CIRCUIT MAINTENANCE SYSTEM 3A

SOFTWARE

GENERAL DESCRIPTION

1. GENERAL

INTRODUCTION

1.01 The Circuit Maintenance System (CMS) 3A is being developed to incorporate automated techniques into the provision and maintenance of telecommunication circuits. This section describes the software required for CMS 3A and the general functions of software in a terminal-oriented computer system.

1.02 When this section is reissued the reason for reissue will be given in this paragraph.

1.03 Figure 1 shows the central computer hardware for CMS 3A. Each regional CMS 3A interfaces various electronic data processing (EDP) systems via on-line data links. These systems supply CMS 3A with source information (service/circuit orders, circuit layout data, etc), and CMS 3A in return supplies them with order status and maintenance report data. The regional system can also interface various test systems via data link as they become operational.

1.04 Operating personnel, working in several work centers within a geographic area, communicate with the computer via cathode ray tube (CRT) terminals (Fig. 2) to obtain the information required to perform their assigned work functions. These interfaces, called interactive user/machine interfaces, consist of a CRT display monitor and a keyboard device and may include a hard copy printer. An operator (or user) simply keys in 3-digit numeric commands with appropriate parameters via the keyboard and receives displays of the desired data on the CRT monitor. Data can also be edited or manually created via the CRT monitor/keyboard and transmitted for storage in the regional data base. For a general description of the CMS 3A, refer to Section 190-101-100.

1.05 The data displays that a user may access are controlled by parameters that must be input with the sign-on command. These parameters identify a user, a work location (control area), and the work function being performed. Since the general content of most displays applies to all work functions, the parameters assure access of the correct version for a particular use. For example, command 300 returns an index display of commands required to access order work sheets, logs, and trouble reports for the various work functions. Depending on the parameter input at sign-on, a user may enter command 300 and receive the order administration control (OAC) work sheet and log index (Fig. 3A) or the maintenance administration control (MAC) work sheet and log index shown in Fig. 3B.

1.06 Restrictions within the system control the parameters a user may input. The restrictions assure access of the appropriate data for a particular work function. These restrictions are controlled
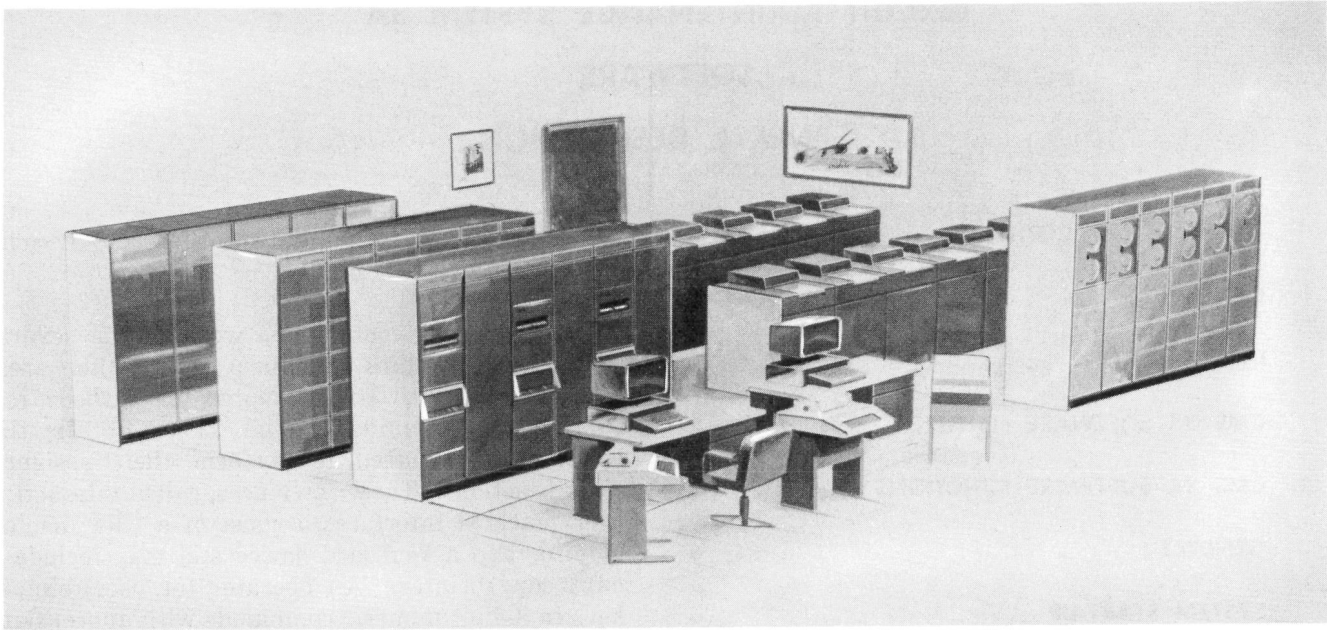
Fig. 1—CMS 3A Central Computer Hardware

