RTE-IVB
Session Monitor

User's Student Course Book
Volume I

data systems
training center

22999-90220

September 1, 1979
updated August 1, 1980

22999-90220 Session Monitor User Student Workbook

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HP 1000 RTE-IVB/SESSION MONITOR USER'S COURSE
STUDENT WORKBOOK — VOLUME 1

This volume of the Student Workbook is for use during week 1 of the 2 week HP 1000 RTE-IVB/Session Monitor User's Course.

The schedule below indicates the chapters of the Student Workbook to be used during the week and the corresponding lab exercises. The topics to be discussed in each chapter are summarized in the Table of Contents.

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8	INTRODUCTION and WELCOME	Review 3. RTE ORGANIZATION	Review 5. PROGRAM DEVELOPMENT	Review 7. USING RTE's SERVICES PROGRAMMATICALLY	Review 10. USING FILES PROGRAMMATICALLY — FMP CALLS
9	1. AN INTRODUCTION TO RTE				
10			LAB 5	LAB 7	LAB 10a
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1	Review 2. USING YOUR RTE SYSTEM	Review 4. FILE MANAGEMENT SYSTEM	Review 6. PROCEDURE FILES	Review 8. INTERACTING WITH YOUR PROGRAM	Review (MORE FMP CALLS)
2					
3	LAB 2	LAB 4	LAB 6	9. TYPE 6 FILES LAB 8, 9	LAB 10b
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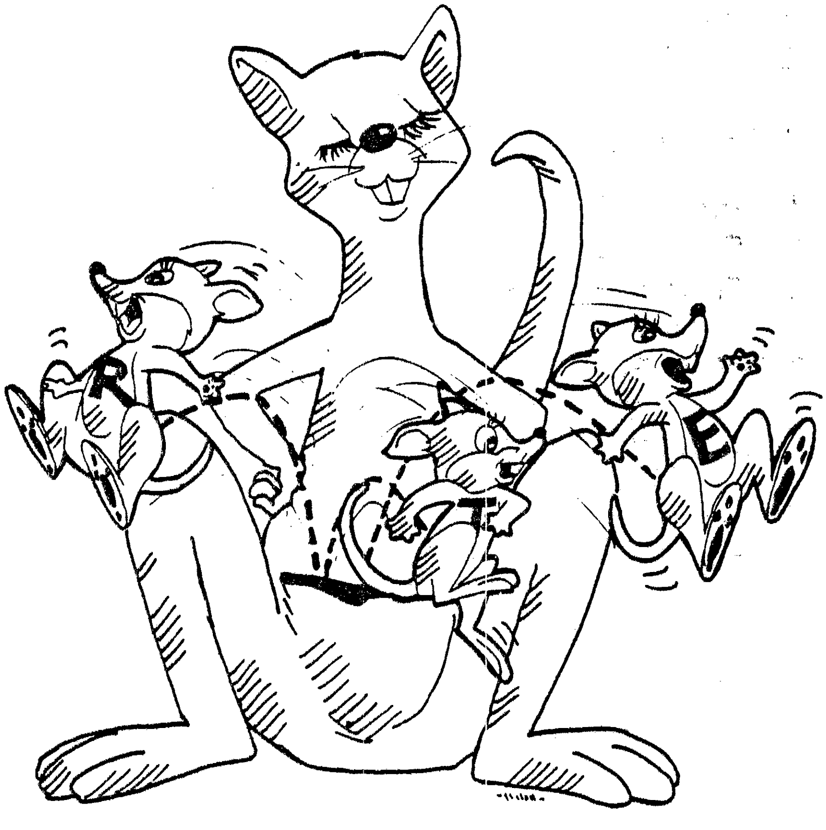
CHAPTER

TABLE OF CONTENTS — VOLUME 1

CHAPTER

1

AN INTRODUCTION TO RTE



SECTION

1A. RTE

THE REAL TIME EXECUTIVE
OPERATING SYSTEM

AN OPERATING SYSTEM IS:

an organized collection of routines which manages the use of system resources for users and their programs.

RTE MANAGES SYSTEM RESOURCES

SYSTEM RESOURCES INCLUDE:

- CENTRAL PROCESSING UNIT (CPU)
  - executes user programs and the routines of the operating system
- MEMORY
  - contains the operating system (tables, routines, data areas)
  - contains user programs and their data areas
- PERIPHERAL DEVICES
  - are used for secondary storage
  - are used to input or output information to or from the computer

RTE IS A

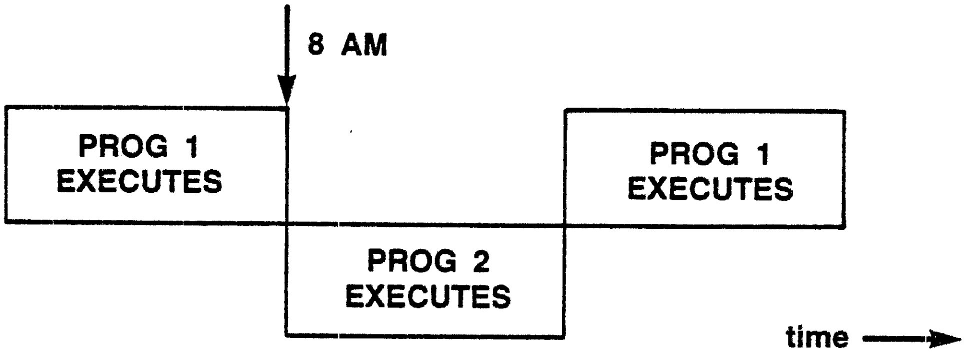
REAL-TIME

MULTIPROGRAMMING

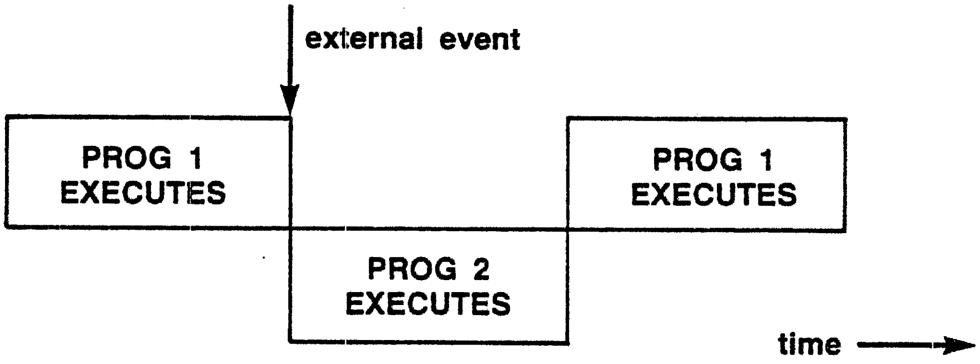
TIME-SLICING

OPERATING SYSTEM

REAL-TIME



- *programs can be scheduled to execute at specific times*



- *programs can execute in response to external events*

RTE IS A
REAL-TIME
SYSTEM

- RTE maintains a SYSTEM CLOCK which is updated every 10 milliseconds.

- RTE is INTERRUPT DRIVEN.

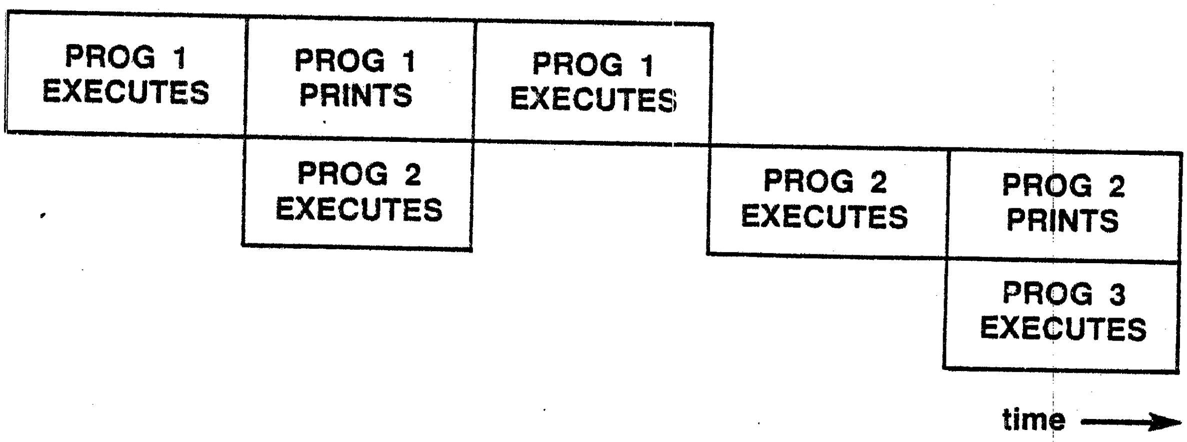
RTE IS INTERRUPT DRIVEN

An INTERRUPT is a voltage pulse that the computer interprets as the signal of an event.

All RTE actions are in response to interrupts:

1. You strike a key on a terminal. The terminal sends an interrupt to the computer. RTE responds to the interrupt by printing a command prompt.
2. The line printer finishes outputting a character. It sends an interrupt back to the computer to request the next character.
3. A steam turbine is about to go critical. A temperature sensor sends an interrupt to the computer. RTE recognizes the interrupt and responds by running a program which shuts off the fuel.

MULTIPROGRAMMING



- while one program is waiting for a data transfer to complete, the CPU can execute another program.

- programs appear to execute in parallel (or concurrently).

RTE IS A MULTIPROGRAMMING SYSTEM

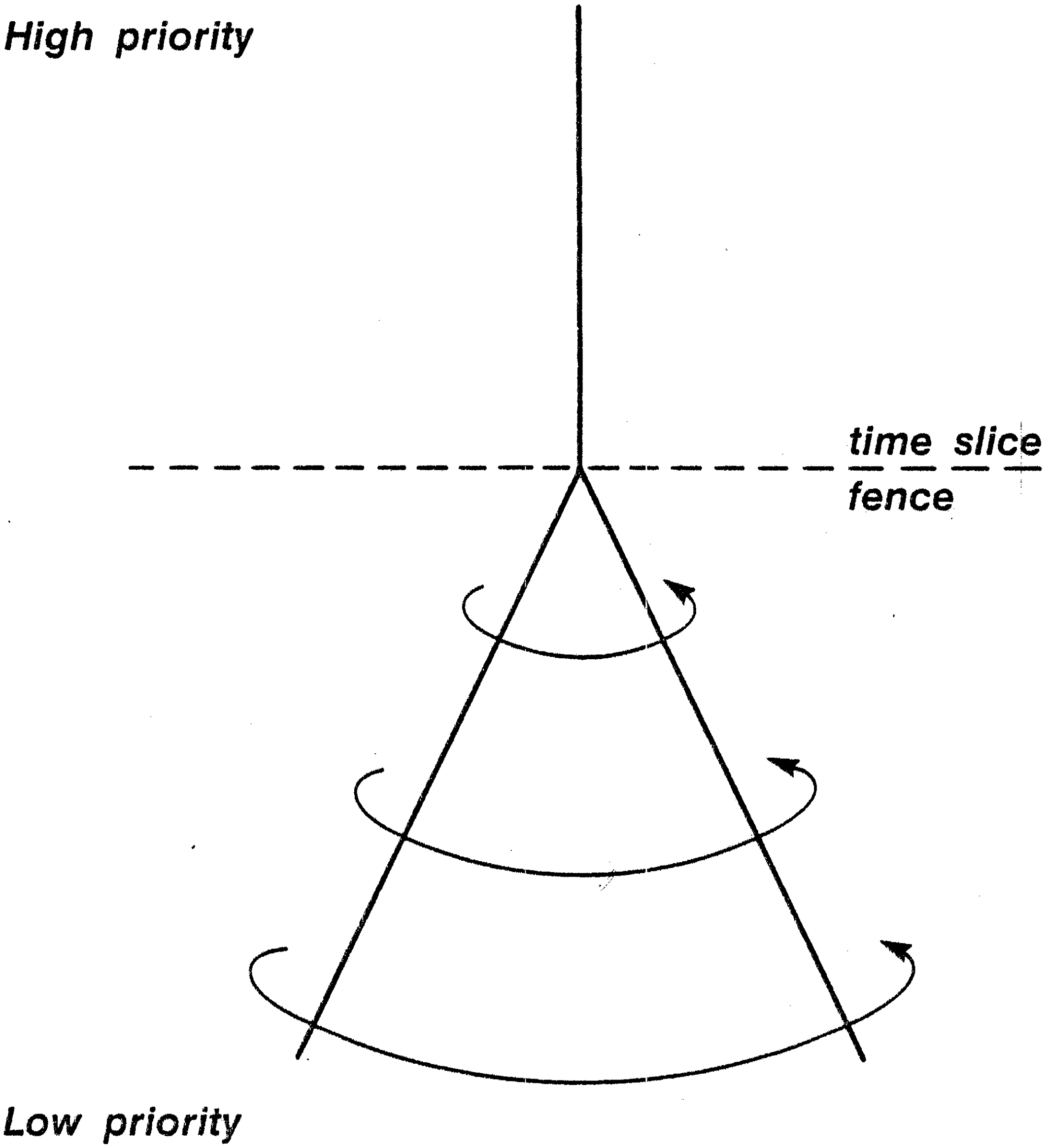
- PROGRAMS EXECUTE BY PRIORITY

  If a program is executing when a higher priority program is scheduled, the higher priority program will begin execution.

- PROGRAMS ARE <u>SUSPENDED</u> WHILE WAITING FOR DATA TRANSFERS (AMONG OTHER THINGS) TO COMPLETE

  While a program is suspended, RTE will not consider it for execution. When the data transfer completes, RTE will again consider the program for execution, according to its priority.

RTE IS A TIME-SLICING SYSTEM



USING RTE

RTE offers many services for its users, including management of

- programs
- memory
- I/O operations

You can request RTE services with

- INTERACTIVE commands entered at your terminal:

```
*RU,PROG6
```

command to run a program

name of program to be run

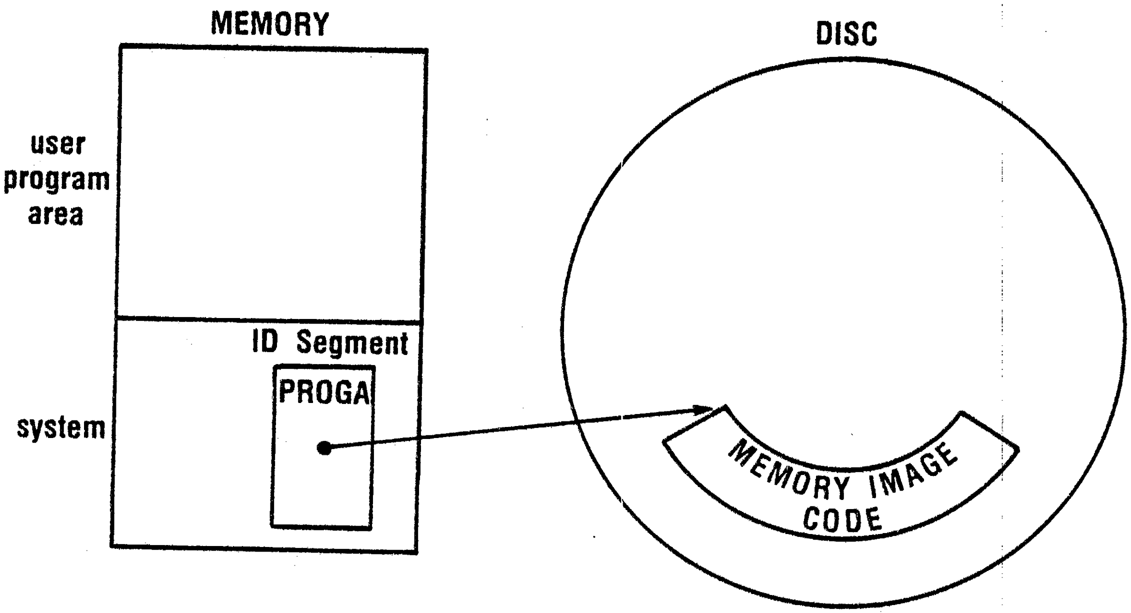
- PROGRAMMATIC REQUESTS (EXEC CALLS) issued by a program:

```
CALL EXEC (9,NAME)
```

request code to run a program

array containing the name of program to be run

RTE RUNS PROGRAMS FOR YOU



In RTE, a program has two parts:

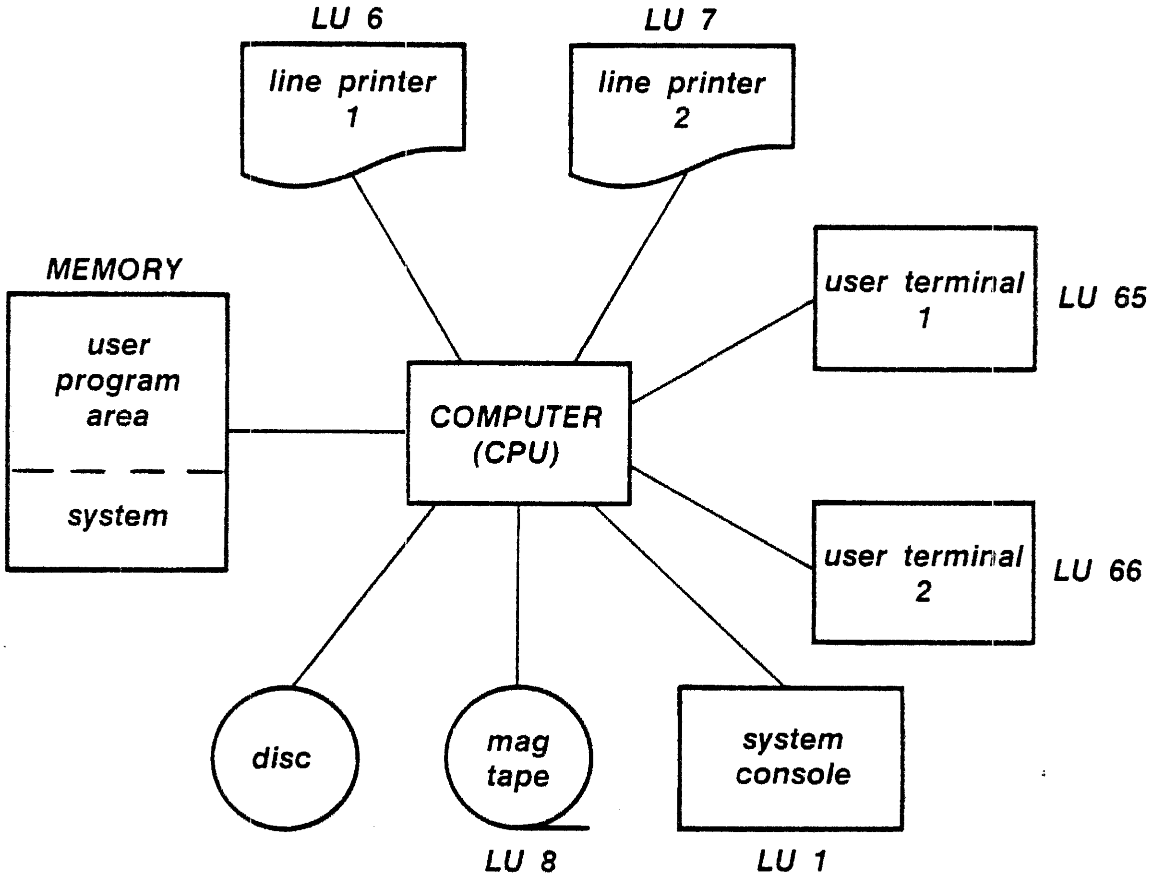
MEMORY IMAGE CODE

- resides on the disc
- contains the program's instructions and data areas
- is created when the program is loaded

ID SEGMENT

- resides in memory
- identifies the program
- contains the location of the program's Memory Image Code on disc
- is filled in (using a blank ID segment) when the program is Run

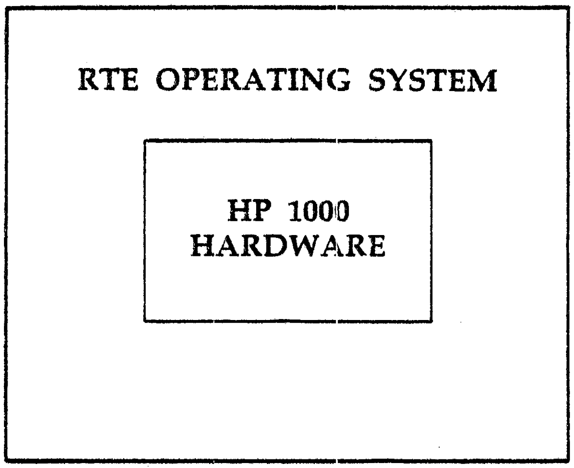
RTE HANDLES I/O FOR YOU



When an RTE system is generated, the System Manager assigns each peripheral device a LOGICAL UNIT (LU) number.

You can then refer to a peripheral device by specifying the appropriate LU.

RTE — A REAL-TIME, MULTIPROGRAMMING, TIME-SLICING OPERATING SYSTEM



RTE OPERATING SYSTEM

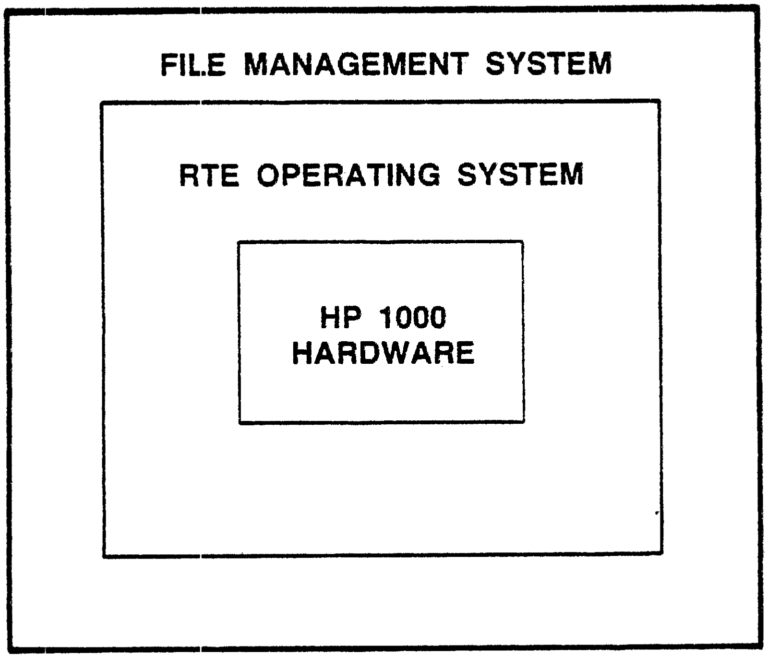
HP 1000
HARDWARE

RTE manages system resources

- program execution
- memory management
- I/O operations

via interactive and programmatic commands

1B. THE FILE MANAGEMENT SYSTEM



THE FILE MANAGEMENT SYSTEM

- acts as a user interface to RTE via interactive commands
- manages files for users via interactive and programmatic commands

THE FILE MANAGEMENT SYSTEM

FMGR

The program FMGR accepts new commands which

- *interface the user to RTE*
- *allow the user to manipulate files interactively*

You normally use the system through FMGR.

FMP LIBRARY

A set of routines which manage files.

Your programs can manipulate files via calls to the routines in the FMP library.

FMGR uses these routines to do its job.

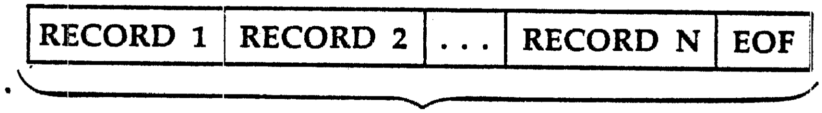
FILES & RECORDS

A FILE is a collection of related pieces of information

- temperature measurements taken last month
- names and addresses of all students in this class
- FORTRAN statements in a FORTRAN source program

A RECORD is an individual piece of information in a file

- a single temperature measurement
- the name and address of one student
- a single statement in a FORTRAN source program

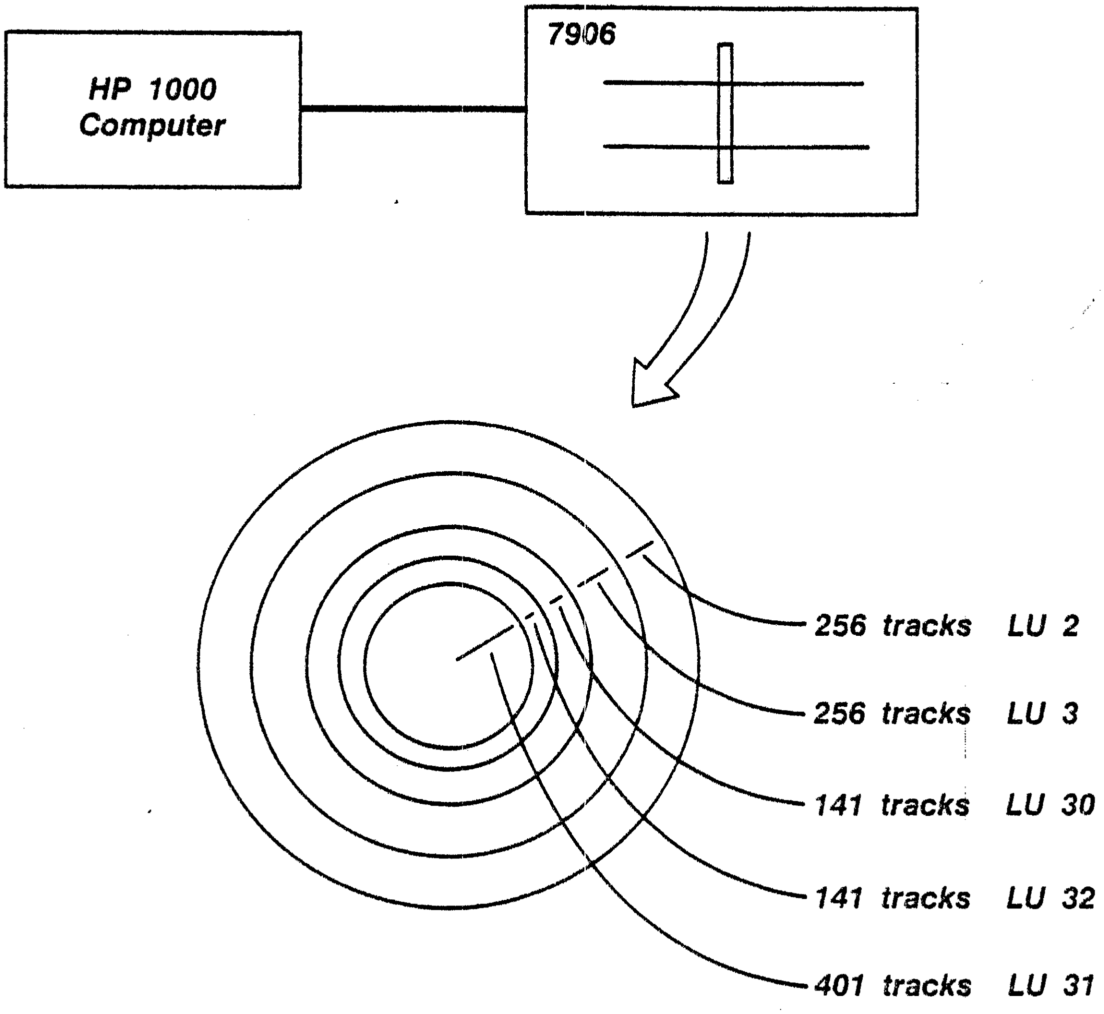


A FILE which might reside

— on disc
— on mag tape
— on cards

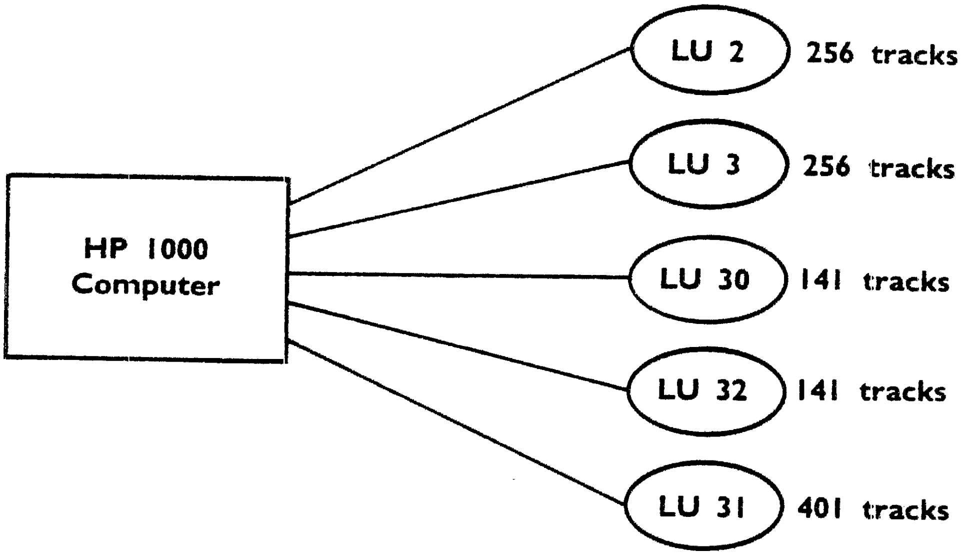
DISC ORGANIZATION

When generating the RTE system, the System Manager divides the disc into several areas. Each of these areas is assigned a Logical Unit number. For example,



(LOGICAL) DISC CARTRIDGES

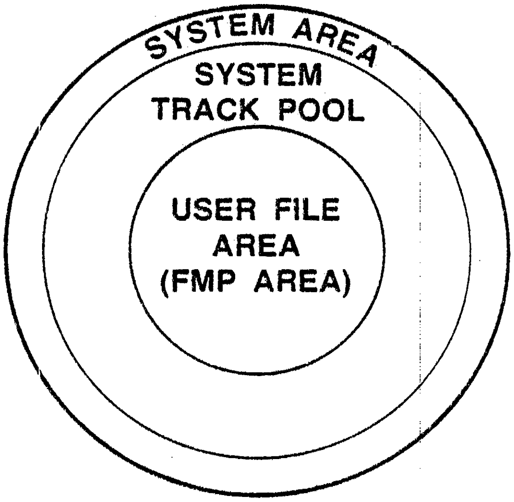
Each disc LU operates independently of the others and can be thought of as a separate "logical" disc.



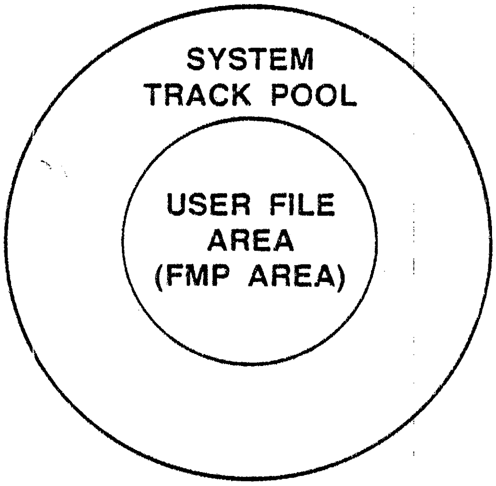
Disc LU's are frequently called DISC CARTRIDGES or CARTRIDGES.

CARTRIDGE ORGANIZATION

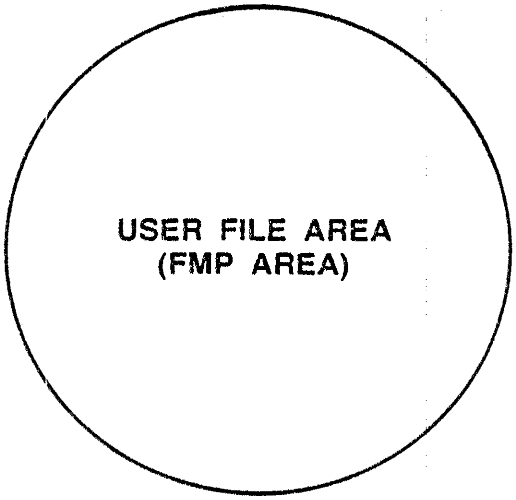
LU 2 —
the system cartridge



LU 3 —
the auxiliary cartridge



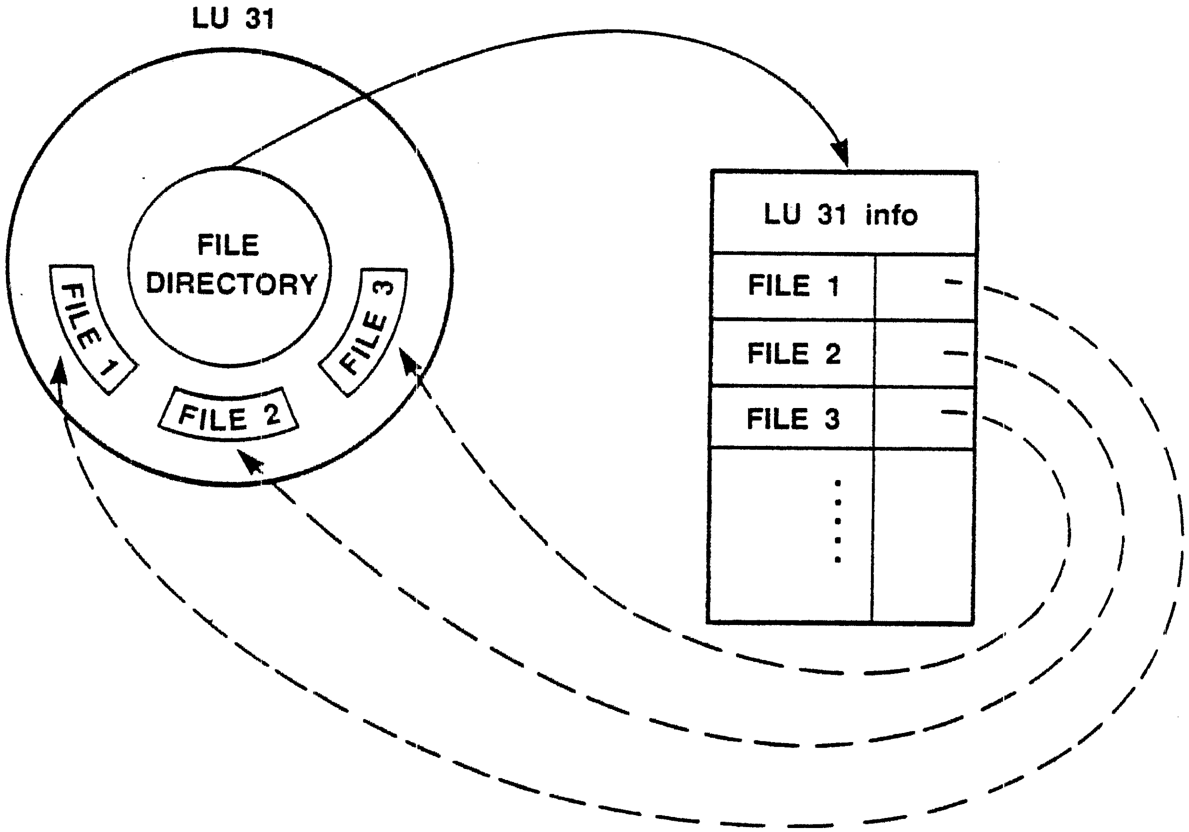
LU x —
a peripheral cartridge



FILE DIRECTORIES

Each cartridge contains a FILE DIRECTORY which

- contains information about that cartridge
- lists the names and locations of all the files residing in the FMP Area of that cartridge



FILES vs PROGRAMS

- **FILE MANAGEMENT SYSTEM**
  creates
  stores
  renames
  .
  .
  .
  .
  FILES

- **RTE**
  schedules
  terminates
  suspends
  .
  .
  .
  PROGRAMS

- **FILES CONTAIN**
  ASCII data
  binary data
  source code
  relocatable code
  .
  .
  .
  .

- **PROGRAMS CONTAIN**
  Memory Image Code

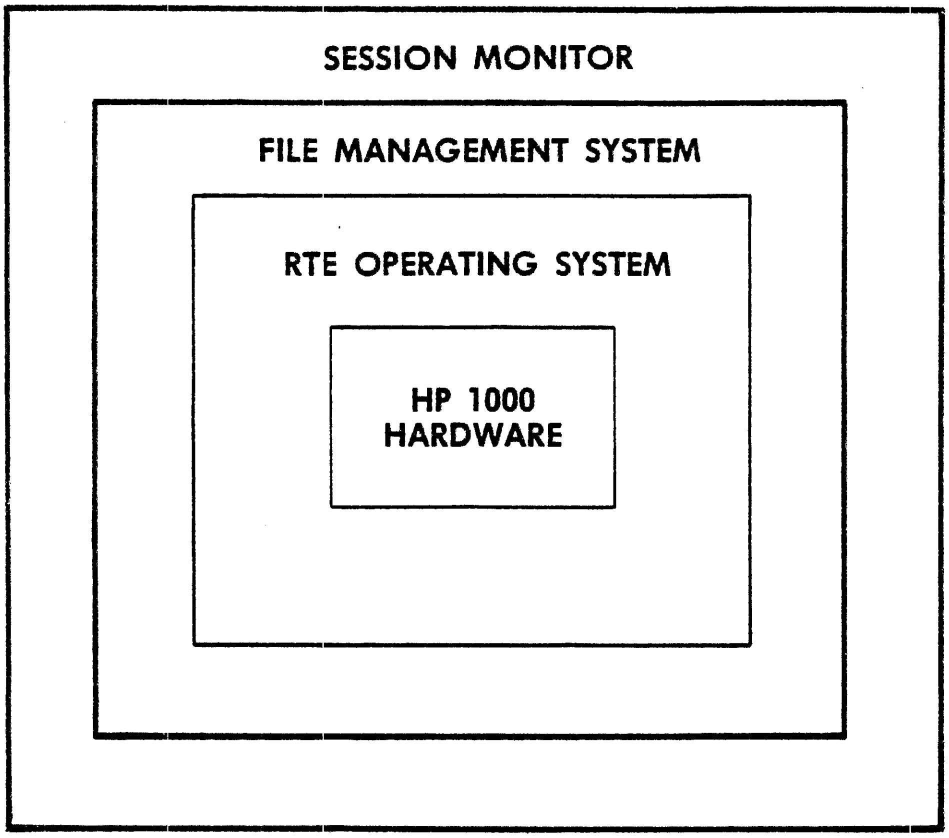
- **FILES RESIDE IN**
  the FMP area of a cartridge

- **PROGRAMS RESIDE IN**
  the system track pool area of LU 2 or 3

- **FILE DIRECTORIES**
  identify FILES

- **ID SEGMENTS**
  identify PROGRAMS

1C. SESSION MONITOR



SESSION MONITOR

FILE MANAGEMENT SYSTEM

RTE OPERATING SYSTEM

HP 1000
HARDWARE

SESSION MONITOR

- restricts access to the system and its resources
- protects users from each other
- provides a friendly multiuser environment

☆ *SESSION MONITOR* ☆

RESTRICTS ACCESS TO THE SYSTEM AND ITS RESOURCES

Each user ➛ must have an account

➛ may be given restricted access to peripheral devices

➛ may be given limited use of commands

PROTECTS USERS FROM EACH OTHER

➛ users can share disc cartridges or have exclusive access to one or more cartridges

➛ user programs are protected from the activities of other users

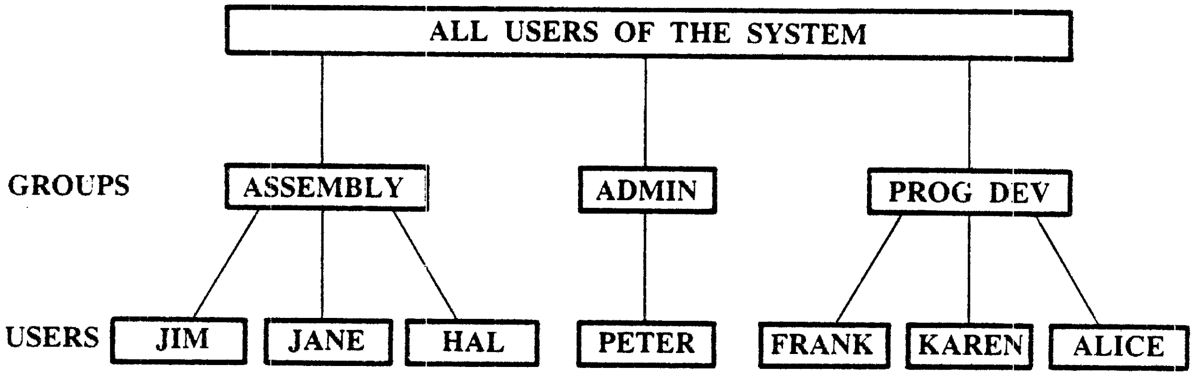
PROVIDES A FRIENDLY MULTIUSER ENVIRONMENT

➛ users do not need to know about "system configuration" — every user's terminal is LU 1

➛ a user at a terminal has the impression of having the system to himself

USERS & GROUPS

The System Manager can view the users of an RTE system as both individual users and members of groups of users.



USER ACCOUNTS

- Each user must have an account set up by the System Manager. The user's account describes what the user "can and cannot" do when using the system.

- A user's account consists of a

  user name — identifies the individual user
  group name — identifies the user's group
  password — protects the user's account
  capability level— restricts the use of commands
  Session Switch Table (SST) — identifies the peripheral devices which the user can access

- The parameters of each user account are stored in the ACCOUNTS FILE which is maintained by the System Manager.

LOGGING ON

1. Strike a key on a terminal; the system will ask you to log-on.

```
                    PLEASE LOG ON: KAREN.PROGDEV
                    PASSWORD?--------
```

   The system checks the validity of your responses, and then

2. Prints information about the time of log-on and messages from the system manager about the status of the system.

```
SESSION   65  ON   7:16 PM  FRI., 20  JULY, 1979
PREVIOUS TOTAL SESSION TIME:2689 HRS.,  48 MIN.,  03 SEC.


***************************************
*                                     *
*                                     *
*              WELCOME TO             *
*                                     *
*      RTE IVB WITH SESSION MONITOR   *
*                                     *
*                                     *
***************************************

THE SYSTEM WILL BE DOWN ON JULY 25 FROM 6 AM TO 9 AM.
```

3. Lets you know if you have any messages from other users:

```
                    MESSAGES WAITING
```

4. **Runs a copy of FMGR at your terminal:**

- **FMGR processes a HELLO file set up by the System Manager to greet you.**

```
HI KAREN, USE THESE LU'S TO REFER TO
I/O DEVICES OR DISC CARTRIDGES:

     LU 1 - YOUR TERMINAL
     LU 4 - THE LEFT CTU
     LU 5 - THE RIGHT CTU
     LU 2 - THE SYSTEM CARTRIDGE
     LU 3 - THE AUXILIARY CARTRIDGE
     LU 6 - THE PRINTER IN ROOM 9
     LU 8 - THE MAG TAPE UNIT
```

- **FMGR then prompts you for a command**

```
:
```

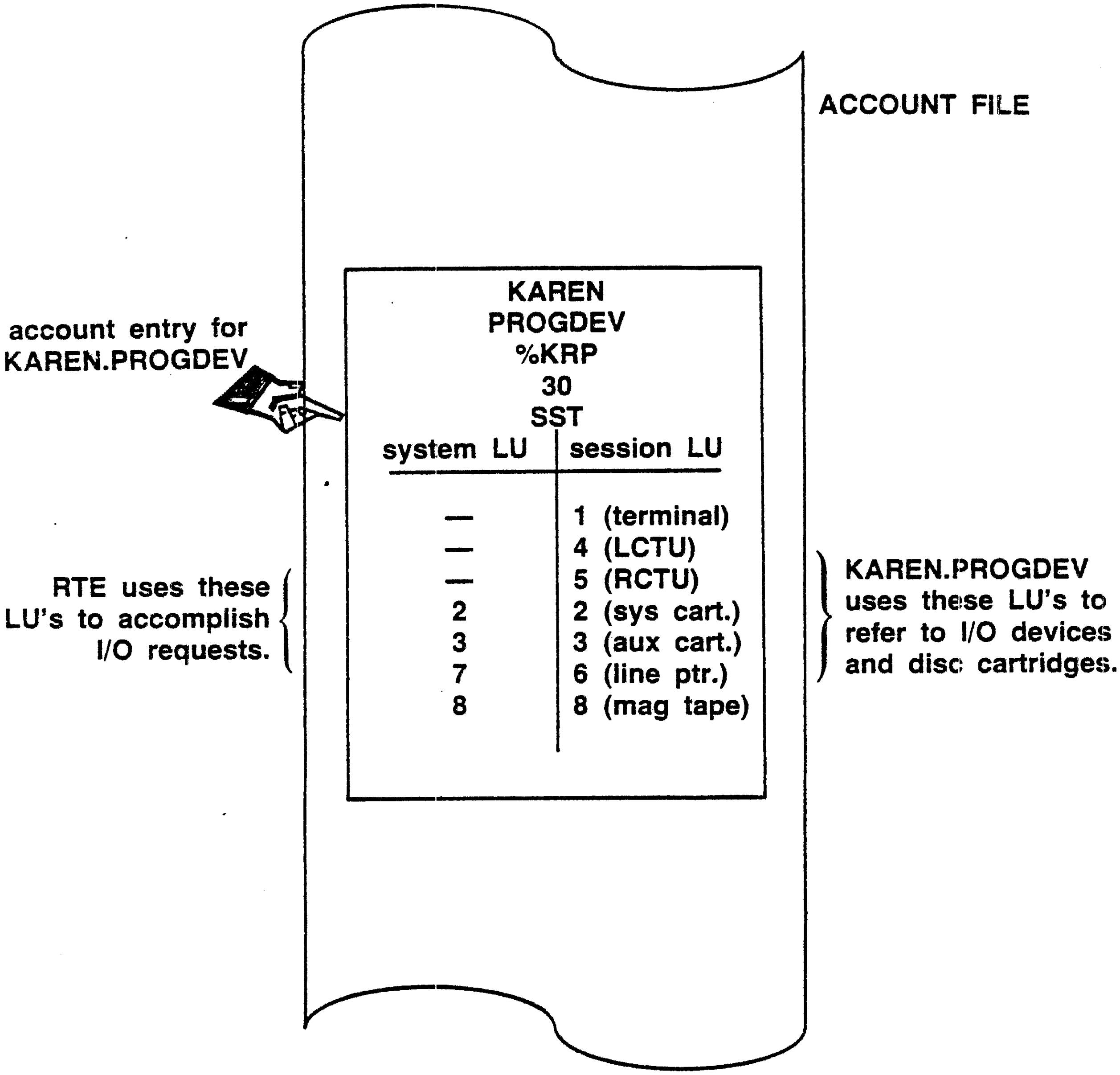
↑

waiting for a command

You are now logged onto a SESSION.

