

I N T R O D U C T I O N

T O

V M / 3 7 0

JULY 7 - 8, 1975

## INTRODUCTION TO VM/370

JULY 7 AND 8

- I. INTRODUCTION OF COURSE AND STAFF
- II. GENERAL DESCRIPTION OF VM/370
- III. VIRTUAL MACHINE DESCRIPTION
- IV. CP FACILITIES
- V. CMS FACILITIES
- VI. CP IMPLEMENTATION
- VII. VM/370 RESTRICTIONS
- VIII. PERFORMANCE TOOLS
- IX. SYSTEM INTEGRITY
- X. DEMONSTRATION

### TEXTS:

- CMS Primer (SR20-4438)
- VM/370 Introduction (GC20-1800)
- Command Language Guide for General Users (GC20-1804)
- VM/370 Edit Guide (GC20-1805)

### PREREQUISITES:

- General knowledge of virtual systems
- Read CMS Primer, Chapters I, II, III, VII, IX
- Read VM/370 Introduction
- Familiarity with:

IBM System/370 Principles of Operation  
(GA22-7000)

G E N E R A L

D E S C R I P T I O N

# Virtual Machine Facility/370 (VM/370) Library

(Release 2 PLC 11)

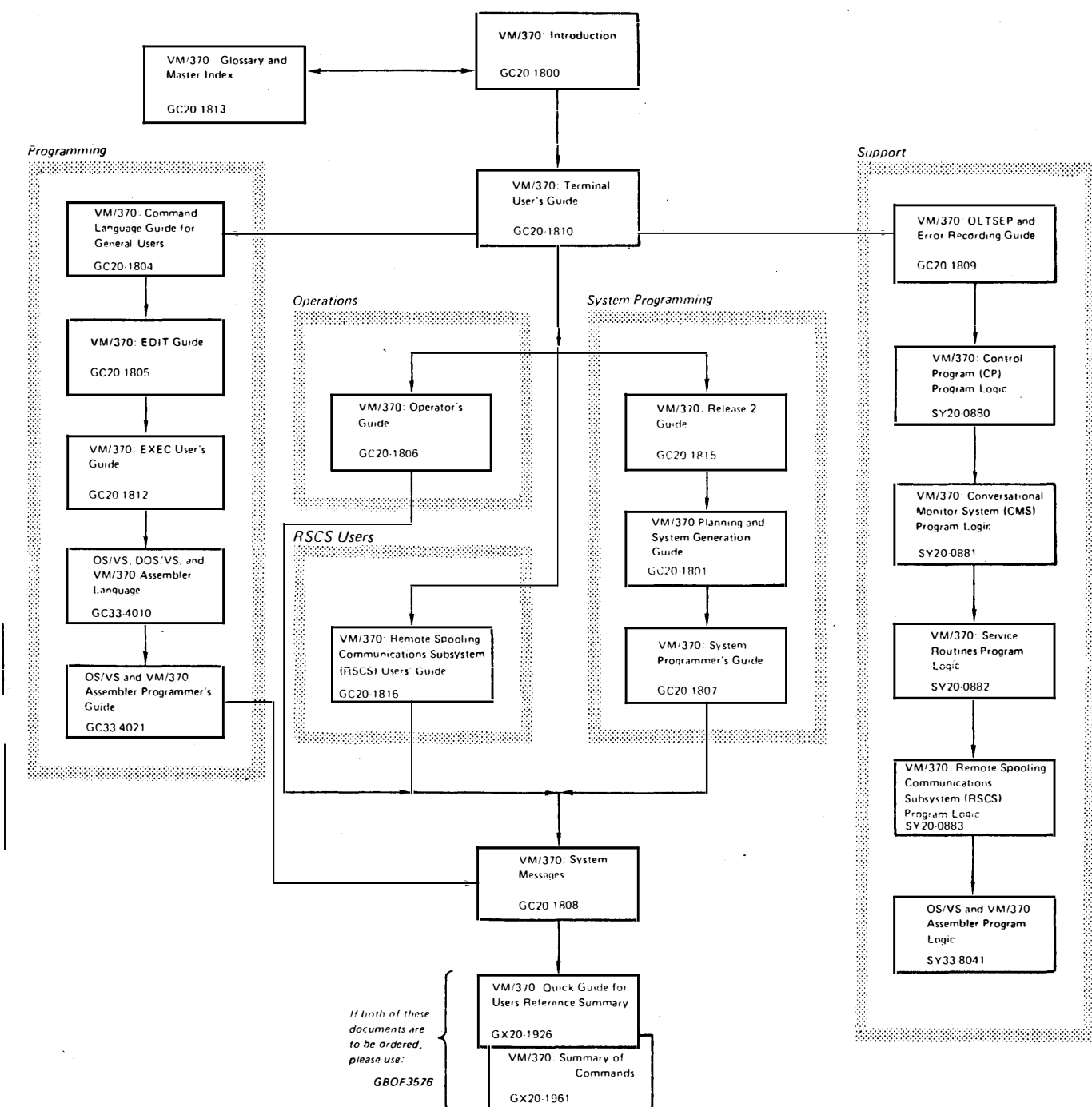


Figure 1. Virtual Machine Facility/370 Library

# VM/370 SYSTEM CONTROL PROGRAM

- CP CONTROL PROGRAM
- CMS TIME SHARING SUBSYSTEM
- RSCS REMOTE SPOOLING SUBSYSTEM

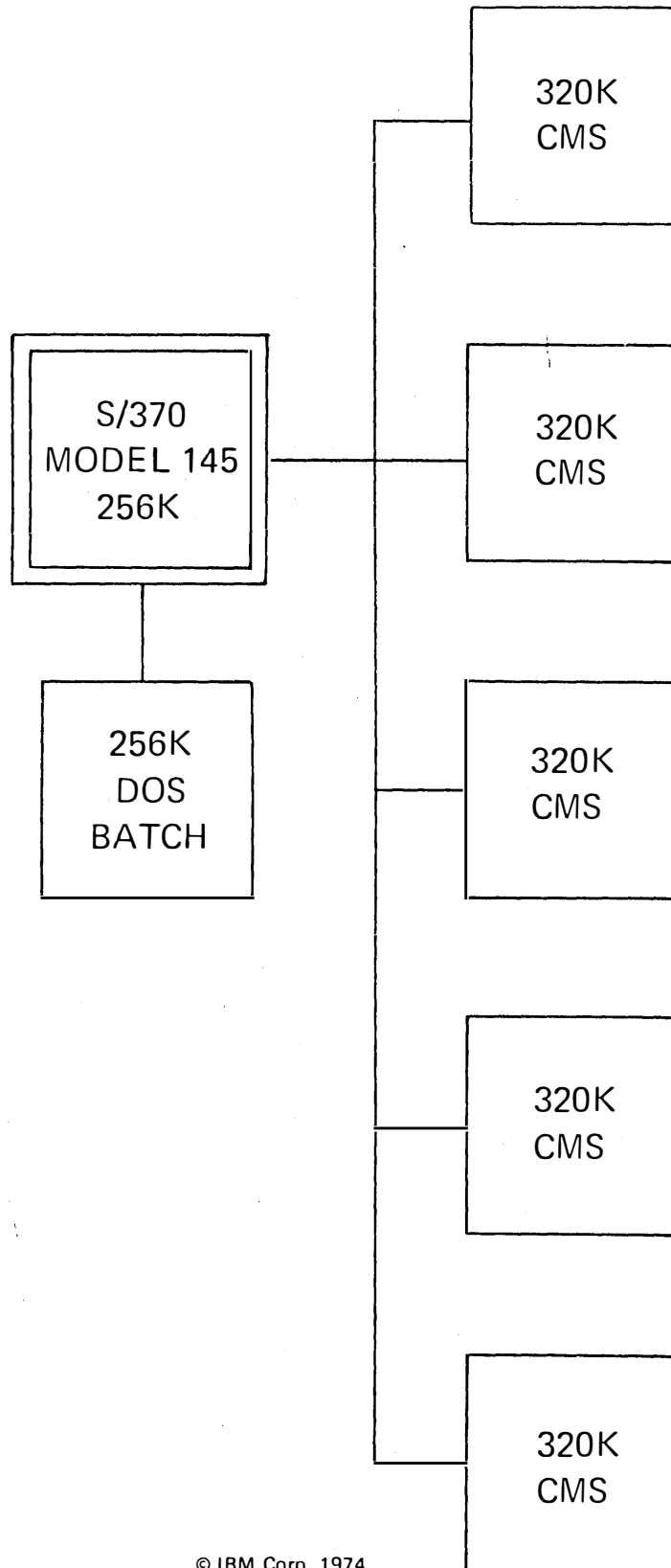
# VIRTUAL MACHINE – THE FUNCTIONAL EQUIVALENT OF A REAL COMPUTING SYSTEM

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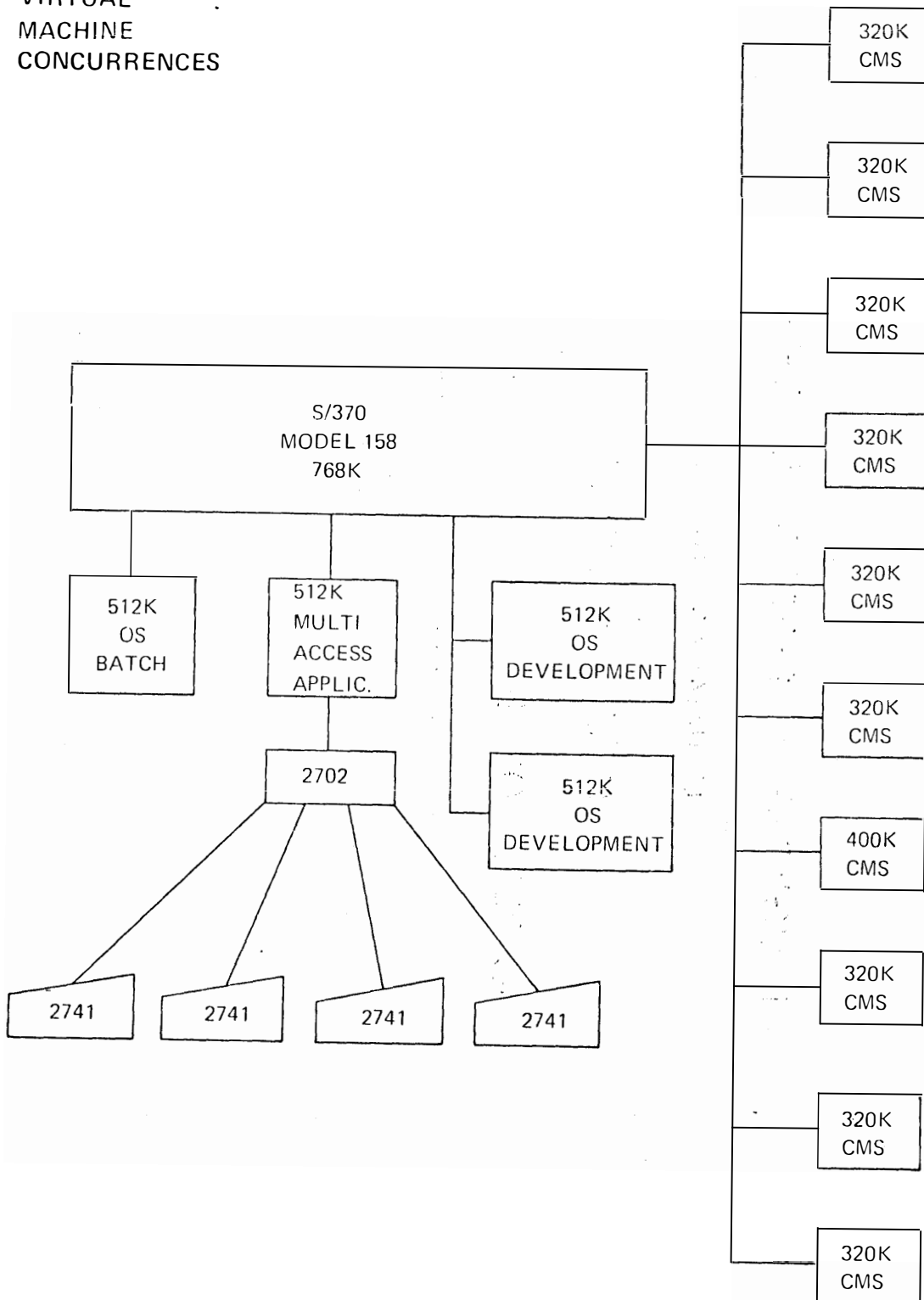
V.1.2/H.1.2

- VM/370 MANAGES CONCURRENT EXECUTION OF MULTIPLE VIRTUAL MACHINES
- VIRTUAL MACHINE OPERATING SYSTEMS SCHEDULE AND CONTROL USER WORK FLOW

# VIRTUAL MACHINE CONCURRENCES



# VIRTUAL MACHINE CONCURRENCES



# VIRTUAL MACHINE OPERATING SYSTEMS

|        |        |
|--------|--------|
| CMS    | VM/370 |
| DOS    | DOS/VS |
| OS     | OS/VS1 |
| OS-ASP | OS/VS2 |
| PS44   | RSCS   |

## MODES OF OPERATION

BATCH

INTERACTIVE

MULTI-ACCESS

## VIRTUAL MACHINE RESTRICTIONS

- NO TIME DEPENDENT CODE
- NO DYNAMICALLY MODIFIED CCWs  
EXCEPT OS-ISAM  
OS/VS — TCAM  
RUNNING IN V=R
- DIAGNOSE A SPECIAL INTERFACE

## SYSTEM REQUIREMENTS

REQUIRES:       240K OF REAL STORAGE  
                  DYNAMIC ADDRESS TRANSLATION FACILITY  
                  SYSTEM TIMING FACILITIES

SUPPORTS:       SYSTEMS/370, 135 THROUGH 168

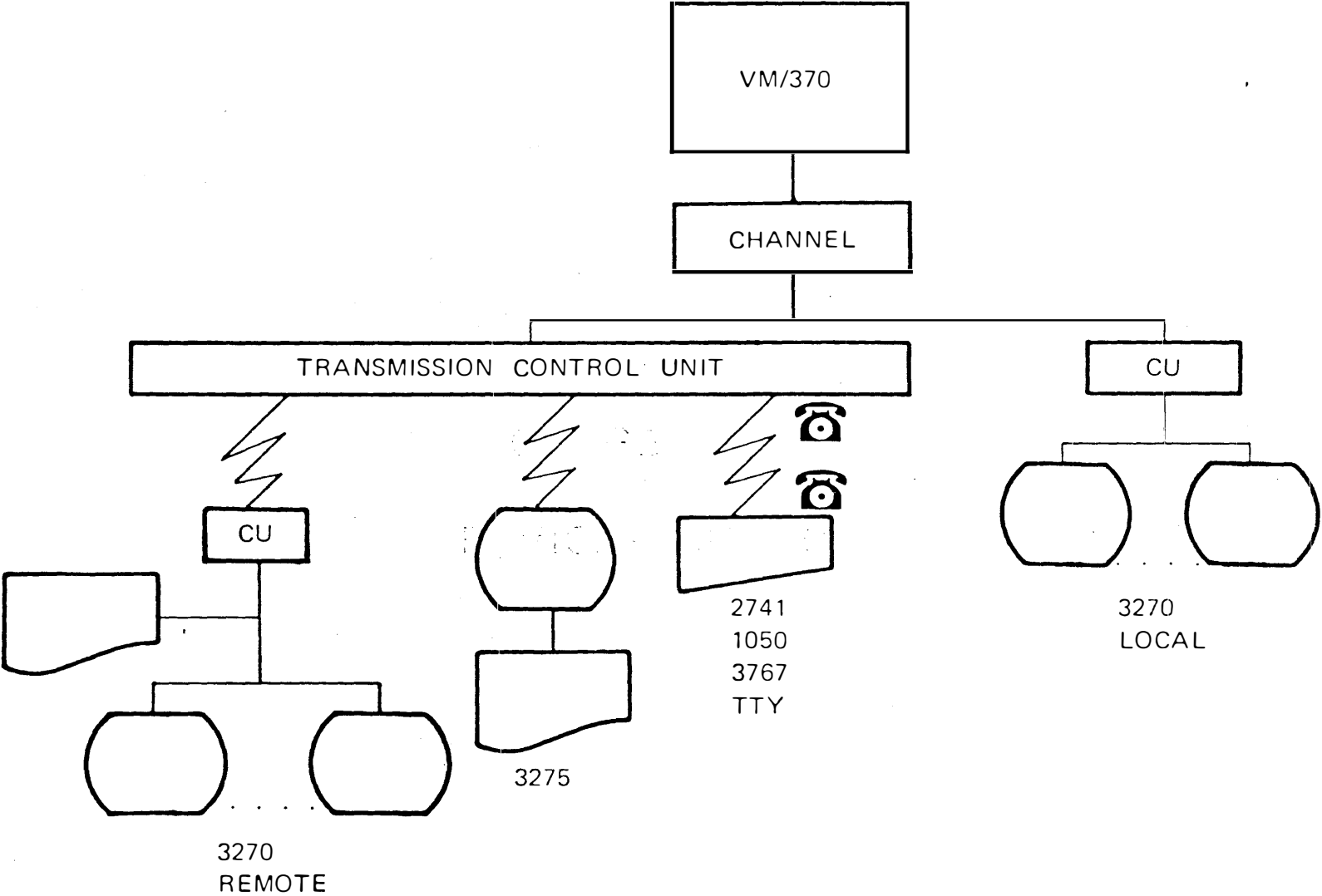
## SUPPORTED DEVICES

|                        |                  |
|------------------------|------------------|
| CONSOLES:              | 3210             |
|                        | 2150             |
|                        | 3066             |
|                        | 3215, 7412       |
| TRANSMISSION CU:       | 2701, 2702, 2703 |
|                        | ICA              |
|                        | 3704/3705        |
| DIRECT ACCESS DEVICES: | 2314/2319        |
|                        | 3330/3333        |
|                        | 3340             |
|                        | 2305             |
| MAGNETIC TAPES:        | 2400, 2415, 2420 |
|                        | 3410/3411, 3420  |
| PRINTERS:              | 1403, 1443, 3211 |
| READERS/PUNCHES:       | 2510, 2520, 2540 |
|                        | 3505, 3525       |

