the Communications Line Management Module and is explained in detail in MSPM section BQ.2.02.

Answering Service Event Dispatching

Following the command by the System Operator to set the initial configuration of "on-hook" lines, the Answering Service Procedure is ready to receive wakeups from user dialups and System Operator commands. Whenever an event of interest to the Answering Service occurs (i.e., whenever an event occurs for which the Answering Service has created an event channel) the process noting the event will send a wakeup to the Answering Service Process via the Interprocess Communication Facility. There are many different types of wakeups which are of interest to the Answering Service and the Answering Service contains a subroutine to process each type of wakeup. All wakeups to the Answering Service Process cause a particular subroutine of the Answering Service Process to be called,

namely that subroutine which was specified at the time that the particular event channel was created. Hence, there exists no event dispatching mechanism within the Answering Service Process. Instead, the dispatching is done within the Interprocess Communication Facility by reference to information which is supplied at event channel creation time. Thus, whenever the Answering Service wakes up, the appropriate procedure within the Answering Service is activated automatically by the Interprocess Communication Facility.

Processing of User Dialups

When a user wishes to gain access to Multics, he dials up on a data set (such as the Bell System DATAPHONE data set 103A) or turns on some device attached to a dedicated line with or without data sets. The resulting interrupt causes the Answering Service Process to wake up and causes the "new-user-dialup" procedure of the Answering Service Process to become active. The "new-user-dialup" procedure calls Process Control to create a user-process-group for this new user. It then calls the Interprocess Communication Facility to create an event channel to signal the return of this user-process-group to the Answering Service Process. The "new-user-dialup" procedure then calls the Reserver to deallocate the line from the Answering Service Process so that the new user-process-group may allocate the line to itself. The deallocate call to the Reserver specifies that the only process which may allocate the line is the new user's user-process-group. This is to insure that there is no period of time during which

the line is not allocated to any process, and hence that another process cannot come along and grab this line away from its intended user-process-group. Once the line has been deallocated from the Answering Service Process, the "new-user-dialup" procedure sets the status switches for this line in the Answering Service Data Base to indicate that this line is in the "active" status (note: for definition of status types see MSPM section BQ.2.00). The "new-user-dialup" procedure then calls the User-Identification-Subsystem in the new user process group which proceeds to log in the new user. Finally, "new-user-dialup" returns to the Interprocess Communication Facility to indicate that it has finished processing the wakeup.

Processing of User-Process-Group Returns

When a user has finished using the system he types the "logout" command to his Working Process which eventually results in a wakeup to the Answering Service Process. The "user-process-group return" procedure is activated and proceeds to call the Reserver to allocate the line to the Answering Service Process. It then calls Process Control to destroy the user-process-group and calls the Interprocess Communication Facility to destroy the event channel which was used to signal the return of this user-process-group to the Answering Service Process. It sets the status switches for this line in the Answering Service Data Base to indicate that the line is in the "on-hook" state, i.e., the line is ready to accept dialups from new users once again. If this user-process-group belongs to the System

Operator the system is being shut down so control is returned by the "user-process-group return" procedure to the System Control Process. If it is not system shutdown time, control is returned to the Interprocess Communication Facility to indicate that the "user-process-group return" procedure is finished processing the wakeup.

APPENDIX C

D R A F T
4/22/67

Identification

Communications Line Management Module
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Purpose

The Communications Line Management Module is a subroutine within the Answering Service Process. Its functions include initialization of all the communications lines at Answering Service initialization time, servicing configuration and reconfiguration requests of the System Operator to set the number of terminals which accept user dialups, servicing System Operator requests to examine the status of particular communications lines, and automatically informing the System Operator whenever a communications line has been classed as "disabled" by any of the subroutines in the Answering Service Process.

Initialization of the Communications Lines

After the Answering Service Procedure creates a user-process-group for the System Operator and calls the User Identification Subsystem in this user-process-group to log in the System Operator, it calls the Communications Line Management Module to initialize the communications lines. The Communications Line Management Module reads the Registry File Names and line types of each line from the Communications Line Table and places this information in the Answering Service Data Base, creating a separate entry for each of

the communications lines. It then calls the Reserver to allocate each of the communications lines to the Answering Service Process. The Communications Line Management Module then calls the Inter-Process Communication Facility to create separate event channels to signal dialup interrupts on each of the allocated lines. The Communications Line Management Module then makes a series of calls to the "set-up-device" entry in ring 0. It specifies the Registry File Name and event channel name of a communications line and the "set-up-device" entry returns the device index of the line. The Communications Line Management Module places the device indices into the appropriate entries in the Answering Service Data Base. The device index of a communications line is used by the Communications Line Interface Modules in their calls to the GIM specifying that a certain line should be placed into a particular state. The device index serves as the identification of the I/O device to the I/O system. The Communications Line Management Module sets the status switches in the Answering Service Data Base to indicate that each of the communications lines is currently in the "off-hook" state, i.e., users may not successfully dialup on any of the lines. To insure that each line appears to the users as if it is indeed "off-hook", the Communications Line Management Module calls the appropriate Communications Line Interface Module for each line specifying that the line should be placed into the "off-hook" state. The Communications Line Interface Modules will make appropriate calls to the GIM to insure that the GIOC actually puts the lines into the proper state

(note: the operation of the various Communications Line Interface Modules is explained in detail in later sections of BQ.2.). The Communications Line Interface Modules each return status information indicating if the attempts to put the lines into the "off-hook" state are successful. The status information for each line is placed in the Answering Service Data Base by the Communications Line Management Module and then the Communications Line Management Module returns to the Answering Service Initialization procedure indicating that its job of initializing the communications lines is complete.