SESSION SWITCH TABLE

When defining a user's account, the System Manager specifies those peripheral devices available to the user. This is done by putting the appropriate LU numbers in the user's Session Switch Table (SST).



KAREN
PROGDEV
%KRP
30
SST

system LU	session LU
—	1 (terminal)
—	4 (LCTU)
—	5 (RCTU)
2	2 (sys cart.)
3	3 (aux cart.)
7	6 (line ptr.)
8	8 (mag tape)

SESSION CONTROL BLOCK

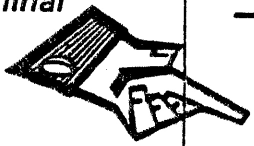
If you specify a valid account when logging on, the system creates a Session Control Block (SCB) for you.

SCB IN MEMORY

KAREN-PROGDEV
30

SST

system LU	*session LU*
65	*1*
71	*4*
72	*5*
2	*2*
3	*3*
7	*6*
8	*8*



These are filled in when you log-on at a specific terminal

The SCB is then used to restrict your access to peripheral devices and interactive commands.

LOGGING OFF

To end your session, use the FMGR EX command to log off.

```
:EX
 $END FMGR
FMG65 REMOVED

SESSION   65  OFF  7:23 PM  FRI., 20  JULY, 1979
CONNECT TIME:               00 HRS.,  07 MIN.,  06 SEC.
CPU USAGE:                  00 HRS.,  00 MIN.,  01 SEC., 40 MS.
CUMULATIVE CONNECT TIME:2689 HRS.,  55 MIN.,  09 SEC.

MESSAGES WAITING
END OF SESSION
```

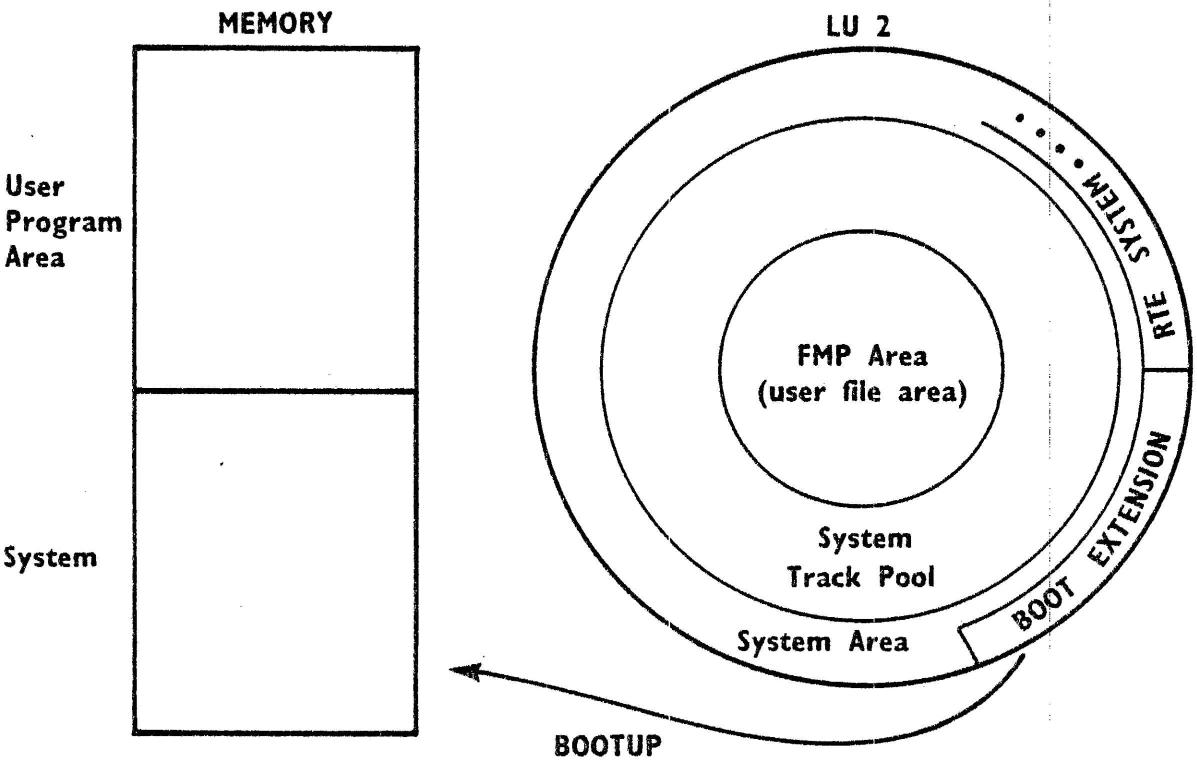
The system logs you off by:

1. **terminating any active programs you have.**
2. **releasing any system resources allocated to you (e.g. releasing any ID segments belonging to your programs; releasing your SCB).**
3. **posting your connect time, CPU usage time and log off time to your account entry in the ACCOUNTS FILE.**
4. **printing a log off message at your terminal.**

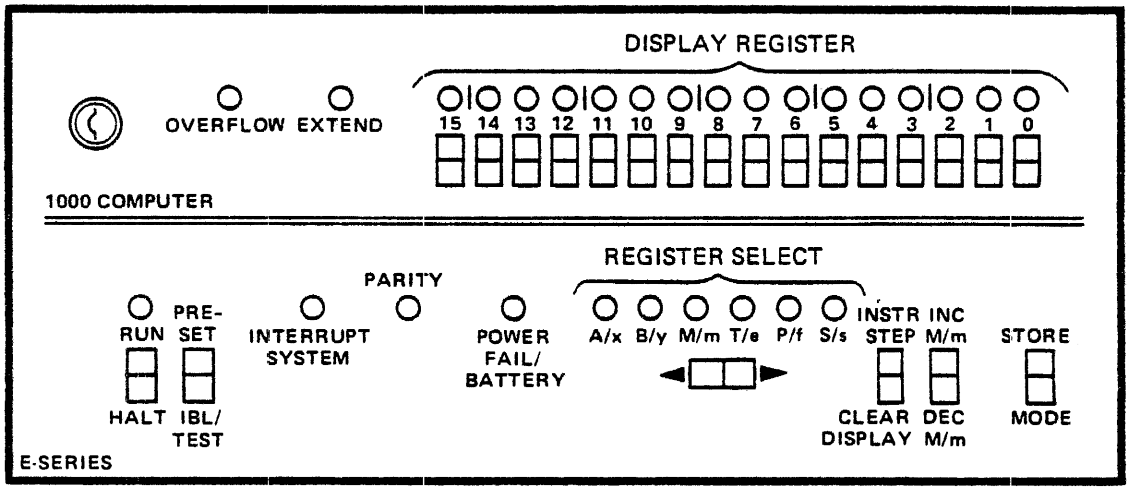
1D. BOOTING UP RTE

RTE resides permanently in the system area of LU 2 (the system cartridge). It must be loaded into memory (booted-up) to execute.

Bootup can be done either manually or automatically.



THE COMPUTER



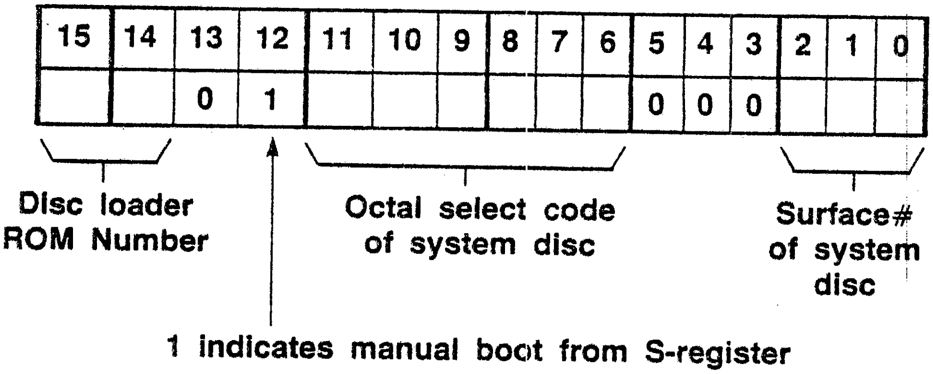
MANUAL BOOTUP is done from the computer's front panel.

MANUAL BOOTUP

With the LOCK/OPERATE switch inside the computer set to OPERATE, the operator must enter information into the S-register to bootup RTE.

Perform these steps to bootup RTE manually:

1. Press HALT
2. Turn on all devices
3. Select the S-Register
4. Enter the following bit pattern into the display register.



15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		0	1							0	0	0			

5. Press STORE to load the display register into the S-Register
6. Press PRESET
7. Press IBL
8. Press PRESET (again)
9. Press RUN

RTE IS NOW UP AND RUNNING!!!

BOOT INTERNALS

The DISC LOADER ROM contains a program which loads the BOOT EXTENSION from disc into memory.

The BOOT EXTENSION is also a program. It loads the RTE system from disc into memory and causes it to be executed.

The BOOT PROCESS STEPS are:

1. Pressing IBL loads the program in the DISC LOADER ROM into memory.
2. Pressing RUN executes this program causing the BOOT EXTENSION to be loaded into memory. Control is automatically transferred to the BOOT EXTENSION which loads and runs the RTE system.
3. The system displays "SET TIME" on the system console and runs FMGR.
4. FMGR processes a "WELCOM" file set up by the System Manager.

AUTOMATIC BOOTUP

* * *

With the LOCK/OPERATE switch inside the computer set to LOCK, RTE will bootup automatically when:

1. the RPL switch is set correctly.
2. the system console is on and on-line.
3. the system disc is on and on-line.
4. the CPU power switch is turned from OFF to ON.

The bootup procedure reads the RPL switch settings to obtain the information needed to boot up RTE.

* * *

10C. USING FMP CALLS

The FILE MANAGEMENT SYSTEM supports two types of files, which differ only in their maximum sizes.

	Files allocated by — blocks (STANDARD FILES)	 128 block multiples (EXTENDED FILES)
max file size	16383 blocks	32767 x 128 blocks
max record size	32767 words	32767 words
max number of records per file	2^{15}-1 records	2^{31}-1 records

Since FORTRAN integer variables (1 word) have a maximum value of 32767, double word integers are needed to create or access extended files. Therefore . . . . .

TWO TYPES OF FMP CALLS

STANDARD FMP CALLS — to manipulate standard files (or access extended files in sequential order only)

EXTENDED FMP CALLS — to manipulate extended files (or standard files)

10

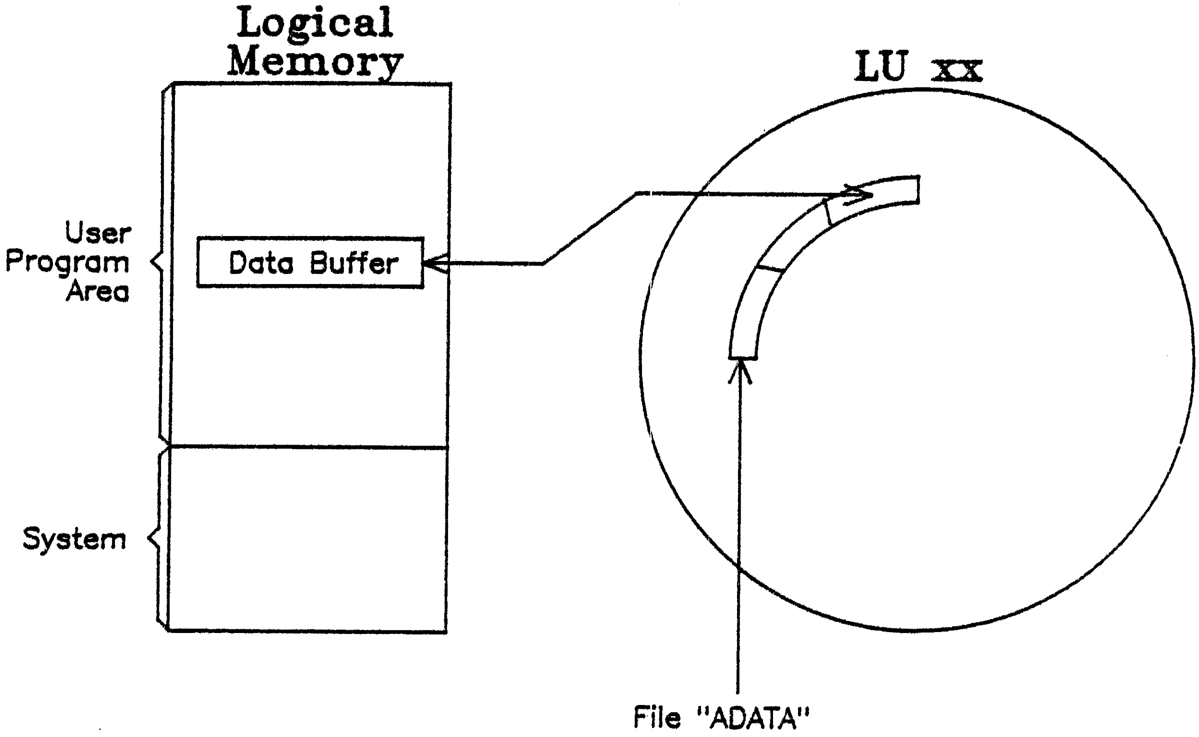
USING FILES PROGRAMMATICALLY FMP CALLS

SELF-EVALUATION QUESTIONS

After the end of this module, the student should be able to answer the following self-evaluation questions.

1. List some of the uses of FMP calls.
2. When doing I/O to the disc, how does RTE transfer data?
3. What is a Data Control Block (DCB) and how is it used?
4. What is an extended file?
5. What are the steps to using FMP calls in a program?
6. Explain the difference between update and non-update mode?
7. What is the difference between a logical and a physical read?
8. Why do type 1 files have the fastest transfer rate?
9. What are two ways of accessing a non-disc device as a file?

10A. WHY FMP CALLS?



FORTRAN READS/WRITES

READ
WRITE (lu,format)------

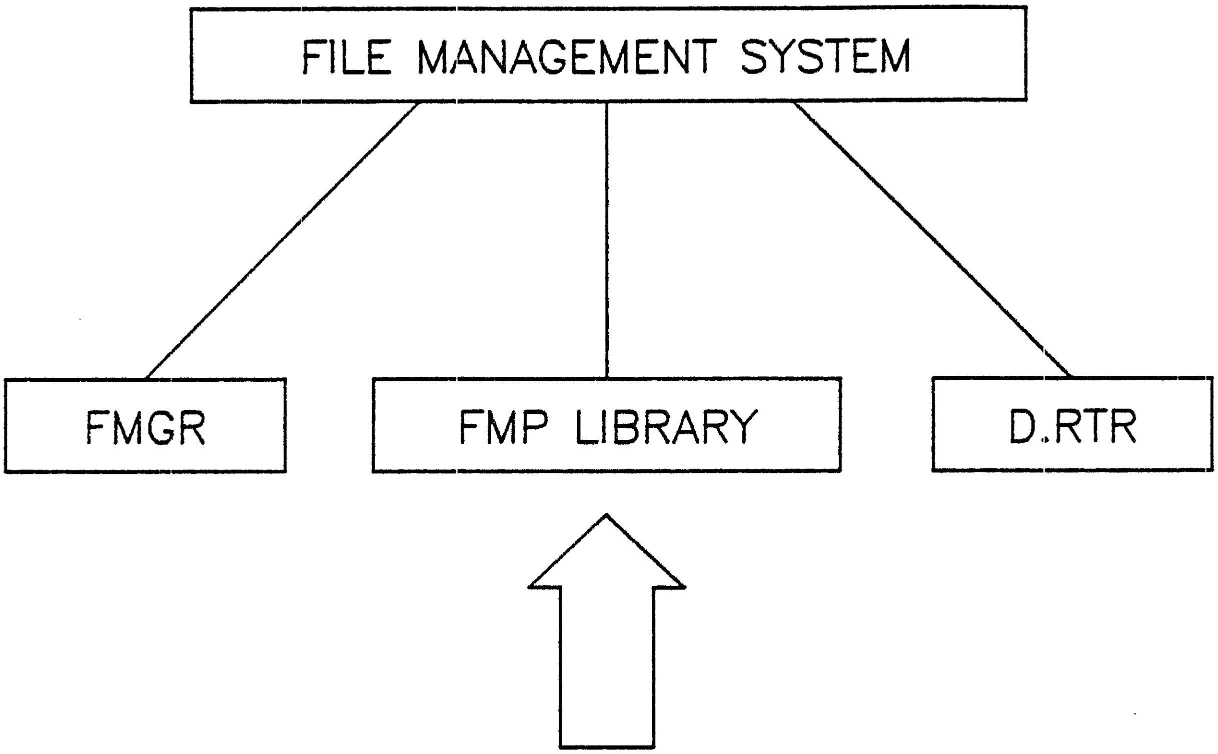
EXEC READS/WRITES

CALL EXEC ($\frac{1}{2}$,lu,------)

can be a disc lu

parameters must specify the exact track and sector address of the desired record.

ACCESSING DISC FILES VIA FMP CALLS



User programs can call these routines to manipulate disc files.

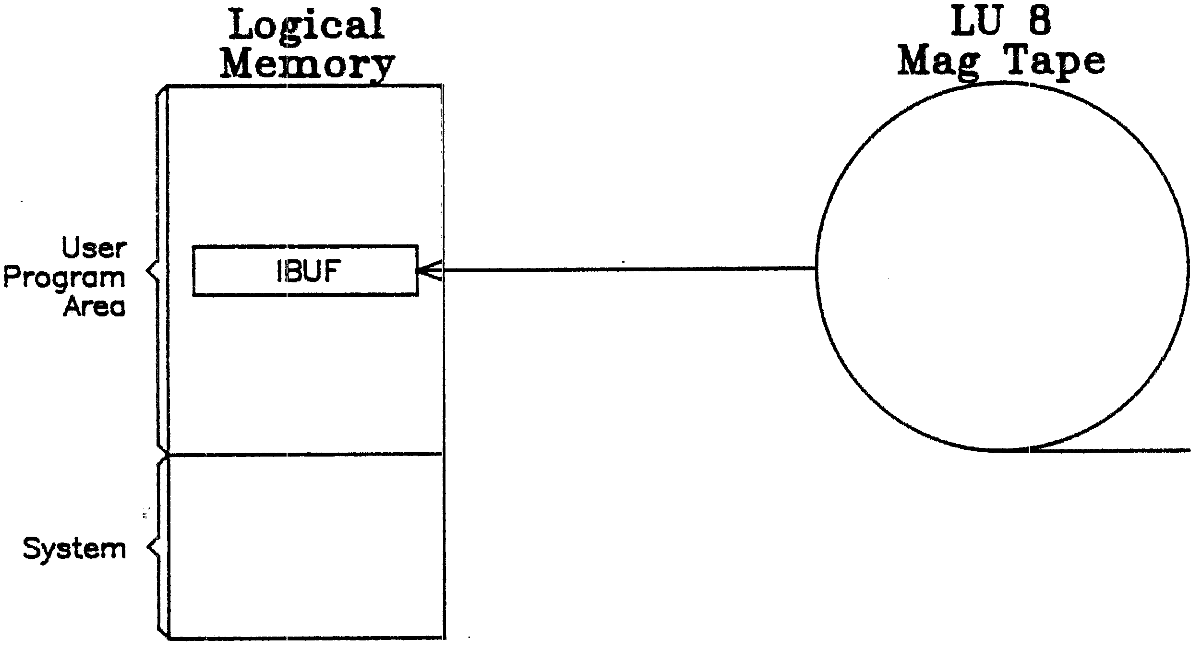
WHAT CAN YOU DO WITH FMP CALLS?

- Create disc files
- Access disc files to:
  - read records in sequential or random order
  - write records in sequential or random order
  - position the file at arbitrary locations
- Purge files
- Rename files
- Obtain information about the cartridges in your cartridge list
- Control non-disc devices by treating them as if they were disc files

10B. HOW FMP CALLS WORK

When a program does I/O to a non-disc device, data is usually transferred directly between the device and a buffer in your program.

For example, consider a file with 100 25-word records on a mag tape.



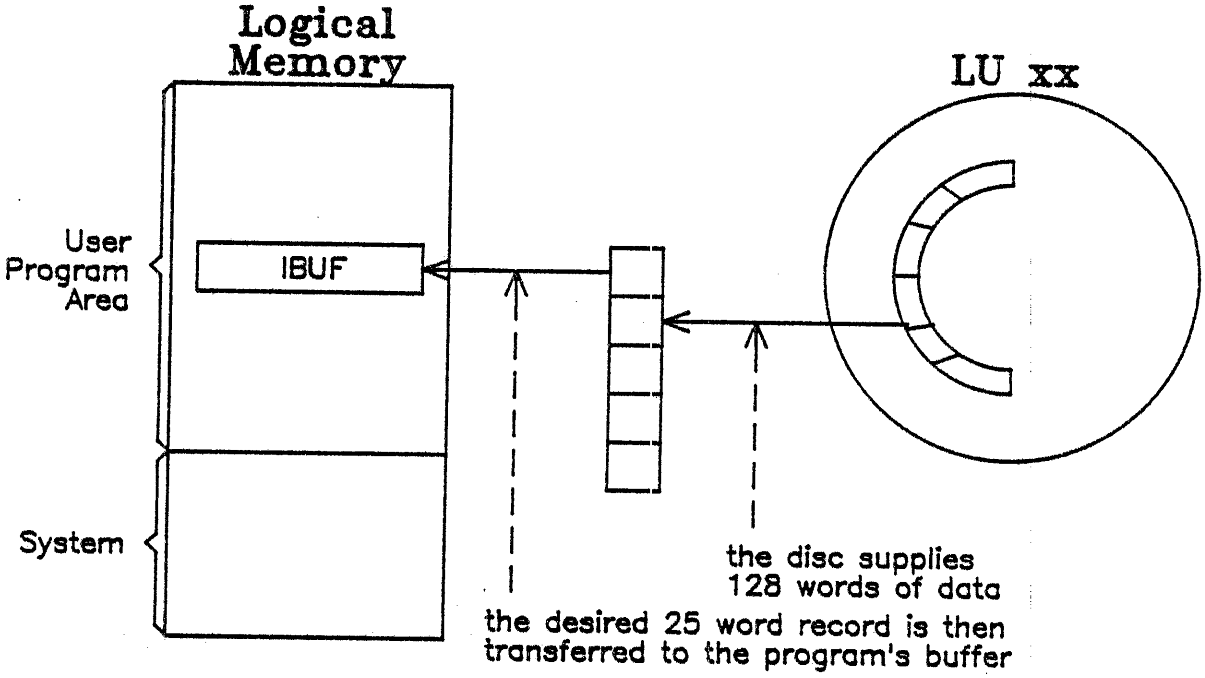
```
ILU = 8
CALL EXEC (1,ILU,IBUF,25)
```

When you input 25 words of data, the mag tape drive reads 25 words from the tape and stores the data in the program's buffer.

ACCESSING THE DISC

When a program does I/O to the disc, RTE always transfers data in blocks of 128 words, regardless of the size of the records being transferred.

For example, consider a disc file with 100 25-word records:



IDEA – why not save all 128 words of data in another buffer in your program? Then, to input the next record, you only need to access memory, not the disc itself.

DATA CONTROL BLOCK

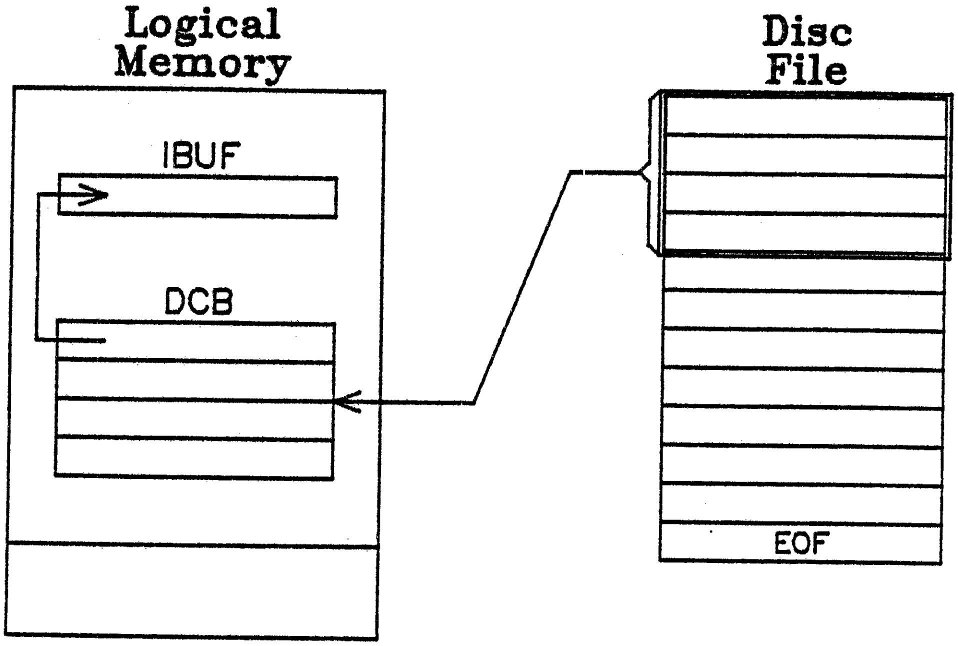
FMP calls do I/O to disc files via a DATA CONTROL BLOCK (DCB) located in your program.

* The DCB is an intermediate memory buffer used in transferring data between a program and a disc file.

* Data is temporarily stored in the DCB and transferred to/from the disc only when necessary or explicitly requested.

* All actions are transparent to the user.

FOR EXAMPLE - READING RECORDS FROM A DISC FILE



When the program reads the first record of the disc file:

1. a 128 word block of data is input from the disc file into the DCB. This is called a "physical read".
2. the first record is then transferred from the DCB to the program's data buffer. This is called a "logical read".

DCB PARTS

The DCB consists of two parts:

CONTROL INFORMATION
(always 16 words)

PACKING BUFFER
(multiple of 128 words)

The control information includes:

1. where the file is located on disc,
2. what type of file is being accessed,
3. what records are in the DCB

The packing buffer contains the actual data from the disc file.

ADVANTAGES TO USING FMP CALLS

FMP calls read/write to disc files by name rather than by disc track and sector. Therefore the files can be moved without affecting program execution.

If a piece of data to be read is already in the packing buffer, it is not necessary to do a physical read. This saves time.

FMP ERRORS

Each FMP call requires an error parameter. If an FMP error occurs when the call is executed, the File Management System returns an error code in that parameter. Your programs should always check for errors and respond accordingly.

For example, if a program is writing records to a disc file:

```
           .
           .
           .
           .
     CALL WRITF(IDCB,IERR,IBUF)
     IF(IERR.LT.0)GO TO 999
           .
           .
           .
           .   (continue on with processing)
           .
           .
C    ERROR REPORTING SECTION
C
999  CONTINUE
     WRITE(1,101)IERR
101  FORMAT("FMP ERROR",I5,"OCCURRED")
     CALL CLOSE(IDCB)
     STOP
           .
           .
           .
           .
```

STEPS TO USING FMP CALLS

Each program using FMP calls needs the following parts:

1. Declare an array of at least 144 words to serve as the DCB for your FMP calls.

2. Open the disc file to the program by

   calling OPEN for an existing disc file or

   calling CREAT to create a file and open it.

   Opening a file sets an open flag in the file directory and associates the user specified DCB with the file.

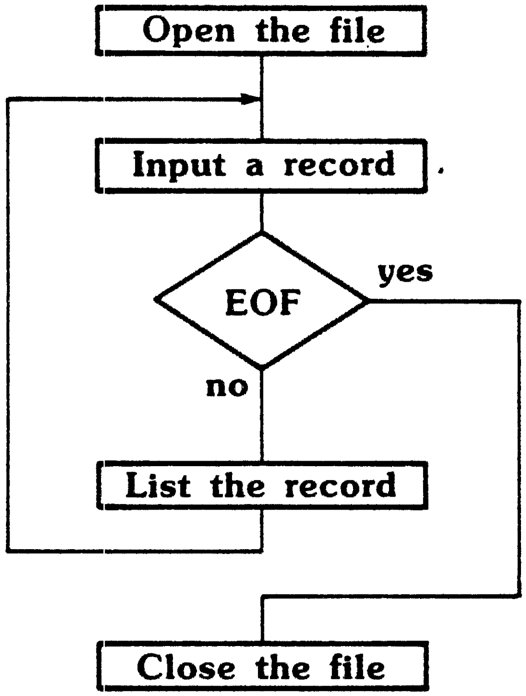
3. Manipulate the disc file as desired, perhaps by calling READF, WRITF, etc.

4. Close the file by calling CLOSE to clear the open flag in the file directory and disassociate the DCB from the file.

A PROBLEM TO CONSIDER

Suppose file &PROGA contains a source program, has a security code of "RT" and resides on cartridge LU 47 (CRN SS).

Write a program to list the file at your terminal.



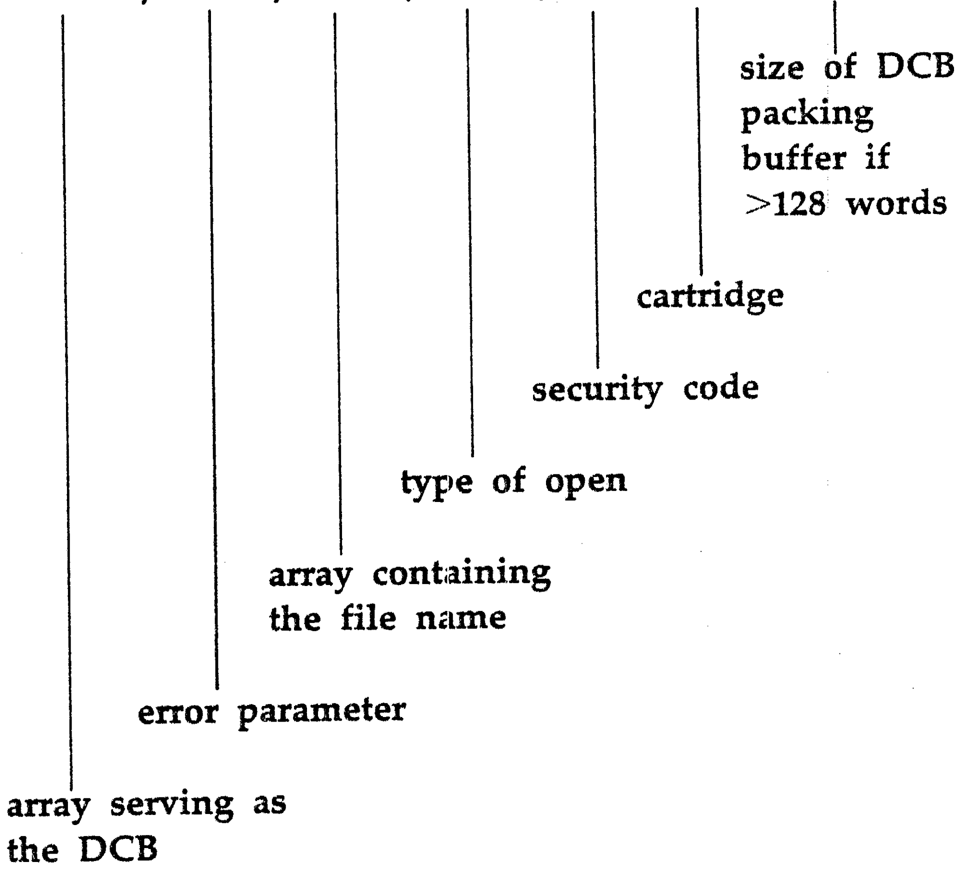
OPENING A FILE

•CALL OPEN•

OPEN will

1. close the DCB if it was left open previously.
2. associate the DCB with the named file and mark the file open.
3. position the file at the first record.

```
CALL OPEN (IDCB,IERR,INAM,IOPT,ISC,ICR,IDCBZ)
```



DIFFERENT WAYS TO OPEN A FILE

EXCLUSIVE vs NON-EXCLUSIVE ACCESS

A file opened exclusively may only be accessed by the program that opened the file. A file opened non-exclusively may be shared by up to 7 programs at the same time.

UPDATE vs NON-UPDATE MODE

If a file is opened in update mode, whenever a record is written to the disc file, a physical read is done first to insure that the data in the DCB is current.

If you plan to do random writes to a disc file, you need to open the file in update mode.

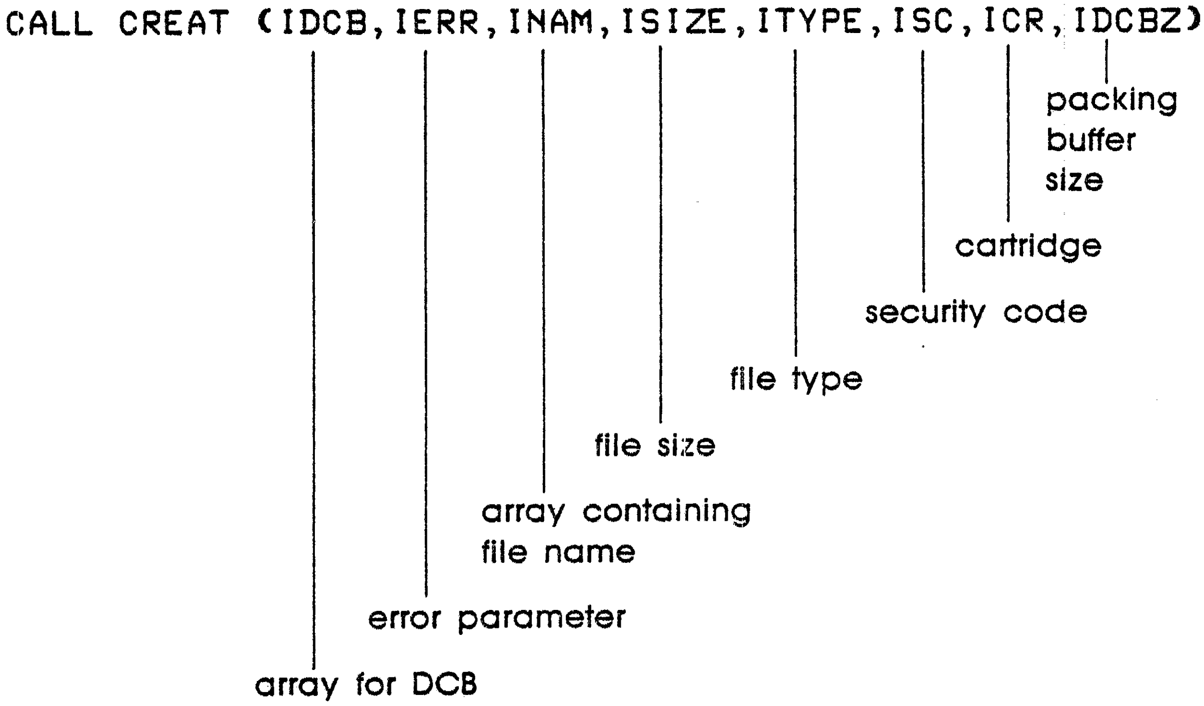
If you are only going to read data from or write data to each record in the file sequentially, you only need to open the file in non-update mode.

CREATING DISC FILES

•CALL CREAT•
(CALL ECREA)

Creates a file on a disc cartridge by

1. making an entry in the file directory
2. allocating disc space for the file (with no data)



```
CALL CREAT (IDCB,IERR,INAM,ISIZE,ITYPE,ISC,ICR,IDCBZ)
```

The CREAT (or ECREA) call will

1. close any file currently associated with IDCB
2. create the file
3. open the file exclusively and in update mode. A call to OPEN may be made to change the type of open to non-exclusive or non-update if desired.

READING RECORDS FROM A FILE

•CALL READF•
(CALL EREAD)

Transfers a record from the file currently associated with the DCB to a buffer in the user's program.

```
CALL READF (IDCB,IERR,IBUF,IL,LEN,NUM)
```

NUM	number of the record to access (type 1 or 2 files)
LEN	number of words actually transferred
IL	number of words requested
IBUF	array (user buffer) to receive the data
IERR	error parameter
IDCB	DCB

WRITING RECORDS TO A FILE

•CALL WRITF•
(CALL EWRIT)

Transfers a record from a buffer in the user's program to the disc file currently associated with the DCB.

```
CALL WRITF (IDCB,IERR,IBUF,IL,NUM)
```

number of the record to access (type 1 or 2 files)

number of words to be transferred

array (user buffer) containing data to be transferred

error parameter

DCB

CLOSING FILES

•CALL CLOSE•
(CALL ECLOS)

Closes the file associated with the specified DCB by

- writing the DCB to the disc if it was modified
- clearing the open flag in the file directory
- disassociating the DCB from the file

```
CALL CLOSE (IDCB,IERR,ITRUN)
```

allows truncating unused blocks or extents

error parameter, only needed if truncating is attempted

DCB

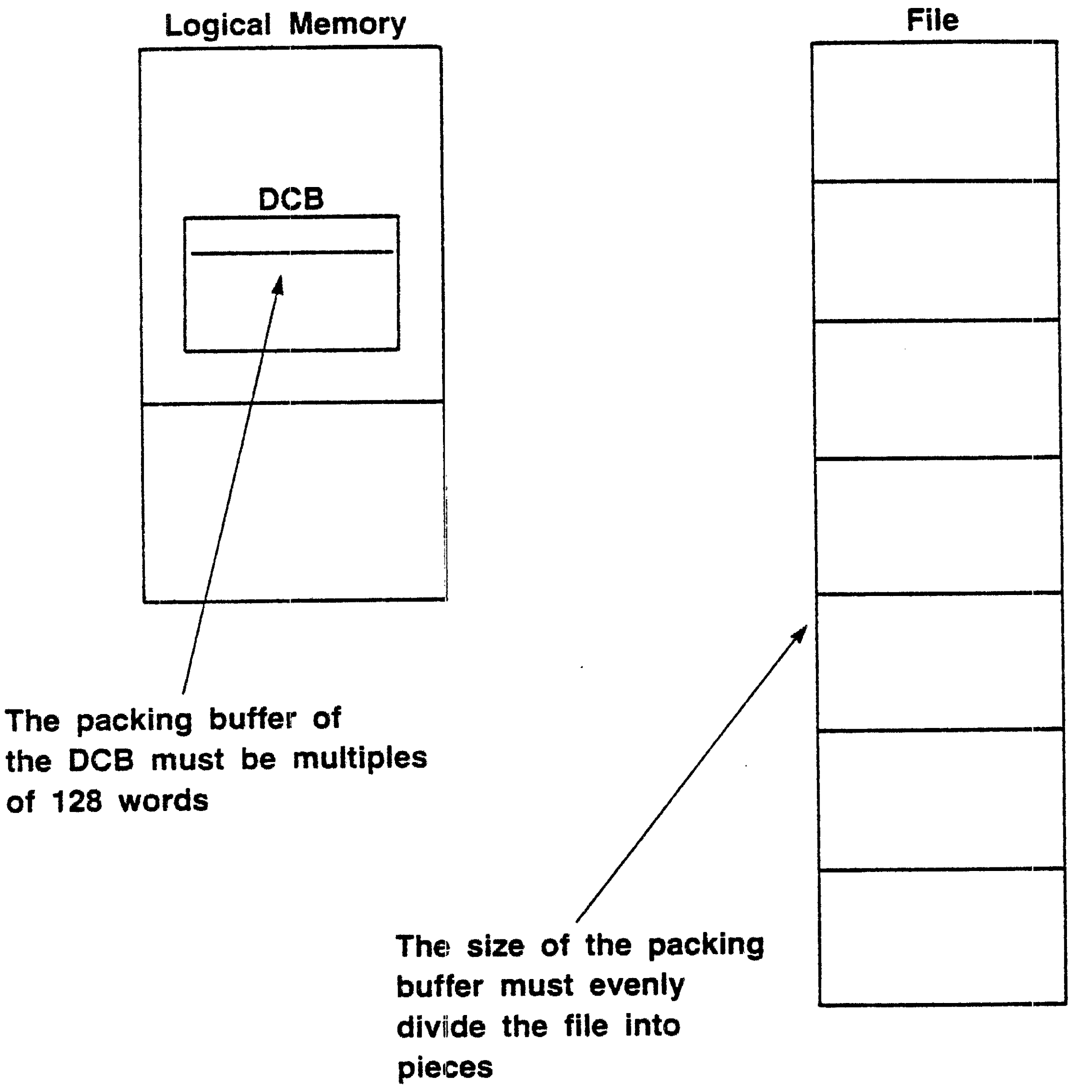
Once closed, IDCB can be associated with another file.

A SOLUTION TO OUR PROBLEM

```
&LISTF T=00004 IS ON CR SS   USING 00002 BLKS R=0000

FTN4,L
      PROGRAM LISTF
C
C     THIS PROGRAM LISTS FILE '&PROGA:RT:SS' ON THE
C     USER'S TERMINAL.
C
C
      INTEGER DCB(144), IBUF(40)
      INTEGER FILE(3), SEC, CART
C
      DATA FILE/2H&P,2HRO,2HGA/, SEC/2HRT/, CART/2HSS/
C
C
C     OPEN THE FILE TO BE LISTED
C
      CALL OPEN(DCB,IERR,FILE,0,SEC,CART)
      IF(IERR .LT. 0) GOTO 999
C
C
C     READ RECORDS FROM THE FILE,
C     LIST EACH TO TERMINAL UNTIL EOF
C
10    CONTINUE
      CALL READF(DCB,IERR,IBUF,40,LEN)
      IF(IERR .LT. 0) GOTO 999
      IF(LEN .EQ. -1) GOTO 90
C
C
C         LIST RECORD, LOOP BACK FOR NEXT RECORD
C
          WRITE(1,101) (IBUF(I),I=1,LEN)
101       FORMAT(1X,40A2)
          GOTO 10
C
C
C     AFTER EOF IS FOUND, CLOSE FILE AND QUIT
C
90    CALL CLOSE(DCB)
      CALL EXEC(6)
C
C
C     ERROR REPORTING SECTION
C
999   CONTINUE
      WRITE(1,102) IERR
102   FORMAT(/"FMP ERROR ",I5)
      CALL CLOSE(DCB)
      END
```

10D. MORE ON HOW FMP CALLS WORK

The DCB acts as a "window" through which your program looks at your file.



The packing buffer of the DCB must be multiples of 128 words

The size of the packing buffer must evenly divide the file into pieces

ACTUAL vs DECLARED DCB SIZE

The FMP routines will only use part of your declared DCB's packing buffer if the packing buffer does not evenly divide the file.