by the system maintenance center and are discussed in Sections 190-101-160 and -360. The Circuit Maintenance System Maintenance Center (CMSMC) is a work center collocated with the central computer hardware and dedicated to overall administration of a regional CMS 3A.

CMS 3A SOFTWARE FEATURES

1.07 CMS 3A is a terminal-oriented, on-line computer system. For a system of this type, the software is organized in layers. The first layer is the system manager, the second layer contains system software and the rest of the layers are made up of application (sometimes called user) software.

1.08 CMS 3A software is comprised of Operating System (OS) 11 and various user-oriented task group programs that either reside in core or are stored on disks and loaded into core when needed. OS 11 is comprised of an operating system executive, EX 11, and various system managers (eg, FS 11, FB/R 11, etc.) Core regions (specific core spaces) are allocated to particular task group programs. These core regions are "boundary-protected"; ie, the tasks are protected against unauthorized memory alteration.

1.09 EX 11 controls the computer hardware and is in charge of releasing the central processing unit (CPU) and allocating other resources (tape, disks, printers, etc.) to the various system or application task group programs (core regions) as required.

1.10 A task is defined under OS 11 as any program which requires some operating system services for its execution. The required services may be task management, intertask management, hardware resource allocation, or input/output (I/O) handling. A terminal manager task is typical. This task processes all the terminal messages and requires most of the operating system services for its execution.

A. Operating Executive System—EX 11

1.11 EX 11 was developed for the PDP 11 computer family to satisfy two prime objectives: fast response time and backup-recovery capability. EX 11 is designed to optimize the PDP 11 capability in terminal-oriented, high-traffic, real-time computer systems such as CMS 3A.

1.12 EX 11 coordinates all the I/O operations in the system. To perform this function

Fig. 2—Cathode Ray Tube Terminal

efficiently, each task owning resources, ie, system software tasks, must specify all the resources it needs before it starts execution. The resource specification is included as part of the task parameters in a task table maintained by EX 11.

1.13 In general, more than one task will be involved in processing a transaction. For example, a terminal manager task will usually read an operator request and direct it to the appropriate user transaction task for further processing. During the processing of a transaction, filing system tasks may be called to access files in the data base or build a terminal response to the operator. This intertask communication under EX 11 proceeds as follows:

(1) A task is given control of the CPU by EX 11 to enable it to run.

(2) While running, the task calls on another task via the SCHEDULE command.

(3) The SCHEDULE command prepares the requested task for execution after all required resources have been allocated.

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MESSAGES
ACTIVE
DISPLAY
 300  WORK SHEET LOG AND REPORT INDEX              <●●●●●●●●●●●● ●●●>

  381  REPORT

  382  REPORT DISPATCH

  384  REPORT LOG

  386  MAINTENANCE OF FACILITY CHARGE

  387  MAINTENANCE OF SERVICE CHARGE

  388  BILLING INFORMATION REPORT

  389  REPORTS RELEASED FOR RESULTS/ANALYSIS

  390  CALLOUT WORK SHEET

  391  FIELD GROUP (S) STATUS
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Fig. 3A—OAC Work Sheet and Log Index

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MESSAGES
ACTIVE
DISPLAY
 300  WORK SHEET AND LOG INDEX                     <●●●●●●●●●●●● ●●●>