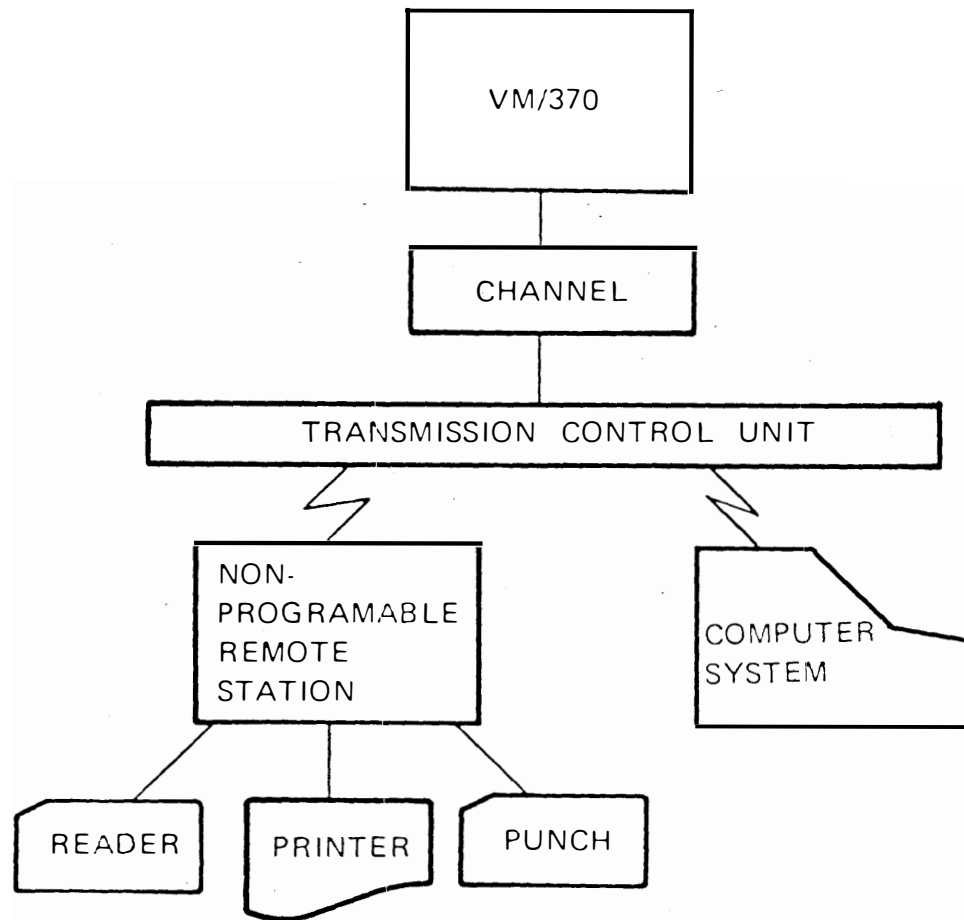
## 3704/3705 COMMUNICATIONS CONTROLLERS

- 270X EMULATION PROGRAM
- NETWORK CONTROL PROGRAM
- PARTITIONED EMULATION PROGRAMMING
- FACILITIES TO:
  - GENERATE
  - LOAD
  - DUMP

VM/370 TERMINALS



## VM/370 REMOTE WORKSTATION SUPPORT



SYSTEM 3 MODEL 10  
SYSTEM/360  
SYSTEM/370  
1130 SYSTEM  
2922 TERMINAL

2770  
2780  
3770  
3780

V I R T U A L  
M A C H I N E  
D E S C R I P T I O N

## MACHINE COMPONENTS

- CONSOLE
- CPU
- STORAGE
- DEVICES AND CHANNELS

## TERMINAL/CONSOLE

| VIRTUAL | OPERATOR'S CONSOLE                                      |
|---------|---------------------------------------------------------|
| REAL    | SYSTEM CONSOLES AND<br>TERMINALS SUPPORTED<br>BY VM/370 |

## STORAGE

|         |                                                                             |
|---------|-----------------------------------------------------------------------------|
| VIRTUAL | 8K TO 16M BYTES MAIN STORAGE                                                |
| REAL    | MINIMUM 240K<br>DYNAMIC RELOCATION<br>ALLOCATION BY PAGE<br>OPTIMIZED USAGE |

## CPU

|         |                                                               |
|---------|---------------------------------------------------------------|
| VIRTUAL | S/370 PRINCIPLES OF OPERATION<br>MULTIPLE SYSTEMS ENVIRONMENT |
| REAL    | TIME SLICING ENVIRONMENT<br>PROBLEM STATE EXECUTION           |

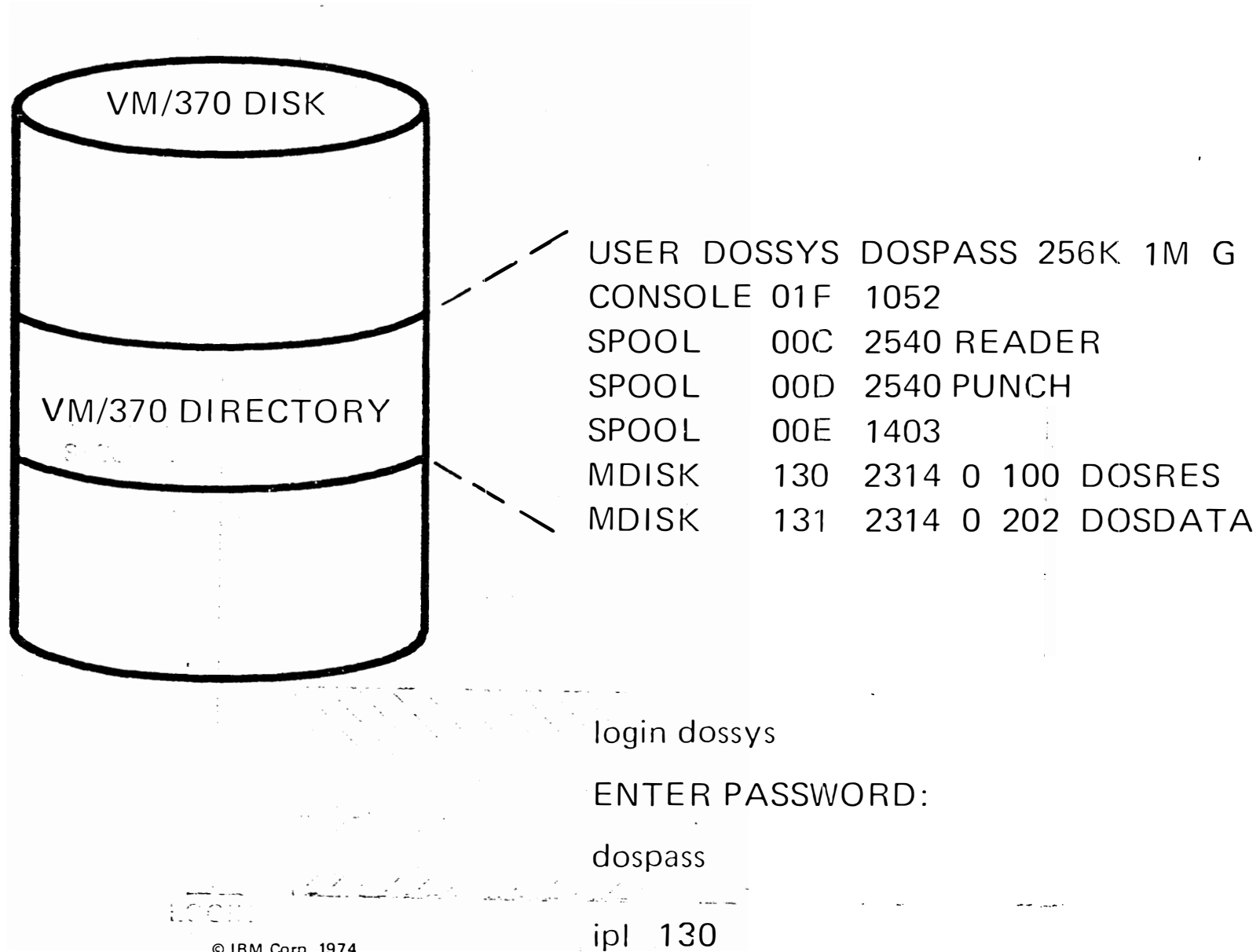
## I/O DEVICES

|         |                                                                            |
|---------|----------------------------------------------------------------------------|
| VIRTUAL | COMPLETE DEVICE CONTROL<br>EXECUTION RESTRICTION                           |
| REAL    | DEVICE TRANSLATION<br>STORAGE TRANSLATION<br>SCHEDULING<br>ERROR RECORDING |

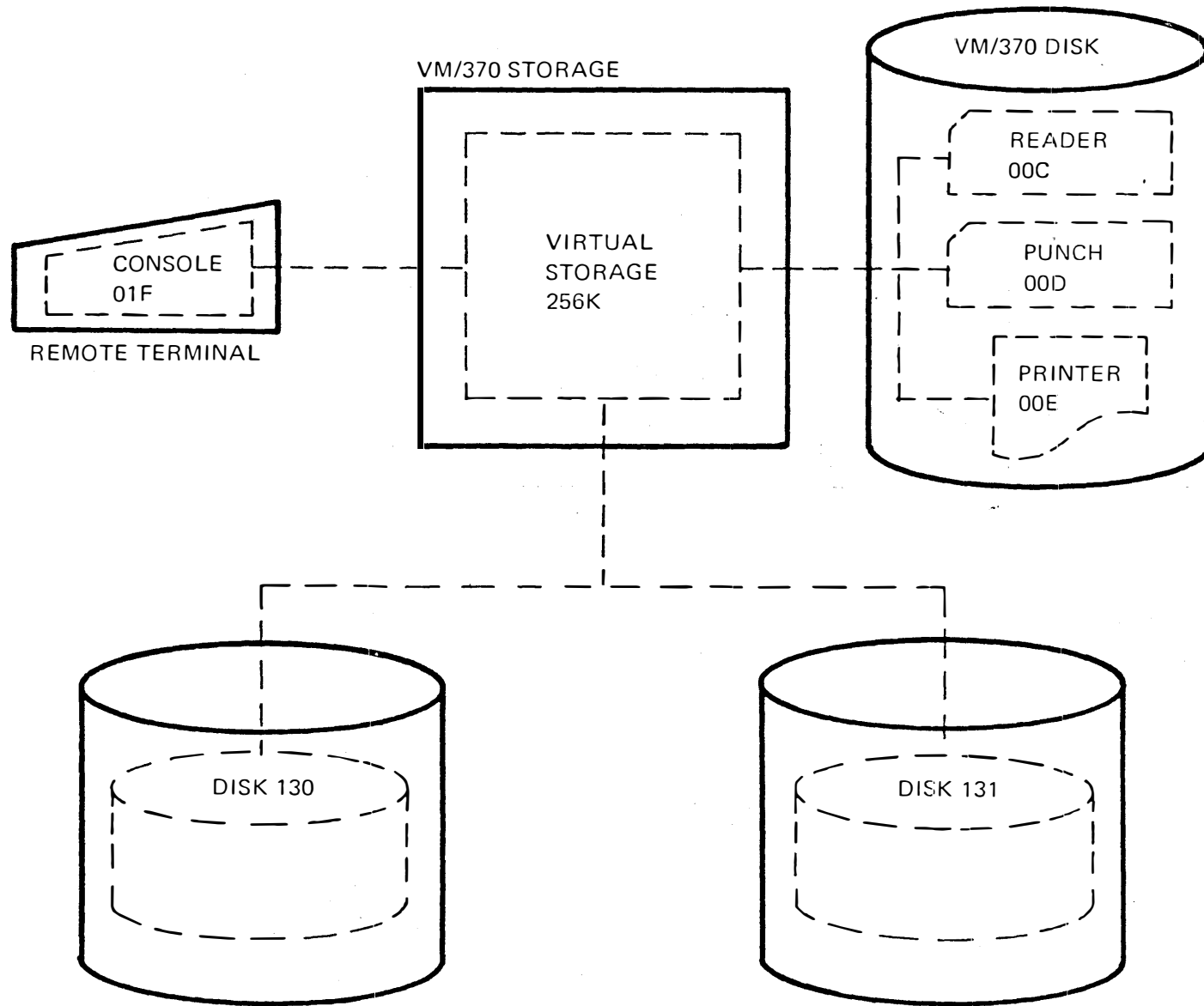
# VIRTUAL MACHINE DEVICE ASSIGNMENTS

- DEDICATED DEVICES
  - TERMINALS
  - DISKS
  - TAPES
  - U/R
  - OTHERS
- SHARED DISKS
- SPOOLED U/R
- MINIDISKS
- SHARED TCU's
- CHANNEL-TO-CHANNEL ADAPTER