For example, for a file of 6 blocks (6 x 128 words):

Declared DCB packing buffer size	Actual DCB packing buffer used
128 words	128 words
2 x 128	2 x 128
3 x 128	3 x 128
4 x 128	3 x 128
5 x 128	3 x 128
6 x 128	6 x 128
7 x 128	6 x 128

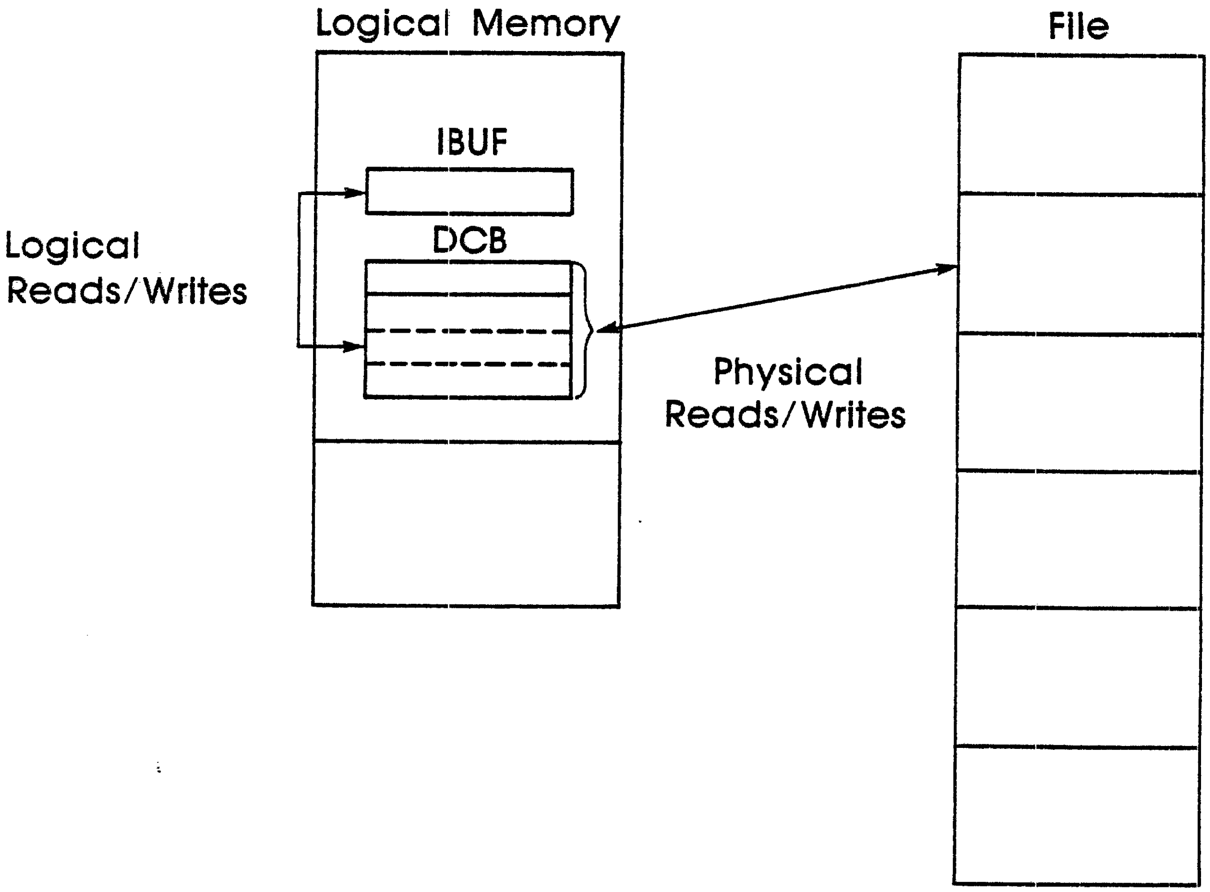
The size of the "actual DCB" used can be obtained by:

```
IUSED = IDCBS (IDCB)
```

DCB associated with your file

Actual DCB size used
(control words + packing buffer)

LOGICAL vs PHYSICAL READS/WRITES



When a program reads or writes a record, a "logical read or write" is done; "physical reads or writes" are done only if the desired record is not in the current DCB.

WHEN IS A PHYSICAL WRITE DONE?

The contents of the DCB are written to the disc file when:

1. the user's program calls CLOSE (or ECLOS) and the DCB contains modified records.

2. the user's program accesses (i.e., reads/writes/positions to) a record not in the current DCB and the DCB contains modified records.

3. the user's program calls POST. POST will write the contents of the DCB to the disc if the DCB contains modified records and set a flag to indicate that there is no data in the DCB.

```
CALL POST (IDCB,IERR)
```

error parameter

DCB for the file

WHEN IS A PHYSICAL READ DONE?

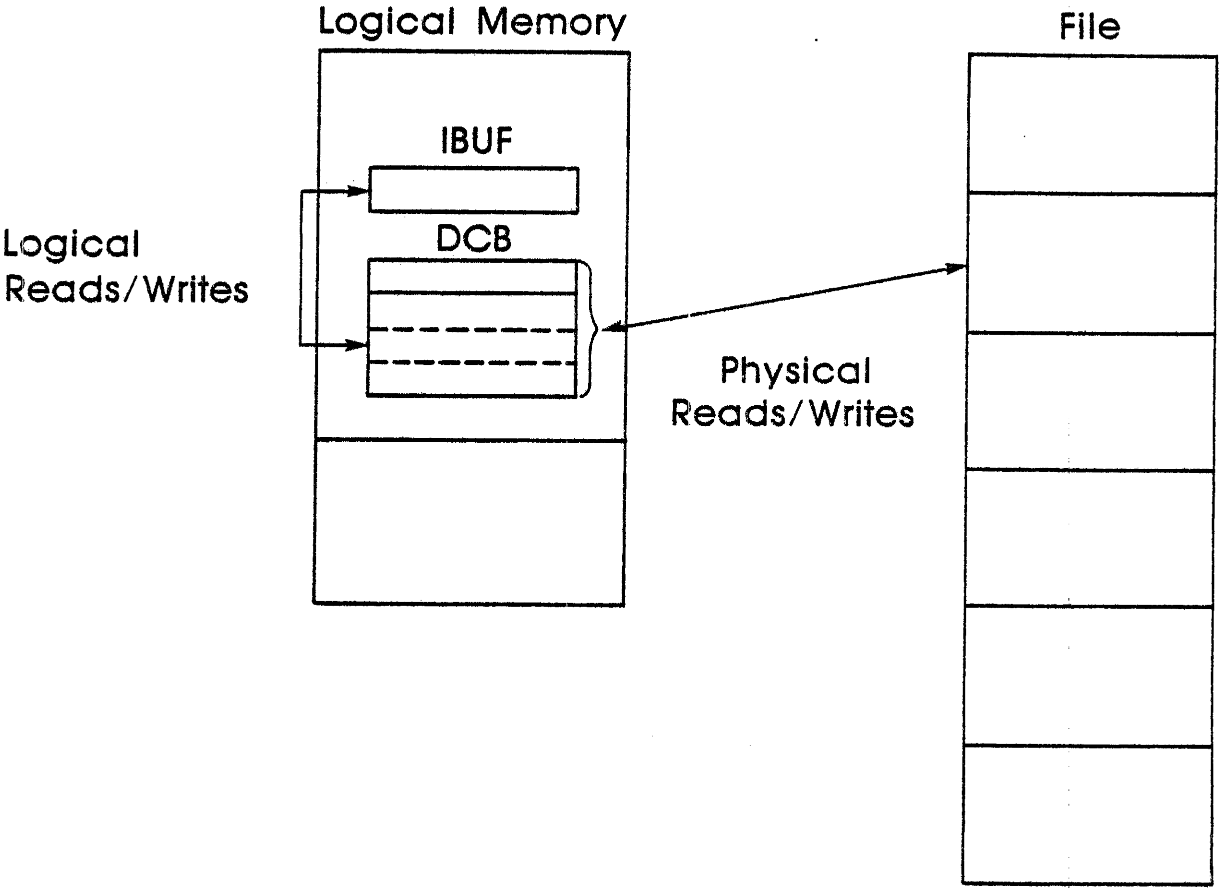
When a DCB is associated with a new "piece" of a disc file, the data may or may not be input from the disc file into the DCB.

- data is not input to the DCB when
  - the file is first opened
  - a program calls WRITF (or EWRIT) and the file was opened in non-update mode
- data is input to the DCB when
  - a program calls READF (or EREAD)
  - a program calls WRITF (or EWRIT) and the file was opened in update mode

TYPE 2,3,. . . . FILE ACCESS

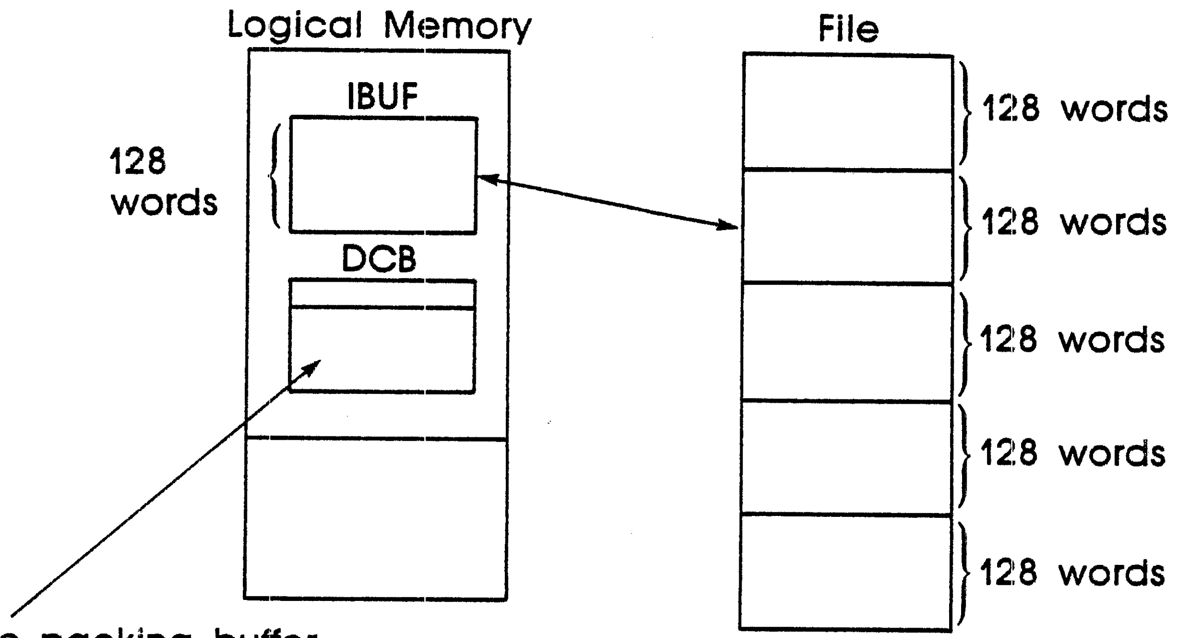
Even though type 2,3,. . . . files have differing characteristics, these types of files are accessed in similar manners:

- records are accessed via the packing buffer in the DCB associated with the file
- data transfers are done record by record



TYPE 1 FILE ACCESS

Each record in a type 1 file is 128 words long. Since the disc drive transfers data in 128 word blocks, the FMP routines transfer data directly between the disc file and the user program's data buffer for type 1 files.



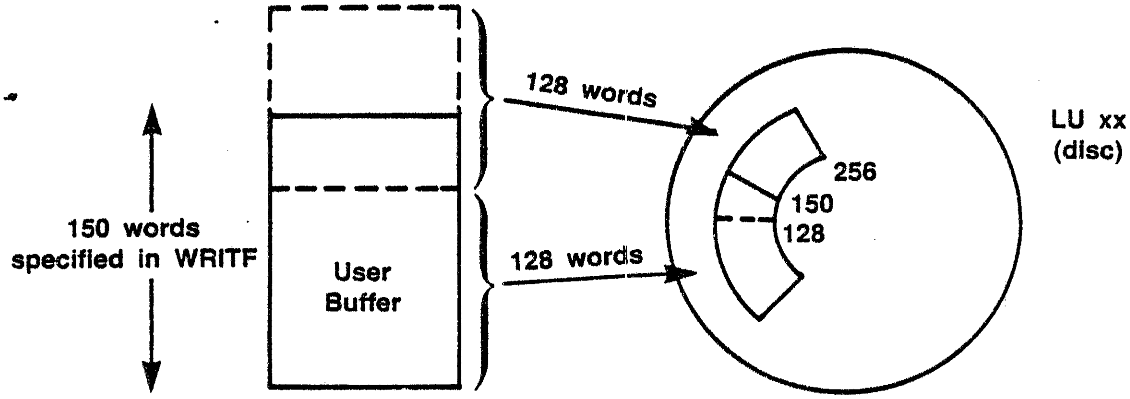
the packing buffer is not used to store data when accessing a disc file of type 1.

Type 1 files have the fastest transfer rate because transfers are directly to or from the user's buffer.

- All files, except type 0 files, may be accessed as type 1 files, i.e., direct transfer through the user's buffer.

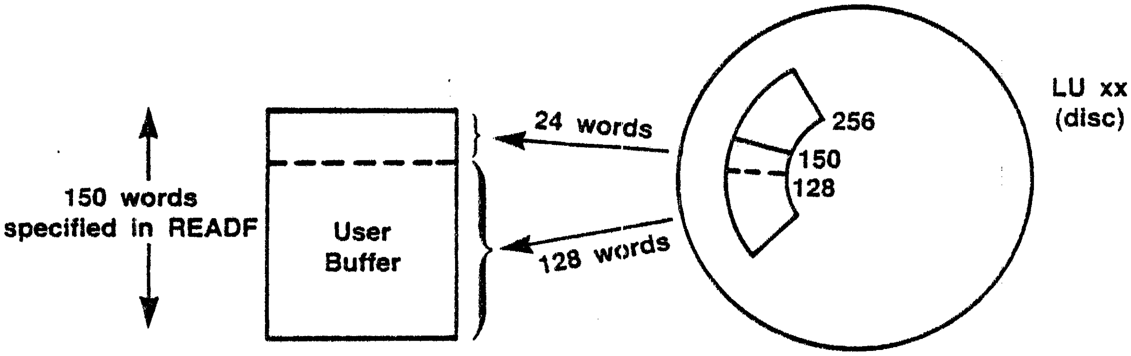
- **Data transfers with type 1 files are not limited to the 128 word record length.**

  - **— for writes, data is transferred in multiples of 128 words**



256 words will actually be written to the disc file

  - **— for reads, data is transferred in the exact amount requested**



the disc drive will read 256 words; the FMP routines will only transfer 150 words to your data buffer.

10E. MORE FMP CALLS

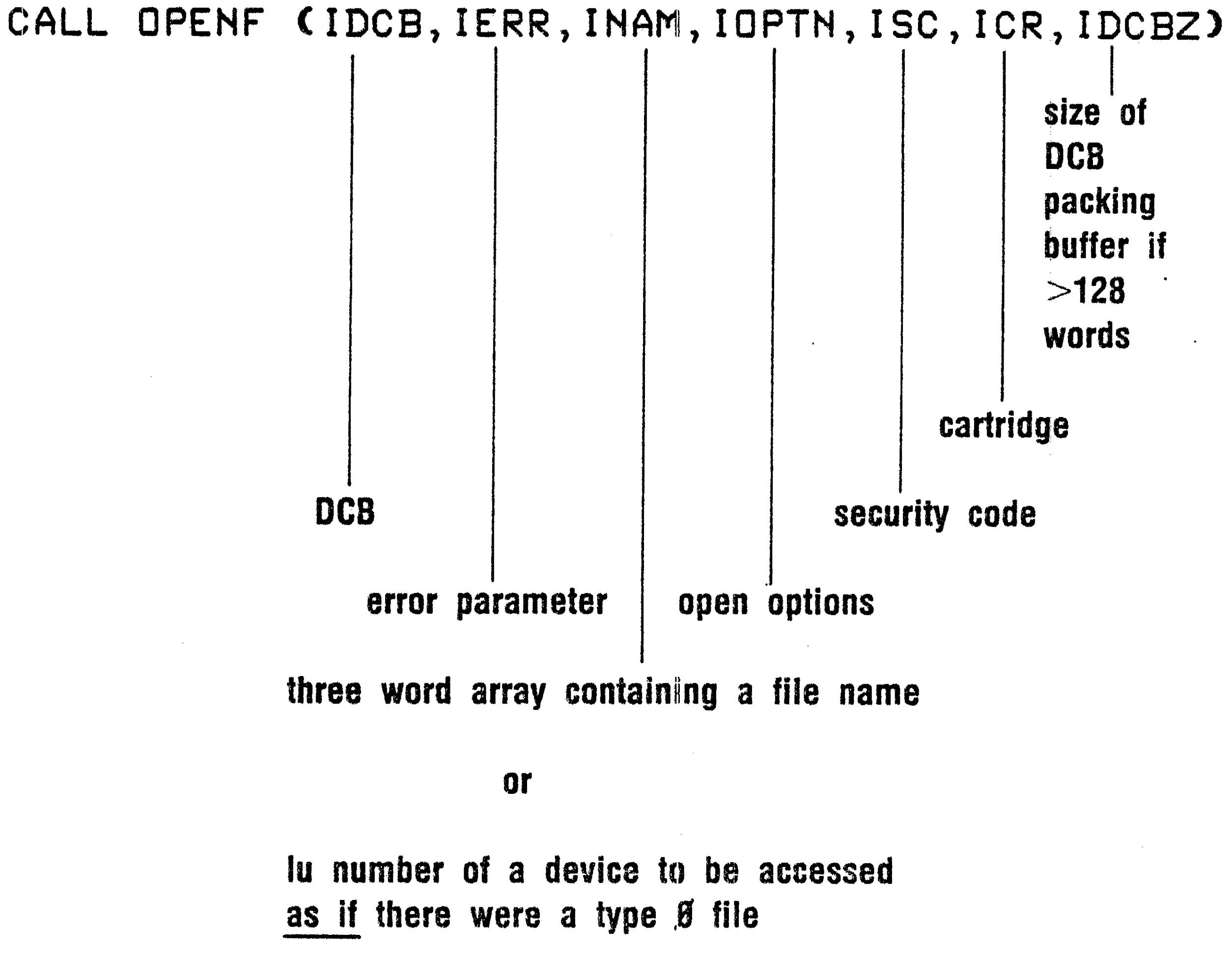
The FMP calls may be grouped as follows:

	Standard Call	Extended Call	Special Call
File Definition	CREAT CRETS OPEN CLOSE PURGE	ECREA CRETS ECLOS	OPENF
File Access	READF WRITF	EREAD EWRIT	
File Positioning	POSNT RWNDF LOCF APOSN	EPOSN ELOCF EAPOS	
Special Purpose	POST IDCBS NAMF FSTAT FCONT		

NON-DISC DEVICES

With FMP Calls, you can access non-disc devices just as you would access disc files. This might be done in two ways.

- **Via a type 0 file**
- **Via an OPENF call**



```
CALL OPENF (IDCB,IERR,INAM,IOPTN,ISC,ICR,IDCBZ)
```

or

lu number of a device to be accessed <u>as if</u> there were a type 0 file

CONTROLLING NON-DISC DEVICES

•CALL FCONT•

To control a device through its type 0 file or to control a device opened via OPENF, use the FCONT routine.

```
CALL FCONT (IDCB,IERR,ICON1,ICON2)
```

more control information

control function

error parameter

DCB

LISTING MOUNTED CARTRIDGES

•CALL FSTAT•

The FSTAT routine returns information about

- the cartridges accessible by your session
- all cartridges currently mounted

```
CALL FSTAT (ISTAT,ILEN,IFORM,IOP,IADD)
```

error parameter

type of cartridge listing

format selection
(show owner of cartridge?)

length of ISTAT

array where the cartridge
information is returned

- Reading or writing random records may be done directly in the READF (EREAD) or WRITF (EWRIT) calls.

```
   CALL WRITF (IDCB,IERR,IBUF,IL,NUM)
or CALL READF (IDCB,IERR,IBUF,IL,LEN,NUM)
```

  - positive record number to read or write
  - negative number of records to backspace before the read or write

- The file may be positioned to (but not accessed) any random record by calling POSNT (or EPOSN).

```
CALL POSNT (IDCB,IERR,NUR,IR)
```

  - forward space or backspace a relative number of records
  - position to an absolute record

RANDOMLY ACCESSING SEQUENTIAL (TYPE ≥3) FILES

- **Type 3 and above files may be positioned to any random record by calling POSNT (or EPOSN).**

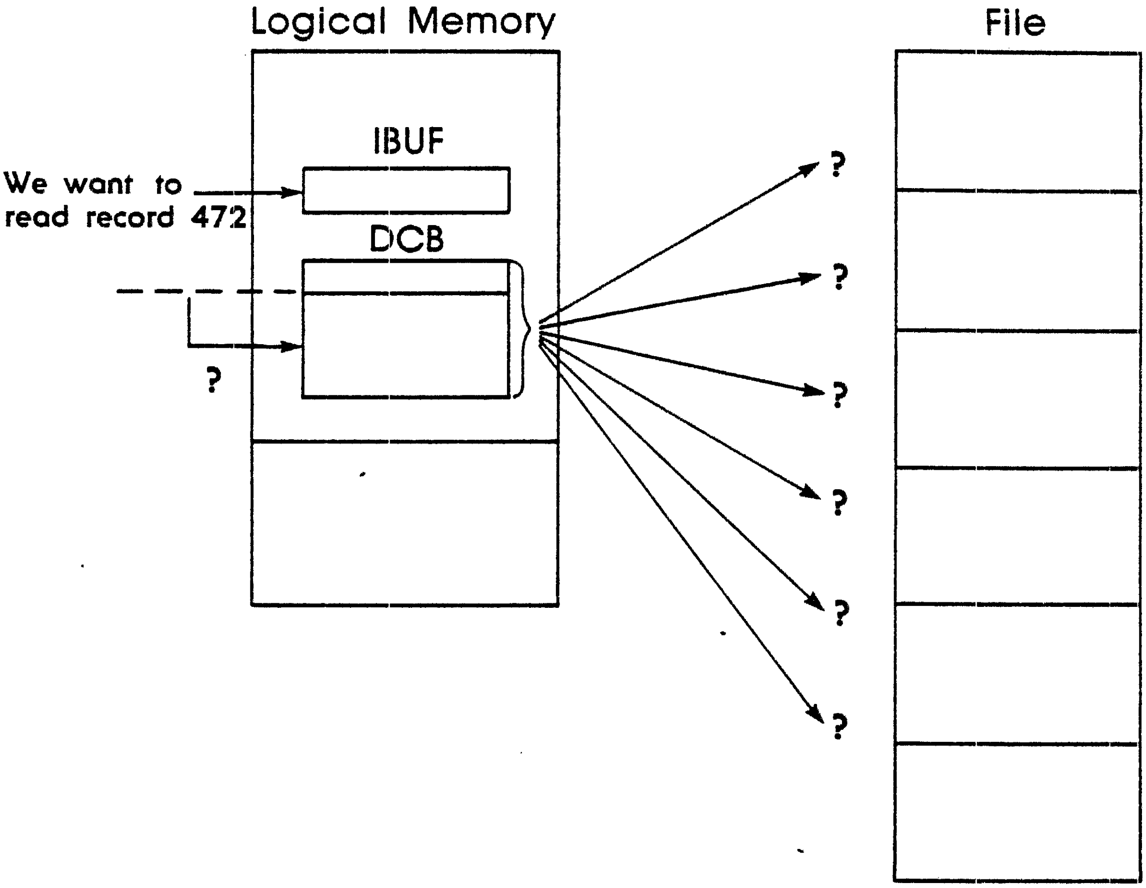
```
CALL POSNT (IDCB,IERR,NUR,IR)
```

Positioning is done by READING SEQUENTIAL RECORDS until the desired record is found.

- **Type 3 and above files may be accessed in a truely random fashion if you build a table of record locations in your program and then use this table whenever a record is to be accessed. The routines LOCF (or ELOCF) and APOSN (or EAPOS) allow you to do this.**

ABSOLUTE RECORD LOCATIONS?

What do you need to know about a given record in order to access that record without doing sequential reads?



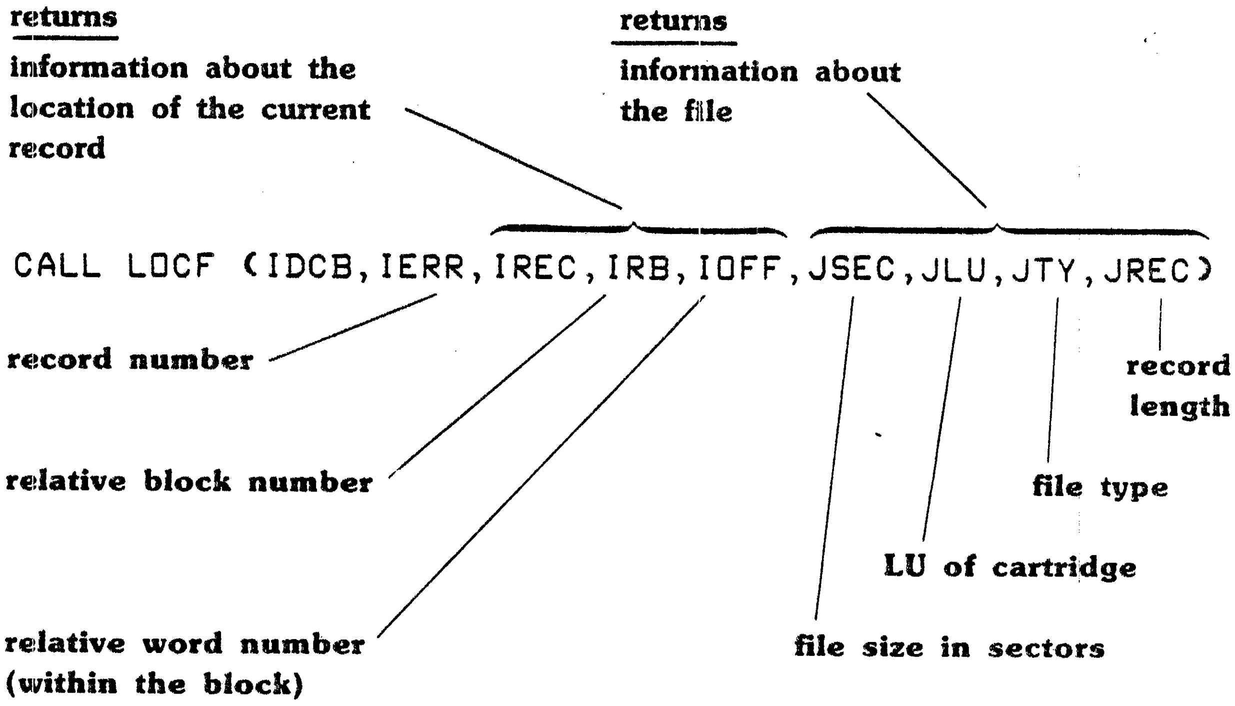
1. which "window" in the file contains the record
2. the location of the record within that "window"

OBTAINING ABSOLUTE RECORD LOCATIONS

•CALL LOCF•
(CALL ELOCF)

These routines return information about the

- size and location of your file.
- location of the record at which the file is currently positioned.



returns

information about the location of the current record

returns

information about the file

```
CALL LOCF (IDCB,IERR,IREC,IRB,IOFF,JSEC,JLU,JTY,JREC)
```

record number

relative block number

relative word number (within the block)

record length

file type

LU of cartridge

file size in sectors

POSITIONING A FILE TO AN ABSOLUTE RECORD LOCATION

•CALL APOSN•
(CALL EAPOS)

These routines use — the record number
— the relative block number
— the relative word number

to position a file at a specified record.

```
CALL APOSN (IDCB,IERR,IREC,IRB,IOFF)
```

obtained from LOCF (or ELOCF)
- record number
- relative block number
- relative word number

2

USING YOUR RTE SYSTEM

SECTION

2A. INTRODUCTION TO FMGR

Remember, when you successfully log on, the system runs a copy of the program FMGR at your terminal.

FMGR accepts commands which allow you to use your RTE system.

```
:
```

↑

waiting for a command

FMGR uses three devices to perform its functions.

INPUT DEVICE

FMGR accepts commands from the input device.

LIST DEVICE

FMGR outputs the results of certain commands to the list device.

LOG DEVICE

FMGR outputs error messages and accepts corrective commands from the log device.

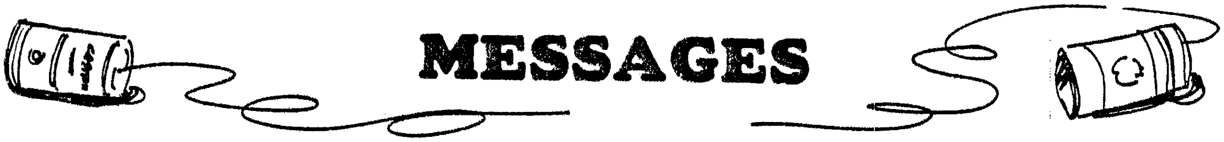
CAPABILITY LEVELS FOR FMGR COMMANDS

	CAPABILITY LEVEL
EX SY TR HE	1
AC MC TE CL ME WH DC *SL ?? DL SM ** LI	10
AN DP RN CN DU ST CO LL SV CR PK CT PU	20
CS +OF RT SL RP RU SP	30
CA PA SE IF LO	40
SL	50
IN OF	60

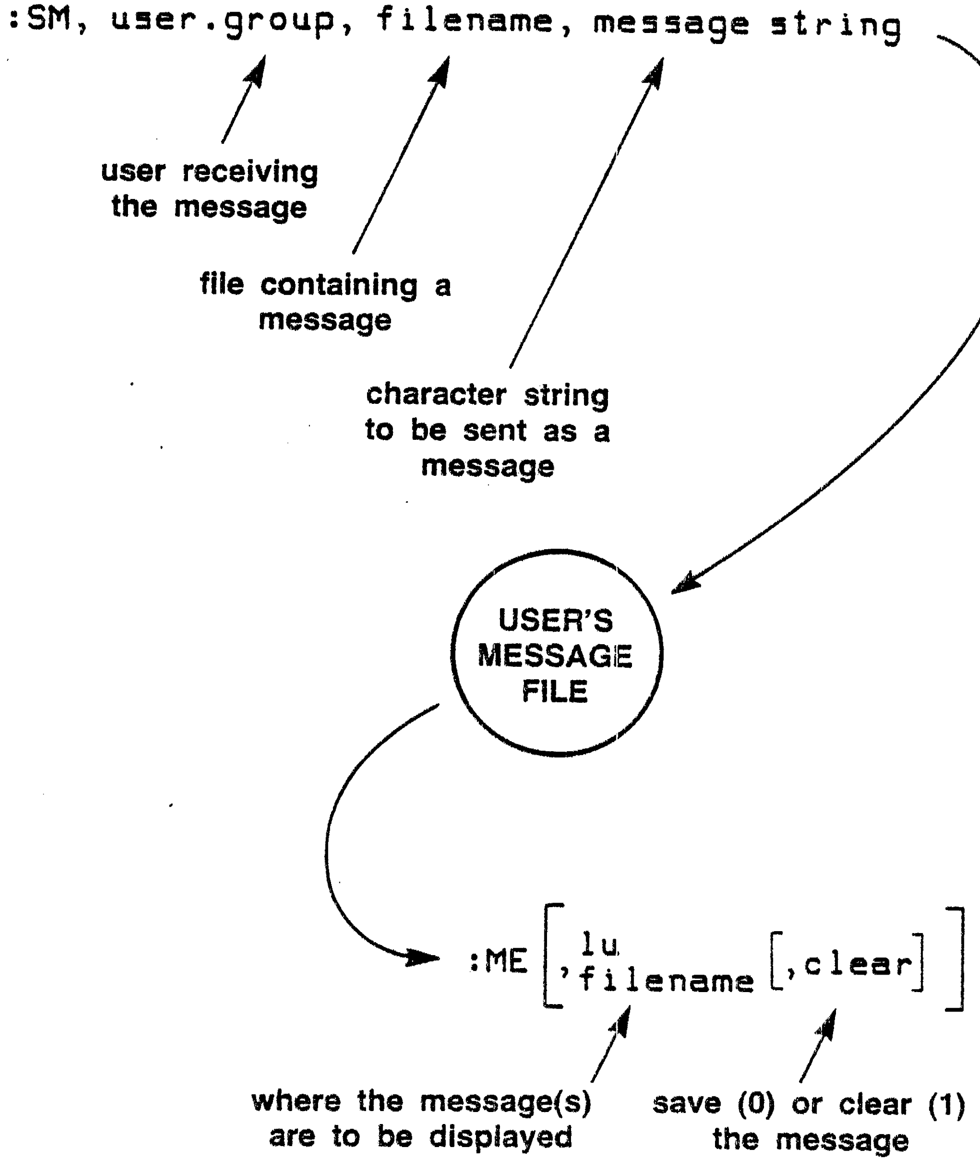
* Single parameter only

\+ Program must be under session's control

MESSAGES



Users can send messages back and forth between each other. RTE keeps a MESSAGE FILE for each of its users.



```
:SM, user.group, filename, message string
```

```
:ME [,lu      [,clear] ]
     filename
```

WHAT LU's CAN YOU ADDRESS?

The FMGR SL command will display the session LU's which you can use and their corresponding system LU's.

```
:SL[,lu]
```

↑

if specified, displays the system LU of the specified session LU

for example,

```
:SL
SLU   1=LU # 21 = E 5
SLU   2=LU #  2 = E 1
SLU   3=LU #  3 = E 1 S 6
SLU   4=LU #  4 = E 5 S 1
SLU   5=LU #  5 = E 5 S 2
SLU   6=LU #  6 = E 6
SLU   7=LU # 10 = E21
SLU   8=LU #  8 = E 8
SLU  25=LU # 25 = E 1 S16
SLU  28=LU # 28 = E 1 S 1
SLU  38=LU # 38 = E 1 S 2
SLU  47=LU # 47 = E 1 S11
:
```

or

```
:SL,1
SLU   1=LU # 21 = E 5
:
```

The SL command directs its output to the log device.

WHAT DISC CARTRIDGES CAN YOU ACCESS?

The FMGR CL command prints a list of the disc cartridges which you can access.

```
:CL
  LU   LAST TRACK    CR    LOCK   P/G/S

  02      00255   00002            S
  03      00255   00003            S
  28      00149      SP            S

:
```

* Access to LU 2 and LU 3 is read only unless you are the system manager.

The CL command directs its output to the list device.

WHAT FILES ARE STORED ON THIS DISC CARTRIDGE?

To see what files are stored on a particular cartridge, use the FMGR DL command to list the contents of that cartridge's file directory.

```
:DL[,cartridge]
```

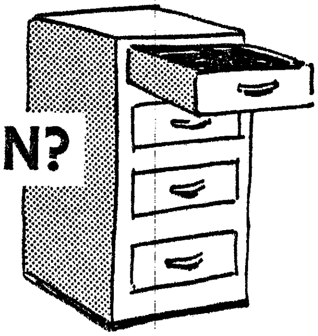
the LU (negative) or CRN (positive) of the cartridge whose file directory is to be listed

for example,

```
:DL,-25
CR=01500
 ILAB=DC0021 NXTR= 00000 NXSEC=076 #SEC/TR=096 LAST TR=00050 #DR TR=01

NAME   TYPE   SIZE/LU    OPEN TO

FILE1  00003 00024 BLKS
DATAF  00004 00010 BLKS
&PROG  00003 00004 BLKS

:DL,1500
CR=01500
 ILAB=DC0021 NXTR= 00000 NXSEC=076 #SEC/TR=096 LAST TR=00050 #DR TR=01

NAME   TYPE   SIZE/LU    OPEN TO

FILE1  00003 00024 BLKS
DATAF  00004 00010 BLKS
&PROG  00003 00004 BLKS

:
```

The DL command directs its listing to the list device.

WHAT DOES THIS FILE CONTAIN?



The FMGR LI command will display the contents of a specified file.

```
:LI, filename
```

the name of a file whose contents are to be listed

for example,

```
:LI,&PROG
&PROG  T=00003 IS ON CR SS   USING 00004 BLKS R=0000

0001  FTN4,L
0002        PROGRAM SFAVG( ), FORTRAN PROGRAM, CALCULATE INTEGER AVERAGE
0003  C
0004        WRITE(1,101)
0005  101   FORMAT(''THIS PROGRAM CALCULATES INTEGER AVERAGES,'')
0006        WRITE(1,102)
0007  102   FORMAT(''WHEN ASKED, ENTER AN INTEGER > 0.'')
0008        WRITE(1,103)
0009  103   FORMAT(''(ENTER 0 TO TERMINATE INPUT)''/)
0010  C
0011        ICT = 0
0012        ISUM = 0
0013  C
    .
    .
    .
```

The LI command also lists on the list device.

CHANGING THE LIST DEVICE

You can change your list device with the FMGR LL command.

```
:LL, lu
```

an LU which is to become the new list device

for example,

```
:CL
  LU  LAST TRACK   CR   LOCK  P/G/S

  02      00255   00002           S
  03      00255   00003           S
  28      00149      SP           S

:LL,6
:CL
:LL,1
:CL
  LU  LAST TRACK   CR   LOCK  P/G/S

  02      00255   00002           S
  03      00255   00003           S
  28      00149      SP           S
:
```

RUNNING PROGRAMS

Use the FMGR RU command to run a program. FMGR requests RTE to schedule the program for execution and then waits for the program to complete before issuing another prompt.

```
:RU, program name
        ↑
        name of a program to be run
```

for example,

```
:RU,SFAVG
THIS PROGRAM CALCULATES INTEGER AVERAGES,
WHEN ASKED, ENTER AN INTEGER > 0.
(ENTER 0 TO TERMINATE INPUT)

INPUT AN INTEGER VALUE: 482
INPUT AN INTEGER VALUE: 412
INPUT AN INTEGER VALUE: 437
INPUT AN INTEGER VALUE: 0

YOU ENTERED     3 VALUES

THE SUM WAS  1331

THE AVERAGE WAS   443
:
```

FMGR ERROR MESSAGES

FMGR uses error messages to report

- **— information**
- **— input errors or illegal commands**

FMGR error messages are of the form:

```
FMGR nnn
```

a positive or negative error number

for example,

```
:LI,AFILE
FMGR-006
:DK,-25
FMGR 010
DK,?
:SE,24
FMGR 046
:
```

WHAT DOES THAT ERROR NUMBER MEAN?

There are two ways to get information about a FMGR error.

LEVEL I Use the FMGR ?? command to see a one-line explanation of a FMGR error.

```
:??[,error number]
```

error number to be explained; the explanation is printed on the list device

for example,

```
:LI,AFILE
FMGR-006
:??
FMGR -06 FILE NOT FOUND.
:??,10
FMGR 010 INPUT ERROR
:
```

"HELP

The file "HELP contains explanations about

- system errors
- FMGR errors
- LOADR errors
- etc.

A second way to get information about a FMGR error is to consult the "HELP file.

LEVEL II Use the FMGR HE command to see the "HELP file explanation about one of these errors.

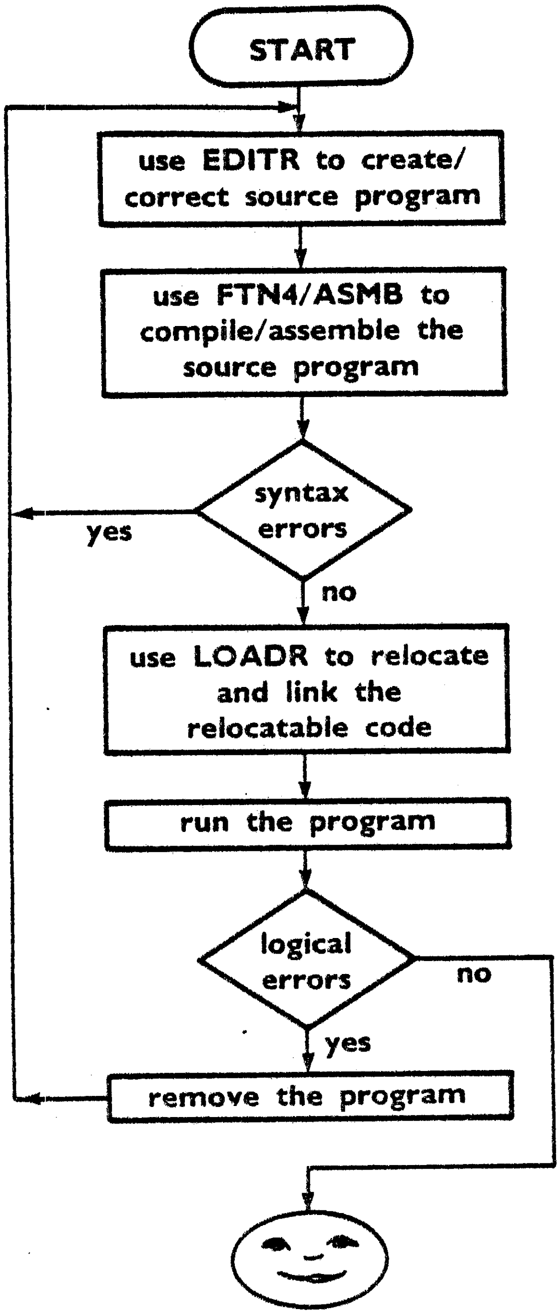
```
:HE,[,keyword [,lu]]
```

lu where the explanation is printed

keyword of the error to be explained, i.e. FMGR-006

```
:LI,AFILE
FMGR-006
:HE
FMGR-006
FILE NOT FOUND
AN ATTEMPT WAS MADE TO ACCESS A FILE THAT CANNOT BE FOUND  CHECK THE
FILE NAME OR THE CATRIDGE REFERENCE.

:HE,IO 12
HELP PROGRAM ERROR  HELP0002
KEYWORD NOT FOUND
    KEYWORD WAS NOT FOUND IN THE HELP FILE.  IF THE
    KEYWORD WAS SPECIFIED IN THE COMMAND, CHECK IT.
:HE,IO12
IO12
AN I/O REQUEST SPECIFIED A LOGICAL UNIT NOT DEFINED FOR USE BY
THIS SESSION.  THE "SL" COMMAND WILL REPORT ALL LOGICAL UNITS
AVAILABLE TO YOUR SESSION.

:
```

2B. INTRODUCTION TO PROGRAM DEVELOPMENT IN RTE



1. The source program consists of your FORTRAN or Assembly Language statements.

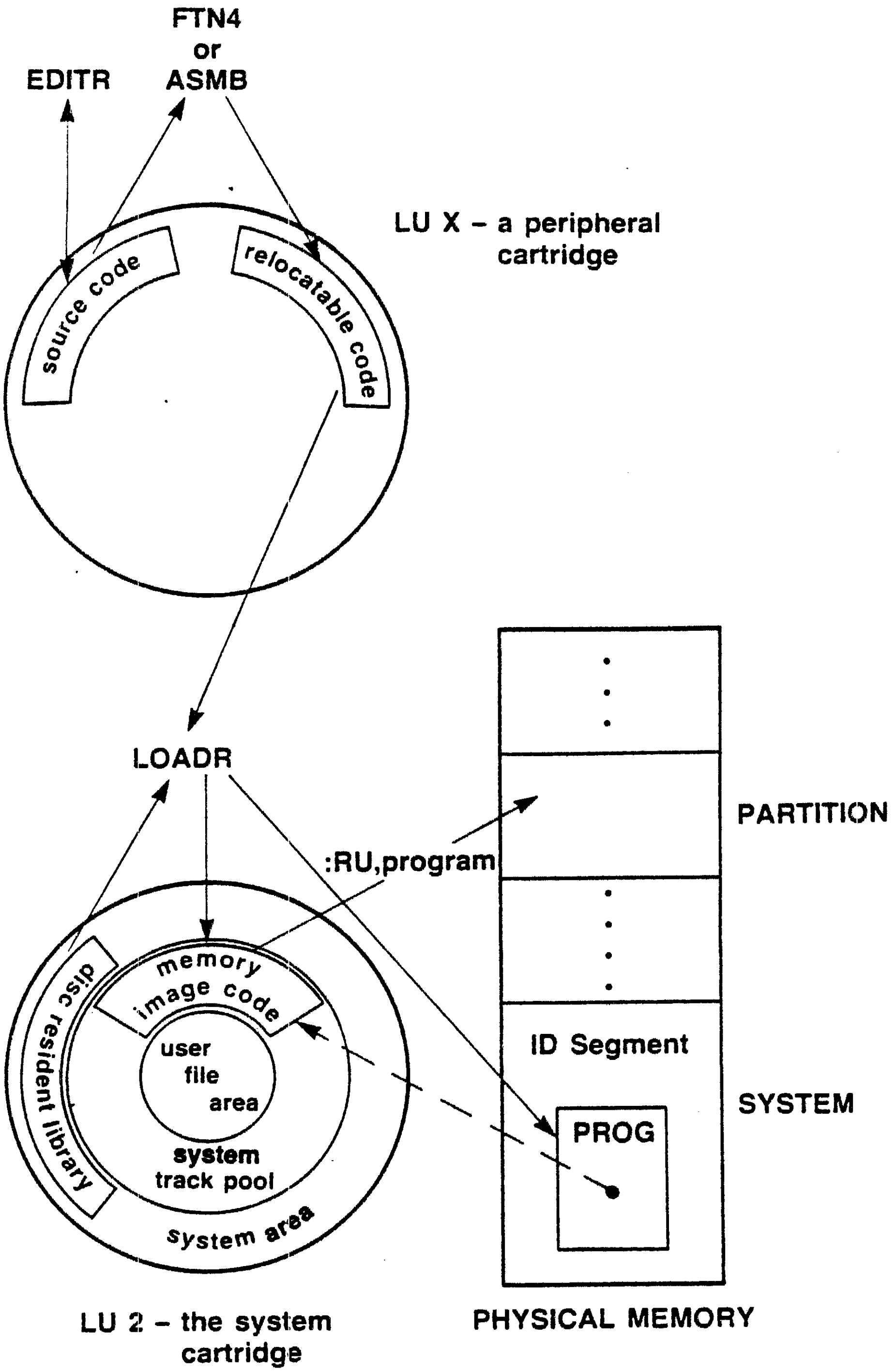
2. The FORTRAN compiler or RTE Assembler processes the source statements and creates the relocatable code.

3. LOADR relocates and links your program's routines and any needed library routines and fills in an ID segment in memory and creates the memory image code on disc for your program.

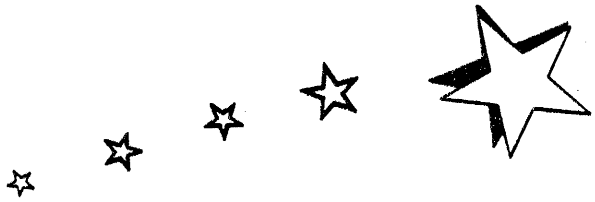
4. When you run your program, the memory image code is loaded from disc into memory and then executed.