  301  JEOPARDY REPORT

  302  ORDER WORK SHEET / LOG

  303  NEW ENTRY

  304  DOCUMENTATION ERROR REPORT

  305  ORDER STATUS

  306  ORDER COMPLETION

  307  PROJECT

  308  DISPATCH
```

Fig. 3B—MAC Work Sheet and Log Index

(4) The caller task relinquishes the CPU and the requested task gains control of the CPU to enable it to run while the caller task waits.

(5) After the SCHEDULE operation has been completed, EX 11 returns control of the CPU to the caller task.

1.14 Under EX 11 management, a task passes through three states: the scheduled state, the running state, and the wait state.

1.15 The *scheduled state* occurs during the period in which the task is prepared to start execution. When it gains control of the CPU and execution starts, it passes into the *running state.* During the course of running, a task may find it necessary to relinquish control of the CPU and enter the *wait state* until an event occurs. While that task is in the wait state, the CPU will be utilized to run other tasks. When the awaited event occurs, EX 11 will give control of the CPU back to the waiting task, thus moving the task back into the running state.

B. System Level Software

1.16 The system level software is defined as those core regions containing manager task programs whose function is to handle the application level requests for service.

C. Application Level Software

1.17 Application software core regions contain the task group programs necessary to implement a logical group of commands. CMS 3A currently has 16 application software developmental categories. These categories imply a maximum of 16 core regions allocated to user-type software.

D. Foreground/Background Concept

1.18 A major part of the CMS 3A application software must be available for on-line scheduling at all times. These programs are core resident and are called "foreground" core regions. The size of the core region allocated to each task group is dependent on the task group size.

1.19 EX 11 builds and maintains a core region directory which lists all task groups that are core resident and identifies their location, priority rating, etc. During on-line operation, when EX 11 receives a request to schedule a task, this directory is searched. If the task is found, it is scheduled to run.

1.20 Some application programs run infrequently: eg, the management report generator which runs once a day. Such programs are usually termed "background" or disk resident software. They are stored on disks and are brought into core by EX 11 only when needed. Once a background program terminates, it is flushed out of core and the core space is reclaimed for use by other background load requests.

1.21 EX 11 builds and maintains a disk directory of background programs. If a requested task is not found in the core region directory, EX 11 searches the disk directory. When the task is found, EX 11 loads the program containing the task into core and the task is scheduled to run.

E. Priority Rating

1.22 Under EX 11 each task must be assigned a priority rating to control program execution. Two situations illustrate the need for task priority:

(a) During the execution of EX 11, a management report generator task may be invoked and requested to run while on-line transactions are being processed. In this case, to ensure that the on-line transaction is not interrupted, the management report generator needs a lower priority rating than that assigned to core regions containing on-line transaction tasks.

(b) Certain critical tasks must run without any interruptions. As an example, consider the log manager task for fallback/recovery. The log manager must stop the execution of subsequent tasks in the system until current executions are logged and all pertinent data is saved. For this reason, the log manager task is given the highest priority.

1.23 When EX 11 allocates a resource (tape, disk, printer, etc) to a running task, it is usually assigned to that task until the task terminates. Requests may be made by other tasks for information from a busy resource. These requests are queued by EX 11 and the resource is allocated on a first-come, first-serve basis as it becomes available.