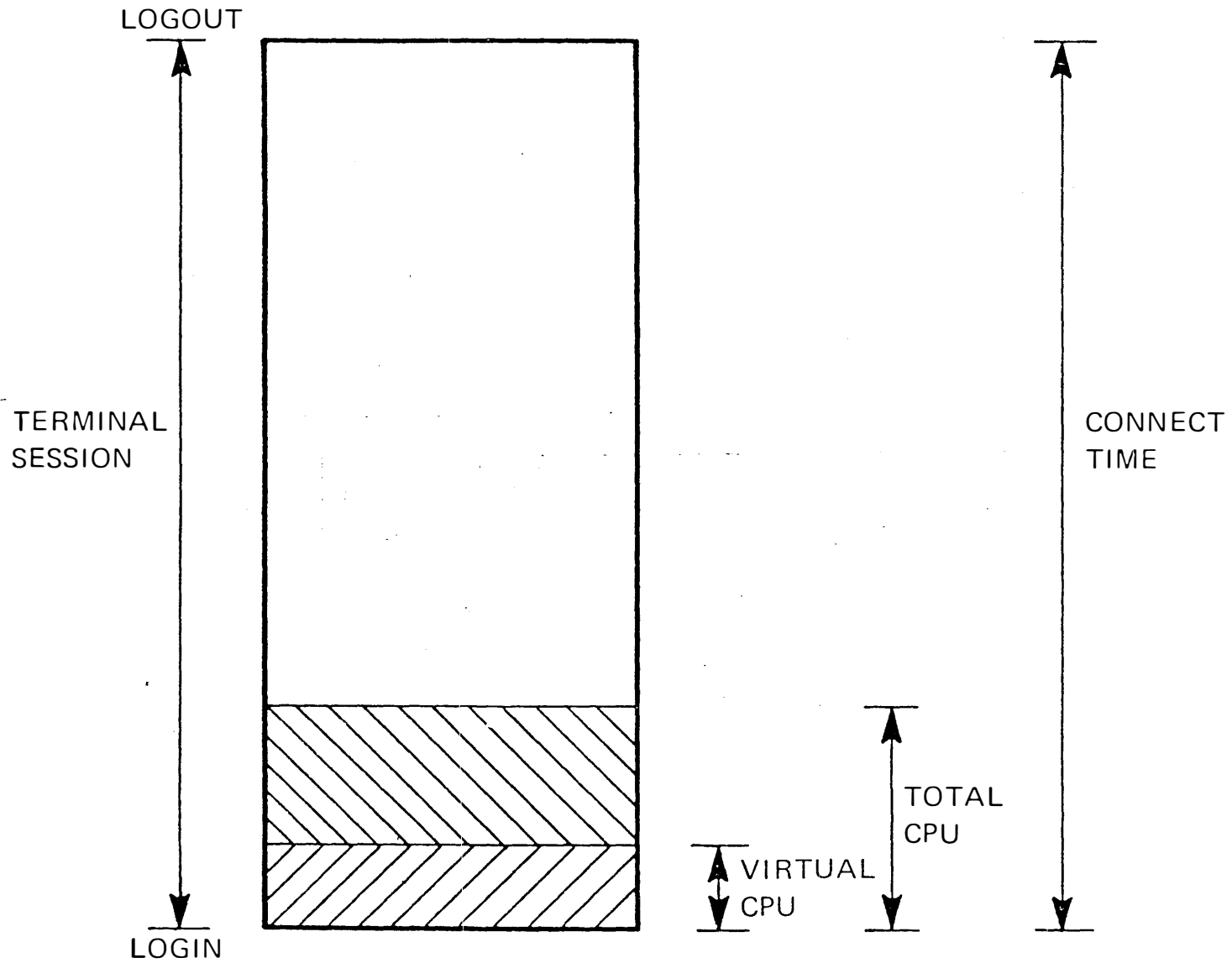
# CREATING A VIRTUAL MACHINE

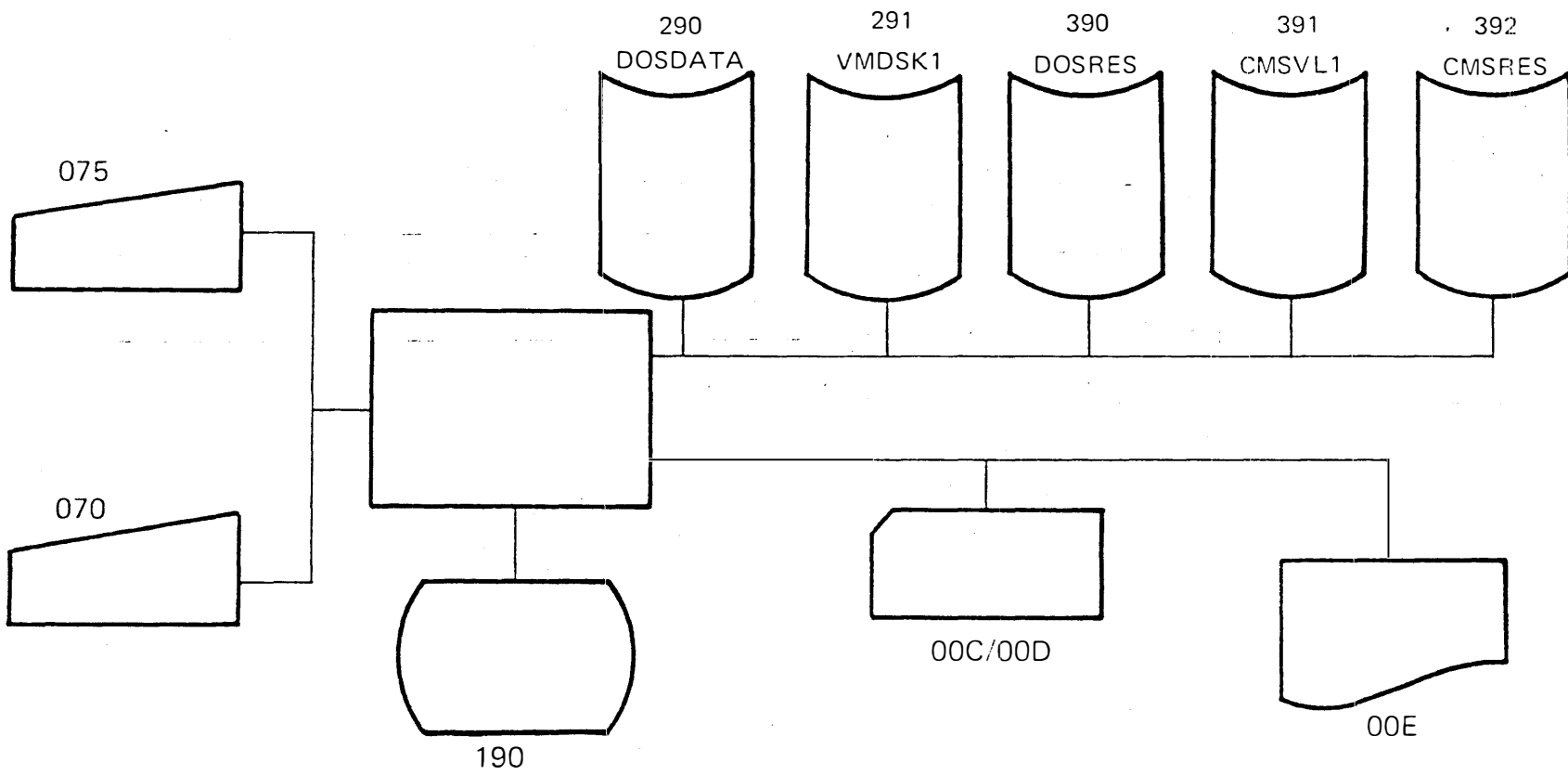


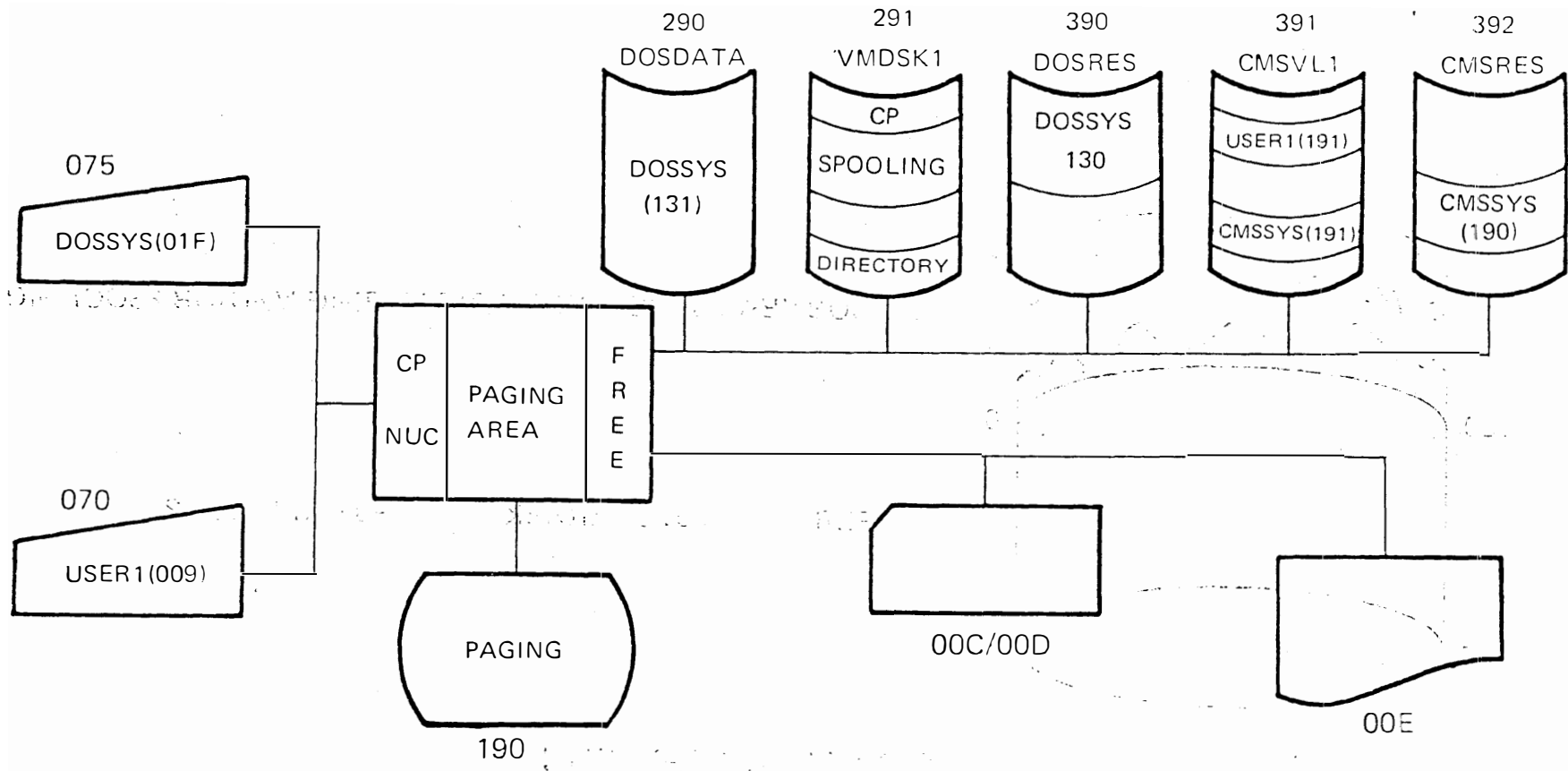
# VIRTUAL MACHINE CONFIGURATION



# VM/370 LOGOUT







## DIRECTORY DESCRIPTION

|         |        |       |        |     |        |
|---------|--------|-------|--------|-----|--------|
| USER    | USER1  | DPEDV | 320K   | 1M  |        |
| CONSOLE | 009    | 1052  |        |     |        |
| SPOOL   | 00C    | 2540  | READER |     |        |
| SPOOL   | 00D    | 2540  | PUNCH  |     |        |
| SPOOL   | 00E    | 1403  |        |     |        |
| LINK    | CMSSYS | 190   | 190    | R   |        |
| MDISK   | 191    | 2314  | 020    | 007 | CMSVL1 |

|         |        |       |        |     |        |
|---------|--------|-------|--------|-----|--------|
| USER    | CMSSYS | SPASS | 320K   | 1M  | EG     |
| CONSOLE | 009    | 1052  |        |     |        |
| SPOOL   | 00C    | 2540  | READER |     |        |
| SPOOL   | 00D    | 2540  | PUNCH  |     |        |
| SPOOL   | 00E    | 1403  |        |     |        |
| MDISK   | 190    | 2314  | 50     | 110 | CMSRES |
| MDISK   | 191    | 2314  | 080    | 010 | CMSVL1 |