5. If you need to correct your program, you will need to release its ID segment and disc tracks before loading a new version.

PROGRAM DEVELOPMENT IN RTE



USING EDITR



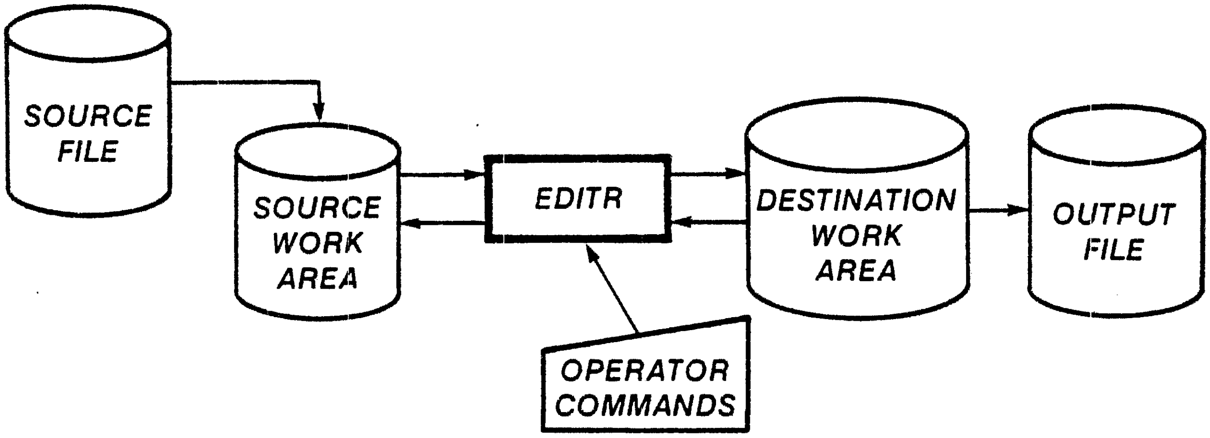
The EDITR program provides an easy means to

- create an ASCII file containing a source program, data or text.
- modify an existing ASCII file.
- append (merge) files together.

EDITR WORK AREAS

EDITR automatically allocates two work areas on the disc

- source work area
- destination work area



The EDITR commands are used to modify lines of ASCII data in the source work area. EDITR automatically moves the corrected lines into the destination work area.

RUNNING EDITR

To invoke EDITR, use the RU command.

```
:RU,EDITR
SOURCE FILE?
/
   ↑
```

The slash (/) is EDITR's prompt for input. Here, EDITR is asking you for the name of the ASCII file to be edited. Enter

- a file name; EDITR will copy the file into its source work area
- zero (0) to indicate you want to create a new file (use a fresh work area)
- colon (:) to terminate EDITOR

for example,

```
:RU,EDITR
SOURCE FILE?
/&PROG
FTN4,L          ←——— EDITR prints the first line
/               ←——— and then prompts for an
                     EDITR command
```

TYPES OF EDITR COMMANDS

DISPLAY	Control the pending line or supply information
LINE EDITS	Edit one line at a time
CHARACTER EDITS	Edit individual characters within a line
PATTERN EDITS	Edit pattern sequences and blocks of text

AN EDITING EXAMPLE

Suppose file &PROG contains this source program.

```
:LI,&PROG
&PROG  T=00003 IS ON CR SS   USING 00004 BLKS R=0000

0001  FTN4,L
0002  PROGRAM SFAVG
0003  C
0004        WRITE(1,101)
0005  101   FORMAT(''THIS PROGRAM CALCULATES INTEGER AVERAGES,'')
0006  102   FORMAT(''WHEN ASKED, ENTER AN INTEGER > 0.'')
0007        WRITE(1,103)
0008  103   FORMAT(
0009  103   FORMAT(''(ENTER 0 TO TERMINATE INPUT)''/)
0010  C
0011        ICT = 0
0012        ISUM - 0
0013  C
0014  10    WRITE(104)
0015  104   FORMAT(''INPUT AN INTEGER VALUE:_'')
0016        READ(1,*9) IVAL
0017        IF(IVAL .LE. 0) GOTO 99
0018          ICT = ICT + 1
0019          ISUM = ISUM + IVAL
0020          GOTO 101
0021  C
0022  99    IF(ICT .LE. 0) GOTO 10
0023  IAVG = ISUM/ICT
0024        WRITE(1,105) ICT
0025  105   FORMAT(/''YOU ENTERED '',I5,'' VALUES'')
0026        WRITE(1,106) ISUM
0027  106   FORMAT(/``THE SUM WAS '',I5)
0028        WRIT(1,107) IAVG
0029  107   FORMAT(/''THE AVERAGE WAS '',I5)
0030        END
0031        END$

:
```

DISPLAY COMMANDS

These commands control the pending line or supply information:

command	description
/P	list the pending line
/Ln	list the pending line and the next "n" lines, making the last line the new pending line
//	advance the pending line by one
/+n	advance the pending line by "n" lines (/+1 is the same as /+ or //)
/^n	back up "n" lines
/N	display the line number of the pending line
/n	make line "n" the pending line
/HL	display column numbers

(and others)

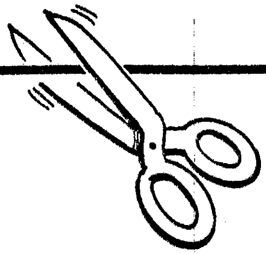
EXAMPLES OF DISPLAY COMMANDS

```
:RU,EDITR
SOURCE FILE?
/&PROG
  FTN4,L
/P
  FTN4,L
/L5
  FTN4,L
  PROGRAM SFAVG
  C
        WRITE(1,101)
  101   FORMAT(''THIS PROGRAM CALCULATES INTEGER AVERAGES,'')
  102   FORMAT(''WHEN ASKED, ENTER AN INTEGER > 0.'')
/^
  101   FORMAT(''THIS PROGRAM CALCULATES INTEGER AVERAGES,'')
/1
  FTN4,L
```

EXAMPLES OF LINE EDIT COMMANDS

```
/1
  FTN4,L
//
  PROGRAM SFAVG
/HL
  ''''/''''1''''/''''2''''/''''3''''/''''4''''/''''5''''/''''6''''/''''
'8
/R      PROGRAM SFAVG
/P
        PROGRAM SFAVG
//
  C
//
        WRITE(1,101)
//
  101   FORMAT(''THIS PROGRAM CALCULATES INTEGER AVERAGES,'')
/       WRITE(1,102)
/P
        WRITE(1,102)
//
  102   FORMAT(''WHEN ASKED, ENTER AN INTEGER > 0.'')
//
        WRITE(1,103)
//
  103   FORMAT(
/-
  103   FORMAT(''(ENTER 0 TO TERMINATE INPUT)''/)
```

LINE EDIT COMMANDS



These commands edit one line at a time:

command	description
`/R text`	Replace the pending line with "text"
`/I text`	Insert "text" before pending line
`/Δ text`	Insert "text" after pending line, make "text" new pending line
`/-n`	Delete "n" lines, starting with the pending line

(and others)

(note: Δ is a blank)

CHARACTER EDIT COMMANDS

These commands edit individual characters within a line:

command	description
/P////text	Replace the characters in the pending line with the characters in ``text'', character by character according to position. The slash (/) represents a placeholder, to preserve existing characters.
/P////text Ⓘ or Ⓢ	Insert the characters in ``text'' into the pending line.
/P////xxx Ⓒ	Cancel (delete) characters in the pending line corresponding to the placeholder ``x'''s.
/P/// Ⓣ	Truncate the pending line.
(and others)	

(Note: ○ represents a CONTROL character)

EXAMPLES OF CHARACTER EDIT COMMANDS

```
  103   FORMAT(''(ENTER 0 TO TERMINATE INPUT)''/)
/+3
        ISUM - 0
/P///////////=
        ISUM = 0
//
  C
//
  10    WRITE(104)                Ⓢ
/P////////////1,
  10    WRITE(1,104)
/+2
        READ(1,*9) IVAL           Ⓒ
/P//////////////X
        READ(1,*) IVAL
/+4
          GOTO 101                Ⓣ
/P///////////////
          GOTO 10
```

PATTERN EDIT COMMANDS

These commands edit pattern sequences of characters:

command	description
`/G old text/new text`	Replaces each occurrence of "old text" with "new text" in the pending line.
`/Fx text` a control option — a slash — an escape — nothing (and other commands)	Search for the next line which contains "text" and make that line the pending line.

EXAMPLES OF PATTERN EDIT COMMANDS

```
/+3
  IAVG = ISUM/ICT
/GIAVG/      IAVG
        IAVG = ISUM/ICT
/F/WRIT
        WRITE(1,105) ICT
/F/WRIT(
        WRIT(1,107) IAVG
/GWRIT/WRITE
        WRITE(1,107) IAVG
//
  107   FORMAT(/''THE AVERAGE WAS '',I5)
//
        END
//
  END$'
/
```

TERMINATING EDITR

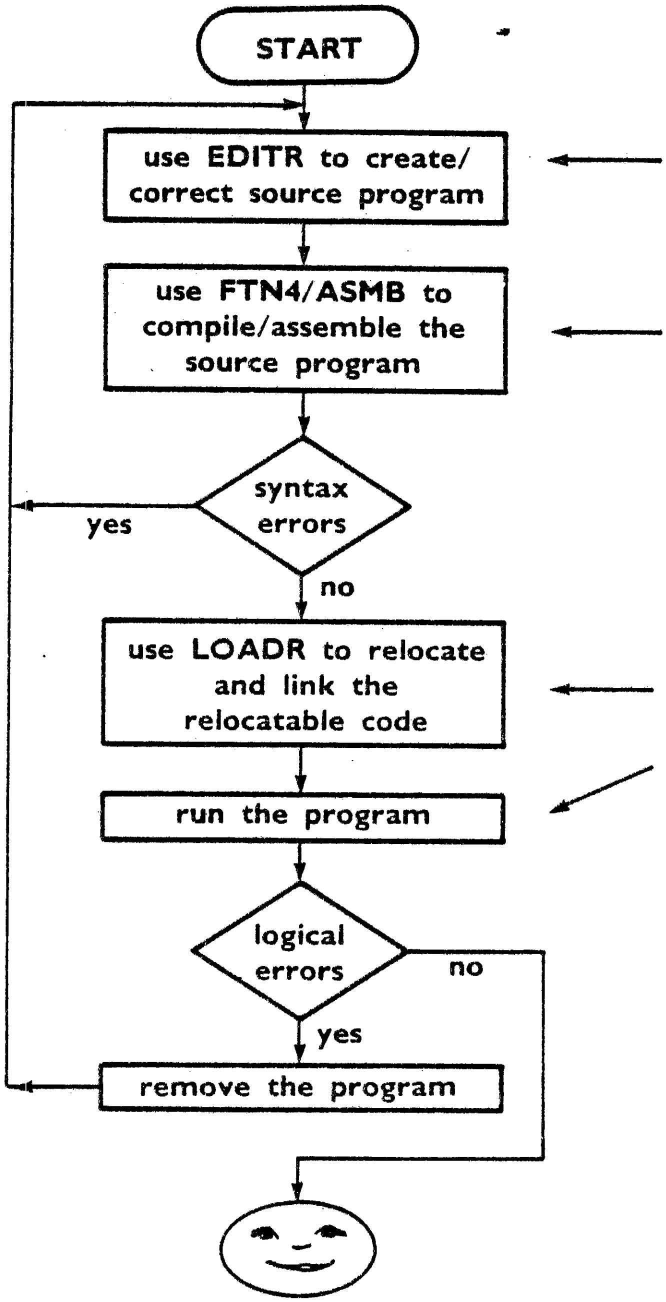
After editing, you must tell the EDITR to store its destination work area in a file you specify. Use one of these commands:

`/EC filename`	End and Create a new file called "filename"
`/ER filename`	End and Replace the contents of file "filename"
`/ER`	End and Replace the contents of the file you named as the source file.

To abort the EDITR without saving your work or altering any existing files, use the command:

`/A`	Abort the EDITR without saving the destination work area.

COMPILING, LOADING AND RUNNING YOUR PROGRAM



Now that you have a correct (?) source program, you need to:

compile the source program,

load the relocatable code,

and *run* the program.

FTN4 — THE FORTRAN IV COMPILER

The RTE FORTRAN IV compiler takes FORTRAN IV source statements as input and outputs:

1. relocatable code
2. a program listing
3. diagnostic error messages if errors occurred

The relocatable code is in a format suitable for the RTE LOADR.

Run FTN4 by —

```
:RU,FTN4, source file name, list lu, relocatable file name
```

contains the source program

where to print the listing

where to put the relocatable code

RUNNING FTN4 — AN EXAMPLE

```
:RU,FTN4,&PROG,1,%PROG

 PAGE 0001  FTN.   8:53 AM  THU., 31  MAY , 1979

0001  FTN4,L
0002        PROGRAM SFAVG
0003  C
0004        WRITE(1,101)
0005  101   FORMAT(''THIS PROGRAM CALCULATES INTEGER AVERAGES,'')
0006        WRITE(1,102)
0007  102   FORMAT(''WHEN ASKED, ENTER AN INTEGER > 0.'')
0008        WRITE(1,103)
0009  103   FORMAT(''(ENTER 0 TO TERMINATE INPUT)''/)
0010  C
0011        ICT = 0
0012        ISUM = 0
0013  C
0014  10    WRITE(1,104)
0015  104   FORMAT(''INPUT AN INTEGER VALUE:_'')
0016        READ(1,*) IVAL
0017        IF(IVAL .LE. 0) GOTO 99
0018          ICT = ICT + 1
0019          ISUM = ISUM + IVAL
0020          GOTO 10
0021  C
0022  99    IF(ICT .LE. 0) GOTO 10
0023        IAVG = ISUM/ICT
0024        WRITE(1,105) ICT
0025  105   FORMAT(/''YOU ENTERED '',I5,'' VALUES'')
0026        WRITE(1,106) ISUM
0027  106   FORMAT(/''THE SUM WAS '',I5)
0028        WRITE(1,107) IAVG
0029  107   FORMAT(/''THE AVERAGE WAS '',I5)
0030        END

  FTN4 COMPILER: HP92060-16092 REV. 1913 (790206)

  **  NO WARNINGS **  NO ERRORS **   PROGRAM = 00211     COMMON = 00000

 PAGE 0002  FTN.   8:53 AM  THU., 31  MAY , 1979

0031  END$

 $END FTN4: NO DISASTRS  NO ERRORS   NO WARNINGS
```

LOADR — THE RTE IV LOADER

The RTE LOADR takes relocatable code as input and outputs:

1. memory-image code in the system track pool area of LU 2 or 3.
2. an ID segment in memory.
3. a load map.
4. diagnostic error messages if any occurred.

Run LOADR by —

```
:RU,LOADR,, relocatable file name, list lu
```

contains the relocatable code

where to print the listing

RUNNING LOADR — AN EXAMPLE

* * * * *

```
:RU,LOADR,,%PROG,1
  SFAVG   40042 40364

  FMTIO   40365 41663    24998-16002 REV.1926 790417
  FMT.E   41664 41664    24998-16002 REV.1901 781107
  PNAME   41665 41732    771121   24998-16001
  REIO    41733 42057   92067-16268 REV.1903 790316
  FRMTR   42060 45515    24998-16002 REV.1926 790503
  .CFER   45516 45573   750701   24998-16001

   4 PAGES RELOCATED      4 PAGES REQ'D    NO PAGES EMA       NO PAGES MSEG
  LINKS:BP     PROGRAM:BG    LOAD:TE    COMMON:NC
   /LOADR:SFAVG  READY AT  2:27 PM  THU.,  1  MAY , 1980

   /LOADR:$END

:
```

RUNNING YOUR PROGRAM

Once you have created the memory image code and filled in an ID segment, you can run your program:

```
:RU,SFAVG
THIS PROGRAM CALCULATES INTEGER AVERAGES,
WHEN ASKED, ENTER AN INTEGER > 0.
(ENTER 0 TO TERMINATE INPUT)

INPUT AN INTEGER VALUE: 425
INPUT AN INTEGER VALUE: 413
INPUT AN INTEGER VALUE: 465
INPUT AN INTEGER VALUE: 478
INPUT AN INTEGER VALUE: 436
INPUT AN INTEGER VALUE: 0

YOU ENTERED     5 VALUES

THE SUM WAS  2217

THE AVERAGE WAS   443
:
```

REMOVING PROGRAMS

RTE only allows one program for each program name; if you wish to re-load a program which already exists, you must release its ID segment and disc tracks.

The FMGR `OF` command will do this for you.

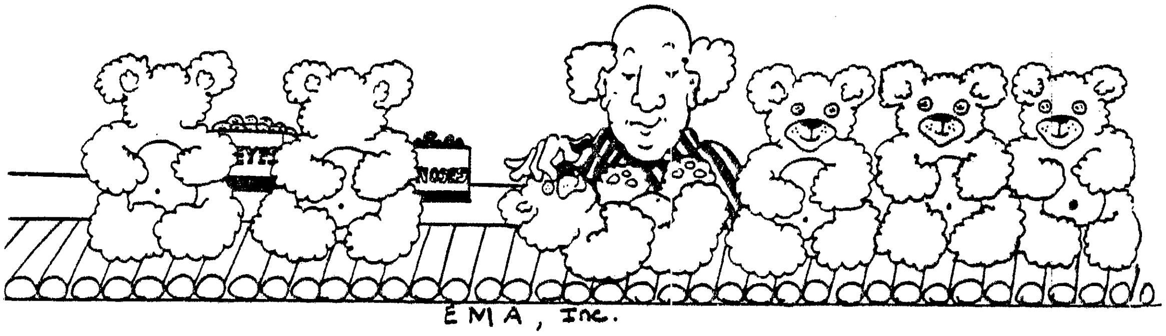
```
:OF, program name
```

The FMGR `OF` command will:

- terminate the program if it is executing.
- release the program's ID segment and the disc tracks containing its memory image code.

3

RTE ORGANIZATION



SECTION

3A. BREAKMODE — INTERACTING WITH RTE

Consider this program:

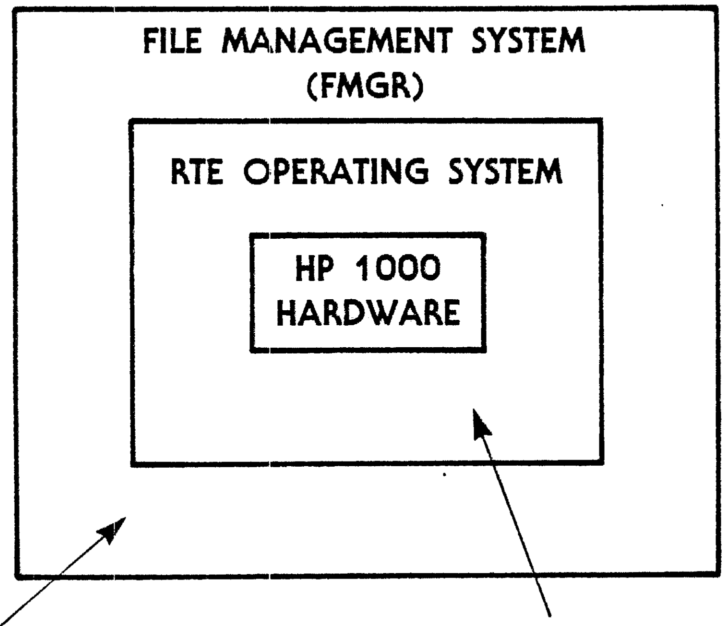
```
      PROGRAM INF
C
10    CONTINUE
      GO TO 10
      END
```

If you run this program,

```
:RU,INF
```

← FMGR will wait for your program to complete before issuing another prompt.

BREAKMODE vs FMGR COMMANDS



FILE MANAGEMENT SYSTEM
(FMGR)

RTE OPERATING SYSTEM

HP 1000
HARDWARE

You normally operate at this level, using FMGR commands.

RTE will also accept commands. Enter any breakmode command in response to a breakmode prompt:

```
S = xx COMMAND?
```

waiting
for
a
breakmode
command

COMMAND FORMATS

FMGR COMMANDS –

```
:command,p1,p2,p3,...
```

FMGR command,
only the first two
characters are significant

Parameters used to further
specify the command

BREAKMODE COMMANDS –

```
S = xx COMMAND? xx,p1,p2,p3,...
```

A two character
mnemonic for the
breakmode command

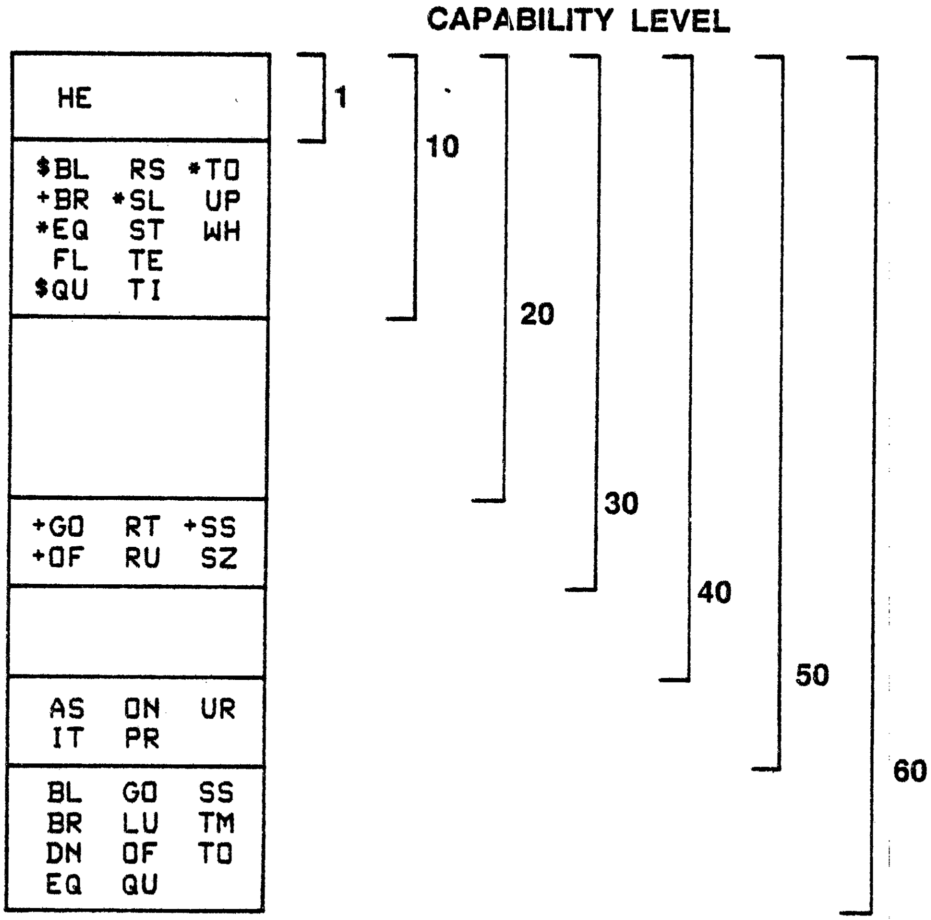
Parameters used to further
specify the command

EXAMPLES OF BREAKMODE SERVICES

There are several types of breakmode commands:

- GET STATUS OF SYSTEM
  - TI displays current system time
  - ST displays status of a program
  - TO displays timeout value of a device
- CONTROL PROGRAMS AND I/O OPERATIONS
  - UP make a peripheral device available
  - SS suspend a program
  - OF terminate a program
- ALTER SYSTEM PARAMETERS
  - TM set system time
  - QU change time-slicing parameters
  - TO change the time-out value of a device

CAPABILITY LEVELS FOR BREAKMODE COMMANDS



- * Single parameter only
- \+ Program must be under session's control
- $ No parameters permitted

EXAMPLES OF BREAKMODE SERVICES

There are several types of breakmode commands:

* GET STATUS OF SYSTEM

TI – displays current system time
ST – displays status of a program
TO – displays timeout value of a device

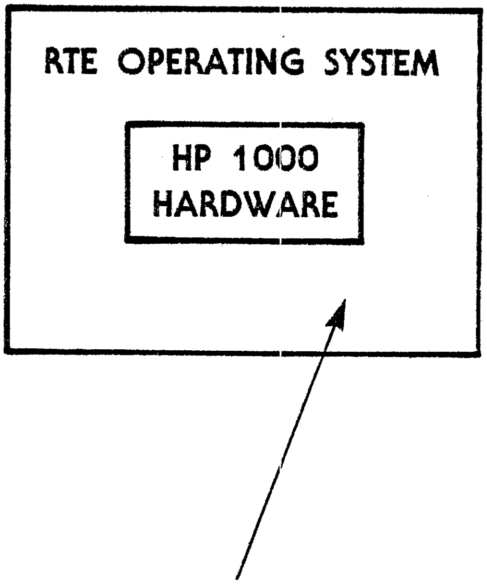
* CONTROL PROGRAMS AND I/O OPERATIONS

UP – make a peripheral device available
SS – suspend a program
OF – terminate a program

* ALTER SYSTEM PARAMETERS

TM – set system time
QU – change time–slicing parameters
TO – change the time–out value of a device

3B. RTE CONCEPTS

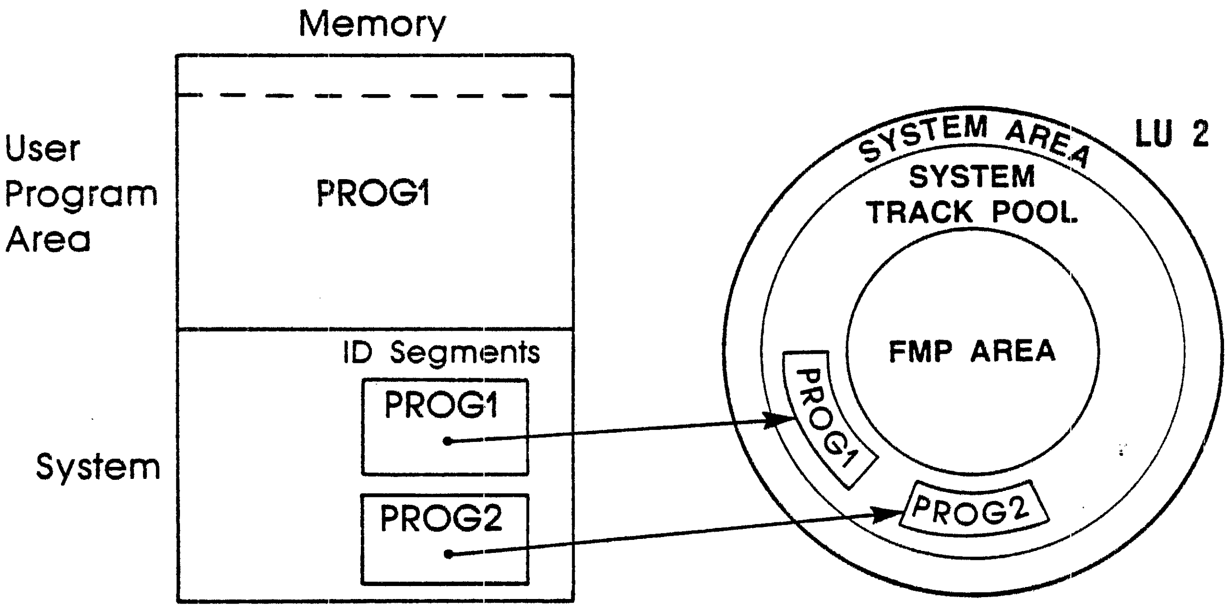


RTE manages system resources.

- MEMORY
- I/O OPERATIONS
- PROGRAMS

MEMORY MANAGEMENT

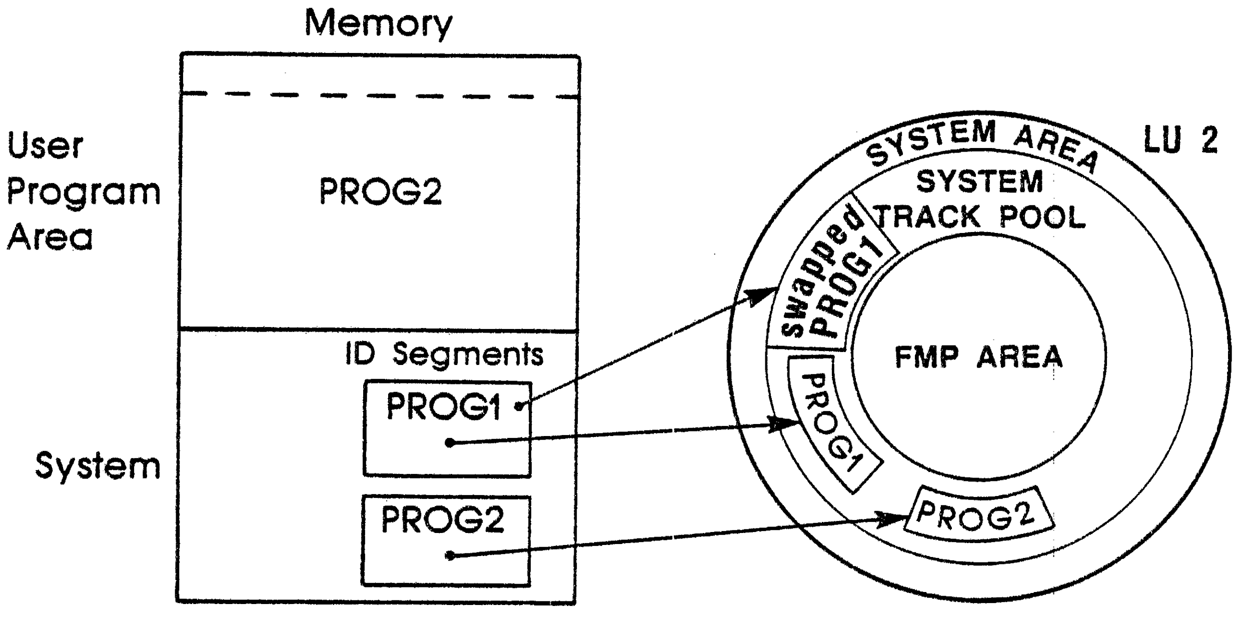
Suppose you have two programs, PROG1 and PROG2. PROG1 is currently executing and so resides in the user program area of memory; PROG2 is waiting its turn for execution.



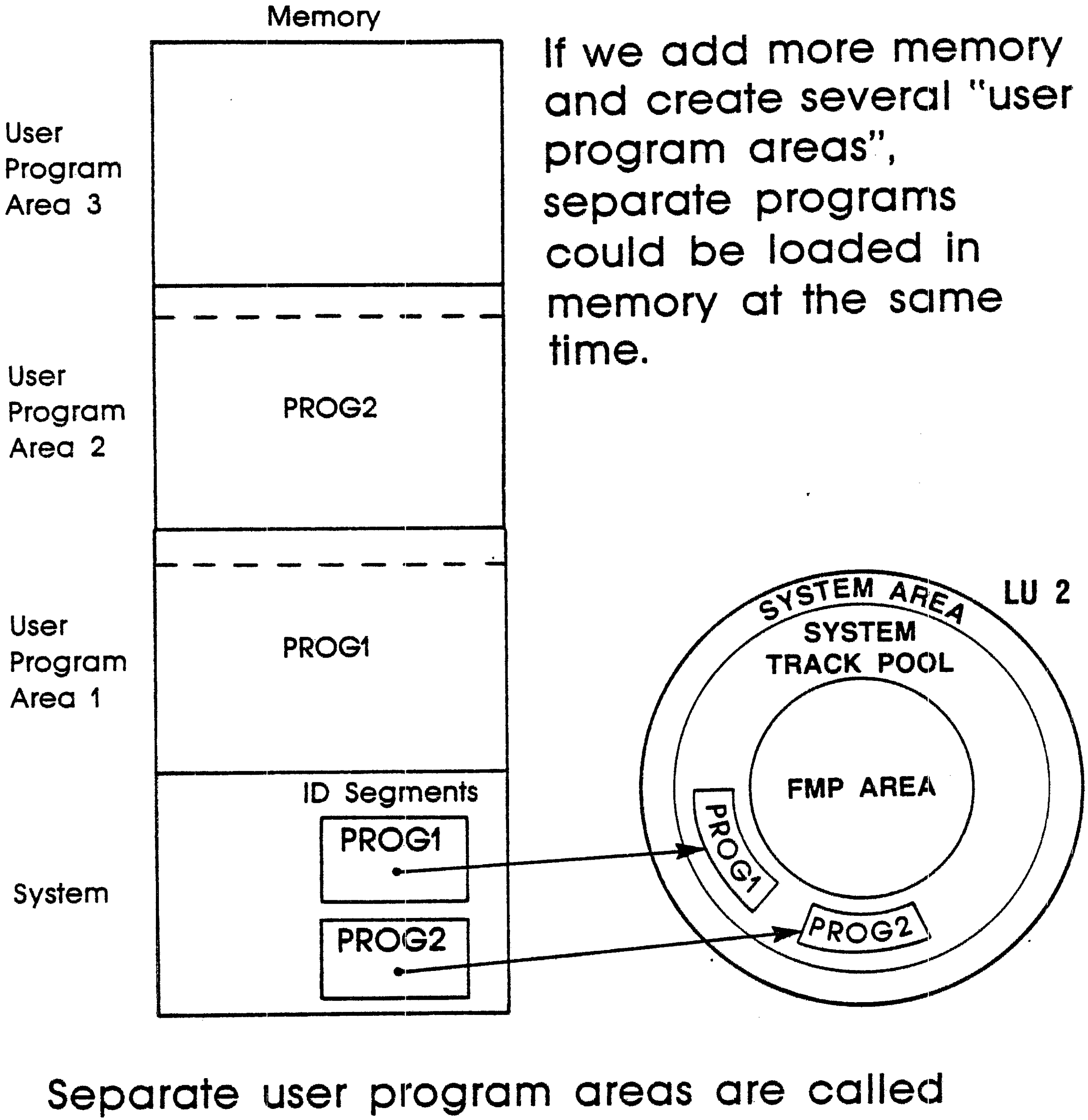
If PROG1 initiates a data transfer, how does the CPU begin execution of PROG2?

SWAPPING

If PROG1 initiates a data transfer, then the CPU can execute PROG2. PROG1 must first be *swapped* out of memory so PROG2 can be loaded into memory and executed.



PARTITIONS



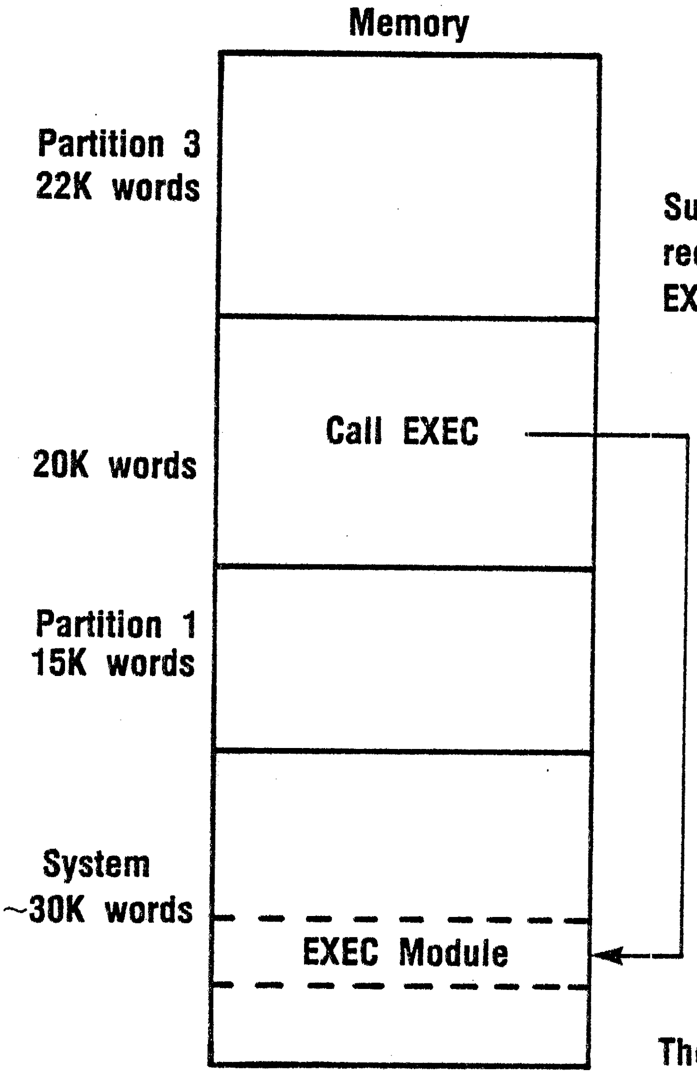
If we add more memory and create several "user program areas", separate programs could be loaded in memory at the same time.

Separate user program areas are called PARTITIONS. Partitions are defined when the RTE system is generated.

TOO MUCH MEMORY?

HP 1000 computers have 15 bits for addressing; hence, you can access 32K words or memory locations.

An RTE system with several partitions might have memory sizes as follows:



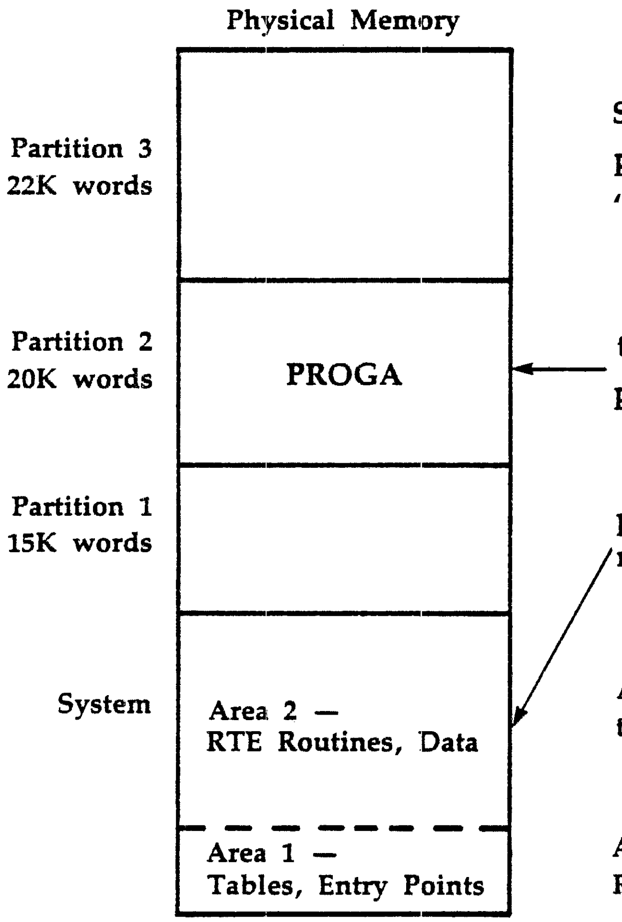
Suppose a program in partition 2 requests an RTE service with an EXEC call.

The EXEC module of RTE resides in the system area of memory, more than 32K words away from the program in partition 2.

DYNAMIC MAPPING SYSTEM

The DYNAMIC MAPPING SYSTEM (DMS) allows an HP 1000 computer to access up to 1024K words of "physical memory" using 15 bits for addressing.

With DMS, the 32K words which your program can "logically" address only needs to include that part of physical memory needed to execute the program.



Suppose PROGA is executing in partition 2. PROGA needs to "logically" address —

the memory making up partition 2 and

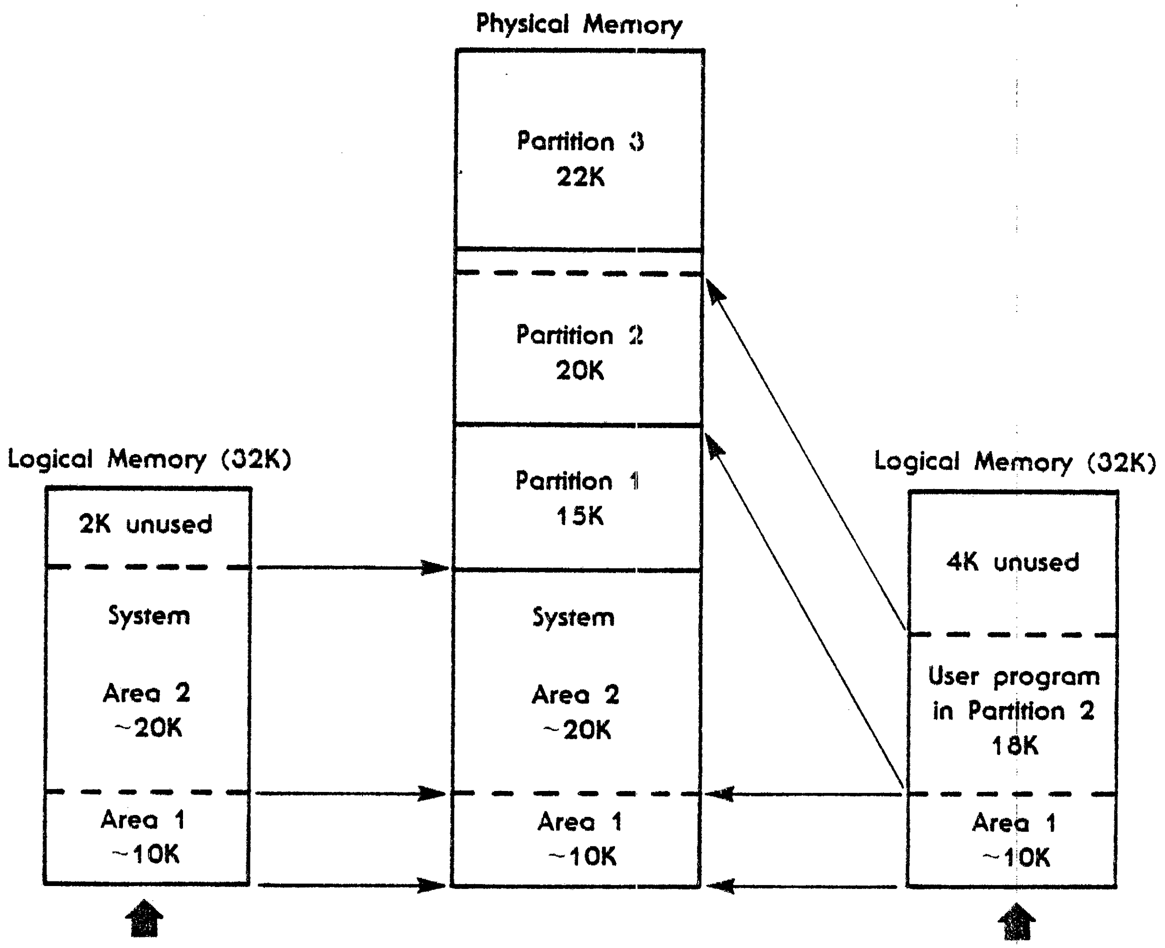
part of the system area of physical memory

AREA 2 needs to be addressed only when the actual RTE routines are executing.

AREA 1 needs to be addressed by both RTE and user programs in partitions.

LOGICAL vs PHYSICAL MEMORY

RTE, in conjunction with DMS, allows access to only those parts of physical memory which are needed by the currently executing program.



When the operating system is executing, DMS makes memory look like this.

When the user program in Partition 2 is executing, DMS makes memory look like this.

BACKGROUND vs REAL-TIME

Partitions may be defined as

BACKGROUND or REAL-TIME PARTITIONS

Programs may be defined as

BACKGROUND or REAL-TIME PROGRAMS

- BACKGROUND programs will run in BACKGROUND partitions.
- REAL-TIME programs will run in REAL-TIME partitions.
- If only one type of partition is defined, all programs will run in that type of partition.
- Programs may be assigned to a partition; a partition may be reserved for a specific program.

Both BACKGROUND and REAL-TIME programs reside on the disc, hence the terms:

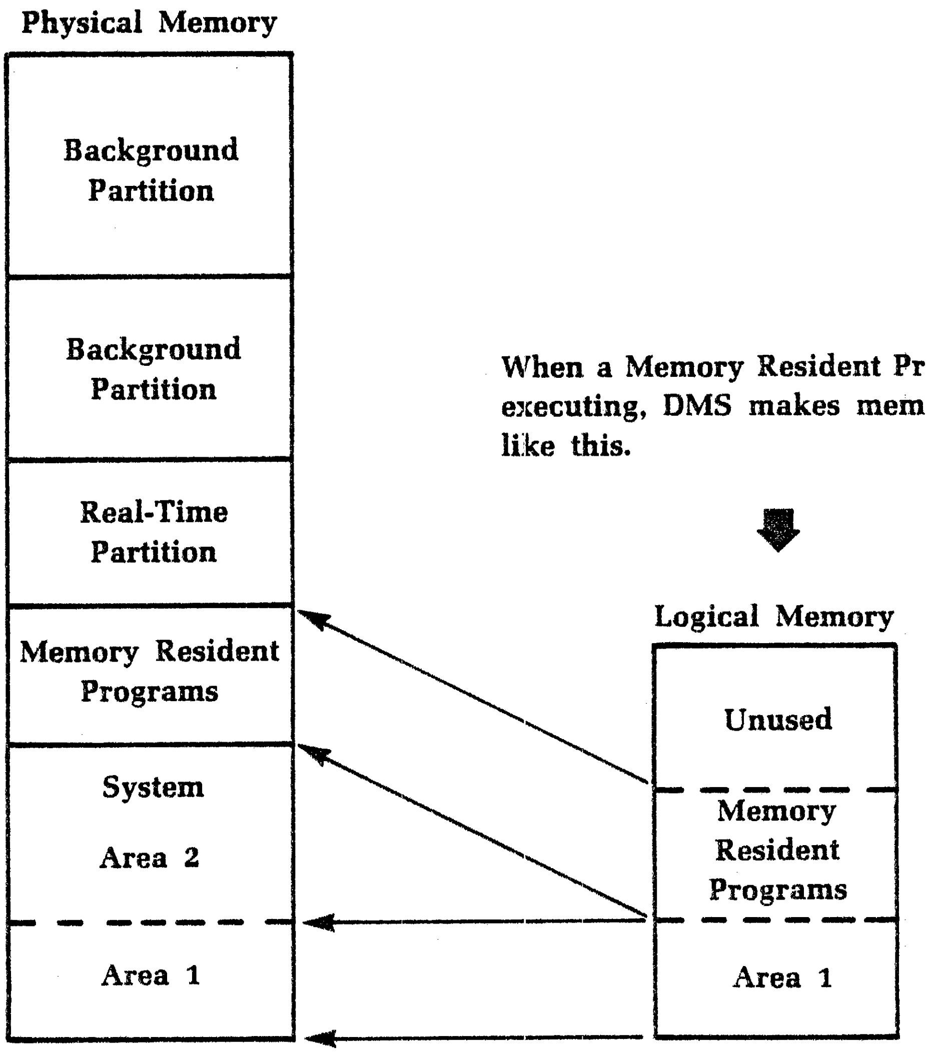
REAL-TIME DISC RESIDENT PROGRAMS
BACKGROUND DISC RESIDENT PROGRAMS

Both types of disc resident programs can be swapped.