2. CMS 3A SOFTWARE FUNCTIONS

GENERAL

2.01 The CMS 3A software structure is shown in block diagram in Fig. 4. It is comprised of EX 11 (the system manager), four foreground system software core regions, *n* number of foreground application software core regions (possibly 16), and one or more background core regions for disk resident programs.

2.02 EX 11 controls the computer resources and provides the user interface necessary to implement the application programs. EX 11 releases the CPU to the core regions either on a priority-scheduled basis or at timed intervals and manages all hardware resources as required for overall system control.

SYSTEM START-UP

2.03 At system start-up, EX 11 is loaded from disks into core. As part of the start-up procedure, EX 11 automatically tests and computes the amount of core available on the host machine and prints it on the system device. After computing the core size, EX 11 requests a list of all the task groups which must be loaded as foreground (core resident) and those which must remain on the disks (background). Upon receipt of the task group list, EX 11 proceeds to load all the foreground task groups into core. Each foreground task group is given a boundary-protected core region of a size dependent on the task group size. EX 11 builds a task table for all foreground core regions, listing the content, priority rating, location, etc, as mentioned in Part 1. For background task groups, EX 11 builds a directory of all tasks contained in
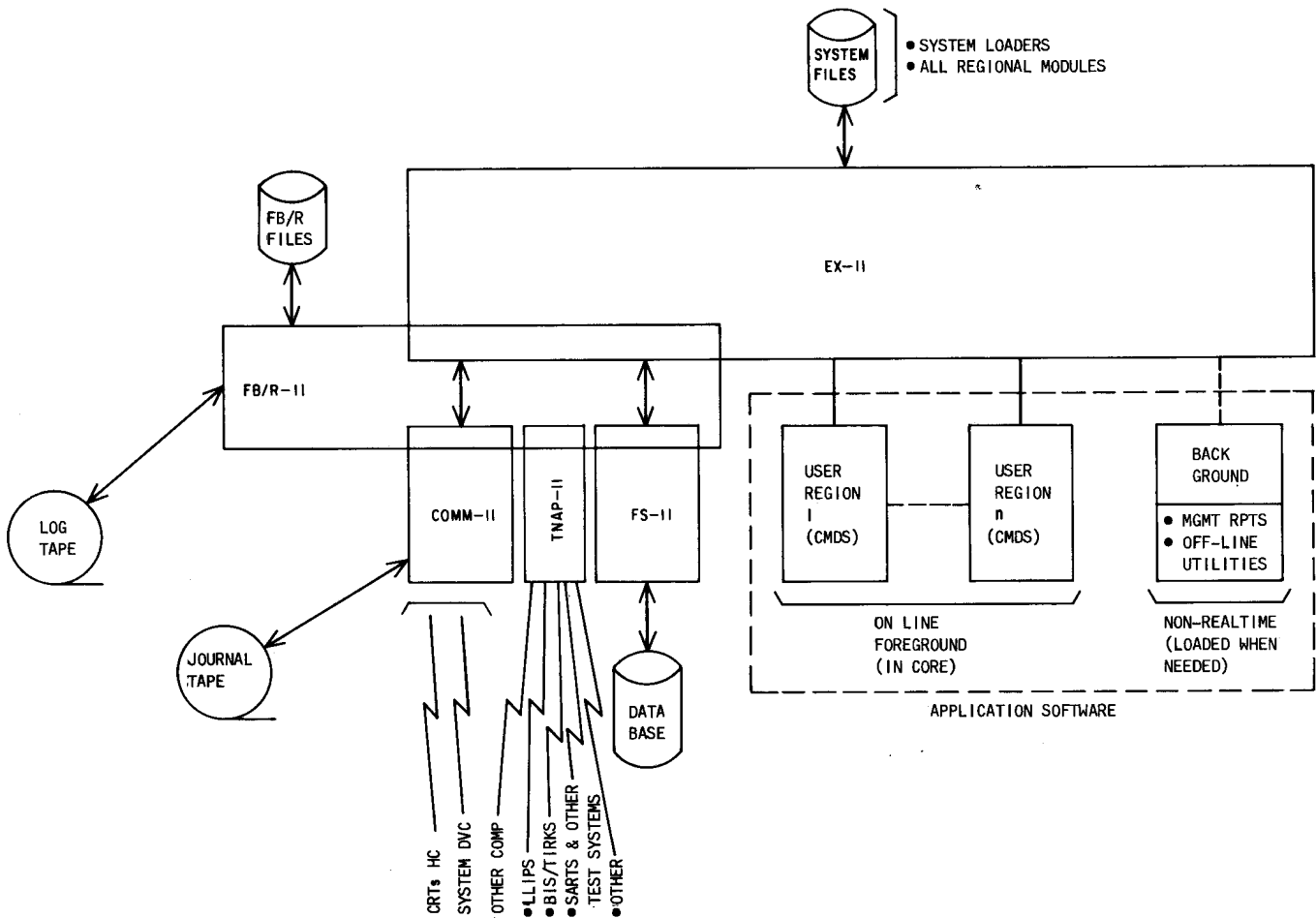

Fig. 4—CMS 2A Software

them (same as for foreground) and computes the core size required for loading.

2.04 After EX 11 is loaded into core, the core region software is loaded in the following order:

   (a) Fallback and recovery

   (b) File system

   (c) Communication network control

   (d) Telecommunications network access programs

   (e) Foreground application software

   (f) Background application software.

SOFTWARE CORE REGIONS

A. System Software

2.05 The following paragraphs briefly describe the functions of CMS 3A software core regions.

2.06 The core regions defined as system software in Fig. 4 contain manager task group programs designed to handle application-level requests. In CMS 3A, the system software core regions are designated

   ● Fallback and recovery (FB/R 11)

   ● File System (FS 11)

   ● Communication network control (COMM 11)

   ● Telecommunications network access program (TNAP 11)

FB/R 11

2.07 The FB/R core region protects system integrity by maintaining temporary disk files for recording changes to on-line disk packs. These temporary areas are written on tape for pack recovery.

2.08 Duplicate or image copies of any disk pack can be furnished by FB/R 11 upon request. FB/R 11 can reconstruct corrupted on-line packs by processing the last image copy of the packs

affected and all log tapes created since the last image copy.

2.09 In the event of a serious malfunction, FB/R 11 saves system parameters and is capable of restarting the system.

FS 11

2.10 The file system task group handles application (user) level requests for data base service, both read and write. The file system controls user access to the data base. All data base changes are logged onto the FB/R disk files and are finally written on the log tape by FB/R 11 for future data base recovery should a major disk failure occur.

COMM 11

2.11 In CMS 3A, the communication network is the direct path of communication between users operating the CRT terminal devices in remote offices and the computer. The communication network hardware consists of line multiplexing units (LMUs), modems, station cluster controllers (SCCs), device cluster controllers (DCCs), CRTs, Digital Equipment Corporation (DEC) writers in the system maintenance center, and CRTs and printers in the remote offices (work centers). The COMM 11 controls all system communication.