Processing Operator Requests to Set the Configuration of Lines

During the operation of the system it is desirable for the Operator to be able to specify the configuration of communications lines over which the Answering Service should accept user dialups. For example, at system shutdown time the Operator specifies that all of the communications lines should be placed into the "off-hook" state so that no user may dial up, and at system initialization time the Operator specifies the initial configuration (perhaps "all") of the lines which should accept dialups. During the operation of the system, the Operator may want to ready specific lines and busy others so that only users of a certain type of line may have access to the system. Each of these configuration requests is typed by the Operator to his Working Process. This results in an interprocess call which wakes up the Answering Service Process and activates a procedure within the Communications Line Management Module. The configuration

information is deposited in a segment accessible to the Answering Service and the Communications Line Management Module reads this information from this segment. The Communications Line Management Module then makes a series of calls to the appropriate Communications Line Interface Modules to put the specified lines into the specified states. The Communications Line Interface Modules return status information indicating the states the communications lines are put into and the Communications Line Management Module deposits this information in the interprocess segment used to communicate with the System Operator's Working Process. Finally, the "Set Configuration" procedure returns to the Interprocess Communication Facility to indicate that it has finished processing its wakeup. See a later section of this document for a detailed description of the Operator commands used to interface with the various procedures of the Communications Line Management Module.

Processing of Disabled Line Information

When the Answering Service discovers that a line is not responding properly to its requests to place the line into a certain state, it classifies the line as "disabled" (see MSPM BQ.2.00) and immediately informs the System Operator of the Registry File Name of the disabled line. The Operator sees that any difficulties with the line are repaired and then informs the Answering Service that the line is once again operative. When the Operator discovers some

malfunction (independently of Answering Service prompting) he informs the Answering Service that the line is to be "disabled" until further notice. The Communications Line Management Module contains the procedures which handle disabled line problems. The module which responds to the Operator's request to disable a line sets the switches for this line in the Answering Service Data Base to indicate that the line is "disabled" and then calls the appropriate Communications Line Interface Module for that type of line to make any appropriate calls to the GIM to disable the line from system usage. This module then returns status information to the System Operator and returns control to the Interprocess Communication Facility to indicate that it has finished processing its wakeup. The module which informs the Operator that the Answering Service has disabled a line is called by any subroutine of the Answering Service which sets the status switches for a line to indicate that the line should be disabled. The Registry File Name of the line is deposited in the Interprocess Communication segment and a wakeup is sent to the System Operator. This module then returns control to the subroutine of the Answering Service which called it.

Processing of Operator Requests for Status of the Communications Lines

At any time during the operation of the system the System Operator may request a description of the status of the communications lines by typing the appropriate command to his working process. The details of these Operator commands are explained in a later section of this

document. The parameters of the command are deposited in the interprocess communication segment shared by the Answering Service and the System Operator's Working Process and then a wakeup is sent to the Answering Service. This causes the "Inventory Request" procedure of the Communications Line Management Module to become active. The "Inventory Request" procedure reads in the status request and depending upon the particular request returns either the status of a line or a list containing the status of each of several lines. The "Inventory Request" procedure gets its information from the Answering Service Data Base and for each line it returns the following:

1 - Registry File Name of the line

2 - Line type

3 - Line status

a - "active"
b - "off-hook"
c - "on-hook"
d - "disabled"

Operator Commands to Set the Line Configuration and Request Line Status

To inform the Answering Service to set a particular line configuration or to have the Answering Service return line status information, the System Operator types commands to his Working Process. These commands deposit parameter lists in a segment shared by the Answering Service and the System Operator's Working Process, and then send a wakeup to the Answering Service specifying which

procedure of the Answering Service is to be activated. The activated procedure reads the parameter lists and performs the appropriate activity. It then returns status information to the System Operator by depositing the information in the common segment. The following commands are available to the System Operator:

set_line_config - this command is used by the System Operator to set the configuration of communications lines, i.e., to specify over which lines users are allowed to dial up and log in to the system.

There are three methods of specifying the line configuration:

a- the Registry File Name of each line is specified along with the operation which is to be performed to that particular line (i.e., put the line into the "on-hook" or "off-hook" or "disabled" state). This form is used mainly during the operation of the system when the Operator wants to change the status of a few lines. In particular, he might specify that a line be placed into the disabled status (for test and diagnostic observation) so that the Answering Service will not allow or wait for incoming interrupts until the line has been serviced.

b- the line type is specified along with the number of lines of that type which are to be in each state. This form is used in the specification of the states of a large number of terminals such as at Answering Service initialization time when the entire configuration must be specified.

c- the Operator may specify that all or none of the communications lines should be in a particular state.

get_line_inventory - this command is used by the System Operator to examine the status of a line or group of lines. The information returned to the Operator is the Registry File Name, line type, and status of the line.

Here, too, there are three forms of the command:

a- the Operator may specify the Registry File Names of one or a number of lines.

b- the Operator may specify that he wants status for all lines of a particular type (or several types).

c- the Operator may specify that the status information for all of the communications lines should be presented.

REFERENCES

Abbreviations used in the references:

AFIPS	American Federation of Information Processing Societies
FJCC	Fall Joint Computer Conference

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