MEMORY RESIDENT PROGRAMS

RTE also allows you to define Memory Resident Programs which

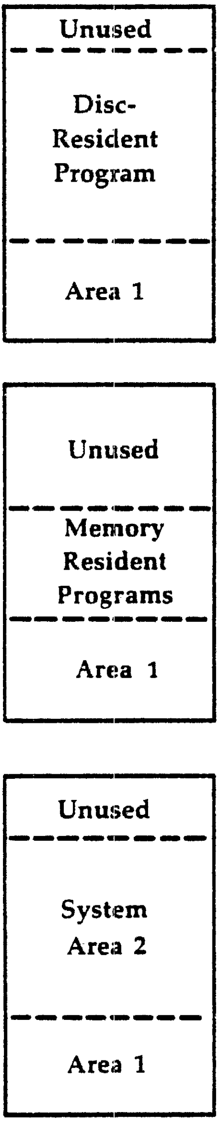
- **are resident in memory at all times**
- **are not swappable**
- **are included in the system when it is generated**



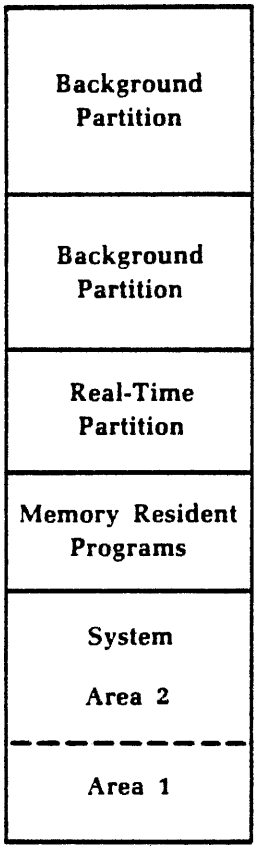
When a Memory Resident Program is executing, DMS makes memory look like this.

RTE and MEMORY MANAGEMENT

Logical Memory: how memory looks to the currently executing program.

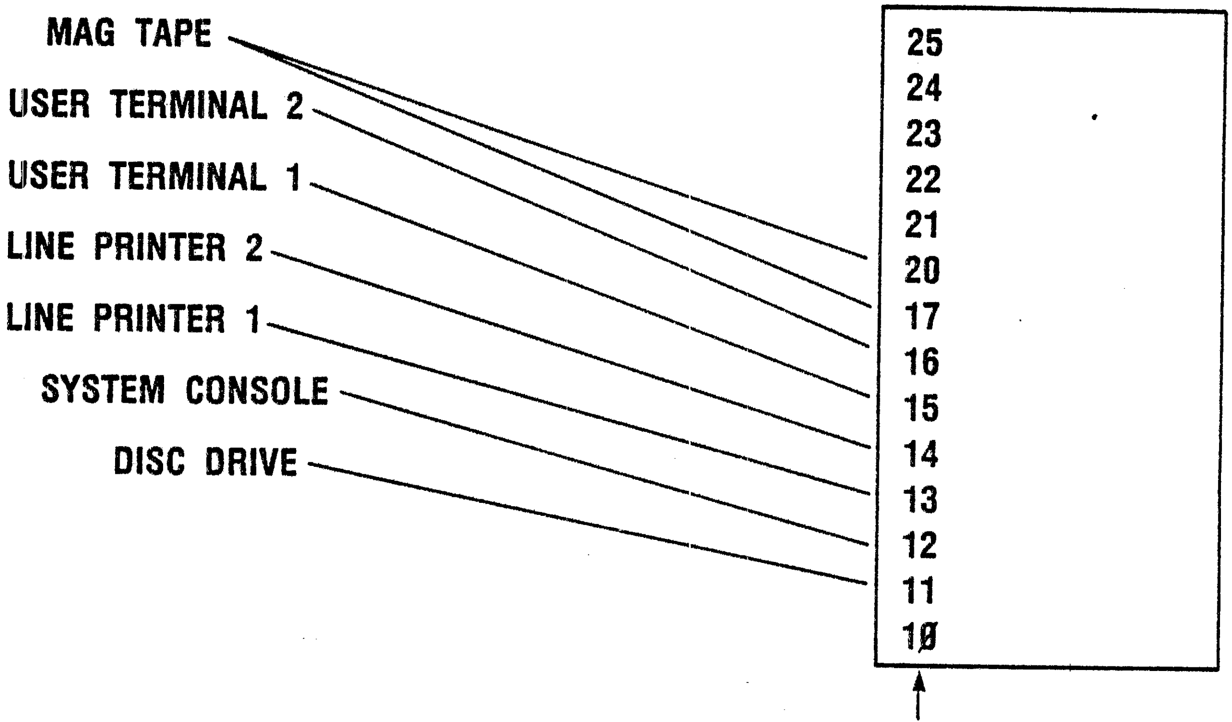


Physical Memory: the actual organization of RTE in memory.



I/O STRUCTURE

Each peripheral device is connected by a cable to an interface card. The interface card is plugged into a numbered I/O SLOT in the back of the computer.



Select codes: determine the priority of a device's interrupt

When an RTE system is generated, the select code assignments are incorporated into RTE's I/O structure.

EQT's

At generation time, each device is assigned an EQUIPMENT TABLE (EQT) number. This number represents an entry in RTE's EQUIPMENT TABLE (EQT).

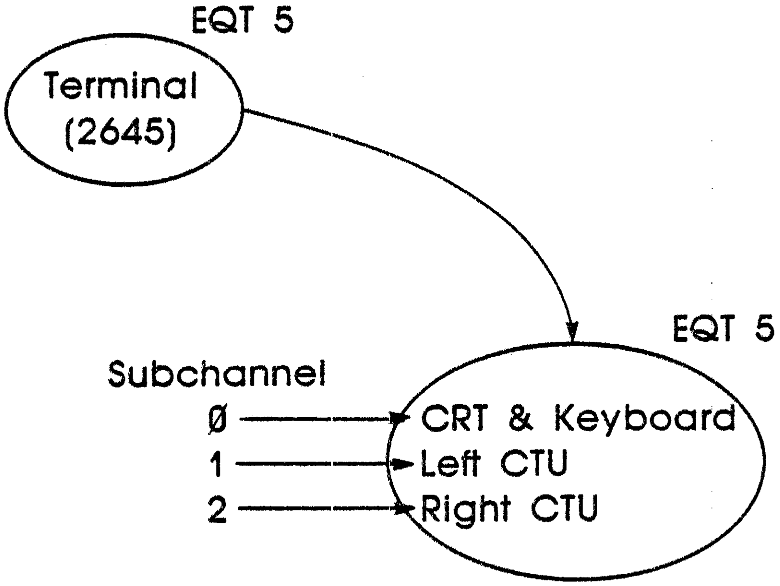
EQT

Eqt numbers	select code	driver	last subchannel addressed	
1	11	DVR32		(disc)
2	12	DVR05		(system console)
3	13	DVA12		(line printer 1)
4	14	DVA12		(line printer 2)
5	15	DVR05		(user terminal 1)
6	16	DVR05		(user terminal 2)
7	17	DVR23		(mag tape)

SUBCHANNELS

Some devices have several component parts. Each component part is identified by a SUBCHANNEL number.

for example,



SYSTEM LOGICAL UNIT (LU) NUMBERS

When the RTE system is generated, each EQT-SUBCHANNEL pair is assigned a SYSTEM LOGICAL UNIT (LU) number. This represents an entry in RTE's DEVICE REFERENCE TABLE (DRT).

DRT

	Eqt #	Subchannel
1	2	0
2		
3		
4	2	1
5	2	2
6	3	0
7	4	0
8	7	0
⋮		
30		
31		
32		
⋮		
65	5	0
66	6	0
⋮		
71	5	1
72	5	2
73	6	1
74	6	2

↑
Logical Unit (LU) Numbers

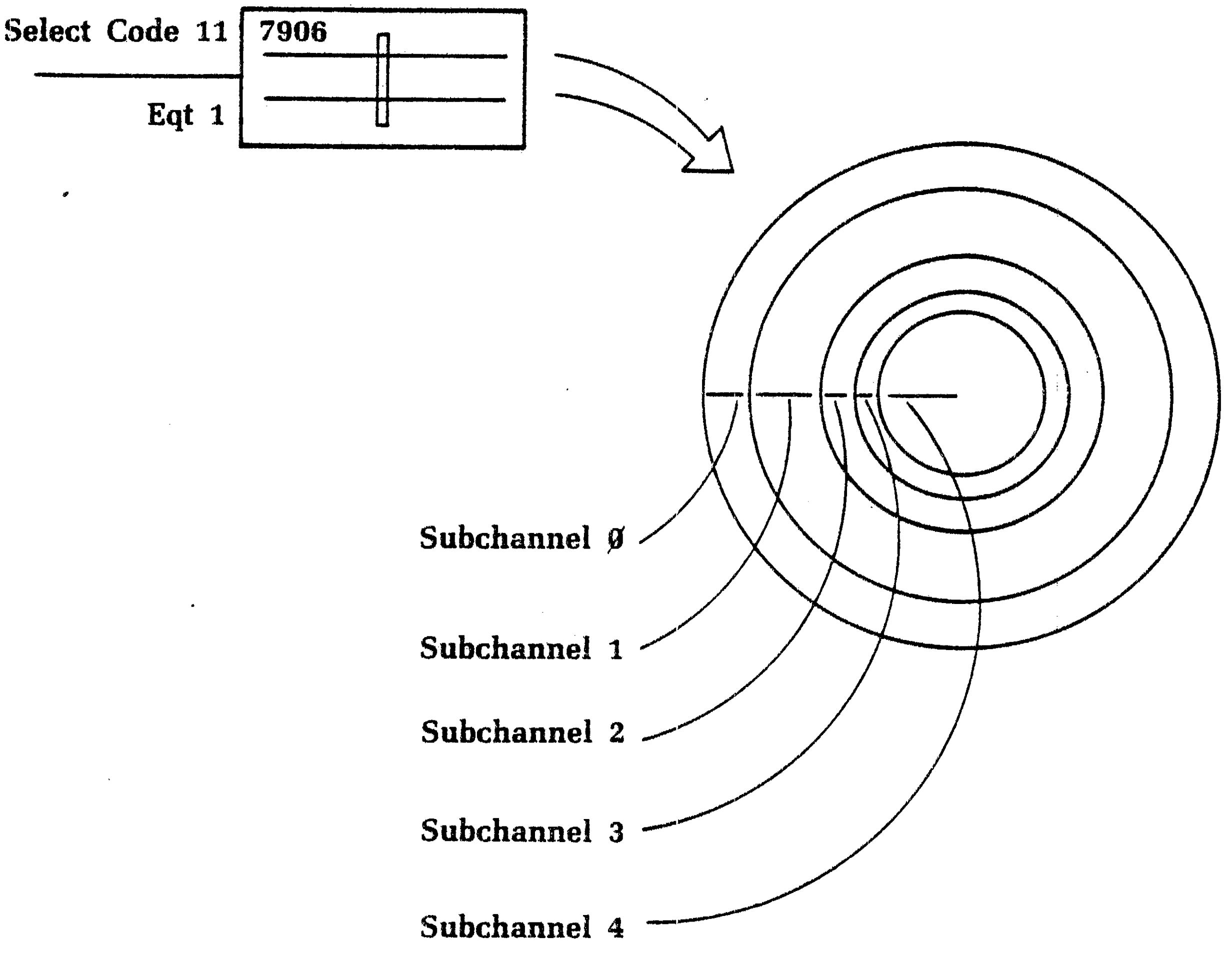
EQT

	select code	driver	last subchannel addressed	
1	11	DVR32		(disc)
2	12	DVR05		(system console)
3	13	DVA12		(line printer 1)
4	14	DVA12		(line printer 2)
5	15	DVR05		(user terminal 1)
6	16	DVR05		(user terminal 2)
7	17	DVR23		(mag tape)

DISC CARTRIDGES

When RTE is generated, the System Manager divides the disc into areas, each of which becomes a subchannel.

For example,



DISC LU's

Each disc area (an Eqt-subchannel pair) is assigned a System Logical Unit (LU) number, perhaps:

System LU	Eqt	Subchannel
2	1	0
3	1	4
30	1	1
31	1	2
32	1	3

DRT

	Eqt #	Subchannel
1	2	0
2	1	0
3	1	4
4	2	1
5	2	2
6	3	0
7	4	0
8	7	0
⋮		
30	1	1
31	1	2
32	1	3
⋮		
65	5	0
66	6	0
⋮		
71	5	1
72	5	2
73	6	1
74	6	2

↑ Logical Unit (LU) Numbers

EQT

	select code	driver	last subchannel addressed	
1	11	DVR32		(disc)
2	12	DVR05		(system console)
3	13	DVA12		(line printer 1)
4	14	DVA12		(line printer 2)
5	15	DVR05		(user terminal 1)
6	16	DVR05		(user terminal 2)
7	17	DVR23		(mag tape)

SESSION LU NUMBERS

With SESSION MONITOR, users reference devices via the SESSION LU's set up when their accounts are defined.

For example, if KAREN.PROGDEV logs on at user terminal 1:

DRT

	Eqt #	Subchannel
1	2	0
2	1	0
3	1	4
4	2	1
5	2	2
6	3	0
7	4	0
8	7	0
⋮		
30	1	1
31	1	2
32	1	3
⋮		
65	5	0
66	6	0
⋮		
71	5	1
72	5	2
73	6	1
74	6	2

↑ Logical Unit (LU) Numbers

SCB

KAREN.PROGDEV
30

SST

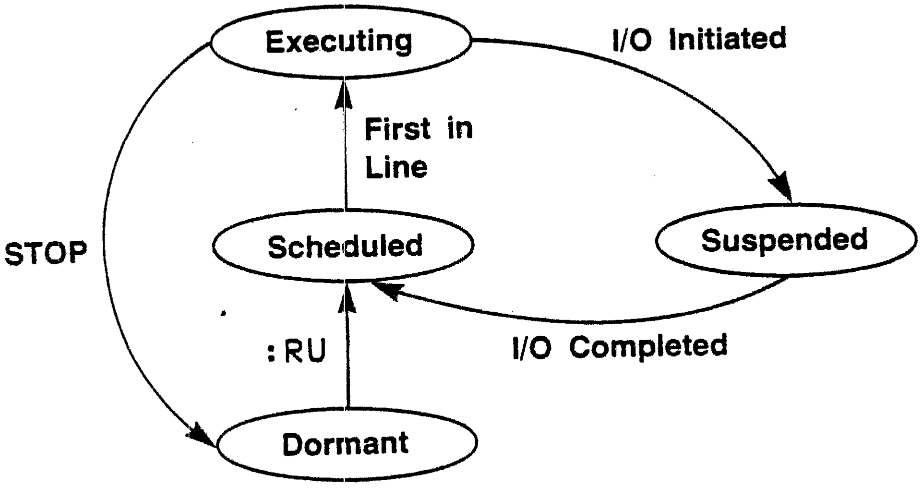
System LU	Session LU
65	1
71	4
72	5
2	2
3	3
7	6
8	8

EQT

	select code	driver	last subchannel addressed	
1	11	DVR32		(disc)
2	12	DVR05		(system console)
3	13	DVA12		(line printer 1)
4	14	DVA12		(line printer 2)
5	15	DVR05		(user terminal 1)
6	16	DVR05		(user terminal 2)
7	17	DVR23		(mag tape)

PROGRAM MANAGEMENT

A program's STATE describes the relationship between the program and RTE, which is managing the program's execution.

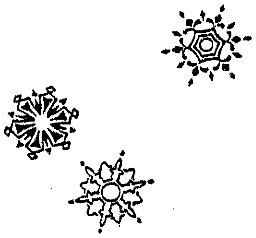


Operator commands, program calls or changes in the environment cause RTE to change a program's state.

Changes in a program's state are called

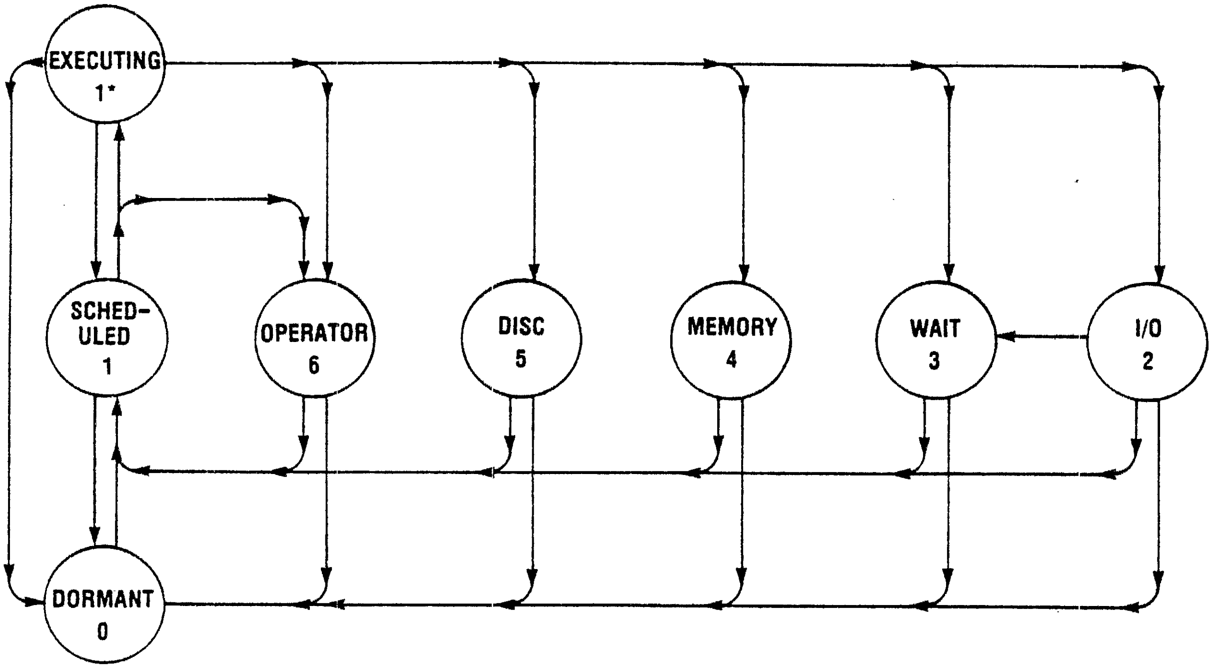
STATE TRANSITIONS

PROGRAM STATES IN RTE



State	Status
0	Dormant
1	Scheduled or Executing
2	I/O suspended
3	General wait
4	Unavailable memory suspend
5	Disc allocation suspend
6	Operator suspend or programmed suspend

USER PROGRAM STATE DIAGRAM



RTE changes a program's state because of operator commands, program requests or changes in the environment.

3C. TROUBLE SHOOTING

Breakmode is usually needed for trouble shooting programs or system operation. Trouble shooting aids include

- breakmode commands
  - RS
  - SL
  - EQ
  - UP
  - ST
  - OF
  - WH
- utility programs
  - WHZAT
  - LGTAT

AN I/O PROBLEM

Suppose you use the FMGR DU command to dump the contents of a file onto a minicartridge in your left CTU.

```
:DU,&PROG,4
IONR L*  4 E 5 S 1 ***
```

RESTARTING YOUR SESSION

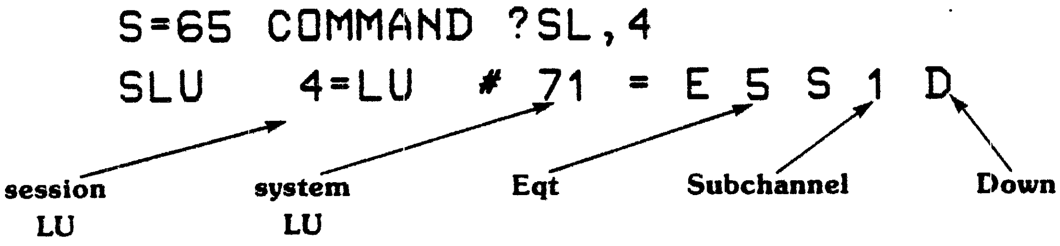
The breakmode RS command aborts and reschedules your Session's copy of FMGR.

```
:DU,&PROG,4
IONR L* 4 E 5 S 1 ***

S=65 COMMAND?RS
FMG65 ABORTED
:
```

DISPLAYING I/O CONFIGURATION AND STATUS OF DEVICES

The breakmode SL command will

- return the system LU, Eqt number, and status of a specified session LU



```
S=65 COMMAND ?SL,4
SLU   4=LU  # 71 = E 5 S 1 D
```

- report all of the user's session LU's if no LU is specified in the command

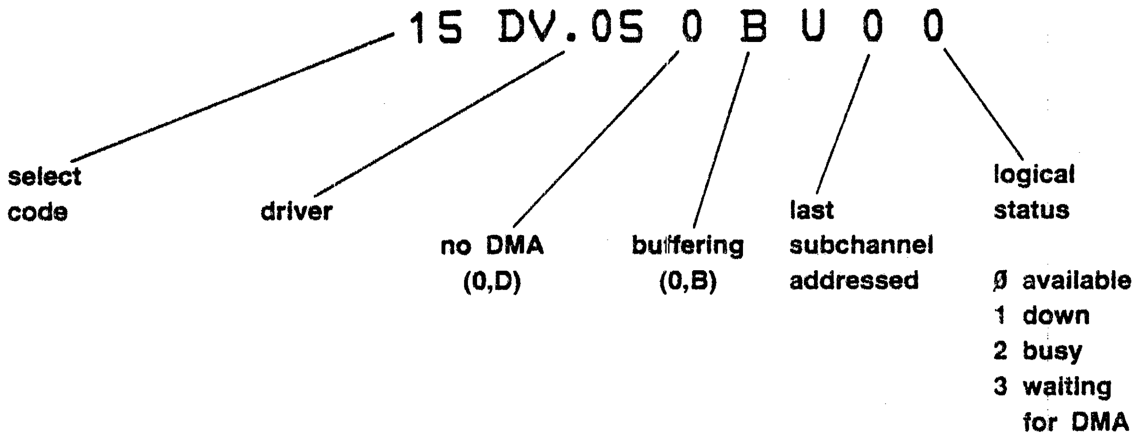
DISPLAYING EQT INFORMATION

The breakmode EQ command returns information about an EQT entry.

```
S=xx COMMAND ?EQ,eqt
```

for example,

```
S=65 COMMAND ?EQ,5
 15 DV.05 0 B U 0 0
```



* * *

MAKING DEVICES AVAILABLE

When a device goes down and the problem is corrected, you must tell RTE that the problem has been fixed.

The breakmode UP command declares an Eqt entry available for I/O.

```
S = xx COMMAND?UP,eqt
```

for example,

```
S =    COMMAND?UP,5
```

BACK TO OUR I/O PROBLEM

```
:DU,&PROG,4
IONR L*   4 E 5 S 1 ***
```

You tried to dump a file to your LEFT CTU but got an error message.

```
S=65 COMMAND ?SL,4
SLU    4=LU   # 71 = E 5 S 1 D

S=65 COMMAND ?EQ,5
  15 DV.05 0 B U 0 0

S=65 COMMAND ?UP,5
IONR L*   4 E 5 S 1 ***
```

After having inquired about the LU of the LCTU, you try to "up the Eqt" but get another error message.

Looking at the minicartridge, you discover that the "record" slide is set for "write protect." You slide it to record and —

```
S=65 COMMAND ?SL,4
SLU    4=LU   # 71 = E 5 S 1 D
```

The device is still down

```
S=65 COMMAND ?UP,5
:SL,4
SLU    4=LU   # 71 = E 5 S 1
:
```

Tell RTE the device is fixed now

After the dump is complete, we get another FMGR prompt.

SETTING EQT's or DEVICES DOWN

A single device or all devices associated with an EQT may be declared down with the breakmode DN command.

```
S = xx COMMAND?DN,eqt
S = xx COMMAND?DN,,system lu
```

for example,

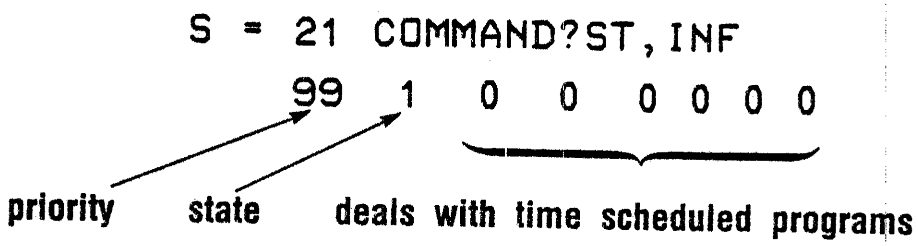
```
S = 65 COMMAND?DN,4
S = 65 COMMAND?EQ,4
   14 DV.12 0 B U 0 1
```

the logical status is

DISPLAY THE STATUS OF A PROGRAM

The breakmode ST command will display a program's status.

- display the status of a specified program



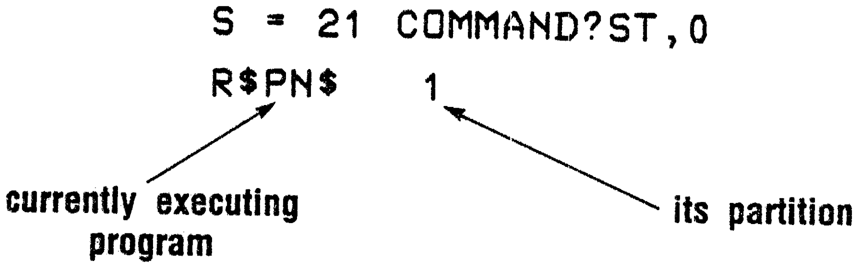
```
S = 21 COMMAND?ST,INF
       99  1   0  0  0 0 0 0
```

priority

state

deals with time scheduled programs

- display the status of the currently executing program

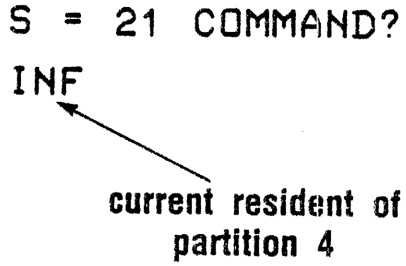


```
S = 21 COMMAND?ST,0
R$PN$    1
```

currently executing program

its partition

- display the name of the program currently residing in a specified partition



```
S = 21 COMMAND?ST,4
INF
```

current resident of partition 4

TERMINATING PROGRAMS

The breakmode OF command terminates programs (and possibly releases a program's ID segment and disc tracks).

```
S = xx COMMAND?OF
```

will terminate the program most recently run with the FMGR RU command

```
                          ┌,0┐
S = xx COMMAND?OF,program │,1│
                          └,8┘
```

,0 terminates a program. If the program is I/O suspend, the program is terminated after the I/O operation is completed.

,1 immediately terminates (aborts) a program, clearing any current I/O operation.

,8 immediately terminates (aborts) a program; if the program is temporary on-line loaded, the program is removed from the system.

UTILITY PROGRAM — WHZAT

You can use WHZAT to look at the current status of the programs and partitions in your system.

WHZAT may be run in several ways:

```
                    :RU,WHZAT [,lu[,option]]
   S = xx COMMAND? RU,WHZAT [,lu[,option]]

                    :WH [,lu[,option]]
   S = xx COMMAND? WH [,lu[,option]]
```

where

lu — where to print the display

option — (default) }
AL } program status displays
SM }
PA partition status display

SAMPLE WHZAT
PROGRAM STATUS DISPLAY

```
:WH

14:28:36: 60
--------------------------------------------------------------------------
  PRGRM T PRIOR PT SZ DO.SC.IO.WT.ME.DS.OP.       .PRG CNTR.  .NEXT TIME.
--------------------------------------------------------------------------
**FMG74 3 00090 23 10 * * * *  3,WHZ74  * * * * * P:46363
  WHZ74 3 00001 31  4 .  1, . . . . . . . . . . . P:43177
.
  TRK   3 00099 34  2 . . . . . . . . . 6,  . . . P:40110
--------------------------------------------------------------------------
DOWN LU'S, 97
ALL EQT'S OK
LOCKED LU'S (PROG NAME)   8(JSA01), 11(SPOUT), 70(E..70), 82(E..82),
MAX CONT. FREE TRKS :    73,  LU   3
--------------------------------------------------------------------------
14:28:37:210

:
```

SAMPLE WHZAT PARTITION STATUS DISPLAY

```
:WH,,PA

14:28:58:100
----------------------------------------------------------------------
PTN#  SIZE    PAGES    BG/RT PRGRM
----------------------------------------------------------------------
  1      2     56-   57 BG     QCLM
  2      3     58-   60 BG     RQCNV
  3      3     61-   63 BG     RPCNV
  4      3     64-   66 BG     DLIST
  5      4     67-   70 BG     CNSLM
  6      8     71-   78 BG     PTOPM
  7      8     79-   86 BG     EXECM
  8      6     87-   92 BG     EXECW
  9     17     93-  109 BG     RFAM
 10     17    110-  126 BG     OPERM
 11     17    127-  143 BG     PROGL
 12     17    144-  160 BG     QUEX
 13     17    161-  177 BG     FLUSH
 14     17    178-  194 BG     E..70
 15     17    195-  211 BG     LOGON
 16     17    212-  228 BG     FMG93
 17     17    229-  245 BG     R$PN$
 18     17    246-  262 BG     FMG82
 19     17    263-  279 BG     SPOUT
 20     17    280-  296 BG     SMP
 21     17    297-  313 BG     E..82
 22     17    314-  330 BG     FMG01
 23     17    331-  347 BG     FMG74
 24     17    348-  364 BG     LGOFF
 25     17    365-  381 BG     FMG68
 26     17    382-  398 BG     FMG73
 27     17    399-  415 BG     FMG89
 28     17    416-  432 BG     FMG94
 29     27    433-  459 BG     FIL78
 30     27    460-  486 BG     WHZ74
 31     27    487-  513 BG     E..94
 32     27    514-  540 BG     RUN68
 33     27    541-  567 BG     JSA01
 34     27    568-  594 BG     TRK
 35     17    595-  611 BG     FMG66
 36     17    612-  628 BG     E..78
 37     11    629-  639 BG     DBONC
38-64   <UNDEFINED>
----------------------------------------------------------------------
14:29: 0:900

:
```

UTILITY PROGRAM — LGTAT

LGTAT displays information about the tracks on the system disc cartridge (LU 2) and the auxiliary disc cartridge (LU 3).

```
S = xx COMMAND?RU,LGTAT[,lu[,option]]
                or
                   :RU,LGTAT[,lu[,option]]
```

where

lu — where to display the information

option — 0 abbreviated output
1 complete output

```
:RU,LGTAT,1,1
TRACK ASSIGNMENT TABLE        & =PROG ^ =SWAP

TRACK     0      1      2      3      4      5      6      7      8      9
   0    SYSTEM SYSTEM SYSTEM SYSTEM SYSTEM SYSTEM AUTOR& JOB  & ,,,,,& FMGR1&
  10    FMGR2& FMGR4& FMGR6& FMGR7& FMGR9& LOGON& LOGON& LGOFF& LGOFF& GASP1&
  20    SPOUT& RFAM & OPERM& QCLM & EDITR& REMAT& RQCNV& HELP & LOADR& ACCTS&
  30    ACCTS& ACCT2& ACCT3& ACCT4& LIBRY  LIBRY  LIBRY  LIBRY  LIBRY  LIBRY
  40    LIBRY  LIBRY  LIBRY  LIBRY  LIBRY  LIBRY  LIBRY  LIBRY  LIBRY  LIBRY
  50    LIBRY  LIBRY  LIBRY  LIBRY  LIBRY  LIBRY  LIBRY  LIBRY   ENTS  D.RTR
  60    E..68  E..70  WHZAT& E..78  E..70  E..82  E..66  E..82  TRK  & E..78
  70      --     --   E..70  SLXFR&   --     --   MACRO& PASS1& POSTP& POSTP&
  80      --     --     --   T5IDM& GLOBAL GLOBAL GLOBAL GLOBAL GLOBAL SFAVG&
  90      --     --     --   LSTEN& TMP  &   --     --     --     --     --
 100      --     --     --   PRTSV& PROGA& MAIN &   --     --     --     --
 110      --     --     --     --     --     --     --     --     --     --
 120      --     --     --     --     --     --     --     --     --     --
 130     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 140     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 150     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 160     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 170     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 180     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 190     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 200     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 210     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 220     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 230     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 240     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 250     FMP    FMP    FMP    FMP   D.RTR

AUXILIARY DISC

   0      --     --     --     --     --     --     --     --     --     --
  10      --     --     --     --     --     --     --     --     --     --
  20      --     --     --     --     --     --     --     --     --     --
  30      --     --     --     --     --     --     --     --     --     --
  40      --     --     --     --     --     --     --     --     --     --
  50      --     --     --     --     --     --     --     --     --     --
  60      --     --     --     --     --     --     --     --     --     --
  70      --     --     --   FIL68^ FIL68^ FIL68^   --     --     --     --
  80      --     --   FIL82^ FIL82^ FIL82^ FIL94^ FIL94^ FIL94^ FIL70^ FIL70^
  90    FIL70^   --     --     --     --     --     --     --     --     --
 100     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 110     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 120     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 130     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 140     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 150     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 160     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 170     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 180     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 190     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 200     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 210     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 220     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 230     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 240     FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP    FMP
 250     FMP    FMP    FMP    FMP   D.RTR

THE LS TRACK(S) ARE UNDEFINED
TOTAL AVAILABLE TRACKS =    130
LARGEST CONTIGUOUS TRACK BLOCK =     73
:
```

3D. BREAKMODE vs SYSTEM COMMANDS

To enter a breakmode command from FMGR use

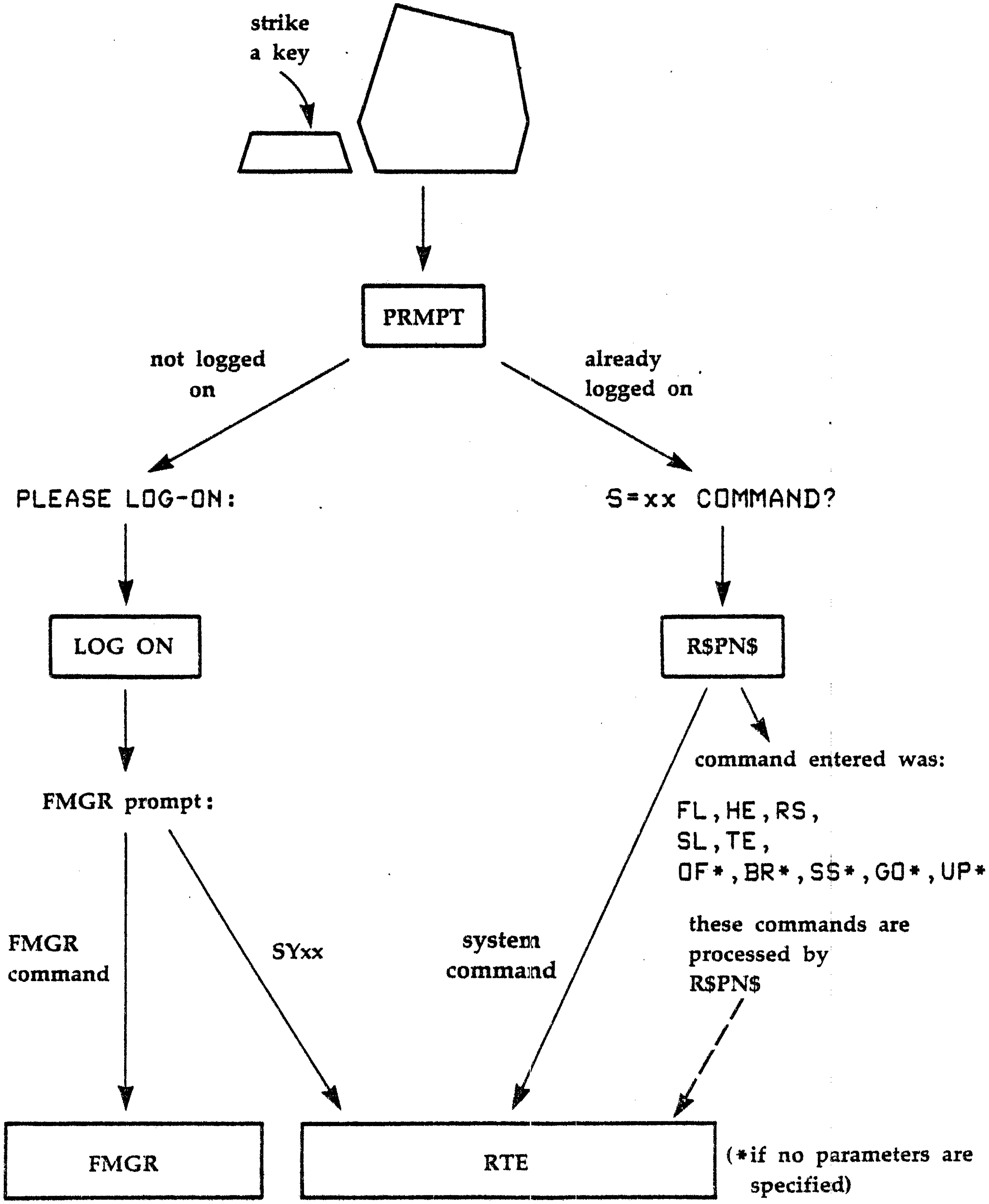
```
:SYxx,parameters
```

two character breakmode command

FMGR will pass the breakmode command directly to RTE.

```
:SYTI
1979 156 15 0 50

:SYEQ,4
 14 DV.12 0 B U 0 0

:SYOF,PROG6,1
```

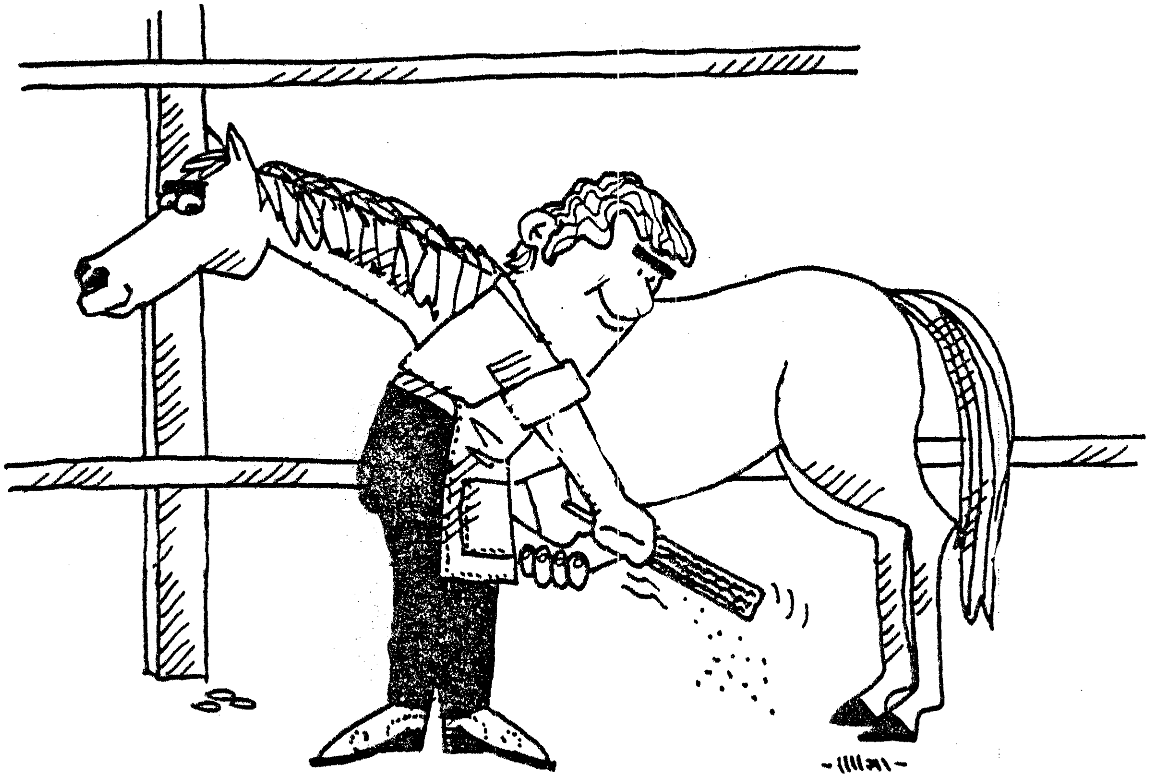
BREAKMODE vs SYSTEM COMMANDS



(*if no parameters are specified)

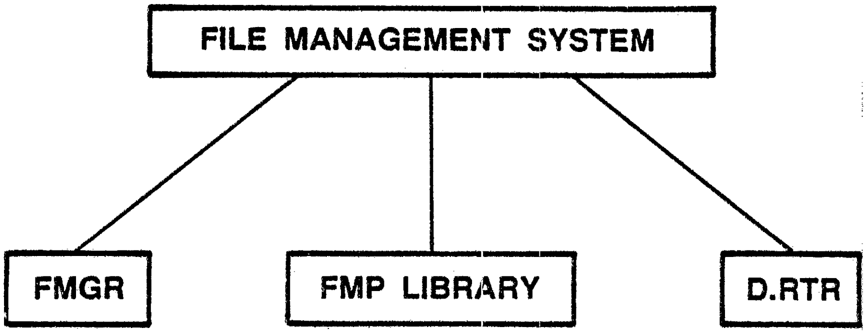
4

FILE MANAGEMENT SYSTEM



SECTION

4A. FILE MANAGEMENT SYSTEM OVERVIEW



FILE MANAGEMENT SYSTEM

FMGR

FMP LIBRARY

D.RTR

FMGR an interactive program that

- interfaces users with RTE
- allows users to manipulate files

FMP LIBRARY a set of routines which manages files

- are used by FMGR
- can be used by your programs

D.RTR *the* program which manages file directories

FILE CHARACTERISTICS

Files may be categorized in several ways.