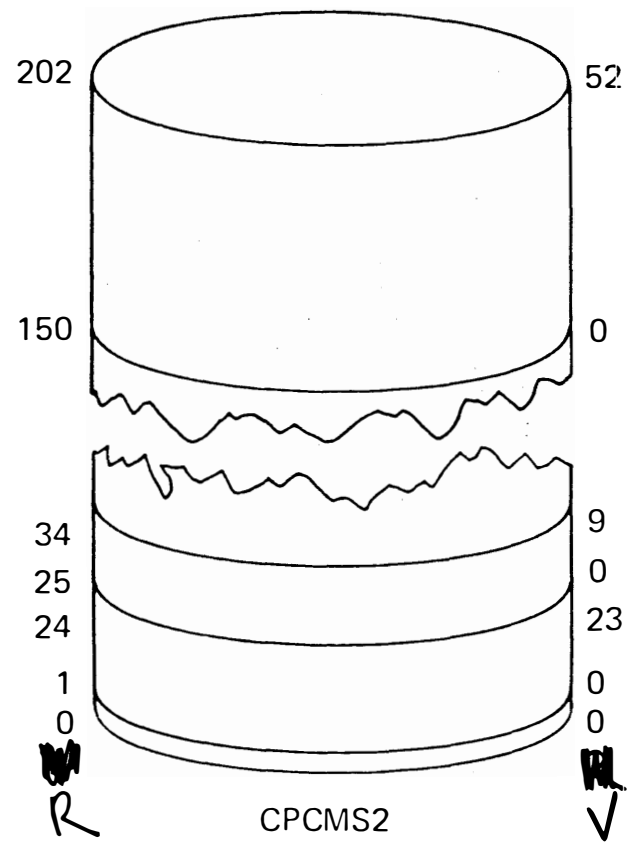
C P

F A C I L I T I E S

# DISK SHARING

- PHYSICAL PACK SHARING
- PHYSICAL DATA SHARING

# PHYSICAL PACK SHARING



USERB 291 MINIDISK 53 CYLINDERS

TEMPORARY SPACE FOR VM/370 PAGING AND/OR SPOOLING

USERA 191 MINIDISK 10 CYLINDERS

USERC 291 MINIDISK 24 CYLINDERS

**IN THE DIRECTORY FOR USERC:**

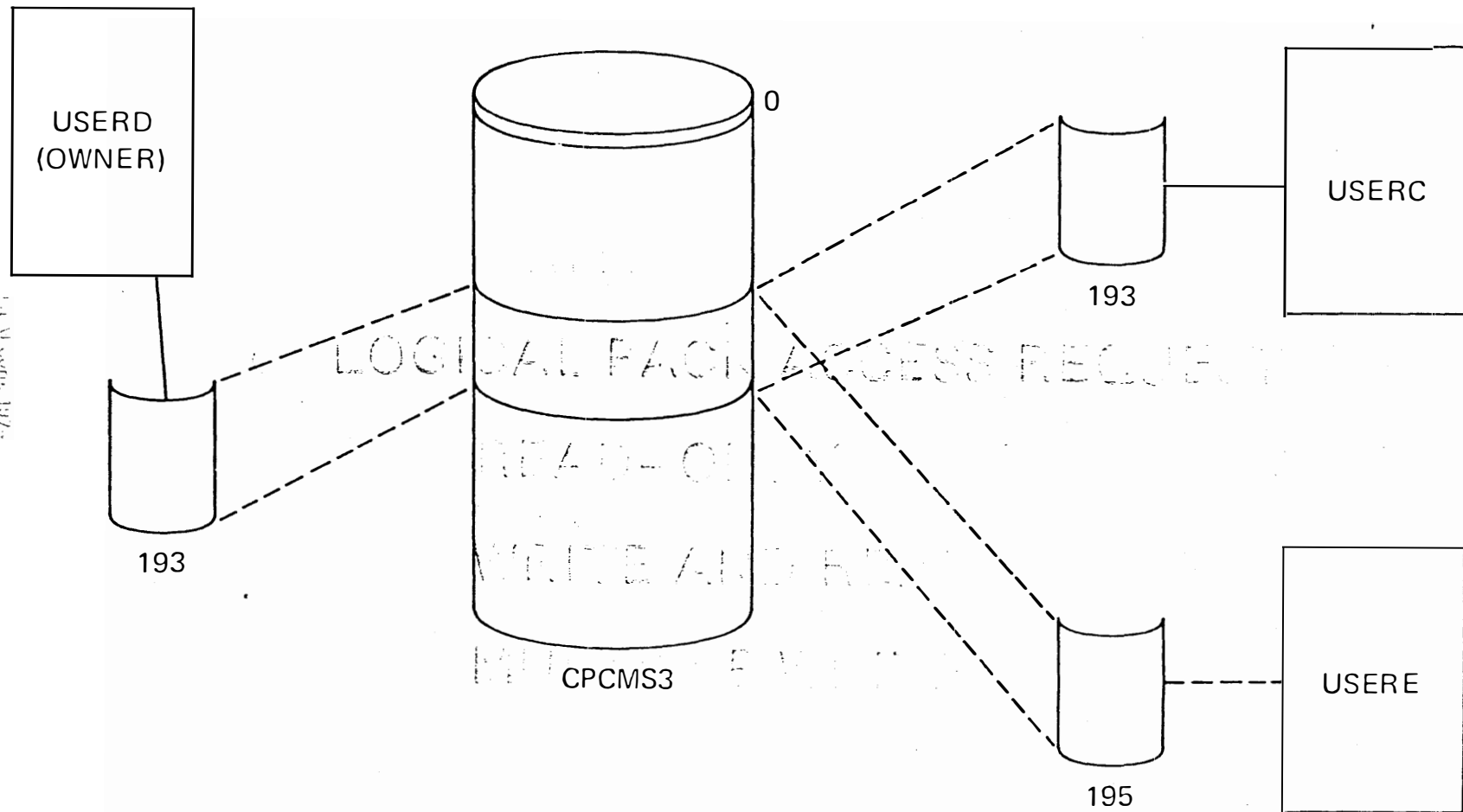
**MDISK 291 2314 001 024 CPCMS2 W**

## TEMPORARY DISKS

CP DEFINE T2319 AS 196 CYL 5

- OBTAINS 5 CYLINDERS
- FROM VM/370 T-DISK AREA
- FOR THE DURATION OF THE TERMINAL SESSION

## LOGICAL PACK SHARING



## LOGICAL PACK SHARING

- DEVICE OWNED BY USERD

MDISK 193 2314 091 010 CPCMS3 R READPASS

- DEVICE AUTOMATICALLY LINKED TO USERC

LINK USERD 193 193 R

- DEVICE DYNAMICALLY LINKED BY USERE

LINK USERD 193 195 R

ENTER READ PASSWORD

READPASS

- LOGICAL PACK ACCESS

READ

WRITE

- LOGICAL PACK ACCESS REQUEST

READ—ONLY

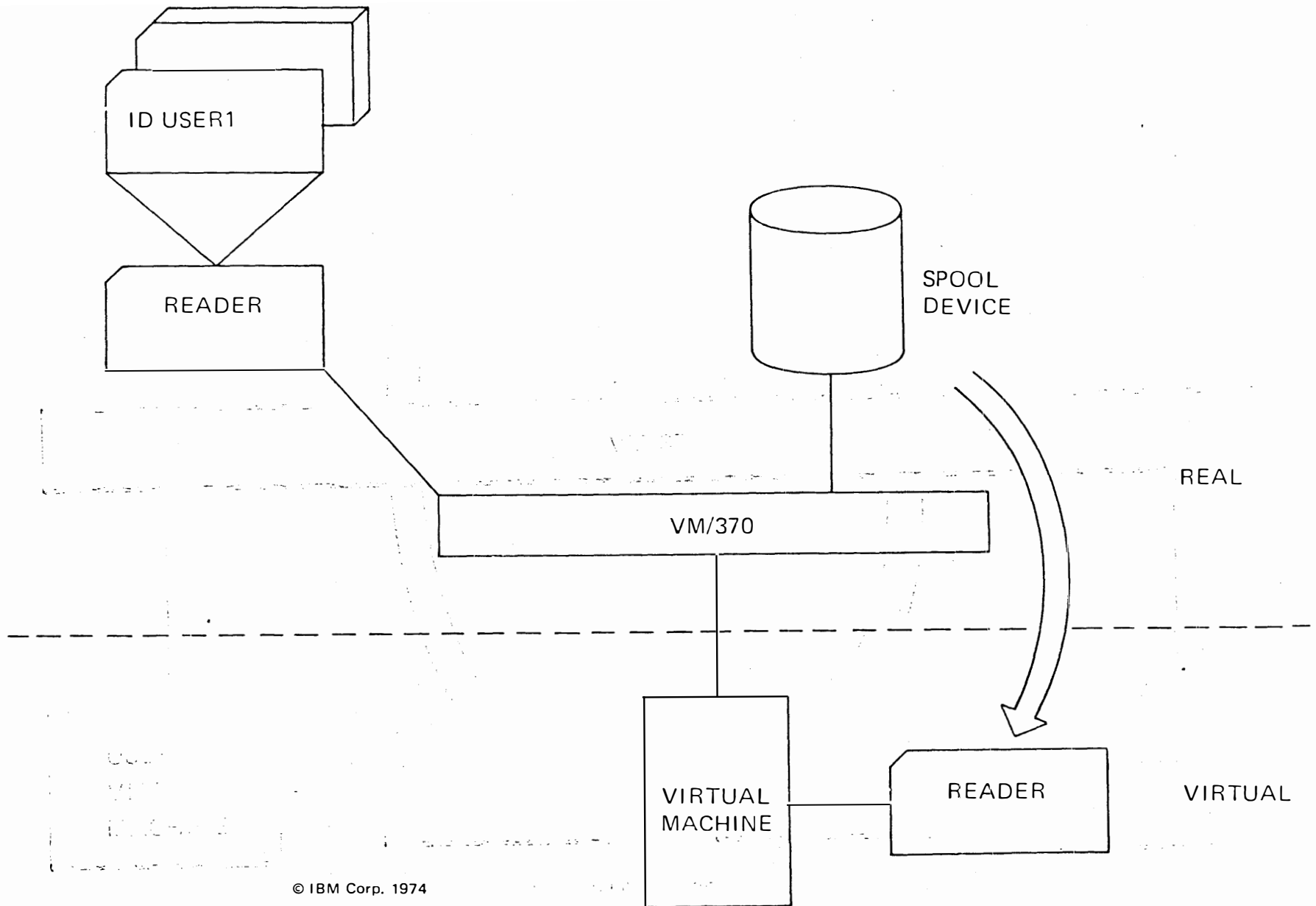
WRITE AND READ

MULTIPLE WRITE

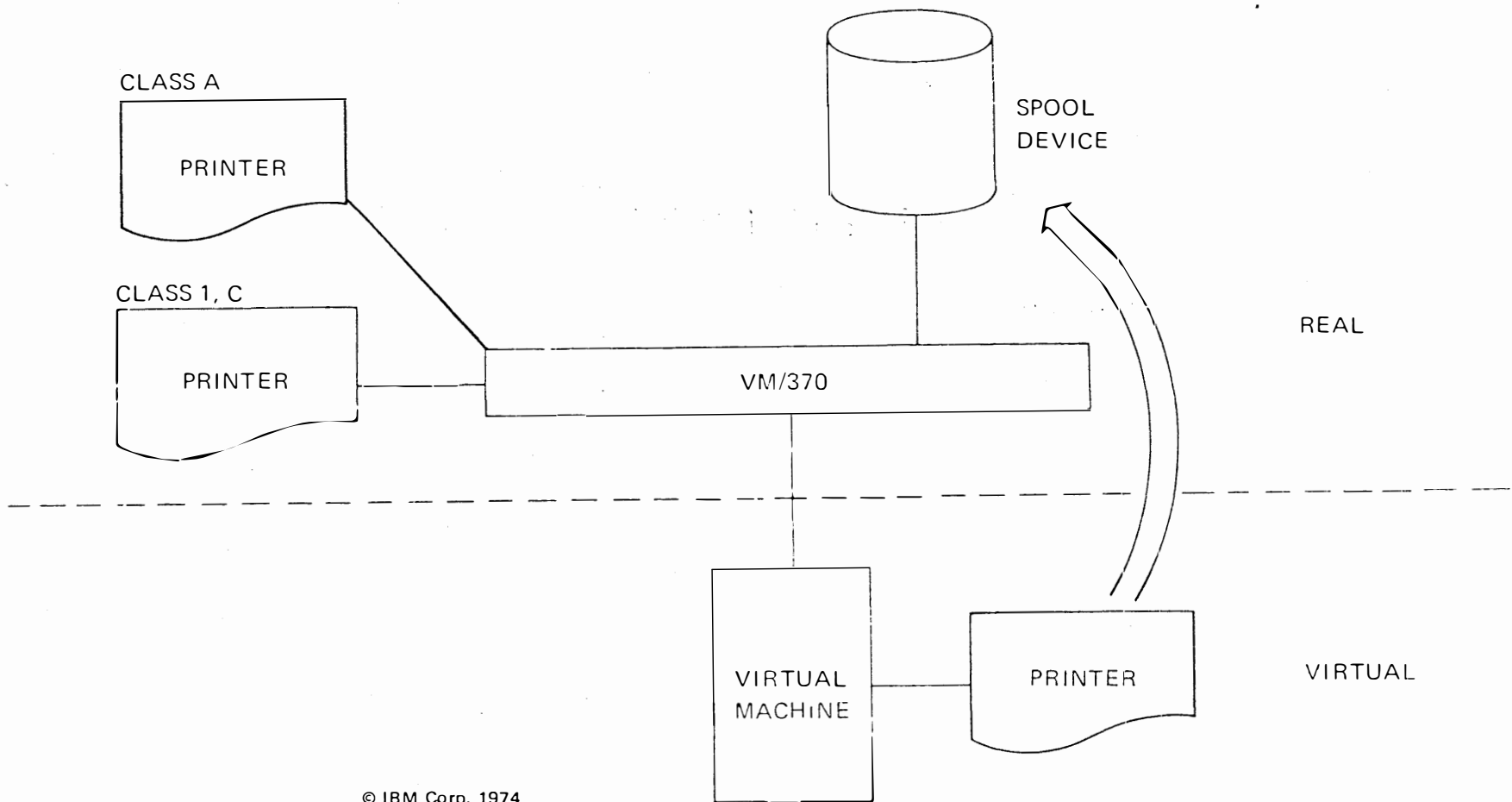
## CP SPOOLING FUNCTIONS

- SIMULATE OPERATION OF VIRTUAL U/R DEVICES
- OPERATE REAL U/R DEVICES
- PROVIDE INTERFACE BETWEEN VIRTUAL MACHINES
  - FILE SHARING
  - REMOTE WORKSTATION
- PROVIDE VIRTUAL CONSOLE SPOOLING