2.12 COMM 11 contains manager task programs designed to control all interaction between CRT terminal users and the computer. COMM 11 is timer driven; ie, EX 11 releases the CPU to COMM 11 at timed intervals, enabling it to run, either to service user requests or via the system maintenance operator, to manage network problems such as patching around a malfunctioning modem.

2.13 When COMM 11 is running, one of its programs, the polling manager, polls all CRT users within the network for requests. Finding a request for service, COMM 11 directs it to the appropriate application and/or system core regions that can service the request and build a response. COMM 11 then outputs the response to the user CRT.

TNAP 11

2.14 TNAP 11 allows direct machine communication between CMS 3A and other computer systems

such as BIS/TIRKS, LLIPS, SARTS and other test systems, etc. (See Section 190-101-101.)

B. Application Software Core Regions

Foreground Application Software

2.15 The foreground application software core regions contain task programs that are necessary for implementing on-line, real-time user requests. The programs are based on 16 software-developed categories of user commands. These 3-digit commands are keyed in via the terminal keyboard, and the desired data display is returned to the CRT monitor. The number of foreground core regions required is based on user response time and processing time for user commands. For detailed information concerning commands, specific displays, etc, refer to Sections 190-101-125, -130, -135, -140, -150, and -160.

2.16 In general, one user at a time can be active on an application core region. EX 11 will queue user requests for a particular core region and allocate the CPU on a predetermined basis.

Background Application Software

2.17 A number of task group programs contain basic software to implement non-real-time system and user functions. These background programs reside on disks and are loaded into core by EX 11 only when needed. Once these programs terminate, their core is reclaimed for use by other parts of the system. An example of a background program is the management report generator which runs once a day. The core region referred to as a background core region in Fig. 4 depicts these programs.

3. TYPICAL CMS 3A TRANSACTION

3.01 A simplified user transaction is traced below from the user request through the system response to the user.

Assumption: The system is up and running.

(1) A user at a CRT keys in a command with appropriate parameters and presses the key "ENTER."

(2) EX 11, at a timed interval, releases the CPU to COMM 11. COMM 11 runs.

(3) While running, COMM 11 polls all user CRTs and detects one that is keyed "ENTER."

(4) COMM 11 reads the user command and schedules the appropriate application core region to service the command. For this example core region *n* (RG N) is used.

(5) The task in RG N specifies the resources needed to service the request and EX 11 allocates the resources to the task. EX 11 releases the CPU to RG N.

(6) The task runs. While processing the request, it may need to access the data base for reading and/or writing of data. If so, then (a) and (b); if not, proceed to Step (7):

  (a) Via intertask communication, the task requests data base access from the file system.

  (b) The task waits while the CPU is released to the file system for data base access.

(7) If changes are made to the data base, the file system waits while the CPU is released to FB/R 11 to log the data base changes onto the temporary disk FB/R 11 files.

(8) The CPU is again released to the application task and the user response is generated and sent to COMM 11.

(9) The application task terminates.

(10) EX 11 releases the CPU to FB/R 11 and the temporary recovery disk files are logged on the FB/R tape.

(11) At the next timed interval, COMM 11 gains control of the CPU and outputs the response to the user CRT.

3.02 Some of the above transactions may occur simultaneously. From the last character of the CRT input to the first character of the response, the elapsed time should be less than five seconds in an appropriately designed system.