- **METHOD OF ACCESS**

  RANDOM vs SEQUENTIAL ACCESS

- **RECORD LENGTH**

  FIXED LENGTH vs VARIABLE LENGTH RECORDS

- **FILE EXTENDABILITY**

  FIXED LENGTH vs EXTENDABLE FILES

- **FILE CONTENT**

  ASCII vs BINARY DATA

FILE TYPES

Category	Type	Description
Non-Disc File	0	Handle non-disc devices just like disc files
Fixed-length record, Random Access, Non-extendable	1	128 word record length
	2	User-defined record length
Variable-length record, sequential access, automatic extents	3	Variable record length
	4	Source program (ASCII)
	5	Relocatable code (binary relocatable)
	6	Memory image program
	7	Absolute Code (binary absolute)
	>7	User defined

*** FILE SIZES

The File Management System allocates space for files in either

- multiples of 128 blocks

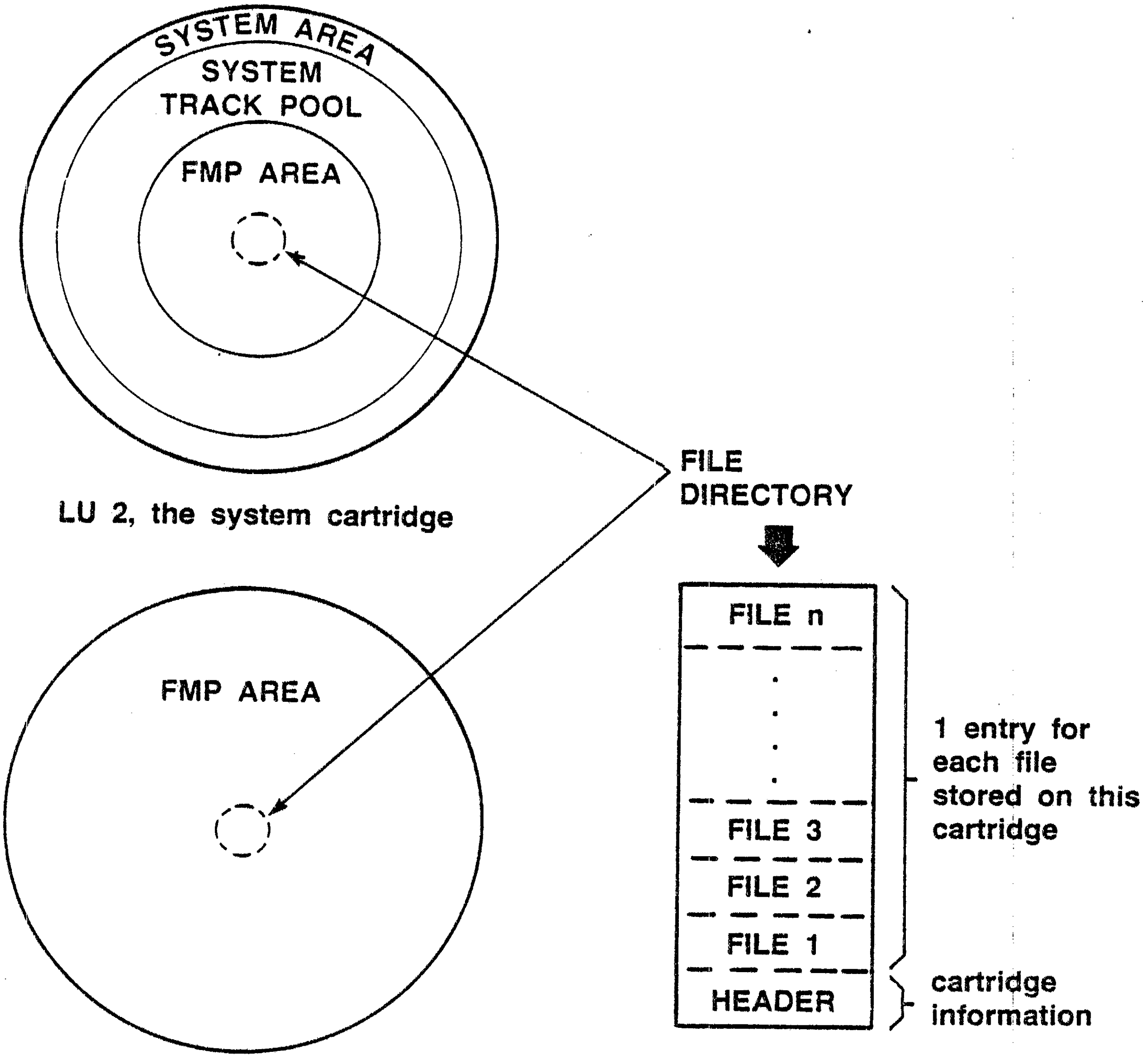
The maximum sizes associated with files are:

	Files allocated by —	
	blocks	128 block multiples
maximum size	16383 blocks	32767 x 128 blocks
maximum record length	32767 words	32767 words
maximum number of records per file	2^{15}-1	2^{31}-1

(1 block = 128 words)

FILES AND DISC CARTRIDGES

Files may be stored in the user file areas (FMP areas) of LU 2 or LU 3 or on any other peripheral cartridge.



LU x, a peripheral cartridge

4B. USING DISC CARTRIDGES

- *Disc cartridges (or disc subchannels) are defined and assigned LU numbers when an RTE system is generated.*

- *Before you can use disc files via the File Management System, you must tell the File Management System that you want to use a particular disc cartridge to hold your disc files. This is done by using a FMGR command to "mount a cartridge".*

- *Session Monitor permits you to use only those disc cartridges which were*
  - *mounted by you*
  - *not mounted by you but are still available for your use.*

YOUR CARTRIDGE LIST

The FMGR CL command displays a list of those disc cartridges which you can access.

For example, if KAREN.PROGDEV does a CL —

```
:CL

LU   LAST TRACK    CR    LOCK   P/G/S

32       00140       SS             P
30       00140    01500             G
02       00255    00002             S
03       00255    00003             S
31       00400    00031             S
```

DISC LOGICAL UNIT NUMBERS VS CARTRIDGE REFERENCE NUMBERS

```
:CL

LU  LAST TRACK   CR    LOCK  P/G/S

32     00140       SS           P
30     00140    01500           G
02     00255    00002           S
03     00255    00003           S
31     00400    00031           S
```

Disc cartridges have two identifiers:

- **LOGICAL UNIT (LU) NUMBERS — are assigned when the disc cartridges are defined during the generation of an RTE system. For disc cartridges, the SYSTEM LU and SESSION LU numbers are the same.**

- **CARTRIDGE REFERENCE NUMBERS (CRN's) — are alternate identifiers for disc cartridges. They are usually assigned by users when cartridges are mounted.**

RESTRICTED CARTRIDGE ACCESS

```
:CL

LU  LAST TRACK   CR     LOCK  P/G/S

32       00140      SS            P
30       00140   01500            G
02       00255   00002            S
03       00255   00003            S
31       00400   00031            S
```

The P/G/S indicates which user "mounted" that cartridge and which user(s) can access that cartridge.

For the cartridge list displayed by KAREN.PROGDEV,

☞ P — PRIVATE

The cartridge was "mounted" by KAREN.PROGDEV and can only be accessed by her.

☞ G — GROUP

The cartridge was "mounted" by a user in the PROGDEV group and can be accessed by any user in that group.

☞ S — SYSTEM

These cartridges "belong" to the System Manager but can be accessed by any user (LU 2 and 3 are "read only" however).

DISPLAYING ALL CARTRIDGES

The CL command lists those cartridges which a user can access; suppose PETER.ADMIN enters a CL —

```
:CL

 LU  LAST TRACK    CR    LOCK   P/G/S

 02      00255   00002            S
 03      00255   00003            S
 31      00400   00031            S
```

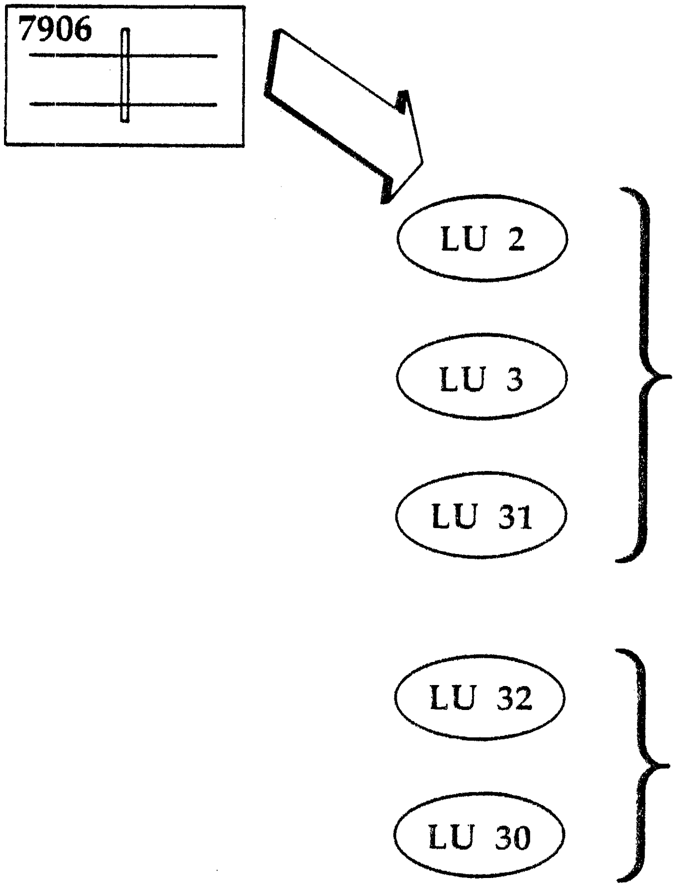
these are the cartridges which PETER.ADMIN can access

An expanded version of the CL command lists *all* cartridges mounted and indicates who "owns" those cartridges. Suppose PETER.ADMIN enters a CLAL —

```
:CLAL

 LU  LAST TRACK    CR    LOCK   P/G/S   USER/GROUP

 02      00255   00002            S    MANAGER.SYS
 03      00255   00003            S    MANAGER.SYS
 30      00140   01500            G    PROGDEV
 31      00400   00031            S    MANAGER.SYS
 32      00140      SS            P    KAREN.PROGDEV
```

DEDICATED vs SPARE CARTRIDGES

When setting up the Session Monitor Accounts System, the System Manager can classify the disc cartridges defined in the system to be either DEDICATED or SPARE cartridges. For example,

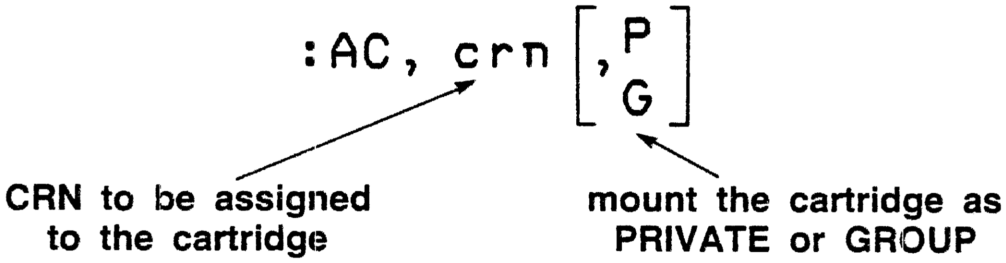


Dedicated cartridges have specific uses, either for the system or for various users or groups.

Spare cartridges have no specific uses and are available to users for temporary disc work space. They are grouped together to form the Spare Cartridge Pool.

ALLOCATING A CARTRIDGE FROM THE SPARE CARTRIDGE POOL

Use the FMGR AC command to allocate (mount) a cartridge from the Spare Cartridge Pool



```
               ┌   ┐
:AC, crn       │,P │
               │ G │
               └   ┘
```

CRN to be assigned
to the cartridge

mount the cartridge as
PRIVATE or GROUP

The AC command will:

- find the first available cartridge in the pool
- initialize the cartridge
- mount the cartridge

EXAMPLES OF ALLOCATING CARTRIDGES

KAREN.PROGDEV might have done the following to mount cartridges:

```
:CL
  LU   LAST TRACK    CR    LOCK   P/G/S

  02      00255    00002            S
  03      00255    00003            S
  31      00400    00031            S

:AC,SS
:CL
  LU   LAST TRACK    CR    LOCK   P/G/S

  32      00140       SS            P
  02      00255    00002            S
  03      00255    00003            S
  31      00400    00031            S

:DL,SS
CR= SS
 ILAB=DC0032 NXTR= 00000 NXSEC=000 #SEC/TR=096 LAST TR=00140 #DR TR=01

NAME    TYPE    SIZE/LU     OPEN TO

:AC,1500,G
:CL
  LU   LAST TRACK    CR    LOCK   P/G/S

  32      00140       SS            P
  30      00140    01500            G
  02      00255    00002            S
  03      00255    00003            S
  31      00400    00031            S

:DL,1500
CR=01500
 ILAB=DC0030 NXTR= 00000 NXSEC=000 #SEC/TR=096 LAST TR=00140 #DR TR=01

NAME    TYPE    SIZE/LU     OPEN TO

:AC,1000
FMGR 064
:??
FMGR 064 NO DISCS AVAILABLE FROM DISC POOL
:
```

YOUR SCB CARTRIDGE LIST

- ***Your SCB contains a list of the PRIVATE or GROUP cartridges currently mounted to your account or to your group.***

SCB

KAREN.PROGDEV
30

SST

system LU	session LU
65	1
71	4
72	5
2	2
3	3
7	6
8	8
31	31
32	32
30	30

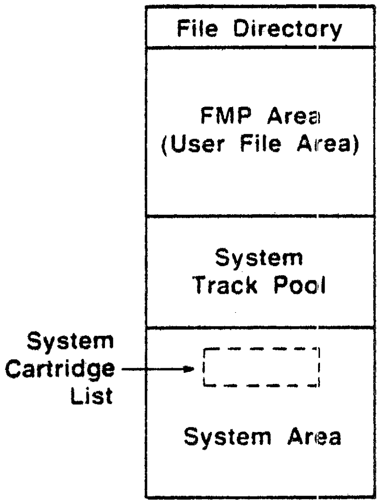
cartridge list: 32, 30

```
LU   LAST TRACK    CR    LOCK   P/G/S

32      00140        SS            P
30      00140     01500            G
02      00255     00002            S
03      00255     00003            S
31      00400     00031            S
```

SYSTEM CARTRIDGE LIST
VS
YOUR SCB'S CARTRIDGE LIST

In addition to the cartridge list in your SCB, the File Management System maintains a list of all currently mounted cartridges.

This list, the SYSTEM CARTRIDGE LIST, is kept in the system area of the system cartridge (LU 2).



System Cartridge
(LU 2)

LOG OFF

Parameters to the FMGR EX command specify whether to save or return cartridges when you log off.

$$:\mathrm{EX}\left[,\begin{matrix}\mathrm{SP}\\ \mathrm{RP}\end{matrix}\left[,\mathrm{RG}\right]\right]$$

SP — save private
RP — release private

RG — release group
(otherwise save)

When you log-on again, any private or group cartridges saved are still available for your use.

4C. USING FILES

Many FMGR commands can refer to either disc files or non-disc devices, for example.

```
      file name
:LI,  lu
```

the parameter can be either the name of a disc file or the LU of a non-disc device

The term NAMR refers to such a parameter:

```
      a non-disc LU
NAMR
      filename:security:cartridge:type:size:record
                  code                      size
```

needed to reference a file

WHY SPECIFY CARTRIDGES?

Suppose you have two files, both called "DATA".

```
LU  LAST TRACK   CR     LOCK  P/G/S

32     00140        SS           P ———→ first "DATA"
30     00140     01500           G╲     stored here
02     00255     00002           S  ╲
03     00255     00003           S   ↘ second "DATA"
31     00400     00031           S      stored here
```

When you run EDITR,

```
:RU,EDITR
SOURCE FILE?
/DATA
```

which file will you be editing?

SEARCHING THE FILE DIRECTORY

- Use the FMGR DL command to list the file directory of a specified cartridge.

```
:DL[,cartridge]
```

positive CRN or
negative LU

- Use the FMGR DL command to search for a particular file on one or all of the cartridges in your cartridge list.

```
:DL,namr
```

if a cartridge is specified, search only
that cartridge, otherwise search all the
cartridges in your cartridge list

- For example,

```
:DL,DATA
:DL,SOURCE:::3
:DL,&-----::-24
```

CREATING FILES -

ASCII source, text or data files may be created by using EDITR.

```
:RU,EDITR
SOURCE FILE?
/0
EOF
/ΔFTN4,L
/Δ;PROGRAM MAIN
/Δ;INTEGER PARM(5)
/Δ .
    .
    .
    .
    .
    .
    .
/Δ;END
/Δ;END$
/EC filename:security code:cartridge
    \________________________________/
```

file to be created

EDITR will create a type 4 file whose size is the number of blocks needed to contain the file being created.

(Δ = space)

(; = EDITR tab character)

CREATING FILES —

You can also create a file and store data in it with the FMGR ST command.

```
:ST,namr1,namr2[,record format]
```

namr1: a non-disc LU or disc file containing data to be stored in the new file

namr2: file to be created and filled with data, or a non-disc LU to receive the data

record format: type of data in namr1:

BR — binary relocatable
AS — ASCII
.
.
.
.
.

If a file is specified for namr2, it must not already exist; the ST command tries to create a file for you.

for example,

- **use the ST command to enter a file from your terminal:**

```
:ST,1,DATA:FF
JACK
SAM
LINDA
PETER
MARY
Ⓓ         (Control — D acts as an EOF
:          to terminate input)
```

- **input a binary relocatable file from a mag tape (LU 8):**

```
:ST,8,%PROG,BR
```

- **duplicate a file on another cartridge:**

```
:ST,TSPD::DP,TSPD::2000
```

CREATING FILES —

To create a file without supplying data, use the FMGR CR command:

```
:CR, namr
```

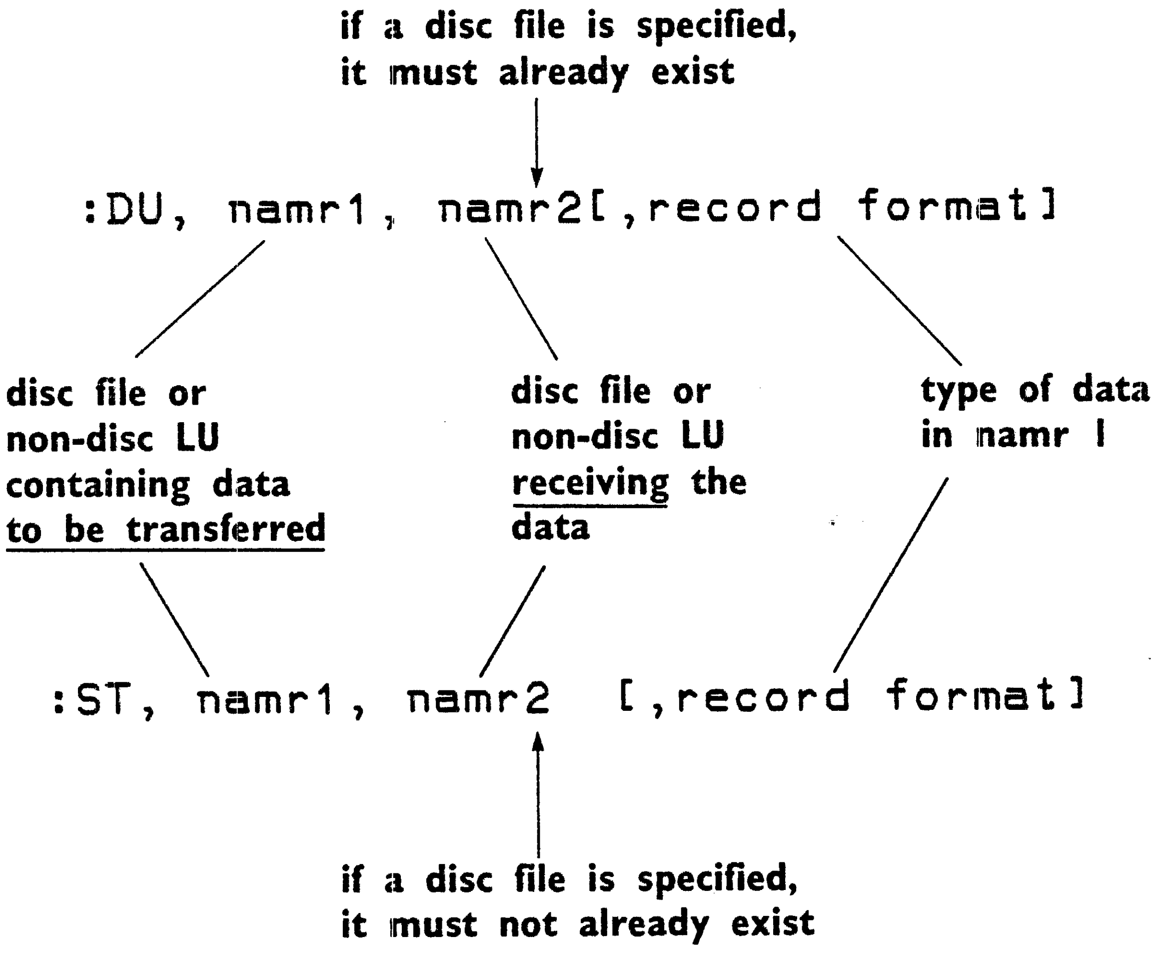
file to be created; in addition to the file name you must specify file type, file size (and record length for type 2 files).

for example, if you wish to list the file directories of all your cartridges but store the list in a file, you might:

```
:CR, DLIST::-24:4:10
:LL, DLIST
:DL
:LL, 1
```

STORING vs DUMPING FILES

Both the FMGR ST and DU commands allow data to be transferred between a source namr and a destination namr.



if a disc file is specified, it must already exist

```
:DU, namr1, namr2[,record format]
```

disc file or
non-disc LU
containing data
to be transferred

disc file or
non-disc LU
receiving the
data

type of data
in namr 1

```
:ST, namr1, namr2  [,record format]
```

if a disc file is specified, it must not already exist

MORE FILE MANIPULATIONS

PURGING FILES

```
:PU, namr
```

file to be purged

RENAMING FILES

```
:RN, namr, new file name
```

file to be renamed

its new name

LISTING FILES

```
:LI, namr[,format[,line 1[,line 2]]]
```

lines to be listed

list in:

S ASCII format
B binary format
D directory info only

4D. ACCESSING NON-DISC DEVICES

You can also use FMGR commands to manipulate non-disc devices, either by referring to their LU numbers or to type 0 files associated with the devices.

TYPE 0 FILES

Type 0 files allow you to refer to a non-disc device by a file name rather than by the device's LU number.

```
                RE[AD]
:CR, namr, lu, WR[ITE]
                BO[TH]
```

type 0 file to be created

lu of the non-disc device to be associated with the type 0 file

I/O mode of the device

CONTROLLING A NON-DISC DEVICE

The CN command allows you to control devices via their LU numbers or type 0 files.

```
:CN[,namr[,function[,subfunction]]]
```

namr: device to be controlled

function: function to be performed

subfunction: more control information

CONTROLLING TERMINALS

Terminals may be controlled with the FMGR CN or CT commands.

```
:CT ,namr[,function[,subfunction[,message]]]
```

interactive device

control function to be performed

additional control information

message to be displayed on the terminal

4E. SWITCHING LU'S

In addition to displaying the LU's in your SST, the SL command may be used to

- add a new Session LU

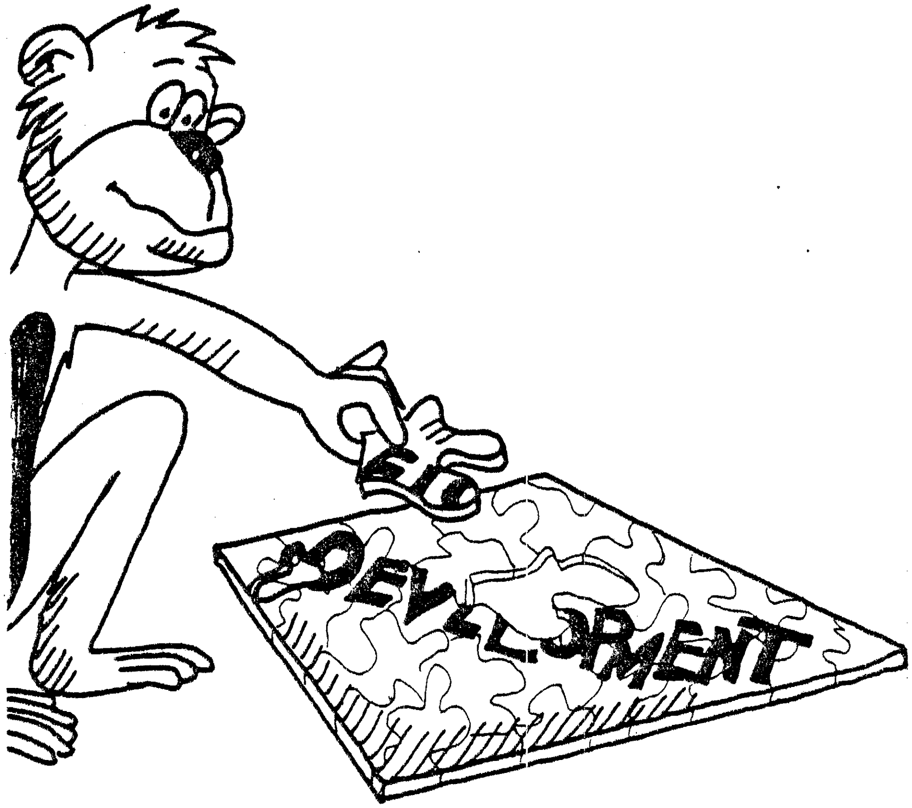
```
:SL,4
SLU   4=LU  #120 = E19 S 1
:SL,10,120
:SL,10
SLU  10=LU  #120 = E19 S 1
:SL,10,-
:SL,10
SLU  10=NOT DEFINE
:
```

- add a new System LU

```
:SL,6
SLU   6=LU  #   6 = E 6
:SL,6,7
:SL,6
SLU   6=LU  #   7 = E 7
:SL,6,-
:SL,6
SLU   6=LU  #   6 = E 6
:
```

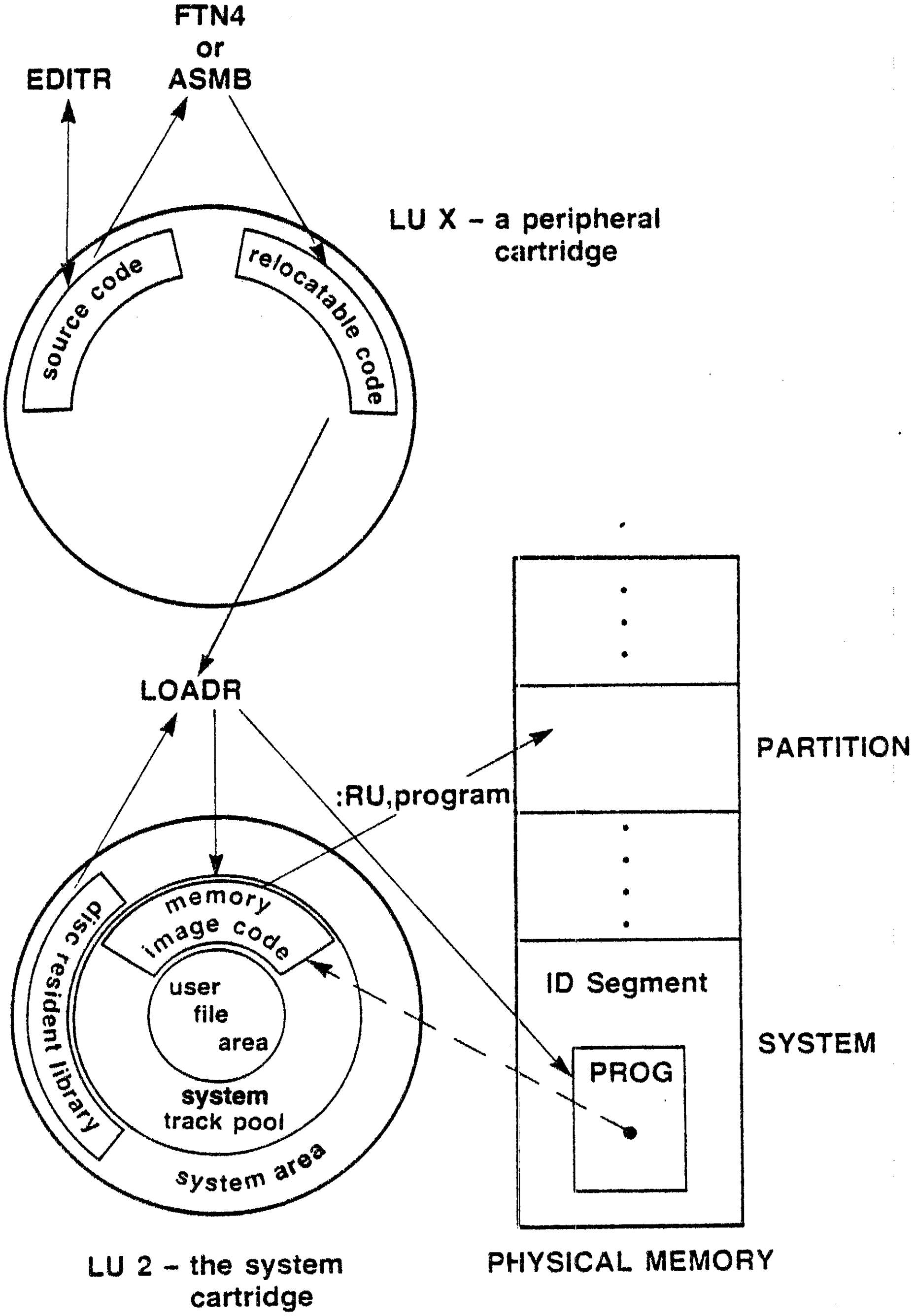
5

PROGRAM DEVELOPMENT



SECTION

5A. THE PROGRAM DEVELOPMENT PROCESS



5B. FTN4 AND ASMB

FORTRAN source programs have this format:

```
FTN4, compiler options

      PROGRAM name [(type,priority,res,mult,hr,min,sec,msec),comments]
      .
      .
      .
      .
      .
      .
      .
      .
      .
      .
      .
      .
      .
      END
      END$
```

ASSEMBLER source programs have this format:

```
ASMB, assembler options

      NAM name [,type,priority,res,mult,hr,min,sec,msec ⊥ id]
      .
      .
      .
      .
      .
      .
      .
      .
      .
      .
      END entry
```

INVOKING FTN4 OR ASMB

You run FTN4 or ASMB by using the FMGR or system RU command.

```
:RU, FTN4, source, list, binary, line count, options
     ASMB
```

source — FILE OR LU containing the source code

list — file or LU to receive the listing of the compilation or assembly

binary — file or LU to receive the relocatable code

line count — number of lines to be printed per page

options — any compiler/assembler options specified here replace those specified in the control statement.

FILE NAMING CONVENTIONS FOR PROGRAM DEVELOPMENT

First character of file name	Type of file
&	Source code file
'	List file
%	Relocatable code file

USING FILE NAMING CONVENTIONS

When you invoke FTN4 or ASMB, you may specify the list or binary parameters as "–" (minus sign).

If the source file name begins with "&", then the compiler or assembler will use a list or binary file whose name begins with "'" or "%" respectively.

For example,

```
:RU,FTN4,&PROG, 1, -
                   ↑
```

the compiler will store the relocatable code in file "%PROG"

```
:RU, ASMB, &APGM, -, -
                  ↑  ↑
```

the assembler will store the listing in file "'APGM" and the relocatable code in file "%APGM"

The list and binary files will:

- reside on the same cartridge as the source file
- will be given the security code of the source file
- will be created or replaced as needed

INTERFACING FTN4 AND ASMB

FORTRAN programs and subprograms can invoke Assembler subprograms

OR

Assembler programs and subprograms can invoke FORTRAN subprograms

IF

you follow the ".ENTR calling sequence."

.ENTR is a subprogram (in RTE's relocatable library) designed to handle passing parameters between programs and subprograms or subprograms and other subprograms.

FTN4 uses .ENTR for your subprograms in FORTRAN. If you code your Assembler programs or subprograms to use .ENTR, then they will be compatible with FORTRAN programs or subprograms.

……

5C. USING LOADR

After you have compiled (or assembled) a source program, you need to use LOADR to *relocate* and *link* the resulting relocatable code.

```
0001  FTN4,L,Q
0002  00000          PROGRAM MAIN
0003  00000          DIMENSION DATA(10)
0004  00000 C
0005  00000 C        INPUT 10 VALUES
0006  00000 C
0007  00000          DO 20 I = 1,10
0008  00031          WRITE(1,101) I
0009  00041 101      FORMAT(''INPUT VALUE '',I2,'' ?_'')
0010  00041 20       READ(1,*) DATA(I)
0011  00041 C
0012  00041 C        USE SUBROUTINE STAT TO FIND AVERAGE, STANDARD DEVIATION
0013  00041 C
0014  00063          CALL STAT(DATA,10,AVG,STDDEV)
0015  00063 C
0016  00063 C        OUTPUT RESULTS
0017  00063 C
0018  00071          WRITE(1,102) AVG, STDDEV
0019  00103 102      FORMAT(/''RESULTS ARE:''/
0020  00103         1          ''AVERAGE - '',F10.5/
0021  00103         2          ''STANDARD DEVIATION - '',F10.5)
0022  00103 C
0023  00103          END

0024  00175          SUBROUTINE STAT(ARRAY,NELE,AVG,STDDEV)
0025  00175 C
0026  00000          DIMENSION ARRAY(NELE)
0027  00000 C
0028  00000          SUM = 0.0
0029  00015          SUMSQ = 0.0
0030  00015 C
0031  00015 C        FIND AVERAGE OF ARRAY ELEMENTS
0032  00015 C
0033  00021          DO 50 I = 1,NELE
0034  00023 50       SUM = SUM + ARRAY(I)
0035  00044          AVG = SUM / FLOAT(NELE)
0036  00044 C
0037  00044 C        FIND STANDARD DEVIATION
0038  00044 C
0039  00056          DO 60 I = 1,NELE
0040  00060          DEV = ARRAY(I) - AVG
0041  00072 60       SUMSQ = SUMSQ + DEV**2
0042  00111          STDDEV = SQRT(SUMSQ)
0043  00111 C
0044  00117          RETURN
0045  00120        . END
```

PROGRAM RELOCATION

LOADR displays a "load map" showing the results of relocating and linking the program in the specified relocatable code file.

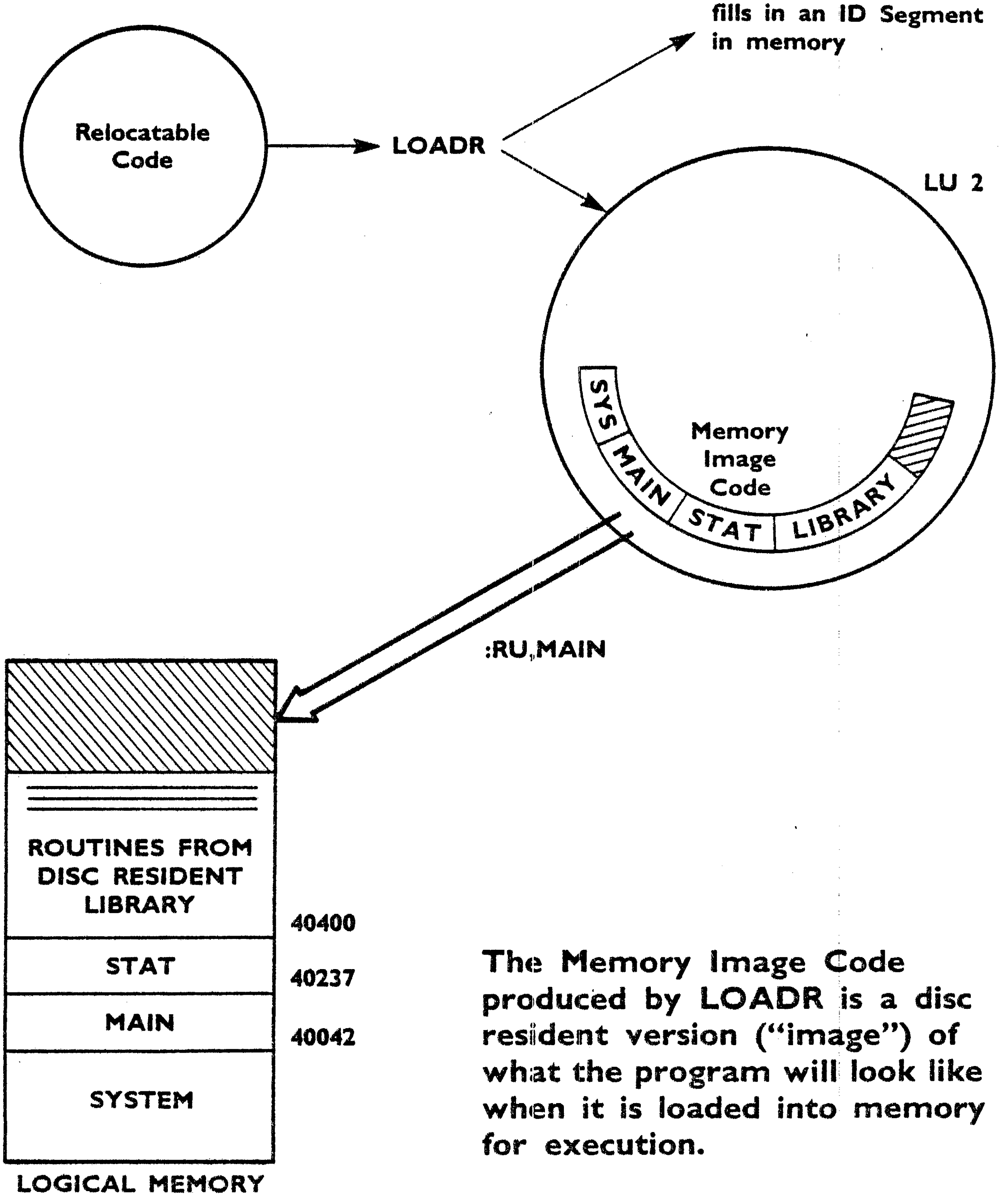
First, the modules in the relocatable file are "loaded"

```
:RU,LOADR,,%MAIN,1
  MAIN    40042 40236
  STAT    40237 40377

  FMTIO   40400 41676   24998-16002 REV.1926 790417
  FMT.E.  41677 41677   24998-16002 REV.1901 781107
  PNAME   41700 41745   771121  24998-16001
  REIO    41746 42072  92067-16268 REV.1903 790316
  ERR0    42073 42162   771122  24998-16001
  SQRT    42163 42264   780424  24998-16001
  .RTOI   42265 42360   780921  24998-16001
  .FPWR   42361 42422   781106  24998-16001
  ER0.E   42423 42423  750701  24998-16001
  FRMTR   42424 46061   24998-16002 REV.1926 790503
  .CFER   46062 46137  750701  24998-16001

   5 PAGES RELOCATED     5 PAGES REQ'D    NO PAGES EMA      NO PAGES MSEG
  LINKS:BP    PROGRAM:BG   LOAD:TE   COMMON:NC
   /LOADR:MAIN   READY AT  1:22 PM  THU.,  1  MAY , 1980

   /LOADR:$END
```

Then, the disc resident library is searched for any routines needed by the program.

***Finally,
LOADR tells you the name of the program just "loaded."***

LOADING PROGRAMS



The Memory Image Code produced by LOADR is a disc resident version ("image") of what the program will look like when it is loaded into memory for execution.

USING LOADR INTERACTIVELY

If you invoke LOADR without any parameters, LOADR will prompt you for a command telling it what to do.

```
:RU,LOADR
 /LOADR:   RELOCATE,%MAIN
  MAIN   40042 40236
  STAT   40237 40377
 /LOADR:   END

  FMTIO  40400 41676   24998-16002 REV.1926 790417
  FMT.E  41677 41677   24998-16002 REV.1901 781107
  PNAME  41700 41745   771121  24998-16001
  REIO   41746 42072  92067-16268 REV.1903 790316
  ERR0   42073 42162   771122  24998-16001
  SQRT   42163 42264   780424  24998-16001
  .RTOI  42265 42360   780921  24998-16001
  .FPWR  42361 42422   781106  24998-16001
  ER0.E  42423 42423  750701  24998-16001
  FRMTR  42424 46061   24998-16002 REV.1926 790503
  .CFER  46062 46137  750701  24998-16001

   5 PAGES RELOCATED      5 PAGES REQ'D    NO PAGES EMA      NO PAGES MSEG
  LINKS:BP    PROGRAM:BG   LOAD:TE   COMMON:NC
   /LOADR:MAIN    READY AT  1:23 PM  THU.,  1  MAY , 1980

   /LOADR:$END
```

The RELOCATE command says to relocate and link the relocatable code in the specified file.

The END command says this is the last command, search the disc resident library to satisfy any remaining unsatisfied external references and create the program.

SEPARATE COMPILATIONS

If relocatable code exists in more than one file, additional RELOCATE commands are used.

```
:RU,LOADR
 /LOADR:   RE,%SFSRT
  SFSRT  40042 40265   PROGRAM TO INPUT AND SORT INTEGERS
 /LOADR:   RE,%BSORT
  BSORT  40266 40416   BUBBLE SORT ROUTINE
 /LOADR:   EN

  FMTIO  40417 41715   24998-16002 REV.1926 790417
  FMT.E  41716 41716   24998-16002 REV.1901 781107
  PNAME  41717 41764   771121  24998-16001
  REIO   41765 42111  92067-16268 REV.1903 790316
  FRMTR  42112 45547   24998-16002 REV.1926 790503
  .CFER  45550 45625  750701  24998-16001

   4 PAGES RELOCATED     4 PAGES REQ'D    NO PAGES EMA      NO PAGES MSEG
  LINKS:BP    PROGRAM:BG    LOAD:TE    COMMON:NC
   /LOADR:SFSRT  READY AT  1:37 PM  THU.,  1  MAY , 1980

   /LOADR:$END
```

DISPLAYING UNDEFS

The LOADR DISPLAY command lists all currently unsatisfied or undefined external references (UNDEF's).

```
:RU,LOADR
 /LOADR:   RE,%SFSRT
  SFSRT  40042 40265   PROGRAM TO INPUT AND SORT INTEGERS
 /LOADR:   DI
   /LOADR:UNDEFINED EXTS
   /LOADR:.DIO.
   /LOADR:.IIO.
   /LOADR:.DTA.
   /LOADR:EXEC
   /LOADR:CLRIO
   /LOADR:BSORT
 /LOADR:   RE,%BSORT
  BSORT  40266 40416   BUBBLE SORT ROUTINE
 /LOADR:   EN

  FMTIO  40417 41715   24998-16002 REV.1926 790417
  FMT.E  41716 41716   24998-16002 REV.1901 781107
  PNAME  41717 41764   771121  24998-16001
  REIO   41765 42111  92067-16268 REV.1903 790316
  FRMTR  42112 45547   24998-16002 REV.1926 790503
  .CFER  45550 45625  750701  24998-16001

   4 PAGES RELOCATED     4 PAGES REQ'D    NO PAGES EMA      NO PAGES MSEG
  LINKS:BP     PROGRAM:BG    LOAD:TE    COMMON:NC
   /LOADR:SFSRT  READY AT  1:39 PM  THU.,  1  MAY , 1980

   /LOADR:$END
```

LIBRARIES

- A LIBRARY is a collection of routines which may be used by many different programs.

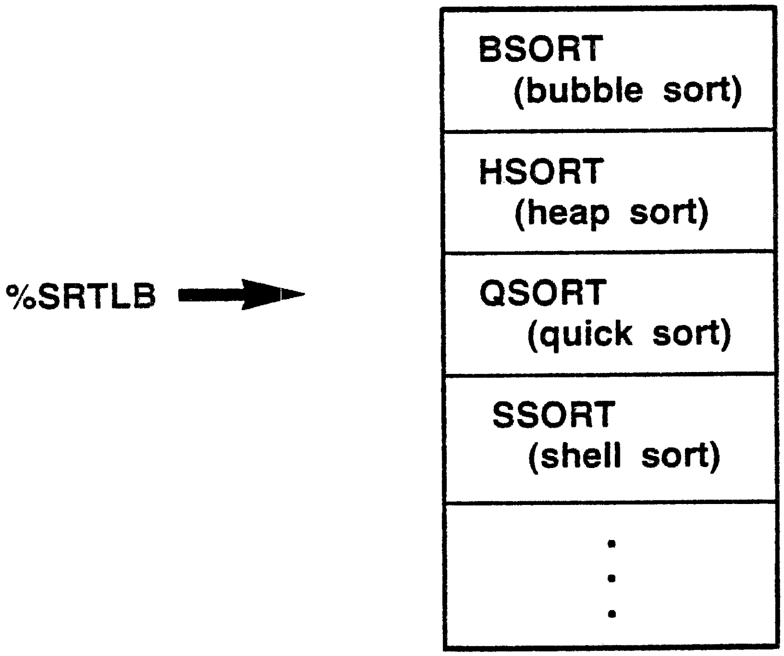
- The DISC RESIDENT LIBRARY is created when RTE is generated and consists of:
  - the system library
  - the relocatable library
  - user libraries (if included in the generation process)

- LOADR automatically searches the Disc Resident Library when you specify the END command.

- USER LIBRARIES not included in the RTE system must be searched by using the LOADR SEARCH command.