## LOCAL SPOOLING

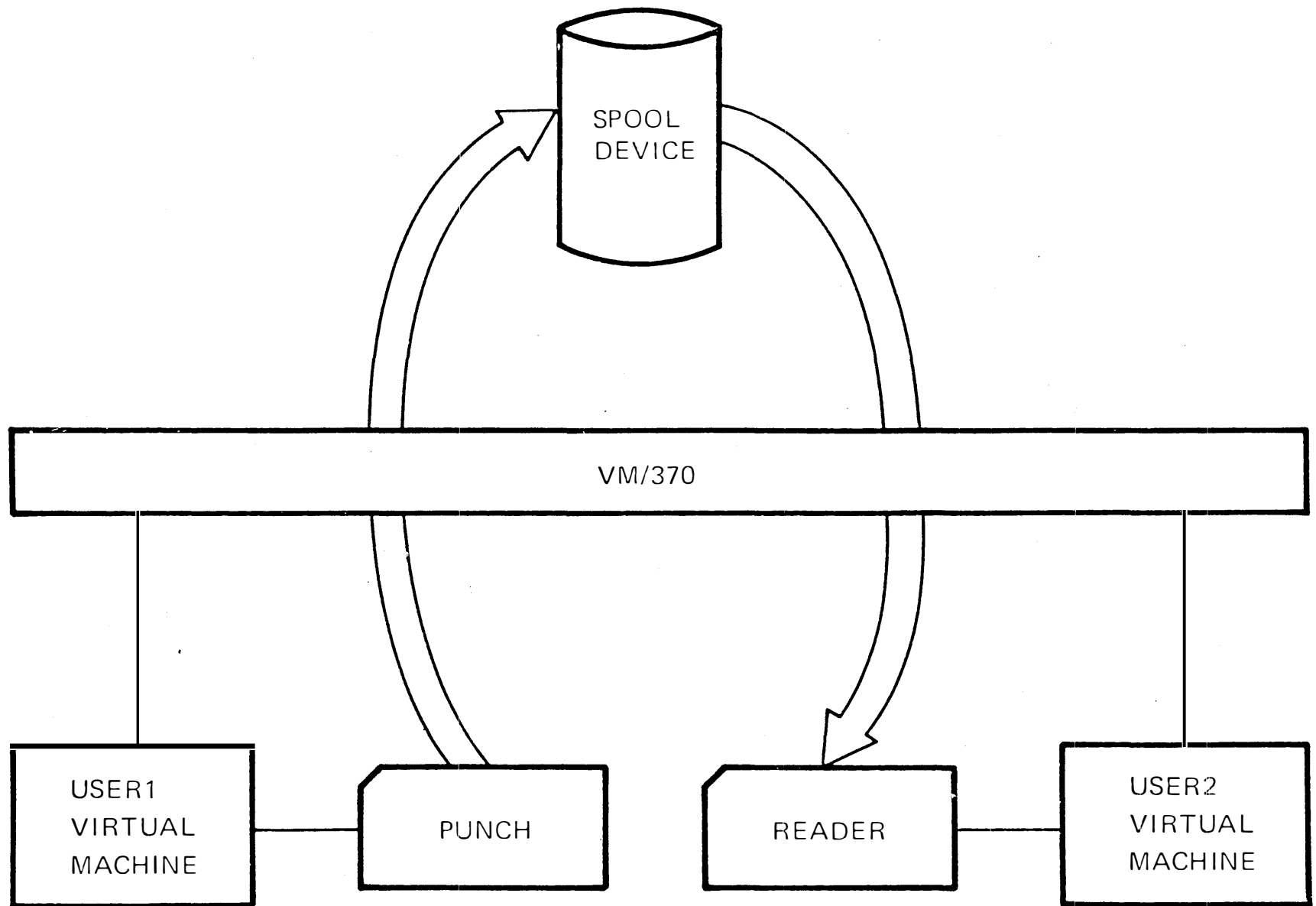


## LOCAL SPOOLING



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## SHARING FILES



# REMOTE SPOOLING COMMUNICATIONS SUBSYSTEM

RSCS IS

A MULTITASKING OPERATING SYSTEM

DESIGNED TO RUN IN A VIRTUAL MACHINE

CONTROLLING THE TRANSFER OF FILES

OVER A REMOTE NETWORK

OF UP TO SIXTEEN REMOTE STATIONS

# REMOTE SPOOLING COMMUNICATIONS SUBSYSTEM

RSCS PROVIDES

- HOST SUPPORT

RSCS ACTS AS THE HOST SYSTEM TO A NETWORK  
OF REMOTE WORKSTATIONS

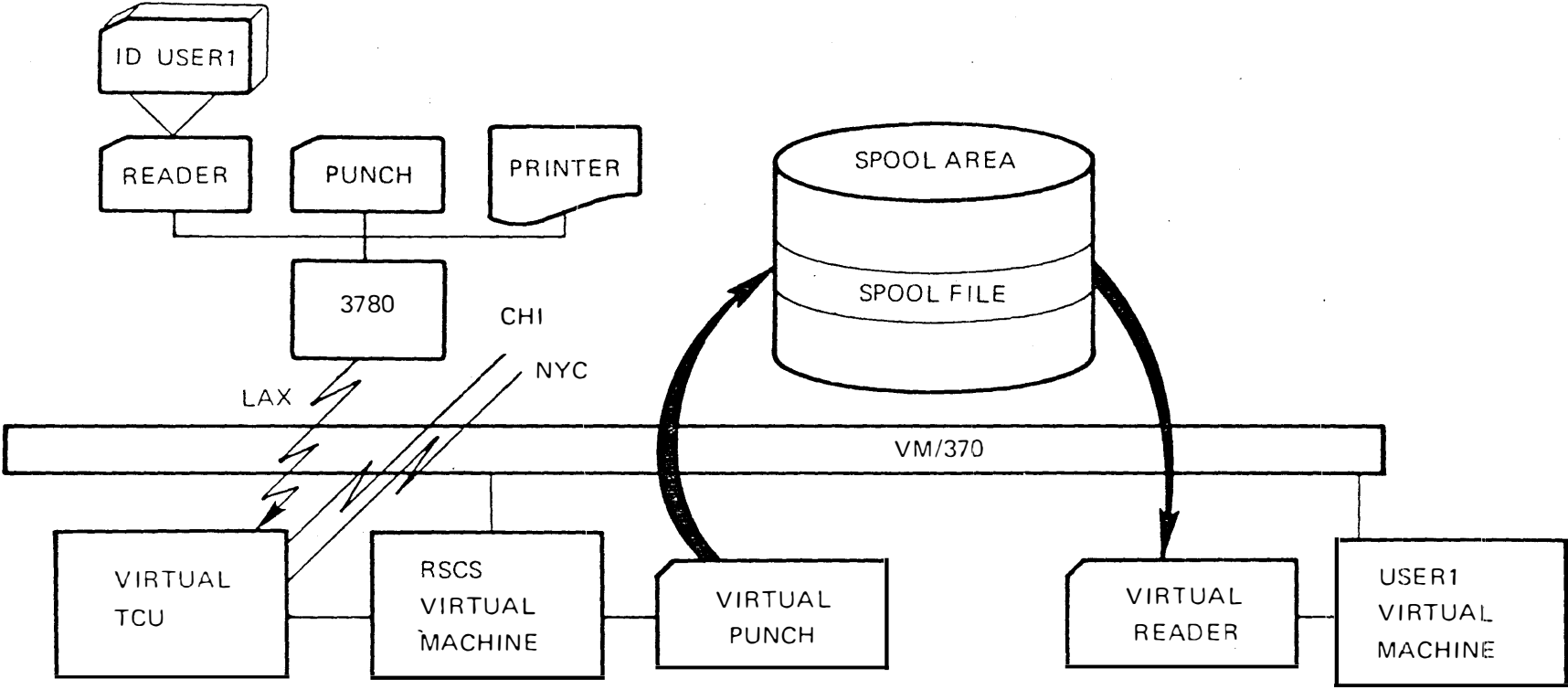
- RJE SUPPORT

RSCS ACTS AS A REMOTE WORKSTATION TO A  
HASP/ASP HOST SYSTEM

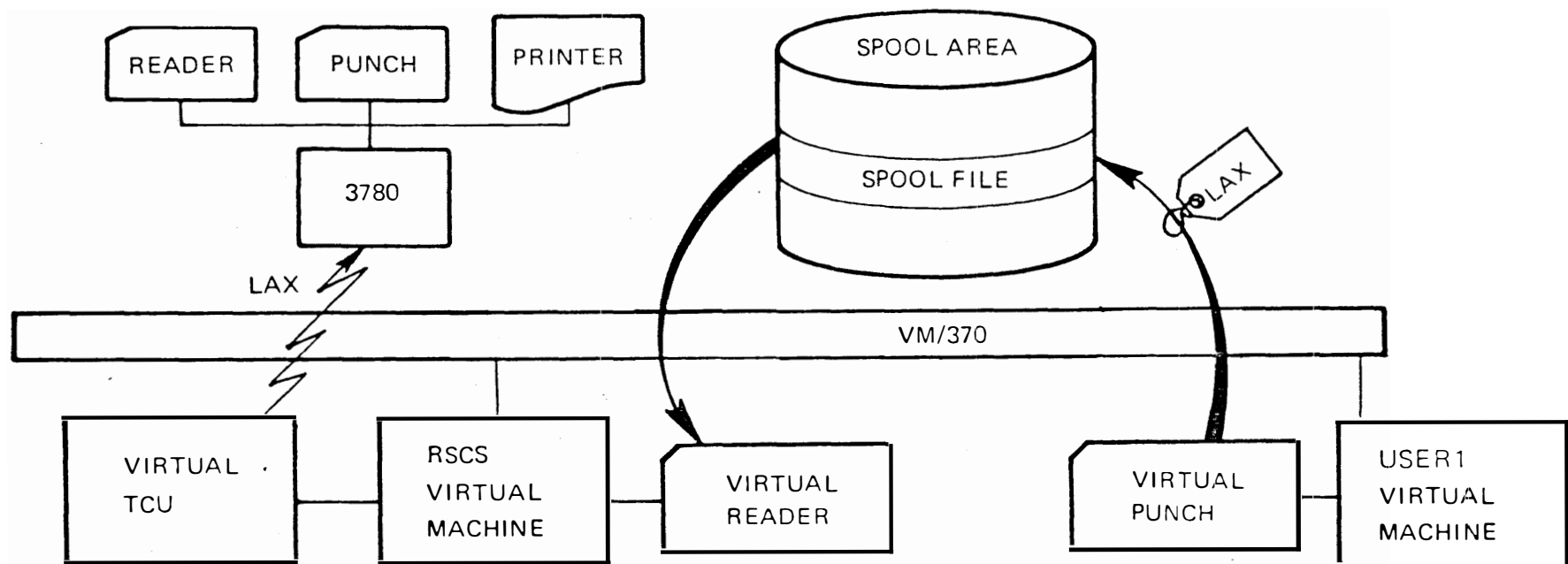
- STATION TO STATION COMMUNICATION

RSCS TRANSMITS A FILE FROM ONE REMOTE STATION  
TO ANOTHER

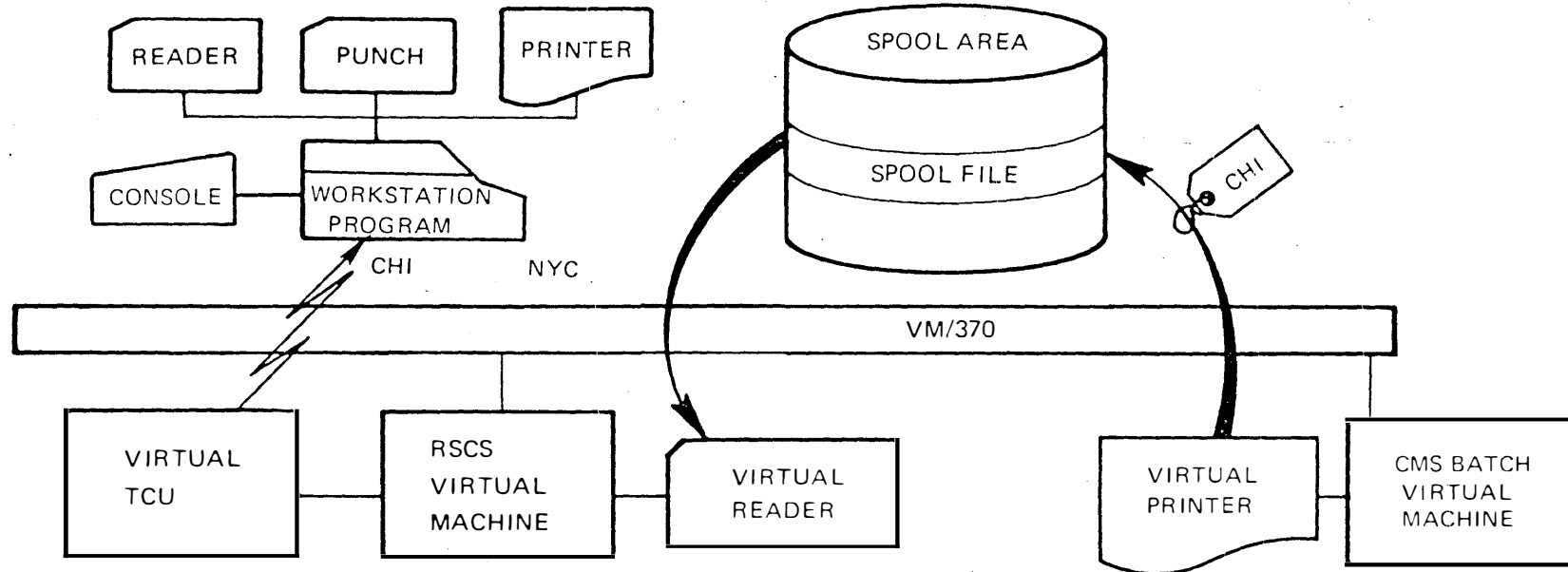
REMOTE SPOOLING INPUT  
TO CMS VIRTUAL MACHINE



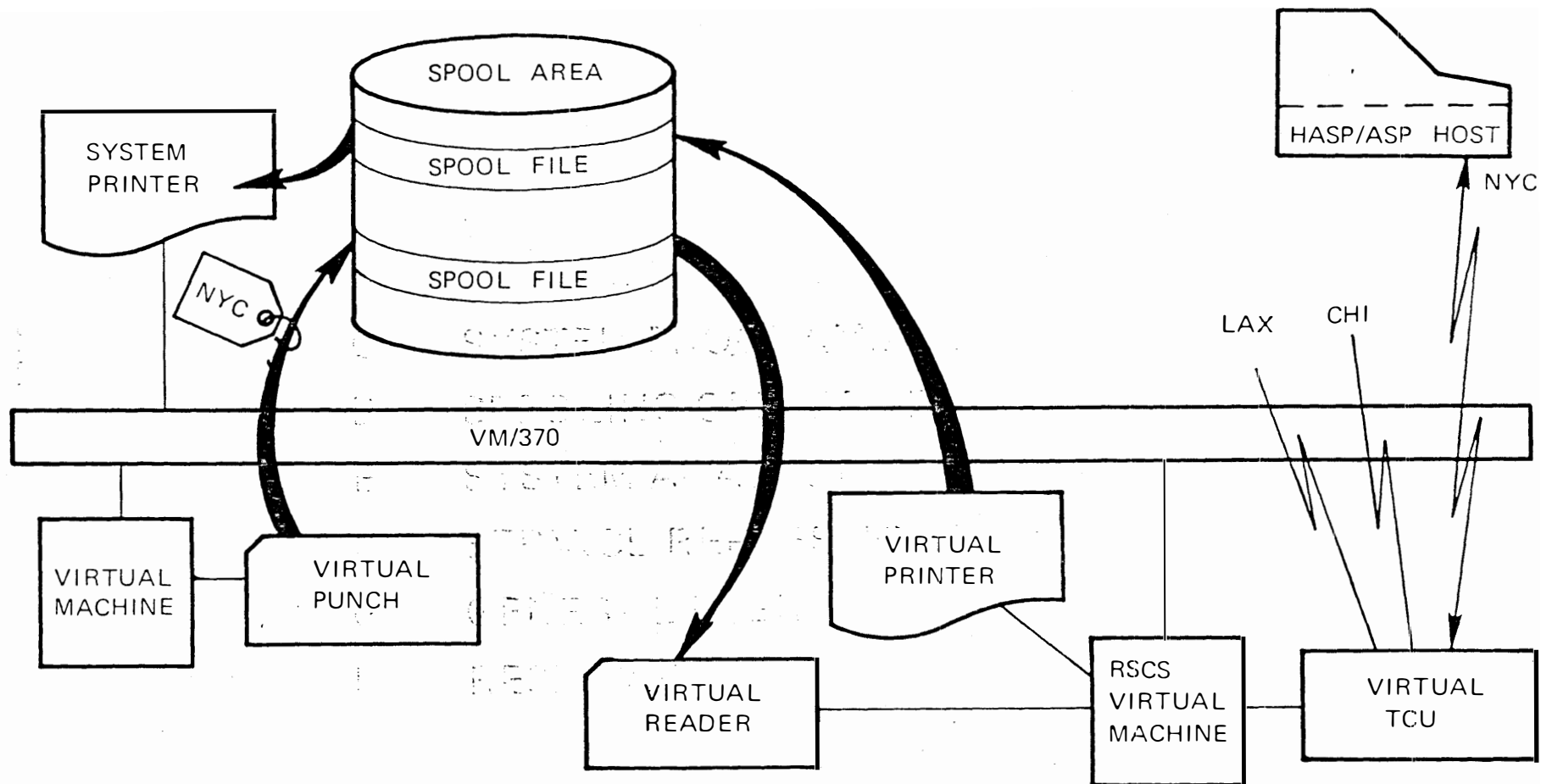
# REMOTE SPOOLING OUTPUT FROM CMS VIRTUAL MACHINE



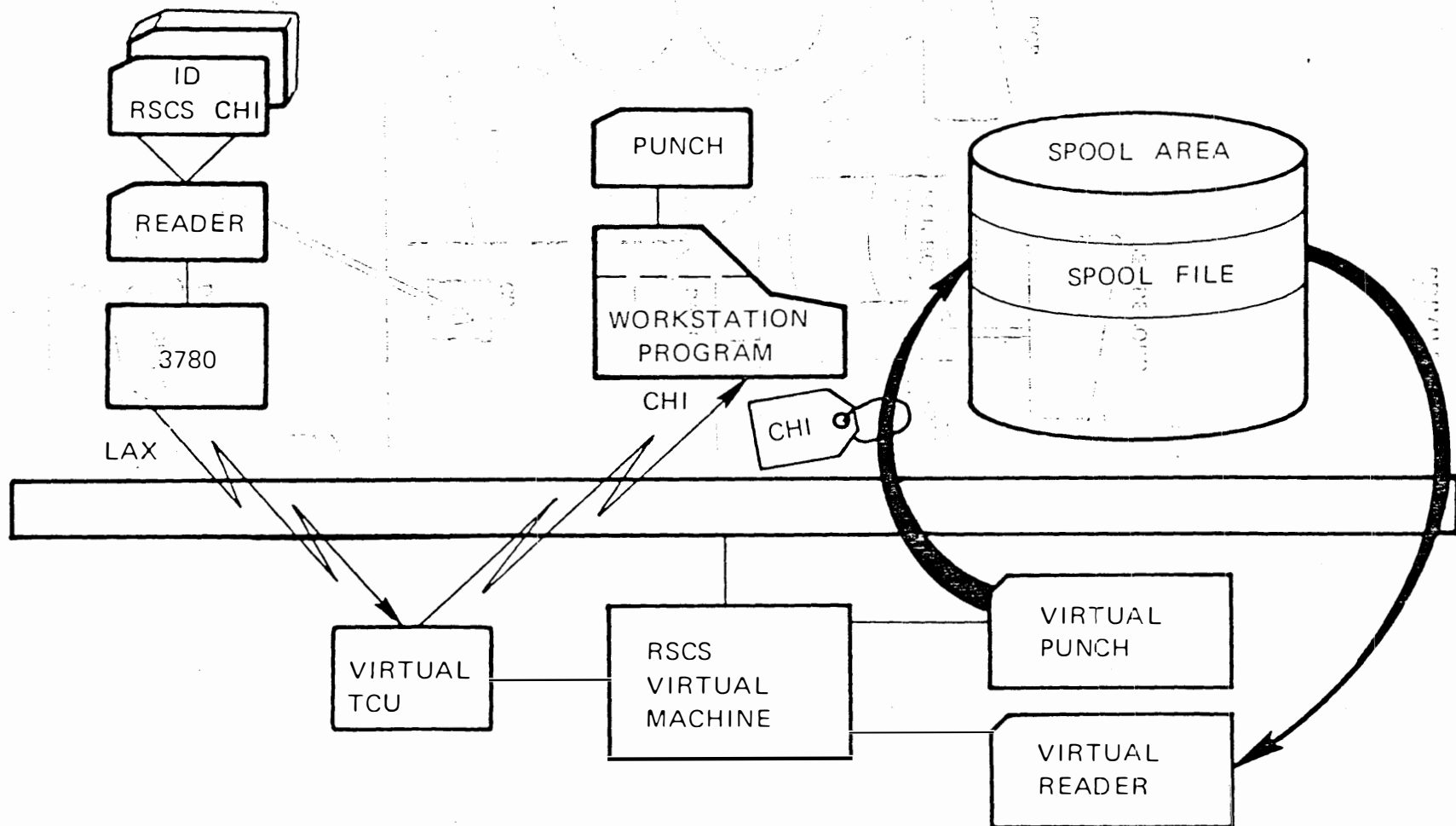
# REMOTE PROGRAMMABLE WORKSTATIONS



# RSCS AS AN RJE STATION



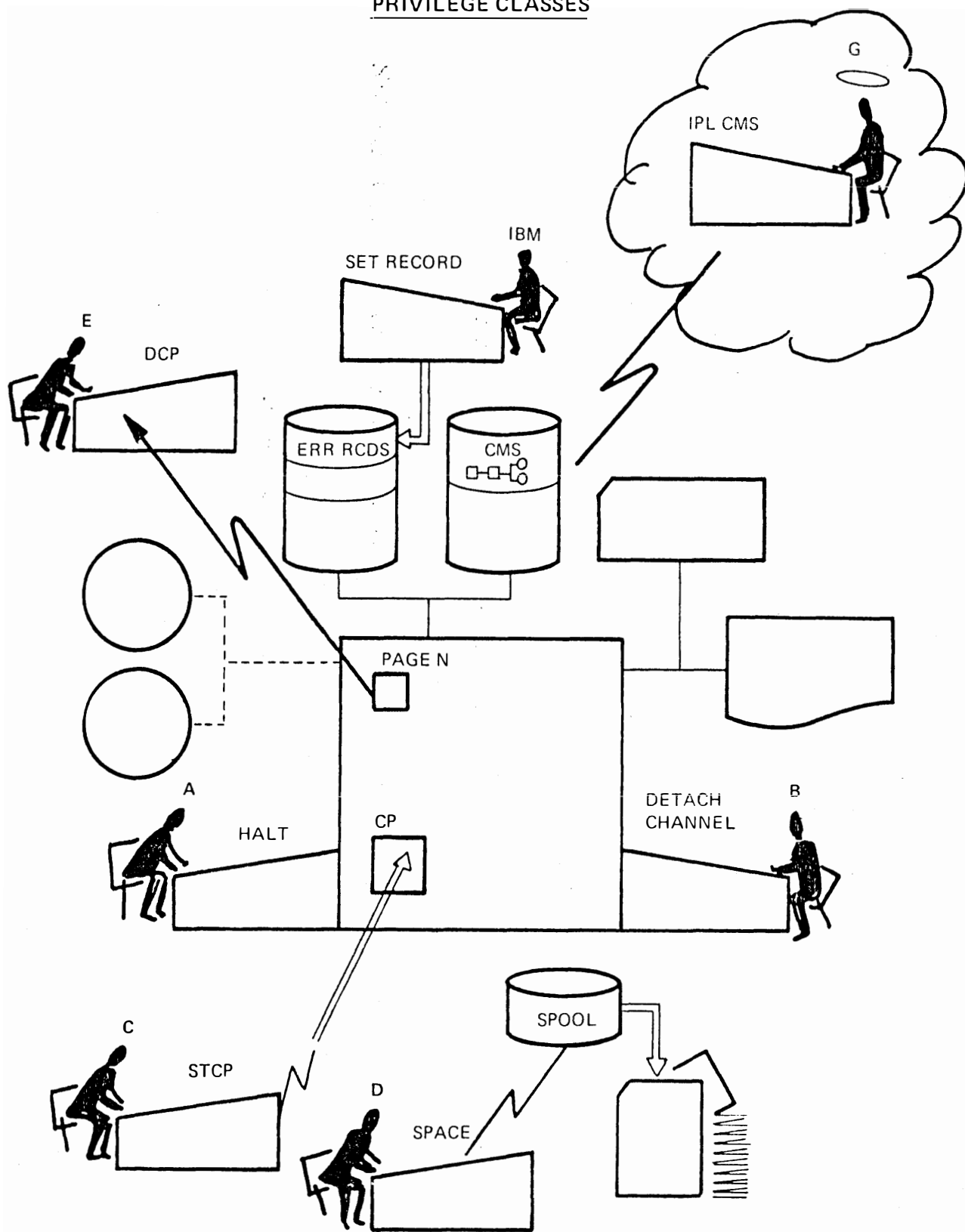
# STATION TO STATION COMMUNICATION

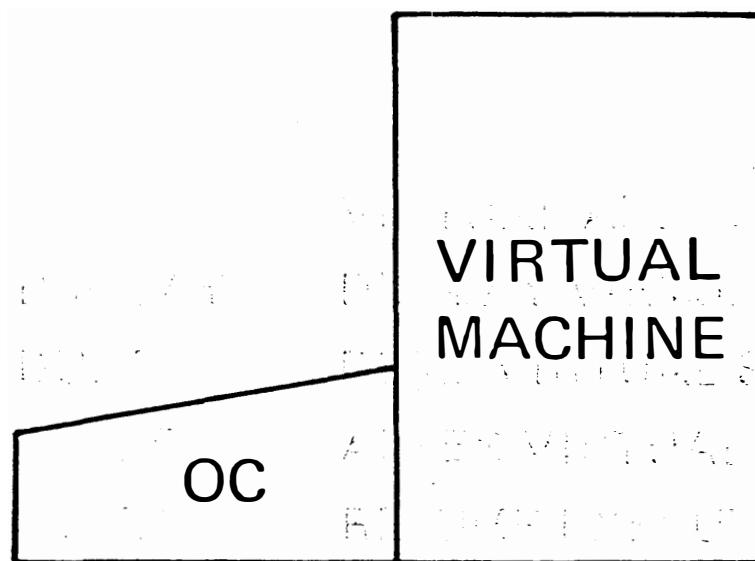


## COMMAND PRIVILEGE CLASSES

- A PRIMARY SYSTEM OPERATOR
- B SYSTEM RESOURCE OPERATOR
- C SYSTEM PROGRAMMER
- D SPOOLING OPERATOR
- E SYSTEM ANALYST
- F SERVICE REPRESENTATIVE
- G GENERAL USER
- H RESERVED

# PRIVILEGE CLASSES





IPL  
BEGIN  
EXTERNAL  
SYSTEM CLEAR  
SYSTEM RESET  
SYSTEM RESTART

## DEVICE CONTROL COMMANDS

|          |                                                  |
|----------|--------------------------------------------------|
| READY    | <i>SET A DEVICE END INTERRUPT</i>                |
| RESET    | <i>CLEAR ALL INTERRUPTS AND ERROR CONDITIONS</i> |
| REWIND   | <i>REWIND AND READY A TAPE DRIVE</i>             |
| NOTREADY | <i>MAKE A DEVICE NOT READY</i>                   |

## CP CONSOLE FUNCTIONS

|         |                                                  |
|---------|--------------------------------------------------|
| ADSTOP  | STOP EXECUTION AT A SPECIFIED<br>VIRTUAL ADDRESS |
| DISPLAY | DISPLAY VIRTUAL STORAGE                          |
| DUMP    | DUMP VIRTUAL STORAGE ON PRINTER                  |
| STORE   | ALTER VIRTUAL STORAGE OR REGISTERS               |
| BEGIN   | RESUME EXECUTION                                 |

## CP TRACE

- TRACE VIRTUAL MACHINE ACTIVITY
- OUTPUT ON CONSOLE AND/OR PRINTER
- OPTION TO ENTER CP CONSOLE FUNCTION MODE AFTER EACH TRACE
- CHOOSE TRACE ACTIVITY
  - SVC INTERRUPTS
  - I/O INTERRUPTS
  - PROGRAM INTERRUPTS
  - EXTERNAL INTERRUPTS
  - PRIVILEGED INSTRUCTIONS
  - I/O INSTRUCTIONS
  - SUCCESSFUL BRANCHES
  - ALL INSTRUCTIONS
  - CHANNEL PROGRAMS

# VIRTUAL MACHINE COMMUNICATION

MSG        OPERATOR

MSG        userid

QUERY     LOGMSG

QUERY     NAMES

QUERY     USERS

QUERY     userid

QUERY     TIME

QUERY     VIRTUAL     DASD

QUERY     VIRTUAL     TAPES

QUERY     VIRTUAL     LINES

QUERY     VIRTUAL     UR

QUERY     VIRTUAL     STORAGE

## USING TAPES IN A VIRTUAL MACHINE

VIRTUAL MACHINE OPERATOR

VM/370 OPERATOR

TAPE 180 ATTACHED

TAPE 283 ATTACH TO DOSSYS 180

rewind 180

.

.

.

detach 180

TAPE 180 DETACHED

TAPE 283 DETACHED DOSSYS

## REDEFINING THE VIRTUAL MACHINE

- CHANGE SIZE OF VIRTUAL STORAGE

*DEFINE STORAGE AS 1024K*

- CHANGE VIRTUAL DEVICE ADDRESSES

*DEFINE 130 AS 135*

- ADD DEDICATED DEVICES

*ATTACH 283 TO DOSSYS AS 180*

- ADD SPOOLED UNIT RECORD

*DEFINE PRINTER AS 00B*

- ADD VIRTUAL LINES

*DEFINE LINE AS 030*

- ADD TEMPORARY DISKS

*DEFINE T2314 AS 132 CYL 20*

- DELETE IO DEVICES

*DETACH 132*

# ACCOUNTING PROCEDURES

THREE TYPES OF ACCOUNTING RECORDS

VIRTUAL MACHINE USAGE

DEDICATED DEVICE USAGE

TEMPORARY DISK SPACE USAGE

ENTRY POINT FOR USER WRITTEN ROUTINES

## USER ACCOUNTING STATISTICS

TERMINAL CONNECT TIME

VIRTUAL CPU TIME

VM/370 EXECUTION TIME

CARDS READ AND PUNCHED

LINEs PRINTED

PAGE READS AND WRITES

NUMBER OF VIRTUAL SIO's

## DEVICE ACCOUNTING STATISTICS

- DEVICE CONNECT TIME
- DEVICE CODE
- NUMBER OF CYLINDERS OF T-SPACE

## SYSTEM PERFORMANCE FACILITIES

- PREFERRED VIRTUAL MACHINE OPTIONS
- VIRTUAL MACHINE ASSIST
- BIASED SCHEDULER
- VM/VS HANDSHAKING FEATURE
- VM/370 MEASUREMENT FACILITY

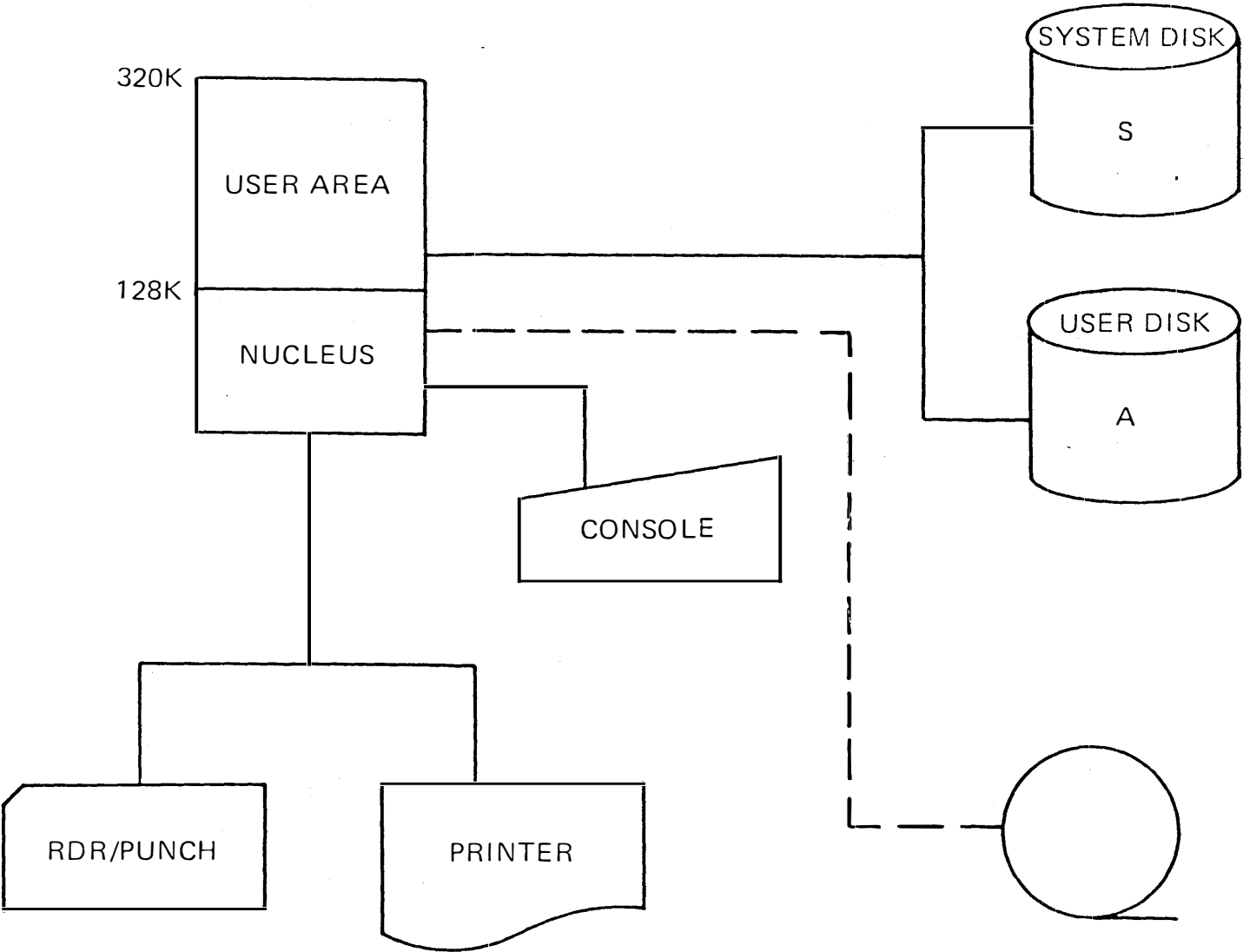
C M S

F A C I L I T I E S

# CONVERSATIONAL MONITOR SYSTEM

- SINGLE USER
- CONVERSATIONAL
  - FILE CREATION AND MANAGEMENT
  - PROGRAM COMPILATION AND EXECUTION
  - APPLICATION PROGRAM EXECUTION

TYPICAL CONFIGURATION



# USER FACILITIES

FILE MANAGEMENT SYSTEM

LANGUAGE FACILITIES

INTERACTIVE EXECUTION

# FILE MANAGEMENT SYSTEM

- CREATE AND UPDATE FILES

FROM THE TERMINAL

FROM A PROGRAM

FROM A VIRTUAL CARD READER

- SHARE FILES AMONG USERS
- NOT COMPATIBLE WITH OS FILES

# PROGRAM LANGUAGE FACILITY

- S/370 ASSEMBLER
- BASIC
- APL
- FORTRAN IV
- ANS COBOL
- PL/I

## INTERACTIVE EXECUTION

- PROGRAMS WRITE TO TERMINAL
- PROGRAMS READ FROM TERMINAL
- DEBUGGING FACILITIES

## EXECUTION TIME RESTRICTIONS

- SYSTEM SERVICES
  - SELECTED OS SVC SIMULATION
  - NO DOS SVC SIMULATION
- DATA MANAGEMENT
  - SIMULATES SELECTED OS ACCESS METHODS AS CMS FILES
    - BDAM
    - BPAM
    - QSAM
    - BSAM
  - READS OS FILES
    - SEQUENTIAL
    - PARTITIONED
  - READS DOS FILES
    - SEQUENTIAL

# ALTERNATING OPERATING SYSTEMS

- AUGMENT CMS WITH  
ADDITIONAL LANGUAGES  
ISAM EXECUTION  
DOS EXECUTION
- PROVIDE ACTUAL ENVIRONMENT TEST  
PROGRAM DEVELOPMENT  
SYSTEM MAINTENANCE
- USE CMS TO  
  
CREATE JOBSTREAMS  
CREATE PROGRAMS  
COMPILE PROGRAMS  
MODIFY PROGRAMS

#  
vm/370 online  
login user1 mask  
ENTER PASSWORD:  
**XXXXXXXXXX**  
LOGMSG - 12:37:20 02/14/74  
\* VM/370 WILL BE UP UNTIL 9:00PM  
LOGON AT 14:26:31 EST THURSDAY 02/14/74  
ipl 190  
CMS VERSION 2.0

```
edit testprog fortran
NEW FILE:
EDIT:
input
INPUT:
      write (6,10)
10    format ('a=')
      read (5,20) a
20    format (8.3)
      x=a**2
      write (6,25) a,x
      return
      end

EDIT:
file
R;
```

```
fortgi testprog
004 20 FORMAT (8.3)
      $
      01) IEY013I SYNTAX
25      IEY022I UNDEFINED LABEL
R(008);
```

```

edit testprog fortran
EDIT:
locate /(8/
20      FORMAT (8.3)
change /8/f8/
20      FORMAT (F8.3)
locate /25/
        WRITE (6,25) A,X
input   25      format (2f8.3)
top
type   *
        WRITE (6,10)
10      FORMAT ('A=')
        READ (5,20) A
20      FORMAT (F8.3)
        X=A**2
        WRITE (6,25) A,X
25      FORMAT (2F8.3)
        RETURN
        END

EOF:
file
R;

```

```
fortgi testprog
```

```
R;
```

```
listfile
```

| FILENAME | FILETYPE | MODE |
|----------|----------|------|
|----------|----------|------|

|          |          |    |
|----------|----------|----|
| TESTPROG | FORTTRAN | A1 |
|----------|----------|----|

|          |         |    |
|----------|---------|----|
| TESTPROG | LISTING | A1 |
|----------|---------|----|

|          |      |    |
|----------|------|----|
| TESTPROG | TEXT | A1 |
|----------|------|----|

```
R;
```

```
run testprog
```

```
A=
```

```
2.5
```

```
2.500 6.250
```

```
R;
```

```
print testprog listing
```

```
R;
```

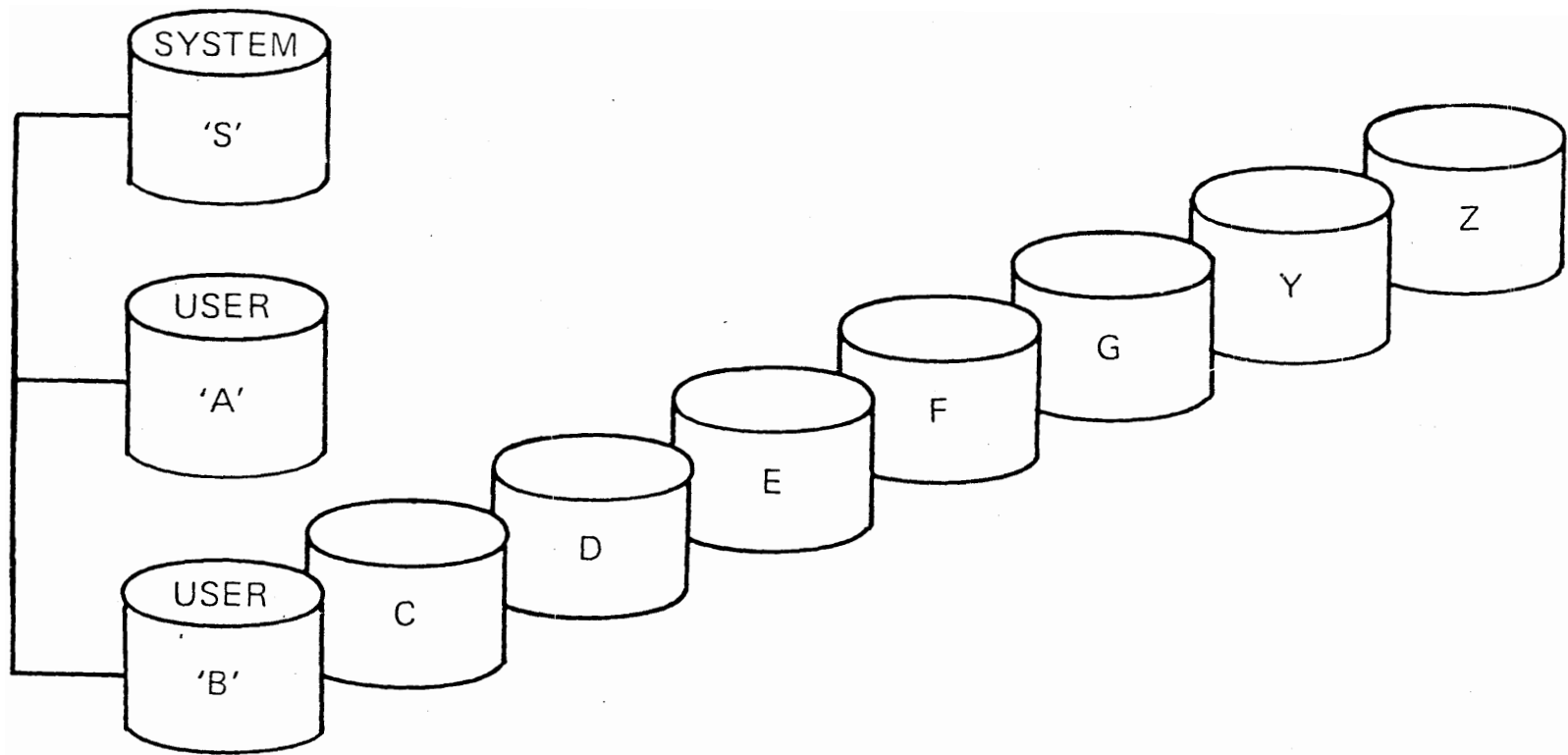
```
punch testprog text
```

```
R;
```

## DISK FILE MANAGEMENT

- S DISK REQUIRED
- UP TO NINE SIMULTANEOUS USER DISKS
- PREFORMATTED PHYSICAL BLOCKS
- FIXED OR VARIABLE LOGICAL RECORDS
- SEQUENTIAL OR DIRECT ACCESS