AN EXAMPLE OF A USER LIBRARY

Suppose %SRTLB contains a collection of sorting routines —



```
:RU,LOADR
 /LOADR:   RE,%PROGA
  PROGA  40042 40265    SPECTRUM DATA ANALYSIS
 /LOADR:   SE,%SRTLB
  BSORT  40266 40416    BUBBLE SORT ROUTINE
 /LOADR:   EN

  FMTIO  40417 41715    24998-16002 REV.1926 790417
  FMT.E  41716 41716    24998-16002 REV.1901 781107
  PNAME  41717 41764    771121  24998-16001
  REIO   41765 42111   92067-16268 REV.1903 790316
  FRMTR  42112 45547    24998-16002 REV.1926 790503
  .CFER  45550 45625   750701  24998-16001

   4 PAGES RELOCATED     4 PAGES REQ'D    NO PAGES EMA      NO PAGES MSEG
  LINKS:BP    PROGRAM:BG    LOAD:TE    COMMON:NC
   /LOADR:PROGA  READY AT  1:41 PM  THU.,  1  MAY , 1980

   /LOADR:$END
```

REAL-TIME VS BACKGROUND PROGRAMS

When you load a program, you can specify it to be a

REAL-TIME DISC RESIDENT PROGRAM

or a

BACKGROUND DISC RESIDENT PROGRAM

The LOADR command —

OP,RT specifies REAL-TIME

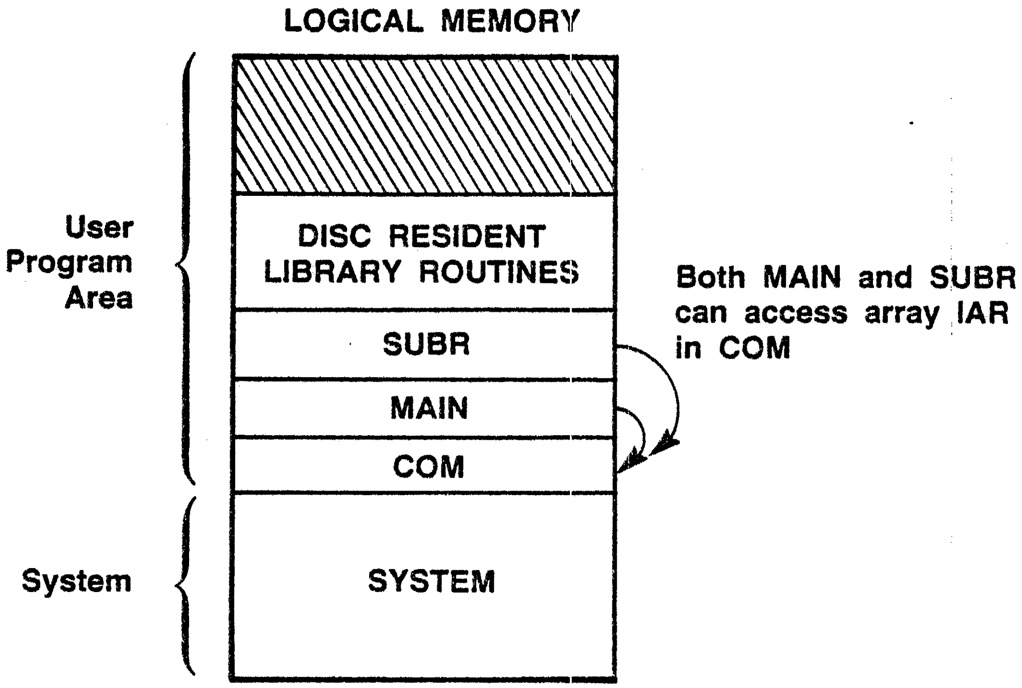
OP,BG specifies BACKGROUND

LOCAL COMMON

The following main program and subprogram share a LOCAL (unnamed or blank) COMMON BLOCK.

```
FTN4,L
      PROGRAM MAIN
      COMMON//IAR(500)
      .
      .
      .
      END
      SUBROUTINE SUBR
      COMMON//IAR(500)
      .
      .
      .
      END
```

```
:RU,LOADR
 /LOADR:   RE,%MAIN
  COM     40042 41025
  MAIN    41026 41077
  SUBR    41100 41117
 /LOADR:   EN

  FMTIO   41120 42416    24998-16002 REV.1926 790417
  FMT.E   42417 42417    24998-16002 REV.1901 781107
  PNAME   42420 42465    771121  24998-16001
  REIO    42466 42612   92067-16268 REV.1903 790316
  FRMTR   42613 46250    24998-16002 REV.1926 790503
  .CFER   46251 46326   750701  24998-16001

   5 PAGES RELOCATED      5 PAGES REQ'D    NO PAGES EMA       NO PAGES MSEG
  LINKS:BP     PROGRAM:BG    LOAD:TE    COMMON:NC
   /LOADR:MAIN   READY AT  1:45 PM  THU.,  1  MAY , 1980

   /LOADR:$END
```

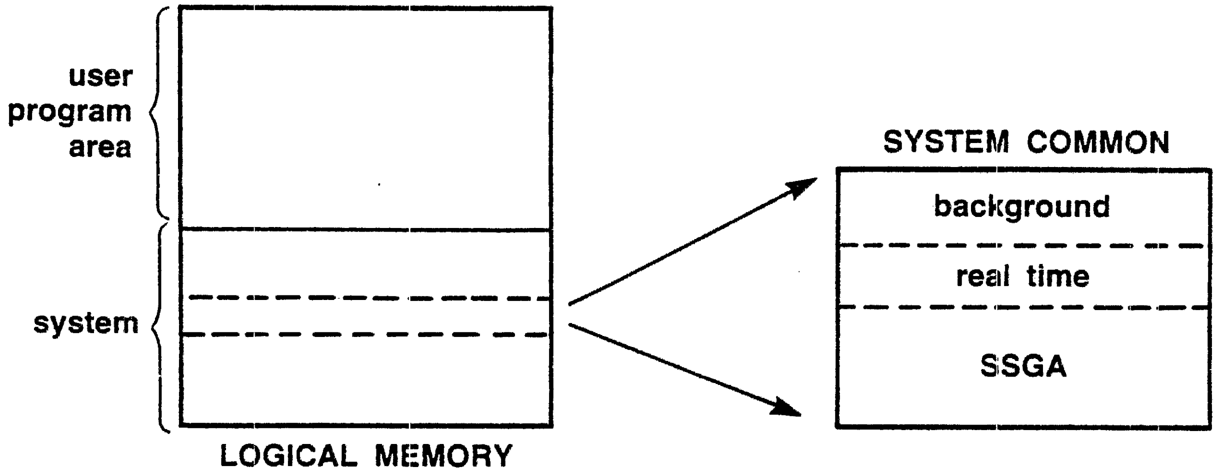


A LOCAL COMMON BLOCK

- **can be shared between a main program and its subprograms or just between subprograms**
- **is within the program itself**
- **is swapped with the program**

SYSTEM COMMON

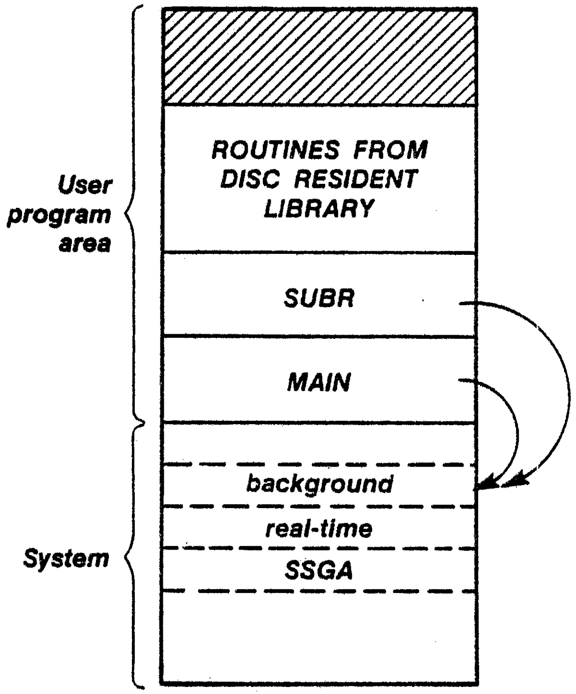
An UNLABELED COMMON BLOCK may be shared between programs if the COMMON BLOCK is associated with SYSTEM COMMON.



```
                  SC
                  RC
The LOADR command OP,   allows your program
                  NC
                  SS
```

to access one or more of these System Common areas.

```
:RU,LOADR
 /LOADR:    OP,SC
 /LOADR:    RE,%MAIN
  MAIN    40042 40113
  SUBR    40114 40133
 /LOADR:    EN

  FMTIO   40134 41432    24998-16002 REV.1926 790417
  FMT.E   41433 41433    24998-16002 REV.1901 781107
  PNAME   41434 41501    771121   24998-16001
  REIO    41502 41626   92067-16268 REV.1903 790316
  FRMTR   41627 45264    24998-16002 REV.1926 790503
  .CFER   45265 45342   750701   24998-16001

   4 PAGES RELOCATED      4 PAGES REQ'D     NO PAGES EMA       NO PAGES MSEG
  LINKS:BP    PROGRAM:BG    LOAD:TE    COMMON:SC
   /LOADR:MAIN    READY AT   1:46 PM   THU.,   1   MAY  , 1980

   /LOADR:$END
```



Both MAIN and SUBR can access the array IAR in System Common.

Any other program could also access IAR if it had been loaded to access System Common.

LOGICAL MEMORY

SYSTEM COMMON

- allows program to program communication
- is external to the program
- is always resident in memory
(it's never swapped)

COMMANDS TO CONTROL LOADR OPERATION

`/A`	Terminates the LOADR
`LL,namr`	Directs the load map to "namr"
`FM,DB`	Appends the DBUGR to the program

`MP`
`FM,CP`
`BP`
	Selects linking mode

INVOKING LOADR

There are a variety of ways to use LOADR.

INTERACTIVELY

```
:RU,LOADR
   /LOADR: LL,6
   /LOADR: OP,SC
   /LOADR: RE,%PROG
   /LOADR: END
:
```

IN A SINGLE RUN COMMAND

```
:RU,LOADR,,%PROG,6,SC
```

FROM A COMMAND FILE

If file PLOAD contains —

```
LL,6
OP,SC
RE,%PROG
END
```

Invoke LOADR with —

```
:RU,LOADR,PLOAD
```

command file containing LOADR commands

LISTING ID SEGMENTS

LOADR will list information about the ID Segments in your system and the programs currently using them.

```
:RU,LOADR
 /LOADR:   OP,LI
  NAME   TY PRIOR LMAIN HMAIN LO BP HI BP  SZ    EMA MSEG  PTN   TM  COM S-ID


  ZHZAT    1    41 44000 46156    22    26                            NC
  D.RTR    1     1 46156 66324    26   250                            NC
  PRMPT    1     5 66324 67316   250   262                            NC
  $YCOM    1    10 67316 67511   262   262                            NC
  EXTND    1    10 67511 67737   262   265                            NC
  UPLIN    1     3 67737 71265   265   305                            SS
  QUEUE    1     2 71265 71534   305   307                            SS
  GRPM     1     4 71534 72372   307   331                            SS
  RTRY     1    20 72372 72620   331   332                            SS
  SRQ.P    1    30 72620 72734   332   335                            SS
  QUEZ     1     2 72734 73025   335   336                            SS
  TTYEV    1     2 73025 73037   336   337                            NC
  LGTAT    1    41 73037 75213   337   362                            NC
  AUTOR    2     1 40000 41151     2    13    2                    PE  NC     0
  SMP      2    30 40000 50737     2   315    6                    PE  NC     0
  JOB      2    30 40000 51400     2   177    6                    PE  NC     0
  ,,,,,    3    99 40000 44150     2   207    4                    PE  NC     0
  FMGR     3    90 40000 46003     2    60   10                    PE  NC     0
  LOGON    3    50 40000 64035     2   426   12                    PE  NC     0
  LGOFF    3    90 40000 60523     2   377   10                    PE  NC     0
  R$PN$    3     5 40000 44420     2    46    4                    PE  NC     0
  GASP     3    80 40000 51107     2   135   10                    PE  NC     0
```

This information can also be listed by —

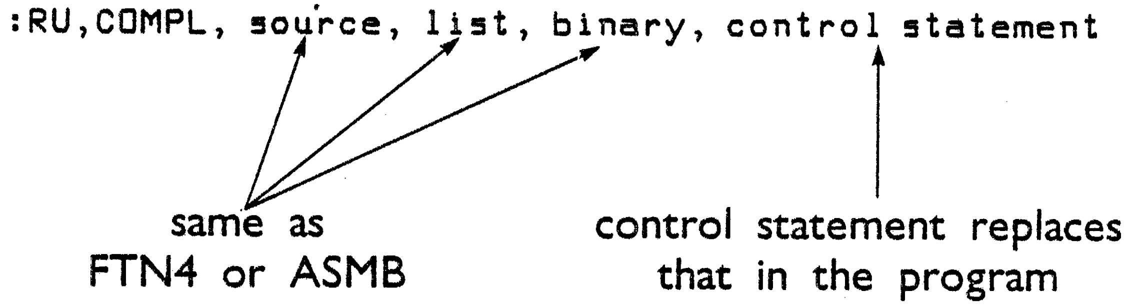
```
:RU,LOADR,,,lu,LI
```

or

```
:RU,LOADR,,program,lu,LI
```

5D. COMPL/CLOAD

COMPL — this utility will examine the source program and run the appropriate compiler or assembler.



```
:RU,COMPL, source, list, binary, control statement
```

same as FTN4 or ASMB

control statement replaces that in the program

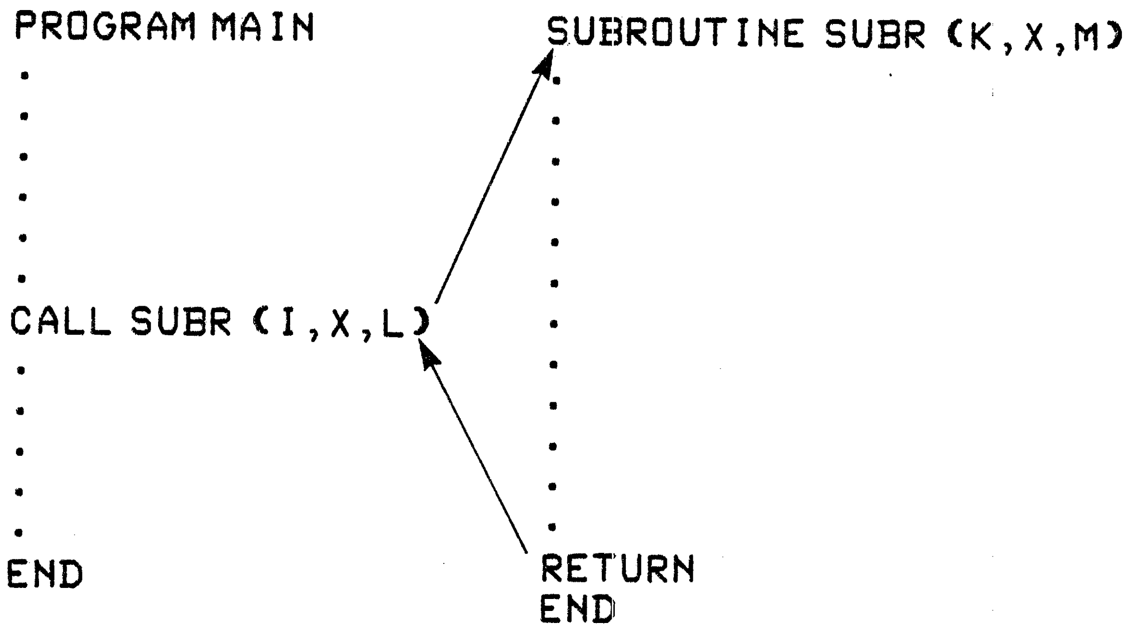
CLOAD — this utility will examine the source program and run the appropriate compiler or assembler (as does COMPL) and then run the LOADR.

```
:RU,CLOAD, source, list, binary, control statement
```

SECTION

6A. WHAT IS A PROCEDURE FILE?

Procedure Files are very similar to subprograms. A main program and a subprogram might be structured like this.



```
PROGRAM MAIN
.
.
.
.
.
.
CALL SUBR (I,X,L)
.
.
.
.
.
END
```

```
SUBROUTINE SUBR (K,X,M)
.
.
.
.
.
.
.
.
.
.
.
.
RETURN
END
```

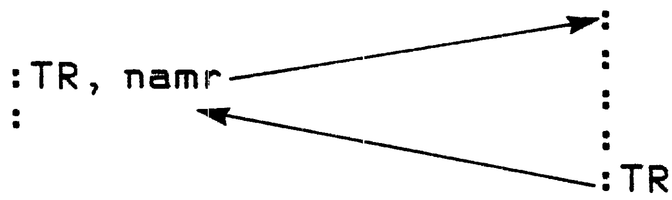
PROCEDURE FILES

A PROCEDURE FILE is:

1. a series of FMGR commands stored in a file or on a device.
2. designed to execute a frequently used series of FMGR commands.

commands entered at a terminal

commands in a file

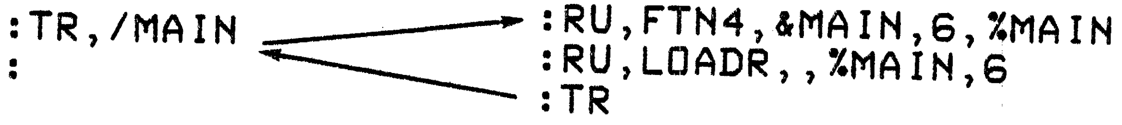


The FMGR TR command will invoke (transfer control to) a specified procedure file.

A TR command at the end of the procedure file will return control back to your terminal.

The commands in the procedure file will be echoed on the log device as they are executed.

A PROCEDURE FILE EXAMPLE



commands entered at a terminal

```
:TR,/MAIN
:
```

commands in file /MAIN

```
:RU,FTN4,&MAIN,6,%MAIN
:RU,LOADR,,%MAIN,6
:TR
```

The procedure file /MAIN can be used whenever you wish to compile and load the program in &MAIN.

FMGR COMMENTS

You can comment a FMGR procedure file by using the FMGR ** command.

```
              :** comments
        or
              :*, comments
        or
              :* ƀ comments    (ƀ = blank)
```

When FMGR encounters a "comment" command, it ignores the command and proceeds to the next command.

```
:** THIS IS A PROCEDURE FILE TO
:** COMPILE AND LOAD THE PROGRAM
:** STORED IN FILE &MAIN
:**
:RU,FTN4,&MAIN,6,%MAIN
:RU,LOADR,,%MAIN,6
:TR
```

HELLO FILES

Session Monitor allows a System Manager to create a HELLO file for each user. The HELLO file is just a personalized procedure file.

After a user successfully logs on, FMGR will automatically transfer control to that user's HELLO file (if one was specified in the user's account).

HELLO files can be used to

- — display informative messages
- — set up an operating environment for the user who is logging on.

For example,

```
:RU,ANALY
:EX
```

FMGR COMMENTS

You can comment a FMGR procedure file by using the FMGR ** command.

```
        :** comments
or
        :*, comments
or
        :* ƀ comments     (ƀ = blank)
```

When FMGR encounters a "comment" command, it ignores the command and proceeds to the next command.

```
:** THIS IS A PROCEDURE FILE TO
:** COMPILE AND LOAD THE PROGRAM
:** STORED IN FILE &MAIN
:**
:RU,FTN7X,&MAIN,6,%MAIN
:RU,LOADR,,%MAIN,6
:TR
```

6B. GENERALIZED PROCEDURE FILES

procedure file
/MAIN

```
:RU,FTN4,&MAIN,6,%MAIN
:RU,LOADR,,%MAIN,6
:TR
```

A GENERALIZED PROCEDURE FILE TO COMPILE AND LOAD A PROGRAM

A procedure file to compile and load any program and list to any device might be —

```
:RU,FTN4,   /unspecified\   /unspecified\   /unspecified\
            \   source  / , \    list   / , \relocatable/
            /unspecified\   /unspecified\
:RU,LOADR,, \relocatable/ , \    list   /

:TR
```

You "specify the unspecified" when invoking the procedure file.

```
:TR,/MAIN,&MAIN,6,%MAIN
          /     ^     \
  specify the  specify the  specify the
    source        list      relocatable
```

JUST LIKE A SUBPROGRAM

A generalized procedure file is analogous to a subprogram with parameters.

For example,

```
     SUBROUTINE PSUM (I,J,LU)
     ISUM=I+J
     WRITE (LU, 101) ISUM
101  FORMAT (/"SUM IS", I5)
     RETURN
     END
```

Variables I, J, LU are "unspecified" values; they are assigned values when the subprogram is invoked.

The calling program might contain these statements,

```
•
•
•
K=15
CALL PSUM (K,35,6)
•
•
•
```

The unspecified parameters (I,J,LU) are then assigned values:

K ⟶ I
35 ⟶ J
6 ⟶ LU

GLOBALS

FMGR has a set of variables, called GLOBALS, that may be set, modified or examined by FMGR commands entered interactively or via a procedure file.

GLOBALS in a procedure file serve to generalize the procedure file.

- GLOBALS represent the unspecified parameters of the commands in the procedure file.
- Values are passed to these unspecified parameters (GLOBALS) when the procedure file is invoked.

G GLOBALS

FMGR has 12 G GLOBALS called —

0G 1G 2G 3G 4G 5G 6G 7G 8G 9G 10G 11G

Each G GLOBAL can contain

1. nothing (null value)
2. an integer value
3. up to 6 ASCII characters

Only G GLOBALS 1G→9G may be set or modified by a FMGR command (interactive or in a procedure file).

PASSING VALUES TO G GLOBALS

An extended form of the TR command will invoke a procedure file and pass up to 9 values to the Globals 1G ⟶ 9G.

```
:TR, namr[,v1,v2,v3,v4,v5,v6,v7,v8,v9]
```

up to 9 optional values passed to 1G ⟶ 9G

- *values are passed according to position*
- *omitted values cause no change to the corresponding G GLOBAL*
- *the value may be specified as a constant or another GLOBAL*

For example,

```
:TR, /MAIN,,7,THIS,25
:TR,/PROG,7G
```

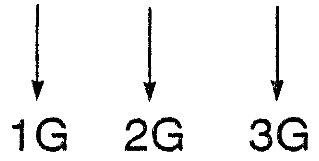
A GENERALIZED COMPILE AND LOAD PROCEDURE FILE

Procedure file /MAIN might be generalized as follows:

```
:**  PROCEDURE FILE TO COMPILE AND
:**  LOAD A PROGRAM
:**
:**  GLOBAL  1G  REPRESENTS SOURCE FILE
:**          2G  REPRESENTS LIST
:**          3G  REPRESENTS RELOCATABLE FILE
:**
:RU,FTN4,1G,2G,3G
:RU,LOADR,,3G,2G
:TR
```

/MAIN might be invoked with:

```
:TR,/MAIN,&PROGA,1,%PROGA
```



SPECIAL G GLOBALS

G GLOBALS 0G and 10G have special uses:

0G	contains FMGR's input device LU
10G	LOADR places the name of the program just loaded into 10G

For example, /MAIN can be modified to compile, load and run a program:

```
:RU,FTN4,1G,2G,3G
:RU,LOADR,,3G,2G
:RU,10G
:TR
```

/MAIN might be invoked with:

```
:TR,/MAIN,&FILE,0G,%FILE
```

DISPLAYING GLOBAL VALUES

The FMGR DP (DISPLAY) command will display constants, character strings and values of GLOBALS on the log device.

$$\texttt{:DP,}\underbrace{\texttt{x1,x2,x3 . . . .}}_{\text{parameters to be displayed}}$$

for example

```
:DP,17,0G,THIS IS A STRING,10G
17,1, THIS IS A STRING, PROGX
```

SETTING G GLOBALS

You can also use the FMGR SE command to assign values to G GLOBALS.

$$\texttt{:SE,}\underbrace{\texttt{x1,x2,x3,x4,} \;\; . \;\; . \;\; . \;\; . \;\; \texttt{,x9}}_{\text{values to be assigned to } 1\text{G}\longrightarrow 9\text{G}}$$

- position determines which G GLOBAL is assigned a value
- omitted values do not affect the value of the corresponding G GLOBAL
- values may be constants, character strings or other GLOBALS

For example,

```
:SE,17,-13,FTN4,2000B
:DP,1G,2G,3G,4G

:SE,,-15
:DP,1G,2G

:SE,2G
:DP,1G,2G
```

CALCULATING G GLOBALS

A third way to assign a value to a G GLOBAL is with the FMGR CA command.

```
:CA, global number, expression
```

A number, 1 to 9

an expression whose value is assigned to the specified G GLOBAL

The expression is of the form:

```
t1, op1, t2, op2, t3 ....
```

operands
- constants
- globals

operators

+	O (OR)
−	X (XOR)
*	A (AND)
/	

for example,

```
:SE,3
:SE,,,15
:CA,9,5,+,3G,/,2
:DP,1G,3G,9G

:CA,8,150
:DP,8G
```

DECISIONS AND LOOPS IN PROCEDURE FILES

The FMGR IF command allows you to alter the normal flow of control in a procedure file.

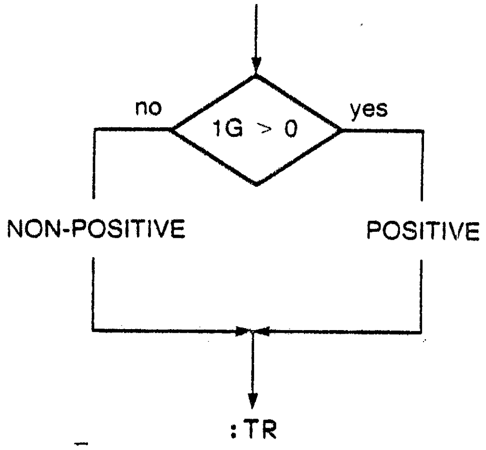
```
:IF, o1, relation, o2, skip
```

operands whose values are to be compared	relation to be tested	number of commands to skip if relation is true
• constant • global	EQ NE LT GT LE GE	(default is 1)

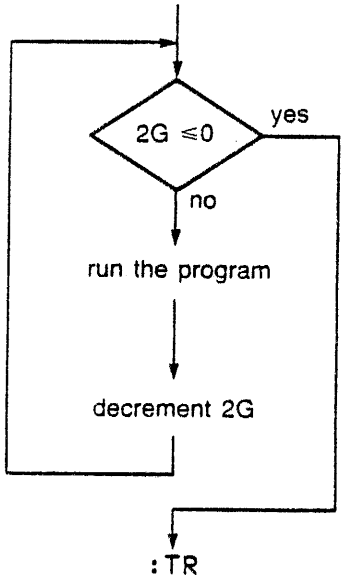
THE IF COMMAND MAY NOT BE USED INTERACTIVELY!

IF COMMAND EXAMPLES

A DECISION Procedure file /DEC is to be invoked with one value passed to it (in 1G). /DEC should examine the value and print either POSITIVE or NON-POSITIVE.



A LOOP Procedure file /LOOP is to be invoked with two values passed to it. lG is a program name; 2G is the number of times 1G should be run.



INTERNAL G GLOBAL STRUCTURE

G Type Globals are stored as four words each as follows:

0	**TYPE**
1	**DATA 1**
2	**DATA 2**
3	**DATA 3**

where:

TYPE = 0 if the global is null

= 1 if DATA 1 is an integer

= 3 if DATA 1 ⟶ DATA 3 are ASCII characters

GLOBAL FORMAT

WORD 0	**GLOBAL TYPE=0 (NULL)**	**GLOBAL TYPE=1 (NUMERIC)**	**GLOBAL TYPE=3 (ASCII)**
WORD 1	**0**	**INTEGER**	**CHARACTERS 1,2**
WORD 2	**0**	**0**	**CHARACTERS 3,4**
WORD 3	**0**	**0**	**CHARACTERS 5,6**

GLOBAL EQUIVALENCE

G	P
0	-40 Type
	-39
	-38
	-37
1	-36 Type
	-35
	-34
	-33
2	-32 Type
	-31
	-30
	-29
3	-28 Type
	-27
	-26
	-25
4	-24 Type
	-23
	-22
	-21

G	P
5	-20 Type
	-19
	-18
	-17
6	-16 Type
	-15
	-14
	-13
7	-12 Type
	-11
	-10
	- 9
8	- 8 Type
	- 7
	- 6
	- 5
9	- 4 Type
	- 3
	- 2
	- 1
10	0 Type
	1
	2
	3
11	4
	5
	6
	7
	8
	9

P GLOBALS

P GLOBALS may be examined, set or modified exactly like G GLOBALS, except that they refer to one word only and are interpreted as integer values.

You can use the FMGR CA (CALCULATE) command to assign values to the P GLOBALS —

-36 P to -1P (correspond to 1G ⟶ 9G)
or
1P to 5P

The command format is —

```
:CA, n:P, expression
```

n can be —

-36 to -1 or 1 to 5	an expression whose value is assigned to the specified P global

P GLOBAL EXAMPLES

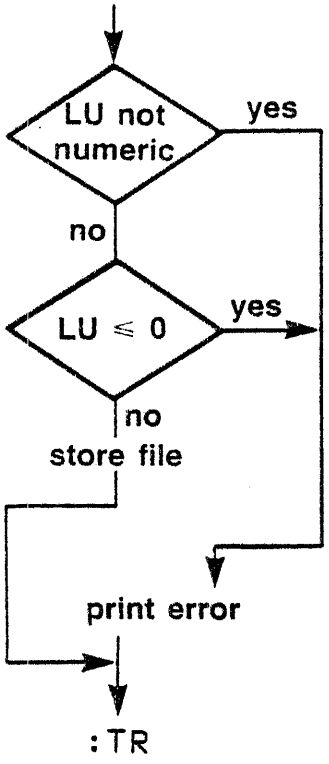
Example 1

```
:SE,15,,14
:CA,3:P,1G,-,3G
:DP,3P
```

Example 2

```
:SE,,,,15
:CA,-23:P,5
:DP,-23P,4G
```

Example 3 Procedure file /DUMP will read a file from a mag tape and store it into a disc file. 1G is used for the mag tape LU; 2G is used for the disc file. /DUMP should check to see if the mag tape LU specified is a positive numerical value.



SPECIAL USES OF P GLOBALS

FTN4 P GLOBALS 1P to 5P are set to values reflecting the number of errors found in the source program just compiled.

1P	total number of disasters, errors and warnings
2P	number of disasters
3P	number of errors
4P	number of warnings
5P	revision number of the compiler

LOADR For a successful load —

1P	program name
2P	
3P	
4P	spaces
5P	

For an unsuccessful load —

1P	6 character mnemonic error code
2P	
3P	
4P	L-
5P	0

SPECIAL P GLOBALS

6P—CONTAINS LAST ERROR NUMBER FROM <u>FMGR</u>

7P—CONTAINS CURRENT SEVERITY CODE

8P—CONTAINS YOUR SESSION IDENTIFIER

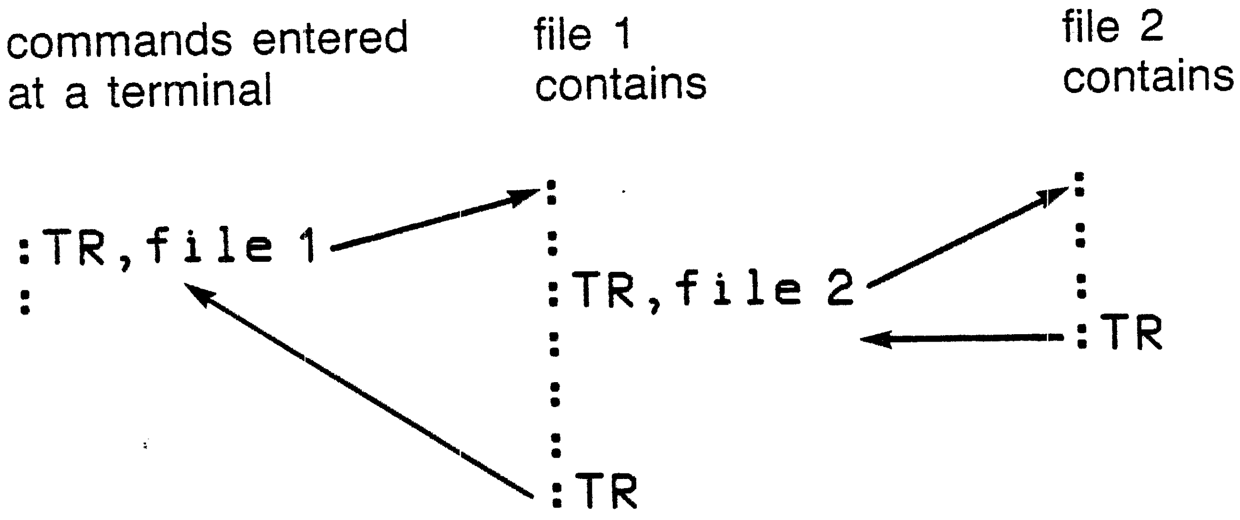
9P—CONTAINS YOUR CAPABILITY LEVEL

EXAMPLE

```
:CR, XYZ:::4:1
:CR,XYZ:::4:1
FMGR-002
:DP,6P
-2
:
```

6C. NESTED PROCEDURE FILES

Procedure files may invoke other procedure files just as subprograms may invoke other subprograms.



FMGR keeps track of nested procedure files with a TRANSFER STACK. The Transfer Stack may contain up to 10 entries.

MORE ON THE TR COMMAND

Additional forms of the FMGR TR command allow various means of controlling the nesting of procedure files.

- invoke a procedure file

```
:TR, namr, parameters
```

- transfer back one procedure file in the stack

```
:TR
```

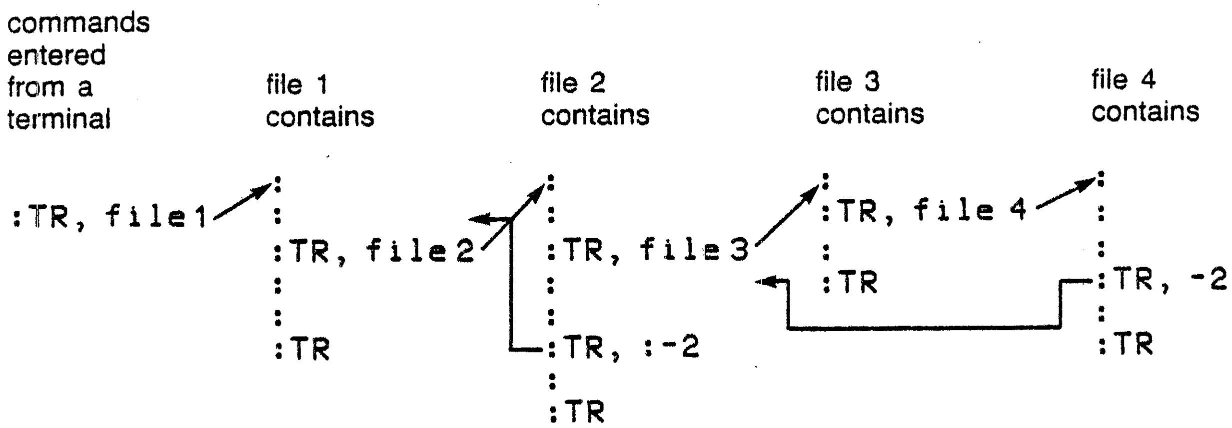
- transfer back a specified number of files in the stack

```
:TR, - integer
```

- transfer back to the previous procedure file, but go back the specified number of commands in that procedure.

```
:TR,: - integer
```

For example



6D. INTERACTING WITH PROCEDURE FILES

MESSAGES

You can use FMGR commands to send messages to be printed at the:

LOG DEVICE, use the FMGR DP (DISPLAY) command

```
:DP, message
```

LIST DEVICE, use the FMGR AN (ANNOTATE) command

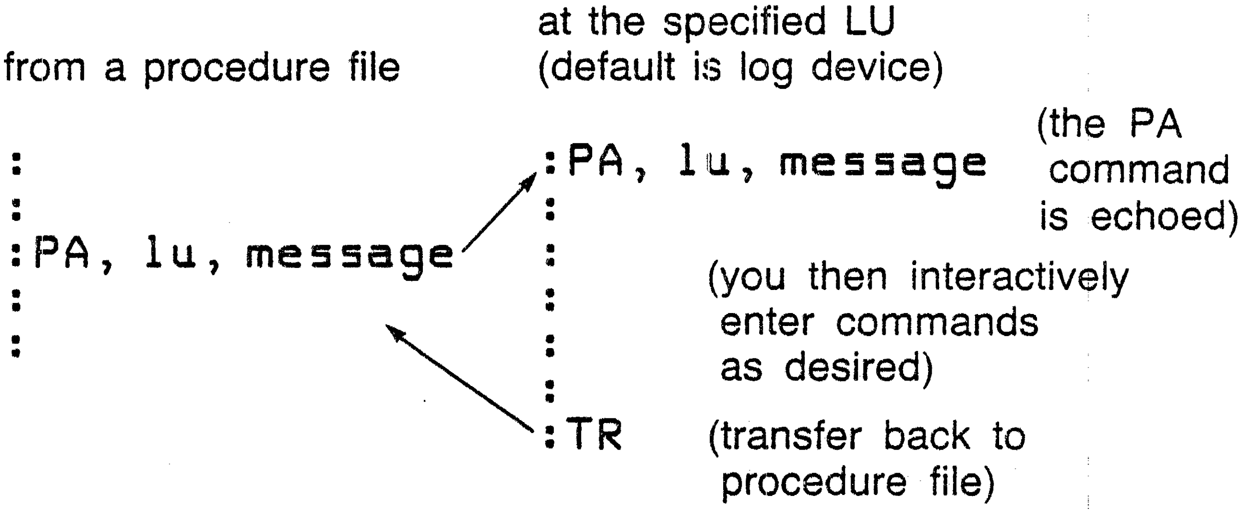
```
:AN, message
```

SYSTEM CONSOLE, use the FMGR TE (TELL) command

```
:TE,message
```

SUSPENDING AND RESTARTING A PROCEDURE FILE

The execution of a procedure file may be suspended and control transferred to an interactive device with the FMGR PA (PAUSE) command.



from a procedure file

```
:
:
:PA, lu, message
:
:
```

at the specified LU
(default is log device)

```
:PA, lu, message
:
:
:
:
:
:TR
```

(the PA command is echoed)

(you then interactively enter commands as desired)

(transfer back to procedure file)

ERRORS IN PROCEDURE FILES

When FMGR encounters an error while executing a procedure file, control is transferred to the log device so corrective action may be taken.

```
procedure file        log device (interactive)

:
:                         FMGR-006        (file not found)
:                        :ST,8,FILEA
:LI, FILEA <----------- :TR,:-1           you then take
:LI, FILEB                                corrective action
:                                         and transfer
:                                         back to the
:TR                                       procedure file
```

By setting FMGR's SEVERITY CODE you can control

- echoing of commands
- listing of errors
- transferring to the log device on errors

7

USING RTE's SERVICES PROGRAMMATICALLY

SECTION

B I/O PROCESSING

7A. INTRODUCTION TO EXEC CALLS

You call EXEC to request RTE services as follows:

```
CALL EXEC (ICODE,p1,p2,p3,...pn)
```

a request code, identifies the service requested

parameters further specifying the request

For example,

An EXEC 11 (ICODE = 11) is a request for RTE's current time of day.

```
DIMENSION ITIME(5)
.
.
.
.
ICODE = 11
CALL EXEC (ICODE,ITIME[,IYEAR])
```

RTE places the
- day
- hour
- minute
- second
- 10's of milliseconds (centiseconds)

in this array.

RTE returns the 4 digit year in this variable

SUCCESS?

A request for an RTE service might be:

SUCCESSFUL	— control is returned to the statement following the EXEC call — status information may be available in the A and B registers
UNSUCCCESSFUL	— your program will usually be aborted and an error message will be displayed at your terminal (and at the system console)

RETRIEVING INFORMATION FROM THE A and B REGISTERS

An EXEC 1 request is for input –

```
.
.
ICODE = 1
CALL EXEC (ICODE,1,I,1)
CALL ABREG (IA,IB)
```

The library routine ABREG stores the A register contents in the first parameter, the B register contents in the second parameter

A successful READ request will return with:

A register: device status

B register: number of words (characters) transferred

You should call ABREG immediately after the call to EXEC.

```
:RU,TMP

ENTER AN INDEX VALUE:
IO12  TMP    40237
TMP   ABORTED
 ABEND  TMP   ABORTED
:HE
IO12
AN I\O REQUEST SPECIFIED A LOGICAL UNIT NOT DEFINED FOR USE BY
THIS SESSION. THE "SL" COMMAND WILL REPORT ALL LOGICAL UNITS
AVAILABLE TO YOUR SESSION.
:
```

DEBUGGING EXEC ERRORS

The compiler listing and load map for program TMP are —

```
0001  FTN4,L,Q
0002  00000          PROGRAM TMP
0003  00000          INTEGER ARRAY(100)
0004  00000 C
0005  00000 C        INITIALIZE ARRAY 1 TO 100, BACKWARDS
0006  00000 C
0007  00000          DO 10 I = 1,100
0008  00151 10          ARRAY(101-I) = I
0009  00151 C
0010  00167 20       CONTINUE
0011  00167          WRITE(1,101)
0012  00175 101      FORMAT(/"ENTER AN INDEX VALUE:")
0013  00175          CALL EXEC(1,15,INDEX,1)
0014  00203          CALL ASCBN(INDEX)
0015  00206          IF(INDEX .EQ. 0) GOTO 99
0016  00215            IVAL = ARRAY(INDEX)
0017  00221            WRITE(1,102) IVAL
0018  00231 102        FORMAT(/"THE CORRESPONDING ARRAY ELEMENT IS ",I5)
0019  00231            GOTO 20
0020  00231 C
0021  00231 99       CONTINUE
0022  00232          END
```

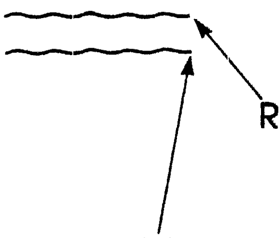
```
:RU,LOADR
 /LOADR:   RE,%TMP
  TMP    40042 40354
 /LOADR:   RE,%ASCBN
  ASCBN  40355 40502
 /LOADR:   END

  FMTIO  40503 42001    24998-16002 REV.1926 790417
  FMT.E  42002 42002    24998-16002 REV.1901 781107
  PNAME  42003 42050    771121   24998-16001
  REIO   42051 42175   92067-16268 REV.1903 790316
  FRMTR  42176 45633    24998-16002 REV.1926 790503
  .CFER  45634 45711   750701   24998-16001

   4 PAGES RELOCATED      4 PAGES REQ'D    NO PAGES EMA      NO PAGES MSEG
  LINKS:BP     PROGRAM:BG    LOAD:TE    COMMON:NC
   /LOADR:TMP     READY AT   2:24 PM   THU.,  1  MAY , 1980

   /LOADR:$END
```

HANDLING EXEC ERRORS PROGRAMMATICALLY

For less severe errors, a user can specify that a program should not be aborted if an EXEC error occurs. If this option is selected however, the program should process an error itself.

The "no abort" option is selected by setting bit 15 of the ICODE parameter of an EXEC call; the "no abort" option is then in effect for that particular call.

```
ICODE = 1 + 100000B
CALL EXEC (ICODE,1,I,1)
```



RTE returns here if an error occurred

RTE returns here if the call was successful

The error return point should always contain a GO TO statement.

RETRIEVING ERROR INFORMATION

When an EXEC error occurs, RTE stores error information in the A and B registers.

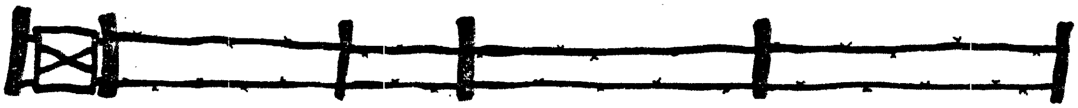
***A register** – 2 character (ASCII) error code: SC, LU, IO, DR or RN*

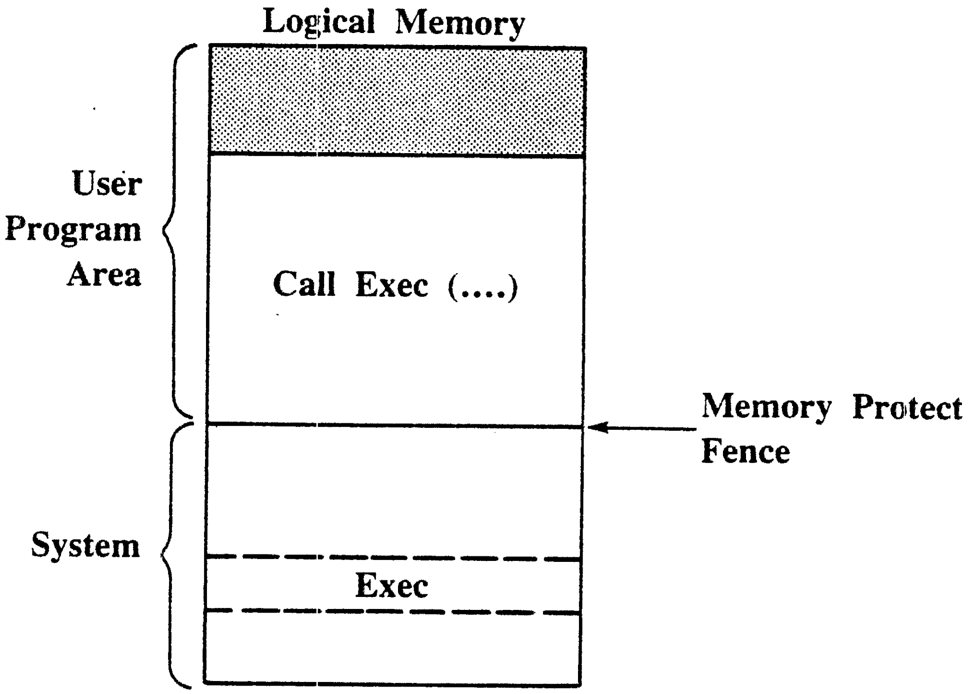
***B register** – 2 digit (ASCII) error number: 01, 02, 03 . . . . .*

For example,

```
       .
       .
       .
       ICODE = 1 + 100000B
       CALL EXEC (ICODE,1,I,1)
       GO TO 99
10     WRITE(1,101)I
       .
       .
       .
       .
99     CALL ABREG(IA,IB)
       WRITE(1,201)IA,IB
201    FORMAT(/"EXEC ERROR ON INPUT:"/
      *         "ERROR CODE",2A2)
       STOP
       .
       .
       .
```

MEMORY PROTECT FENCE



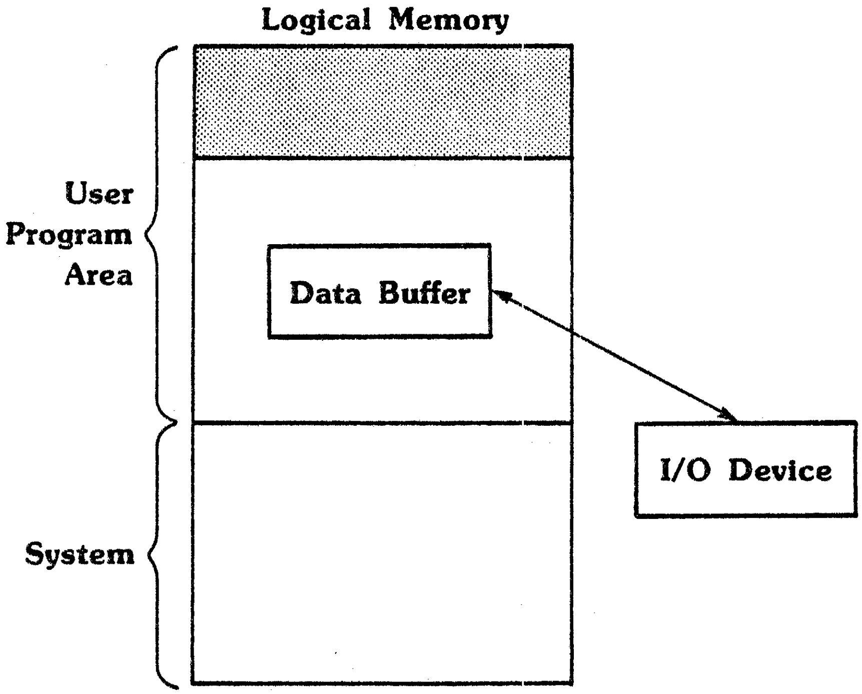


RTE has a MEMORY PROTECT FENCE to protect itself from user programs. User programs crossing the fence will be aborted with an MP error.