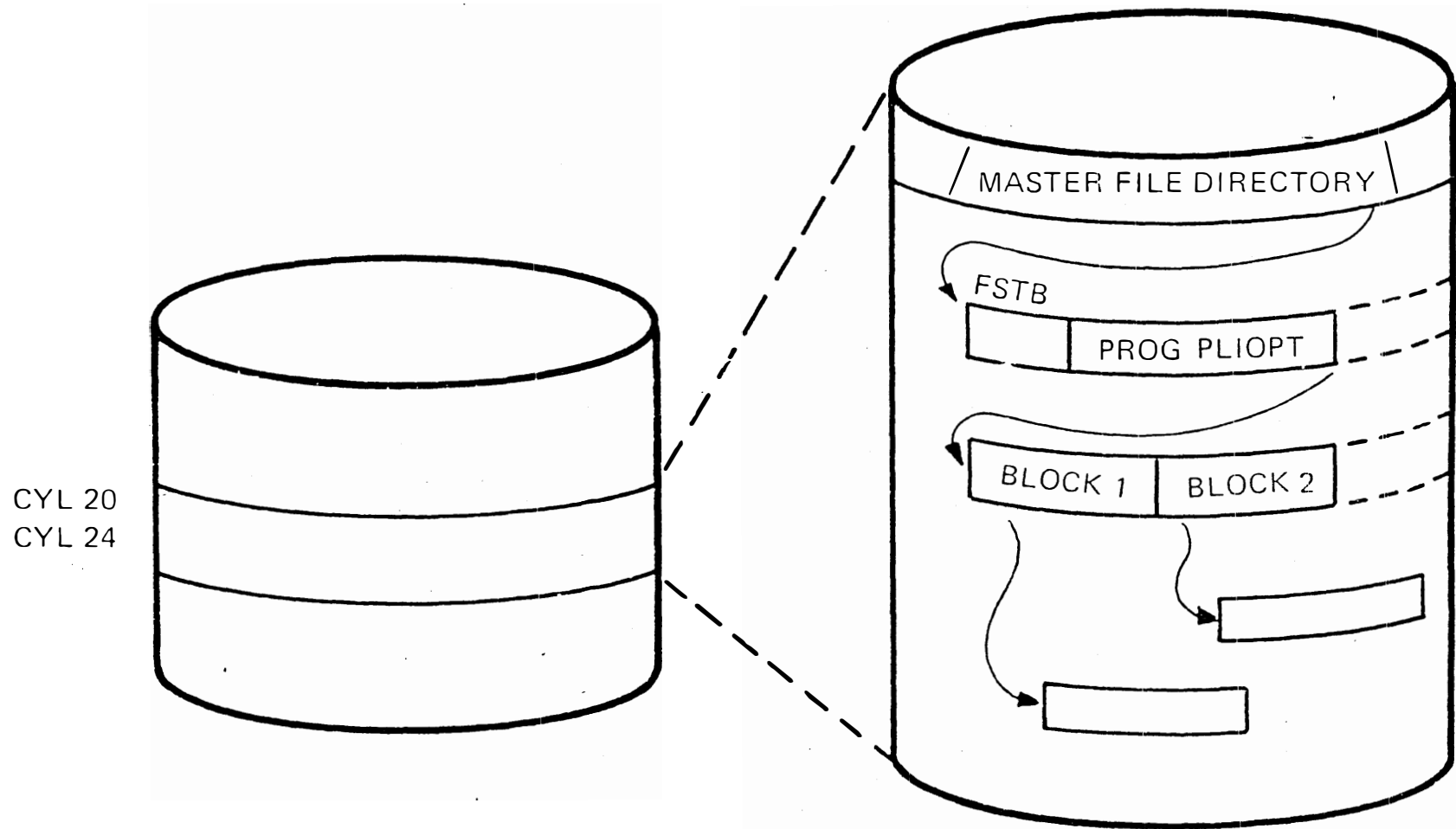
## DISK NAMING



## FILE ALLOCATION

- EACH MINI-DISK IS FORMATTED  
CMS UTILITY  
CONTROL INFORMATION ON CYL 0
- CMS MAINTAINS STATUS OF EVERY BLOCK
- ALLOCATES NEW FILES TO UNUSED BLOCKS
- DEALLOCATES BLOCKS WHEN FILE IS ERASED
- BUILDS A CHAIN LINK REFERENCE

## DIRECTORY ON DISK



## FILE NAMING

- EACH FILE HAS A THREE-COMPONENT NAME
  - FILENAME IDENTIFIES FILE
  - FILETYPE IMPLIES
    - SAME RECORD CHARACTERISTICS
    - SAME USAGE
  - FILEMODE SPECIFIES
    - FILE DIRECTORY
    - MODE OF ACCESS

## TWO LEVELS OF SHARING

- CP LINK BY DISK  
READ/ONLY  
READ/WRITE
- CMS ACCESS BY FILE  
PRIVATE  
READ/WRITE  
READ/ERASE

## CMS EDITOR

- CREATE FILES FROM TERMINAL  
FIXED OR VARIABLE LENGTH RECORDS  
MAXIMUM RECORD SIZE OF 160  
OPTIONAL LINE NUMBER PROMPTING
- SELECT FILE CHARACTERISTICS  
AUTOMATIC BASED ON FILETYPE  
MAY BE SPECIFIED BY USER
- UPDATE FILES FROM TERMINAL  
UPDATE BY CONTEXT OR LINE NUMBER  
ADD, DELETE OR INSERT LINES  
DISPLAY ALL OR PART OF A FILE  
EXTRACT AND COMBINE FILES
- SUPPORT FOR 3270  
FULL SCREEN DISPLAY OPTION  
SCROLL CAPABILITY

# CREATE AND MODIFY DISK FILES

EDIT

COPYFILE

UPDATE

MOVEFILE

SORT

# CONTROL DISK FILES

LISTFILE

TYPE

ERASE

RENAME

COMPARE

DISK

## TAPE SUPPORT

- UP TO FOUR TAPES USED BY COMMANDS
- USER SPECIFIED MODE AND RECORDING
- NO MULTIVOLUME SUPPORT
- NO LABEL SUPPORT

## PROGRAM WRITING

- MULTIPLE PROGRAMMING LANGUAGES
- MACRO LIBRARIES

## PROGRAM LOADING

- TEXT LIBRARIES
- LOADER SATISFIES UNRESOLVED REFERENCES

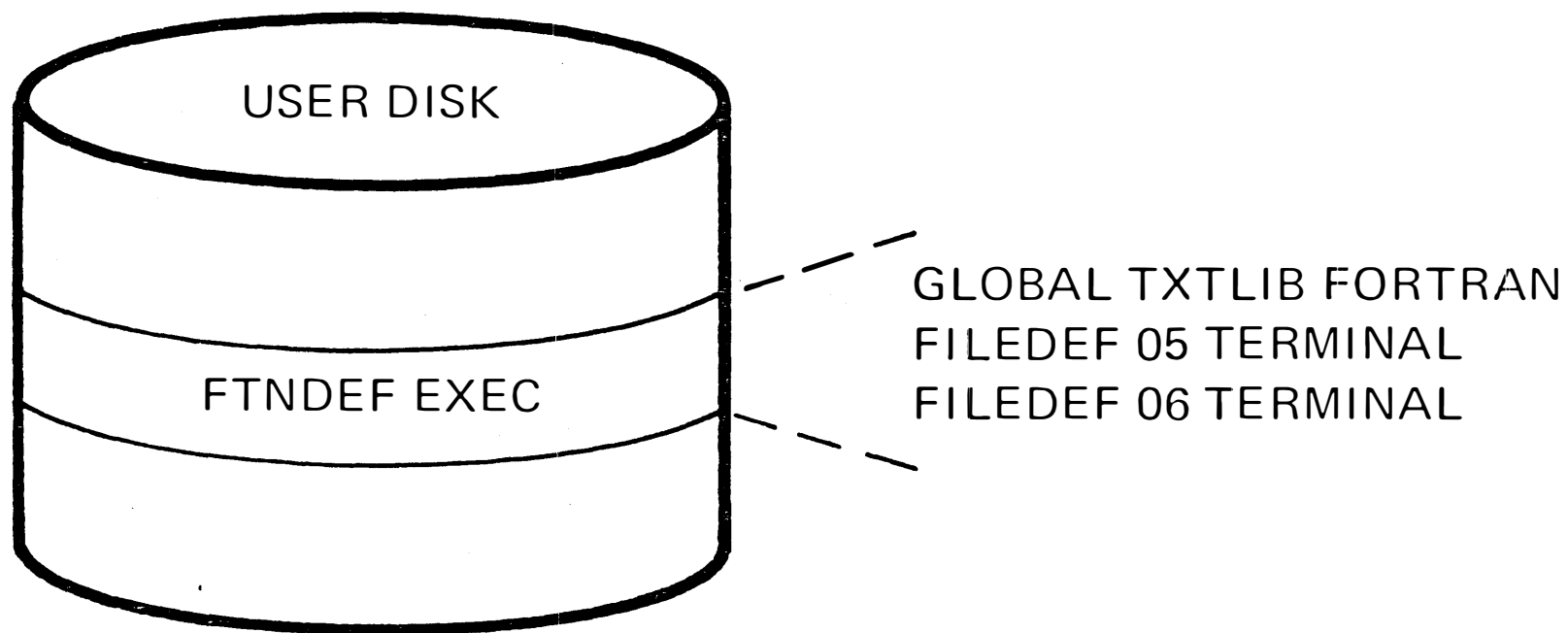
## INTERACTIVE EXECUTION

- READ AND WRITE TERMINAL  
VIA CONSOLE I/O
- USE LANGUAGE FACILITIES  
COBOL INTERACTIVE DEBUG  
FORTRAN INTERACTIVE DEBUG  
PL/I CHECKOUT COMPILER
- SUSPEND PROGRAM EXECUTION  
VIA ATTENTION KEY  
ENTER CP CONSOLE FUNCTIONS  
RESUME EXECUTION
- STOP PROGRAM EXECUTION OR OUTPUT  
VIA ATTENTION KEY  
CMS IMMEDIATE COMMANDS
- TRACE PROGRAM EXECUTION  
CP TRACE  
CMS SVCTRACE
- CMS DEBUG ENVIRONMENT  
MACHINE ADDRESS LEVEL

## COMMAND LANGUAGE EXTENSIONS

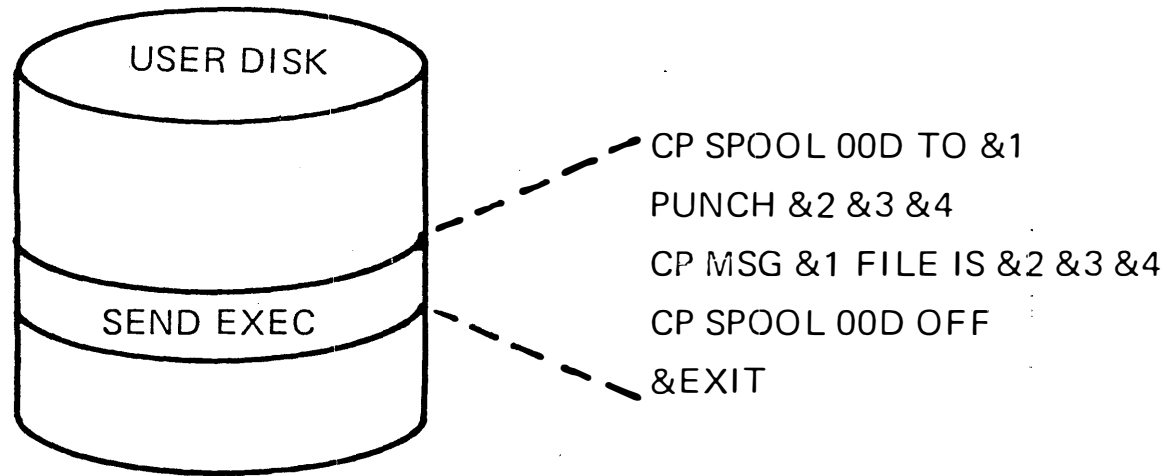
- MODIFY CMS COMMAND NAMES  
STANDARD ABBREVIATIONS  
USER SYNONYMS
- EXEC PROCESSOR  
CATALOGED COMMAND PROCEDURES  
INVOKED LIKE A CMS COMMAND  
PROFILE EXEC
- ADD NEW COMMANDS  
ANY FILE WITH FILETYPE MODULE
- REPLACE EXISTING COMMANDS  
WITH EXEC FILE  
WITH MODULE FILE

## EXEC EXAMPLE



INVOKED FROM TERMINAL:  
FTNDEF

## EXEC EXAMPLE



INVOKED FROM TERMINAL:

SEND USER2 PROGA COBOL A1

COMMAND EXECUTION:

CP SPOOL 00D TO USER2  
PUNCH PROGA COBOL A1  
CP MSG USER2 FILE IS PROGA COBOL A1  
CP SPOOL 00D OFF

## CMS BATCH FACILITY

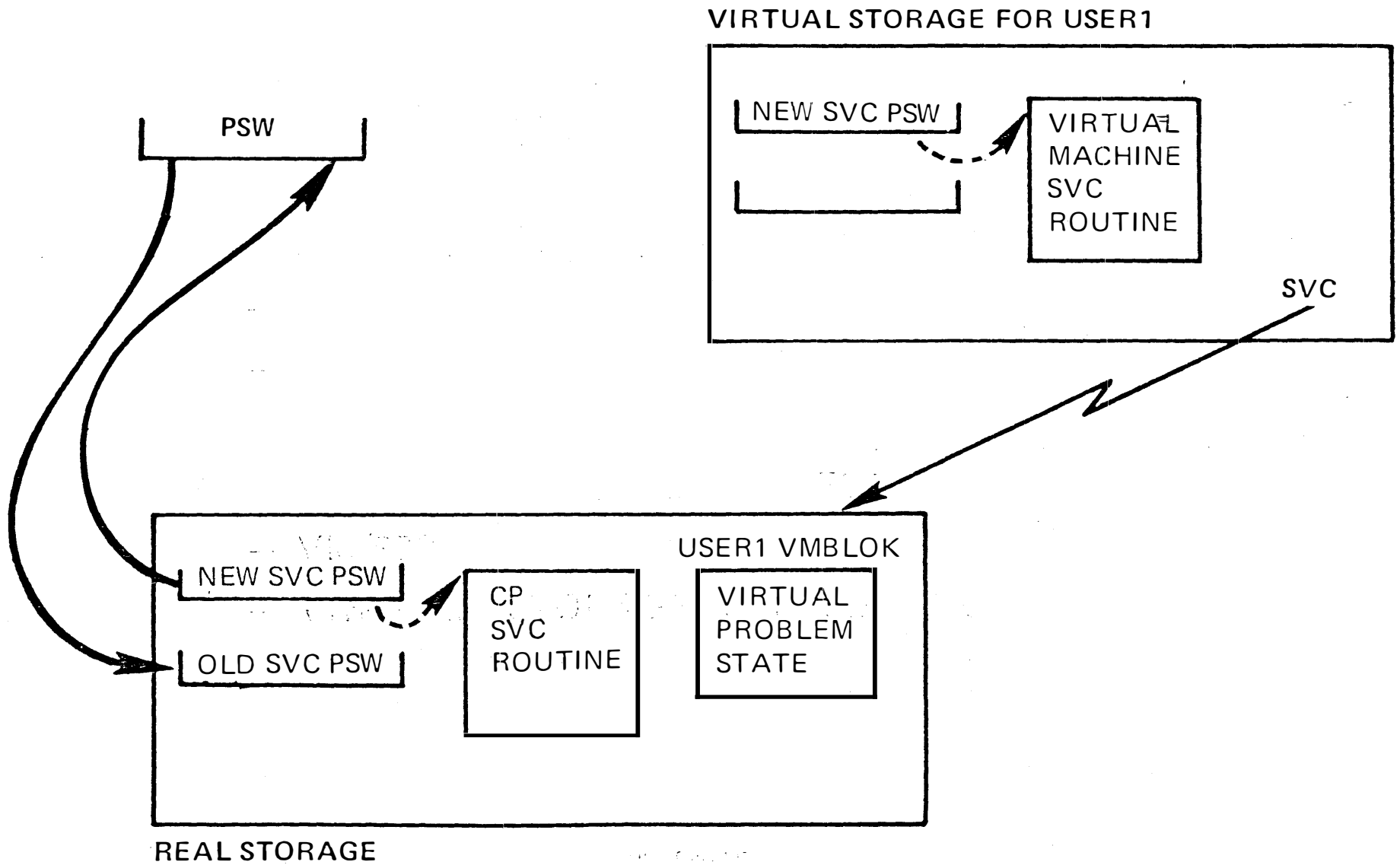
- VIRTUAL MACHINE DEDICATED TO BATCH MODE
- CONTINUOUSLY RUNNING BATCH MACHINE
- INPUT FROM:
  - ANOTHER VIRTUAL MACHINE
  - REAL CARD READER
- ACCEPTS IN AN INPUT JOB:
  - ANY USER PROGRAM WRITTEN IN A LANGUAGE SUPPORTED BY CMS
  - MOST CP AND CMS COMMANDS
- USEFUL FOR:
  - NON-CMS USER WITH BATCH REQUIREMENT
  - CMS USER WITH COMPUTE-BOUND JOBS