7B. I/O PROCESSING

I/O requests made with FORTRAN READ/WRITE statements are first processed by the FORTRAN FORMATTER and then sent to RTE for the actual I/O operation.

By using EXEC I/O requests, you can request I/O operations directly.



EXEC READS & WRITES

EXEC READ (EXEC 1) — inputs data from a device into a buffer in your program

```
ICODE = 1
CALL EXEC (ICODE,ICNWD,IBUFF,ILEN)
```

EXEC WRITE (EXEC 2) — outputs data from a buffer in your program to a device

```
ICODE = 2
CALL EXEC (ICODE,ICNWD,IBUFF,ILEN)
```

where

ICODE — the EXEC request

ICNWD — control word : specifies "how and where" to perform the I/O operation

IBUFF — array in the program acting as the data buffer

ILEN — positive number of words or negative number of characters to be transferred

ICNWD

ICNWD is a control word containing information that tells RTE "how and where" to perform the data transfer.

bit →	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
value →	0	0	0	0	0	X	A	K	V	M	—	—	—	—	—	—

FUNCTION CODE (bits 10–6)

LOGICAL UNIT (bits 5–0)

WHERE:

Logical Unit = LU number of device to use in transfer. "Where to perform the I/O operation"

Function Code = control bits used to control device driver (device driver dependent). "How to perform the I/O operation"

0 = bits used by the system that should be set to 0.

FUNCTION CODE

The function code field of ICNWD is used to control the device driver. The meaning of the bits <u>depends on the driver type.</u>

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
value	0	0	0	0	0	X	A	K	V	M	—	—	—	—	—	—
						FUNCTION CODE					LOGICAL UNIT					

For example:

M =	0	data is ASCII	for a CTU READ or WRITE
	1	data is binary	
V =	0	use first column as carriage control	for a line printer
	1	print the first column	
K =	0	no echo on an EXEC read	for a terminal
	1	echo on an EXEC read	
A =	0	terminal enabled character/block read	for a terminal
	1	program enabled block read	
X =	0	use V bit for control information	for a line printer
	1	user supplies CR, LF, FF controls	

AN EXAMPLE OF EXEC READS & WRITES

```
FTN4,L
      PROGRAM TEXEC
      INTEGER IBUF(5)
C
C     THIS PROGRAM REQUESTS UP TO 10 CHARACTERS FROM THE
C     TERMINAL (LU 1) AND PRINTS THEM ON THE LINE
C     PRINTER (LU 6).
C
      WRITE(1,101)
101   FORMAT(/"PLEASE TYPE UP TO 10 CHARACTERS:")
C
C     EXEC READ TO RETRIEVE INPUT,
C     SET THE "K" BIT FOR ECHO.
C
      ICNWD = 1 + 400B
      CALL EXEC(1, ICNWD,IBUF,-10)
C
C     GET THE NUMBER OF CHARACTERS ACTUALLY ENTERED.
C
      CALL ABREG(IA,IB)
      ILEN = IB
C
C     EXEC WRITE TO PRINT THE STRING,
C     SET THE "V" BIT TO PRINT THE FIRST CHARACTER.
C
      ILEN = -ILEN
      ICNWD = 6 + 200B
      CALL EXEC(2, ICNWD,IBUF,ILEN)
C
      END
```

EXEC DEVICE CONTROL

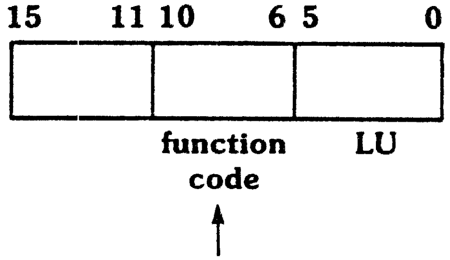
An EXEC 3 call will allow you to programmatically control I/O devices, for example

- **enable/disable a terminal**
- **rewind a mag tape**
- **issue a form feed to the line printer**

```
ICODE = 3
CALL EXEC (ICODE,ICNWD,IOP1)
```

where

ICNWD — **control word specifying the control function and LU**



specifies control function to be performed

IOP1 — **optional parameter, required by some control functions for extra information**

OBTAINING DEVICE STATUS

- DEVICE STATUS AFTER AN EXEC READ/WRITE

  After a successful EXEC 1 or 2 request, the A register contains the device status (Eqt word 5).

- DEVICE STATUS WITH AN EXEC 13 REQUEST

  The EXEC 13 call will return information about a device, including the device type and its last reported status.

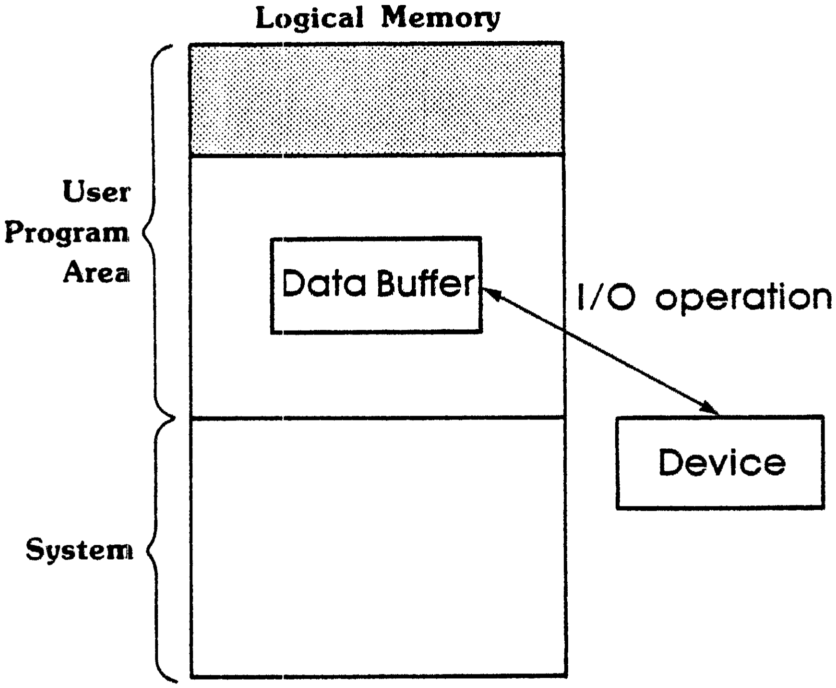
```
ICODE = 13
CALL EXEC (ICODE,ICNWD,IST1,IST2,IST3)
```

where

ICNWD — LU of device being queried
IST1 — returned with word 5 of EQT
IST2 — returned with word 4 of EQT
IST3 — returned with subchannel of device and "up" or "down" information

NORMAL I/O

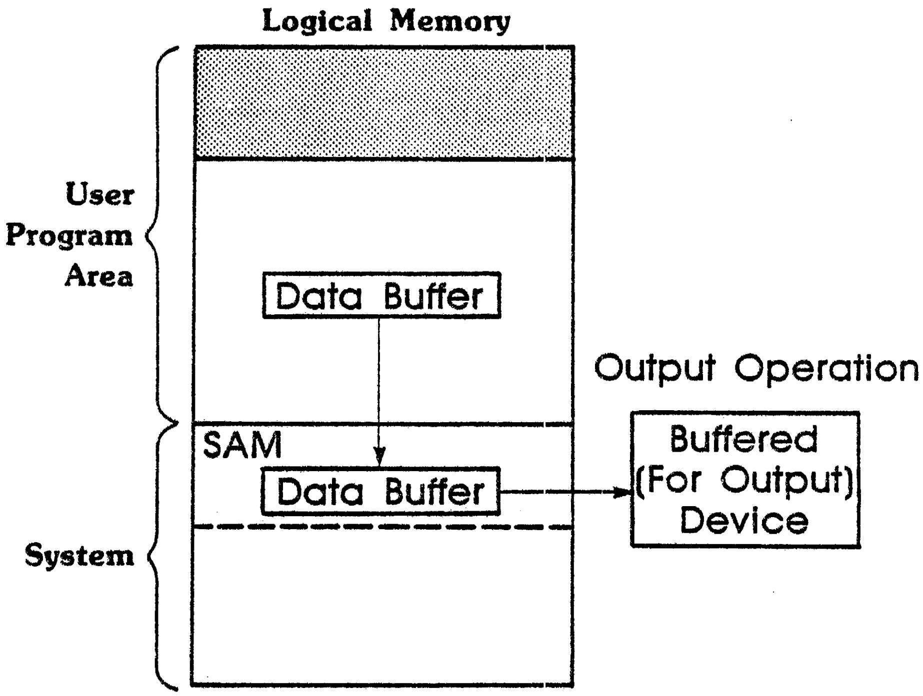
A program doing EXEC READS or WRITES to a (unbuffered) device is requesting a data transfer directly between the device and a buffer in the user program area of memory.



AUTOMATIC OUTPUT BUFFERING

Some devices (such as terminals or line printers) may be specified to be BUFFERED devices for output operations.

This specification is done when the RTE system is generated or by using the system EQ command (high capability).



SYSTEM AVAILABLE MEMORY (SAM) is a dynamic data area in the system area of memory.

REENTRANT I/O

The library routine REIO will perform I/O operations such that:

- the program becomes swappable

$$\texttt{CALL REIO(}\underbrace{\texttt{ICODE,ICNWD,IBUFF,ILEN}}_{\substack{\text{same as for EXEC 1 or 2} \\ \text{(only non-disc devices)}}}\texttt{)}$$

REIO will always perform the requested I/O operation; however, the program will be swappable if

- ILEN is less than 130 words
- IBUFF is at least 5 words from the beginning of your program

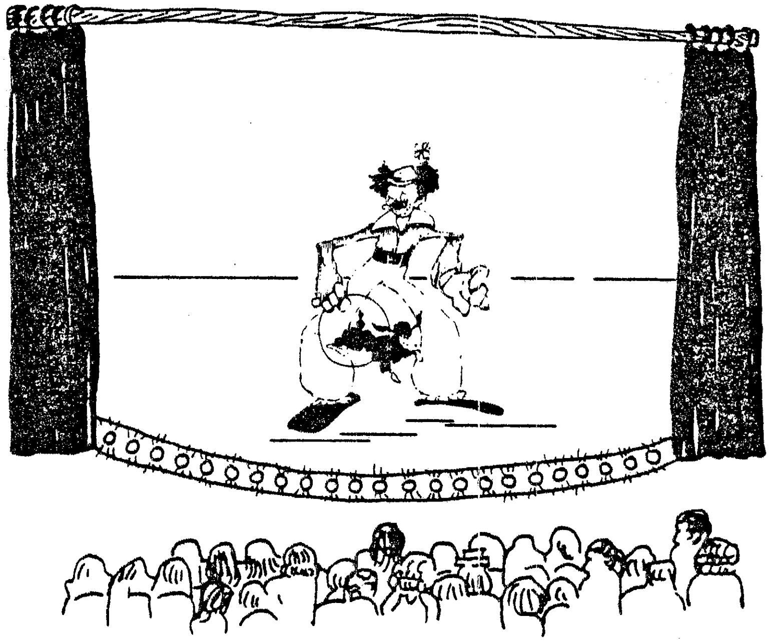
REIO uses a data buffer in SAM to hold the data from your program so that your program may be swapped if needed.

I/O SUMMARY

	PROGRAM STATE	SWAPPABLE?
FORTRAN		
READ WRITE		

8

INTERACTING WITH YOUR PROGRAM



SECTION

8A. PASSING INFORMATION

Values may be passed to

- subprograms when you call them

```
CALL SUBR (I,J,K)
```

- procedure files when you transfer to them

```
:TR,/MAIN,&MAIN,6,%MAIN
```

- programs when you run them

```
:RU,LOADR,,%MAIN,6
```

RMPAR

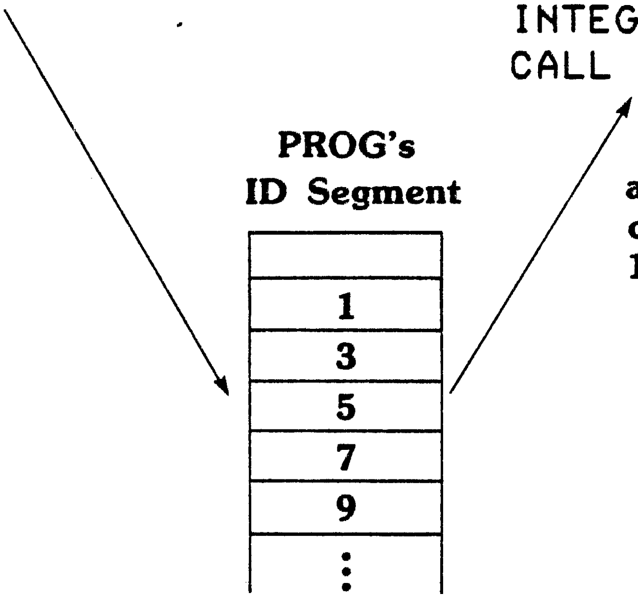
When a program is run, up to 5 integer values (or pairs of ASCII characters) may be included as parameters in the RU command.

```
S= xx COMMAND ?RU,KYDMP,KF,IL,E1
              :RU,LISTR,6,TE,XT,F4
```

The program can then use the library routine RMPAR to retrieve these values and store them in an array in the program.

```
:RU,PROG,1,3,5,7,9
```

```
PROGRAM PROG
INTEGER PARM (5)
CALL RMPAR (PARM)
```



array PARM now contains values 1,3,5,7,9

The call to RMPAR should be the first executable statement in your program.

RETURNING VALUES TO FMGR FROM A PROGRAM

If you run a program with the FMGR RU command, your program can return up to 5 integer values (or ASCII character pairs) to FMGR. FMGR retrieves these values and stores them in globals 1P to 5P.

The library routine PRTN is used to return values, for example:

```
FTN4,L
      PROGRAM INOUT
C
C     THIS PROGRAM IS TO BE RUN WITH 5 VALUES PASSED
C     TO IT.  THE PROGRAM WILL RETRIEVE THE 5 VALUES
C     AND THEN PASS THEM BACK TO FMGR IN REVERSE ORDER.
C
      INTEGER IPARM(5), RPARM(5)
C
C     RETRIEVE THE PASSED VALUES
C
      CALL RMPAR(IPARM)
C
      DO 10 I = 1,5
10    RPARM(I) = IPARM(6-I)
C
C     RETURN THE VALUES TO FMGR
C
      CALL PRTN(RPARM)
C
      END
```

```
:RU,INOUT,1,2,3,4,5
:DP,1P,2P,3P,4P,5P
 5,4,3,2,1
:RU,INOUT,,,UP,DN
:DP,10G
 DNUP
:
```

PASSING STRINGS TO PROGRAMS

Strings of characters may also be passed to a program, for example

```
:RU,GRSTR,THIS IS A STRING
```

string of characters to be passed to GRSTR

A program can retrieve a string via

- EXEC 14 REQUEST — the EXEC 14 will retrieve the “run string”

```
:RU,GRSTR,THIS IS A STRING
```

EXEC 14 will retrieve this

- GETST — the library routine GETST will retrieve the “parameter string” (any characters after the second comma)

```
:RU,GPSTR,THIS IS A STRING
```

GETST will retrieve this

RETRIEVING THE RUN STRING

The EXEC 14 will retrieve the command that scheduled the program.

```
ICODE=14
CALL EXEC (ICODE,1,IBUFF,ILEN)
```

says to retrieve the run string

array to receive the run string

positive number of words or negative number of characters to retrieve

For example,

```
FTN4,L
      PROGRAM GRSTR
      INTEGER IBUF(35)
C
C     RETRIEVE THE RUN STRING VIA EXEC 14
C     SPECIFY THE MAX NUMBER OF WORDS TO BE RETRIEVED.
C
      ILEN = 35
      ICODE = 14
      CALL EXEC(ICODE,1,IBUF,ILEN)
      CALL ABREG(IA,IB)
      ILOG = IB
C
C     PRINT THE RUN STRING,
C     USING THE ACTUAL NUMBER OF WORDS RETRIEVED.
C
      WRITE(1,101) (IBUF(I),I=1,ILOG)
  101 FORMAT(/"THE RUN STRING IS:"/
     1        35A2)
      END
```

```
:RU,GRSTR,THIS IS A STRING

THE RUN STRING IS:
RU,GRSTR,THIS IS A STRING
:
```

RETRIEVING THE PARAMETER STRING

A call to GETST will retrieve the parameter string part of the command that scheduled the program.

```
CALL GETST (IBUF,ILEN,ILOG)
```

IBUF – array to receive the parameter string

ILEN – positive number of words or negative number of character to retrieve

ILOG – number of words or characters actually retrieved

For example,

```
FTN4,L
      PROGRAM GPSTR
      INTEGER IBUF(35)
C
C     RETRIEVE THE PARAMETER STRING VIA GETST,
C     SPECIFY THE MAX NUMBER OF WORDS TO BE RETRIEVED.
C
      ILEN = 35
      CALL GETST(IBUF,ILEN,ILOG)
C
C     PRINT THE PARAMETER STRING,
C     USING THE ACTUAL NUMBER OF WORDS RETRIEVED.
C
      WRITE(1,101) (IBUF(I),I=1,ILOG)
101   FORMAT(/"THE PARAMETER STRING IS:"/
     1      35A2)
      END
```

```
:RU,GPSTR,THIS IS A STRING

THE PARAMETER STRING IS:
THIS IS A STRING
:
```

8B. SUSPENDING PROGRAMS — INTERACTIVELY —

You can INTENTIONALLY suspend a program and then restart its execution by using the system SS and GO commands.

```
S=xx COMMAND? SS,program
```

"program" will be suspended

```
S=xx COMMAND? GO,program
```

"program" will be rescheduled

(If "program" is not specified, the current Session program is suspended or rescheduled)

SUSPENDING PROGRAMS
— PROGRAMMATICALLY —

A program can suspend itself and then be rescheduled by an operator via

- issuing a READ request and waiting for the operator to respond.
- executing a FORTRAN PAUSE statement and waiting for the operator to enter a "GO,program" command.

```
PAUSE xxxx
```

↑ octal value displayed in a PAUSE message at your terminal

- making an EXEC 7 request and waiting for the operator to enter a "GO,program" command.

```
ICODE=7
CALL EXEC(ICODE)
```

PASSING VALUES WHEN RESTARTING A PROGRAM

* * *

The GO command may pass up to 5 integer values (or ASCII character pairs) to the program that is being restarted. RMPAR is used by the program to retrieve the values.

```
PROGRAM PROGA
INTEGER PARM(5)
:
:
CALL EXEC(7)
CALL RMPAR (PARM)
```

PARM then contains
5,6,1,3,8

8C. TERMINATING PROGRAMS

A program may be terminated in several ways:

- FORTRAN STOP statement

```
STOP xxxx
```

octal value displayed in a STOP message at your terminal

- EXEC 6 REQUEST

```
CALL EXEC(6)
```

- FORTRAN END statement

```
END
```

The END statement causes the FTN4 compiler to generate an EXEC 6 request automatically.

TERMINATING A PROGRAM EARLY

If you want to terminate a program before its normal termination —

- use the system OF command

```
                          ⎡,0⎤
S=xx COMMAND? OF,program  ⎢,1⎥
             or           ⎣,8⎦

S=xx COMMAND? OF
```

- your program may be created to allow an early termination by examining its "break bit".

PROGRAM BREAKS

One of the bits in a program's ID segment is the "break bit". The library routine IFBRK allows a program to check its break bit (and clear it if it was set).

```
I=IFBRK(IDUM)
↑
```

returned as: 0 if break bit is not set
negative if break bit is set

Your program can then take an appropriate course of action.

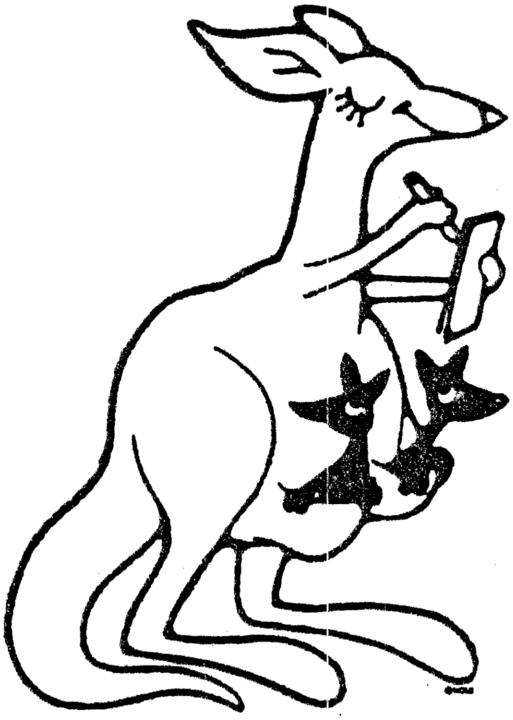
You can set a program's break bit with the system BR command.

```
S=xx COMMAND? BR,program
```

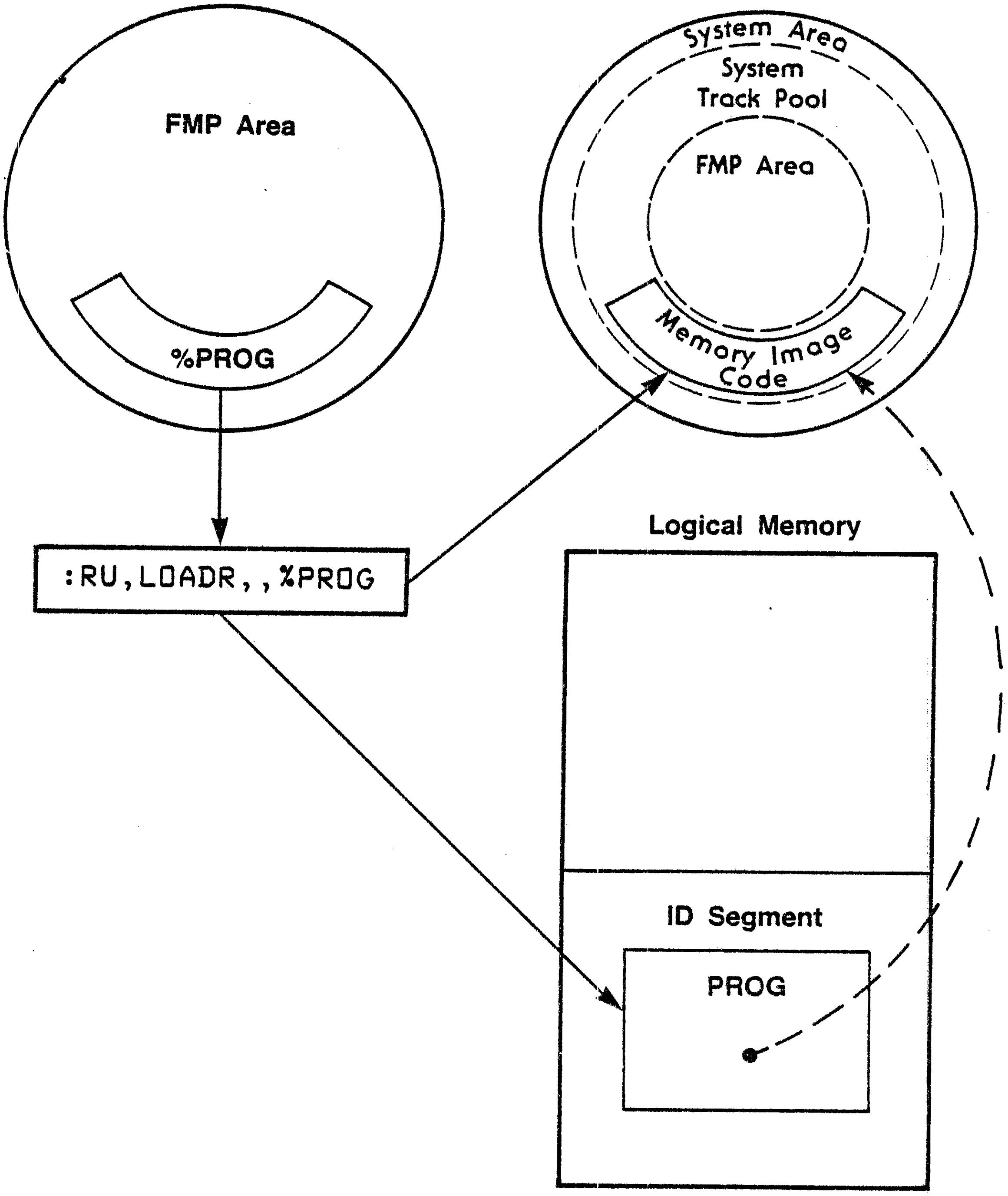
if "program" is not specified, the break bit in the current session program is set.

9

TYPE 6 FILES



LOADR CREATES A TEMPORARY DISC RESIDENT PROGRAM



SAVING PROGRAMS

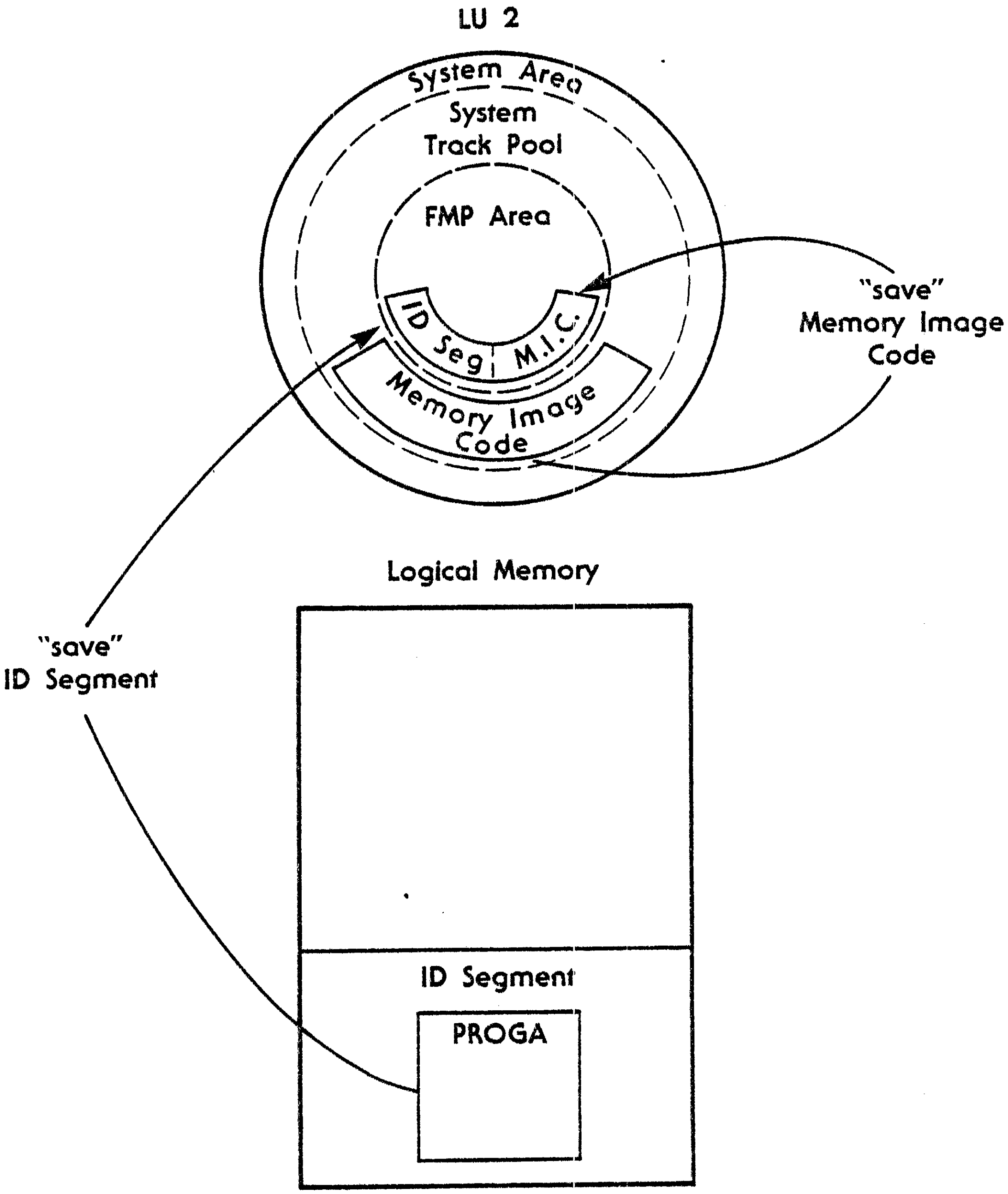
You can use the FMGR SP command to "save" a program as a type 6 file.

```
                 ┌,PR                   ┐
:SP, namr        │                      │
                 └,GR [,capability]     ┘
```

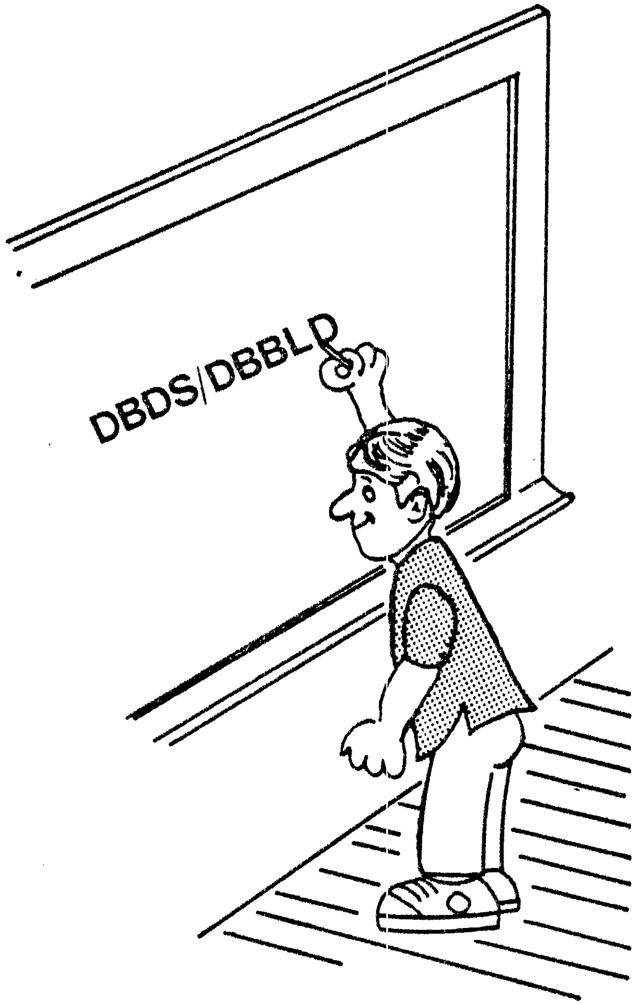
The type 6 file created by the SP command consists of a copy of the program's ID segment and Memory Image Code appended together.

Type 6 files are not affected by the log-off process or the boot-up process.

:SP,PROGA


LU 2
System Area
System
Track Pool
FMP Area
ID Seg
M.I.C.
Memory Image
Code
"save"
Memory Image
Code
Logical Memory
"save"
ID Segment
ID Segment
PROGA

APPENDIX A
LAB EXERCISES



LAB 1 - AN INTRODUCTION TO RTE

1. Your instructor should supply you with the following information

   ______ the Disc Loader ROM Number

   ______ the Octal Select Code of the System Disc

   ______ the Surface Number on the System Disc which contains the RTE system

   for the system you will use for your lab exercises.

   Use this information to boot up the system.

LAB 2 - USING YOUR RTE SYSTEM

1. Log on to the system using the account given to you by your instructor.

   What are the Session LU´s which you can access?
   What are their corresponding System LU´s?

2. Retrieve any messages waiting for you, without purging them. Retrieve the messages again, this time purging the messages so you will not see them again. If you then enter a ME command, what will happen?

3. File &LAB23 contains a FORTRAN source program with a number of errors. You should -

   * create a copy of the source file for your own use, giving it a unique file name.

   * edit the source file, correcting any errors and giving the program a new name.

   * compile, load and run the program.

4. File &LAB24 also contains a FORTRAN source program with a number of errors. Repeat the steps of problem 3 with this source program.

LAB 3 - RTE ORGANIZATION

1. For every Session LU in your SST, determine its -

    a. corresponding System LU
    b. Eqt and subchannel number
    c. select code
    d. driver

2. File &LAB32 contains a FORTRAN source program which outputs several lines to the line printer. Make a copy of the source file for your own use and give the program a unique name. Then compile and load the program.

    Before you run the program, turn the line printer off-line. Run the program and see what happens. Turn the printer back on-line and get your program's output.

    Try the same exercise again but this time run the program with the System (RTE) run command.

    (How do you enter a System command from FMGR?)

3. You can submit a System command with the FMGR SY prefix but you can't submit a Breakmode command this way. Try using the SY prefix with the Breakmode commands and see what happens.

    (See the Terminal User's Manual description of the SY command.)

4. What LU and track(s) contain the Memory Image Code for the program you used for problem 2?

5. Use two different methods to find the priority of your copy of FMGR.

6. a) Enter the following command at your terminal -

    ```
    :DL
    ```

    What three commands can you enter to stop the output and get your FMGR prompt back?

    b) File &LAB36 contains a FORTRAN program which goes into an infinite loop, printing messages at your terminal. Make a copy of the source file for your use (with a new program name, of course) and then compile, load and run the program. Use the three commands you selected above and note what happens.

LAB 4 - FILE MANAGEMENT SYSTEM

1. Allocate (mount) a private cartridge from the Spare Cartridge Pool.

   What is the LU of the cartridge allocated?

2. What are the names of all the type 6 files on LU 2? The names of all the source files (first character of the file name an "&") on the system "lab exercises" cartridge?

3. The FORTRAN program in source file &LAB43 contains READ statements directed to LU 5 and WRITE statements directed to LU 6.

   * Create a copy of the source file for your use. Give the program a new name but DO NOT change the I/O statements.
   * Compile and load your program.
   * Run the program but cause the input and output to be directed to your terminal.

4. What are two ways (two FMGR commands) to tell if there is a file called &LAB31 on the system "lab exercises" cartridge?

5. Use the FMGR ST command to store a file containing relocatable code onto a minicartridge (or magnetic tape). Then use the ST command to input the relocatable code from the tape into a new disc file.

   Can you repeat this exercise using the FMGR DU command instead of the ST command?

6. Store 4 files on a minicartridge or a magnetic tape.

   * use the FMGR CN command to rewind the tape

   * use the CN command to position the tape (forward space) to the third file

   * use the FMGR DU command to list the third file at your terminal

   * use the CN command to backward space the tape to the second file

   * use the DU command to list the 2nd file at your terminal

   Could you use the FMGR LI command instead of the DU command?

7. Use the FMGR LI command to list a source file. List the file again but specify the "B" option. Compare the two listings.

LAB 5 PROGRAM DEVELOPMENT

1. File &LAB51 contains a FORTRAN source program with the following control statement:

   FTN4,L

   Without editing the source file (or a copy), compile the program with

   - a mixed listing
   - a "Q" listing
   - an "L" listing with a symbol table

   What is similar about the mixed and the "Q" listings?

2. Make a copy of source file &LAB52, giving the program a new name. Compile the program and load it as a "real-time" program. Use LOADR to verify that the program really is a "real-time" program. Finally, run the program.

3. Write a FORTRAN program whose source code is contained in two files. One file should contain a main program which calls a subprogram; the other file should contain the source code for the subprogram.

   After you compile the two source files, load the program using LOADR

   - interactively
   - from a command file

   Could you use CLOAD to compile and load this program?

4. Files %GLIB and %XGLIB contain the relocatable code of two library files.

   File &LAB54 contains a FORTRAN source program which uses some of the routines in these two libraries. Make a copy of the source program, giving the program a new name. Compile and load the program, searching the two library files for any needed routines (search %XGLIB before %GLIB). If you want to run the program you need to use a 2648 terminal.

   Try loading the program using the LOADR LIBRARY command (see the Terminal User's Manual for a description of the LIBRARY command).

   How could you determine the names of all the routines in each of these two library files?

5. Write two FORTRAN programs which will communicate with each other via a word in System Common.

   Program 1 should enter a loop, requesting an integer value from the operator and storing this value in System Common. When the value 555 is entered, the program should store the value in System Common, jump out of the loop and terminate.

   Program 2 should also enter a loop, printing the value it finds in System Common on a terminal. When the value 555 is found, the program should print this value, jump out of the loop and terminate.

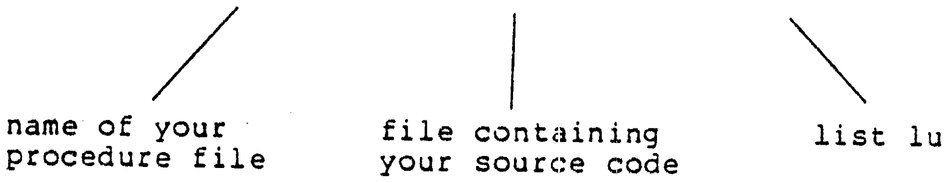
   Some suggestions:

   - be careful when using System Common if someone else is also doing this exercise.
   - run the two programs from separate terminals so they don't interfere with each other when doing I/O.

LAB 6 - PROCEDURE FILES

1. Log on as user LOW.CAPABILITY and see what this user can do. List the user's HELLO file ("LOWCP::2).
2. What FMGR command can you use to determine your account's command capability level?
3. What are 4 ways to determine your Session Identifier (the System LU of your terminal)?
4. Write a procedure file to compile, load and run a program. The procedure file is to be invoked with

```
:TR,procedure file,source file, list lu
```



name of your procedure file

file containing your source code

list lu

version 1	- ignore the possibility of compiler or LOADR errors. - 'OF' the program after it is run to avoid getting duplicate program errors on subsequent loads. - use a file called %TEMP to hold the relocatable code. Will your procedure file work equally well if the relocatable file is called TEMP? See the RTE FORTRAN IV Reference Manual, appendix on compiler operations.
version 2	- if a compiler error(s) occurs, print a message and transfer back to the operator.
version 3	- if a LOADR error(s) occurs, print a message and transfer back to the operator.
version 4	- require that the first character of the source file name be an "&". If not, print a message and transfer back to the operator.
version 5	- make use of the "&" as the first character in the source file name by specifying "-" as the relocatable file in the :RU,FTN4.... command.

5. Write a procedure file which will store 4 disc files on a mini-cartridge or a magnetic tape. Store the procedure file on the tape as the first file, then invoke the procedure file to store the 4 files on the tape. Your tape should then look like this -

SOT EOT

procedure file	file 1	file 2	file 3	file 4

Transfer the 4 files back from the tape into 4 new disc files by

- storing the procedure file from the tape to a new disc file.
- editing the procedure file just input from tape so it will store 4 files from tape into 4 new disc files.
- invoking the new procedure file to read the 4 files from the tape.

The EDITR "X" command will be of use in editing the procedure file.

6. Write a procedure file which will accept the name of an existing file and then create a copy of that file for you with a new name. For example,

```
:TR,procedure file,file name
```

if you specified FILED, the procedure file will create a file called "FILExx", where "xx" is your Session Identifier, and store the contents of FILED into FILExx.

Suggestions:

- assume the file name to be at least 4 characters
- use the FMGR ST command to create the new file and transfer the data from the original file to the new file.

LAE 7 - USING RTE'S SERVICES PROGRAMMATICALLY

1. Files &LB711 and &LB712 each contain a FORTRAN source program. Each program prompts for an LU and then outputs a message identifying itself on that device.

   Make a copy of each source file, giving the programs new names. Then compile and load the two programs.

   For this exercise, you will need to use a terminal in addition to your own. With the second terminal displaying a FMGR prompt,

   - Set the priority of one program to 25.
     Set the priority of the other to 30.

   - Run the priority 30 program, directing the message to the second terminal.
     Run the priority 25 program, also directing the message to the second terminal.

   - Hit the return key on the second terminal.

   In what order do the messages appear? Repeat this exercise but use priorities of 85 and 90.

2. Using EXEC READS and WRITES, write a program which prompts the operator to enter up to 40 characters and then prints those characters (and only those characters) on the line printer. Have your program repeat this process until the operator enters a null string (just a carriage return) in response to the prompt issued by your program.

   If you like, you can use a FORTRAN WRITE for the prompt.

3. Write a program which inputs an integer value and then sets the time-out of your terminal to that value.

   Be careful about the value you enter since time-outs are in units of 10's of milliseconds!

   If you like, you can use FORTRAN READS and WRITES for the program's I/O; use an EXEC Call to set the terminal's time-out.

4. Write a program which prompts the operator for an LU number and then prints a message stating whether that LU is

   - a terminal
   - a magnetic tape drive
   - a printer
   - none of the above

   Again, you can use FORTRAN statements for the I/O; use an EXEC Call to determine the device information.

   What happens if you enter an LU not in your SST?

   Modify your program to print a message if you specify an LU not in your SST.

LAB 8 - INTERACTING WITH YOUR PROGRAM

1. Write a program that prints a message on a device to be specified when the program is run. For example,

```
:RU,program,6
              \
               print the message on LU 6
               (assume non-disc devices)
```

2. Write a program that tells you how many characters are in your first name. Design your program so that it can be run in two ways -

```
:RU,program,name        (The program determines the
                        numbers of characters in the
                        specified name.)

-or-

:RU,program             (The program should prompt the
                        user to enter a name.)
```

3. File &LAB83 contains a FORTRAN source program which accepts a string of 4 to 6 ASCII characters and renames the string for your Session. For example,

```
:RU,program,FILEDD
```

The program uses PRTN to return the string "FILExx", where "xx" is the Session Identifier of the user who ran the program.

If the passed string has less than 4 or more 6 characters, the program will print a message and pass back a 0 in the first return parameter.

Make a copy of the source file (giving the program a new name), then compile and load the program.

Look at the procedure file you wrote for problem 6 of the procedure file lab (a procedure file to accept the name of a file and create a copy of the file with a new name, determined by your Session Identifier).

Modify the procedure file so that it uses this program to determine the new file name. Your procedure file can then use this new name in the FMGR ST command to create the new file and transfer the data from the original file to the new file.

4. Write a program which goes into a loop, writing lines on your terminal until you "break it." Your program should then suspend itself. When you reschedule the program, include a parameter which will specify one of two options:

   - print 1 line on the line printer and then stop

   - stop without doing any more printing.

   While your program is suspended, use WHZAT to determine its state.

LAB 9 - TYPE 6 FILES

1. Write a FORTRAN program which contains an infinite loop, printing a message at your terminal. After compiling and loading your program,

   - run the program
   - terminate the program with the system ´OF´ command
   - save the program as a type 6 file
   - release the program´s ID Segment and disc tracks containing its Memory Image Code
   - run the program
   - terminate the program with the system ´OF´ command.

LAB 10 - USING FILES PROGRAMMATICALLY, FMP CALLS

* PART A *

1. File TLB101 contains an ASCII text file whose maximum record length is 10 words.

   Write a program to list the contents of the file at your terminal.

   Some considerations -

   > Remember that other people may be using the file at the same time you are.
   >
   > You might write your program so you can "break it."

2. Write a program that will create a type 2 file with

   length - 5 blocks
   record length - 1 word

   Your program should store the value 1 into the first record, the value 2 into the second record, the value 3 into the third record and so on.

   After your program terminates, use the FMGR LI command to verify the operation of your program.

3. File &LB103 contains a FORTRAN source program designed to modify the file you created in problem 2. The program will

   - open the file,
   - store the value 7777B into the first record and then
   - terminate.

   Make a copy of the source file, giving the program a new name. Compile, load and run the program. Then use the FMGR LI command to check the program's operation.

4. File VLB104 is a type 1 disc file containing 640 real values.

   Write a program to input the values and then calculate and print the average of the values.