C P

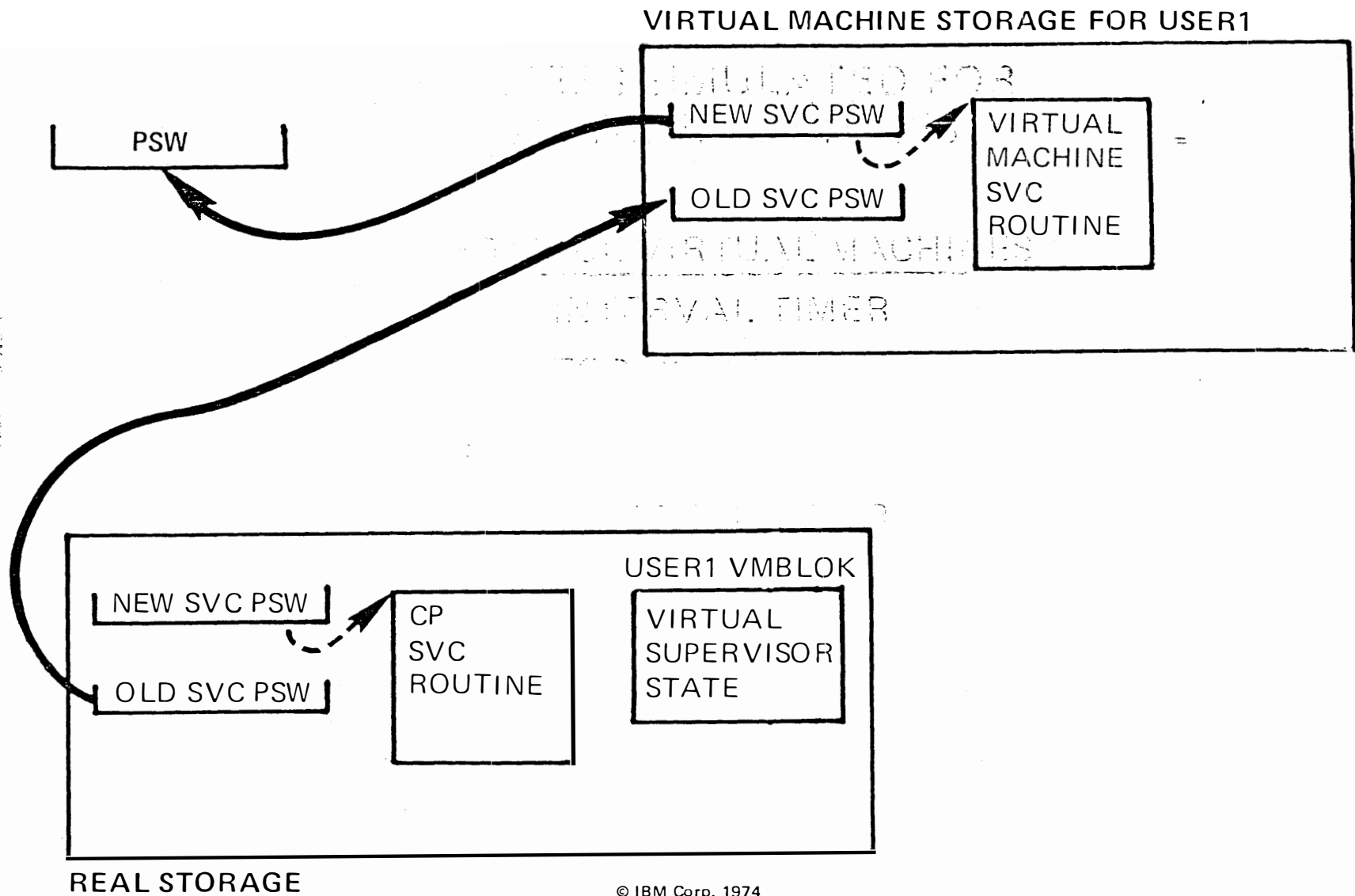
I M P L E M E N T A T I O N

- CPU MANAGEMENT
- STORAGE MANAGEMENT
- I/O MANAGEMENT

## HARDWARE INTERRUPT



# CP SIMULATION



## VIRTUAL MACHINE ASSIST FEATURE

- RELIEVES CP OF PROCESSING OVERHEAD FOR
  - SELECTED PRIVILEGED INSTRUCTIONS
  - SVC INTERRUPTS
  - VIRTUAL MACHINE PAGE FAULTS
- IMPROVED PERFORMANCE FOR
  - VM/370
  - VIRTUAL STORAGE SYSTEMS RUNNING UNDER VM/370

# TIMERS SIMULATED FOR VIRTUAL MACHINES

## BC MODE VIRTUAL MACHINES

INTERVAL TIMER

TOD CLOCK

## EC MODE VIRTUAL MACHINES

INTERVAL TIMER

CPU TIMER

TOD CLOCK

CLOCK COMPARATOR

## CPU MANAGEMENT

- SCHEDULER
  - SELECTS COMPETING SUBSET
  - COMPETING FOR
    - CPU TIME
    - REAL STORAGE
    - IO
- DISPATCHER
  - SELECT FROM COMPETING SUBSET
    - TIME SLICE

## TYPES OF USERS

- INTERACTIVE
  - UTILIZES TERMINAL I/O
  - AT FREQUENT AND REGULAR INTERVALS
  - LOW RESOURCE USER
- NON-INTERACTIVE
  - HIGH COMPUTE USER AND/OR
  - INFREQUENT TERMINAL USER
  - HIGH RESOURCE USER

INTERACTIVE MACHINES RECEIVE  
PREFERENTIAL TREATMENT

## SCHEDULER

- MAINTAINS ELIGIBLE LIST
- IN SCHEDULING PRIORITY SEQUENCE
- PROMOTES A USER TO DISPATCHABLE  
WHEN HIS STORAGE REQUIREMENTS  
WILL NOT OVERLOAD THE SYSTEM
- SERVICES ALL INTERACTIVE USERS  
FIRST

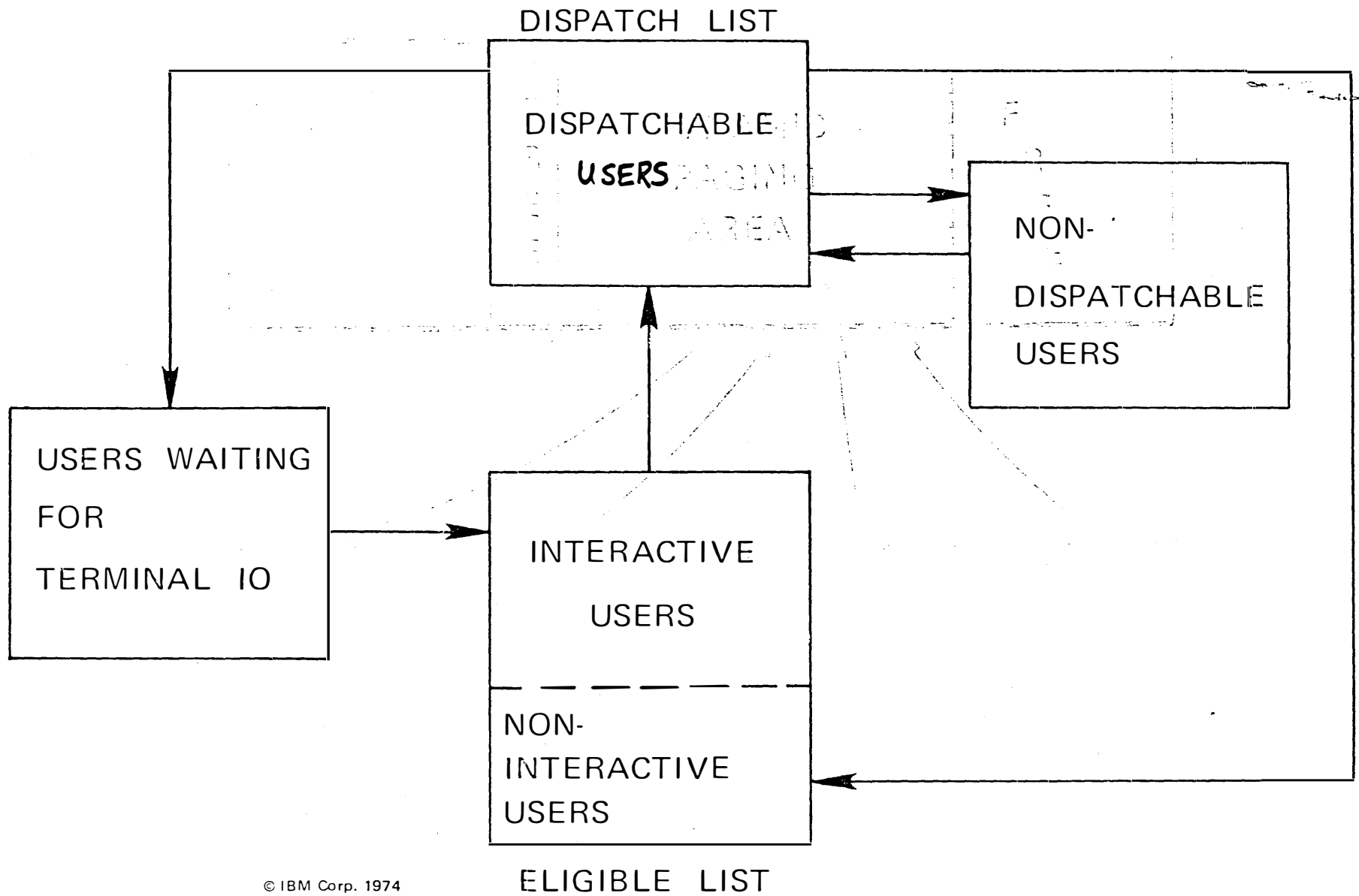
# SCHEDULING PRIORITY

- **USER FACTORS**
  - USER PRIORITY
  - PROJECTED WORKING SET
- **SYSTEM FACTORS**
  - PAGING BIAS
  - USER BIAS
  - INTERACTIVE BIAS
- **TIME FACTORS**
  - TIME STAMP BASE
  - PRIORITY DELAY FACTOR

## DISPATCHER

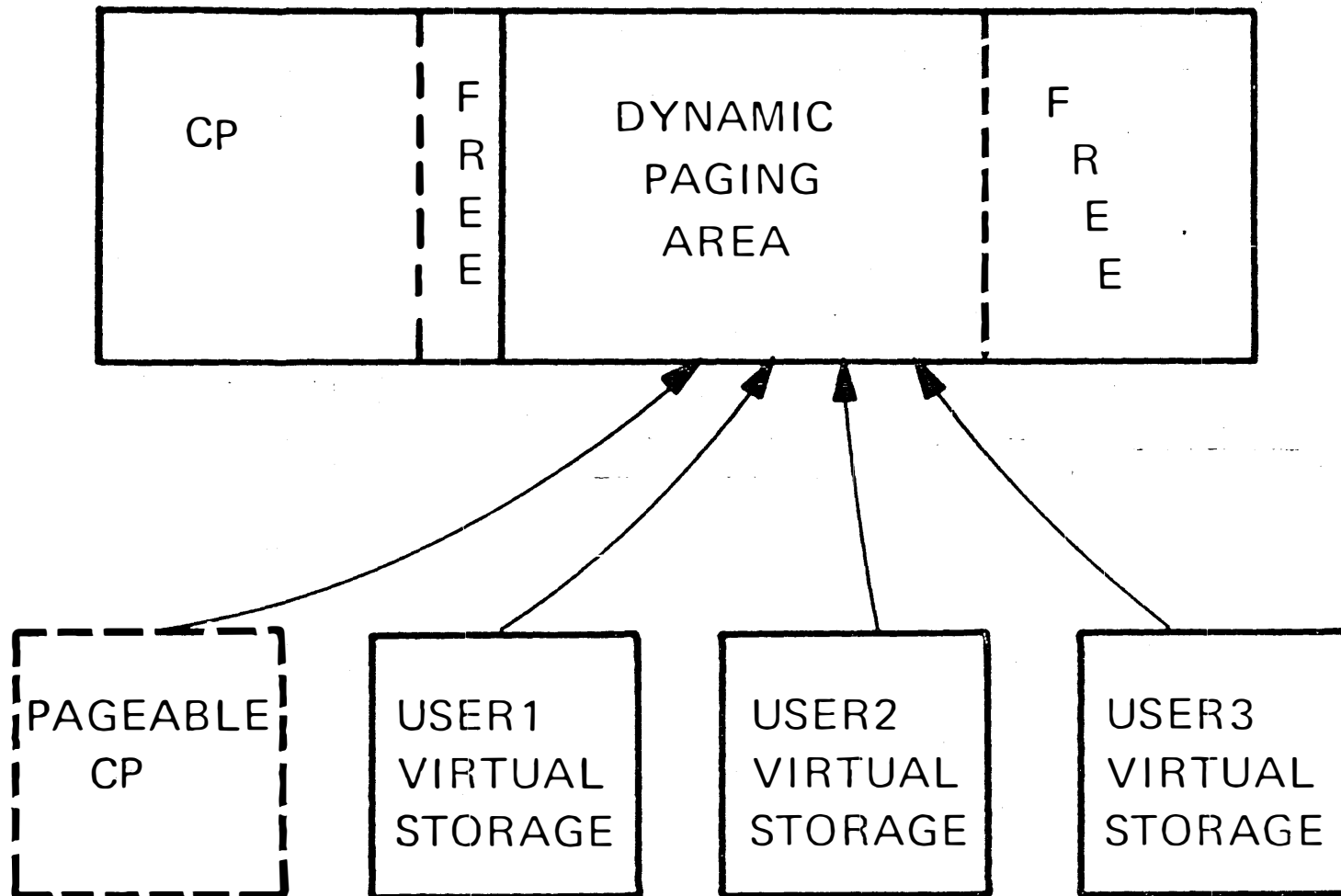
- MAINTAINS DISPATCH LIST
- IN DISPATCHING PRIORITY SEQUENCE
  - RATIO OF CPU TIME TO WAIT TIME
- ALLOCATES A MAXIMUM TIME SLICE
  - BASED ON TYPE OF USER
- ALLOCATES A MAXIMUM QUANTUM OF CPU TIME
  - BASED ON PAST ACTIVITY

# OVERVIEW OF SCHEDULER/DISPATCHER



## FAVORED EXECUTION

- BASIC  
VIRTUAL MACHINE DOES NOT WAIT IN  
ELIGIBLE LIST
- PERCENTAGE  
DISPATCHER ATTEMPTS TO GIVE ONE  
VIRTUAL MACHINE A SPECIFIED PERCENTAGE  
OF CPU TIME

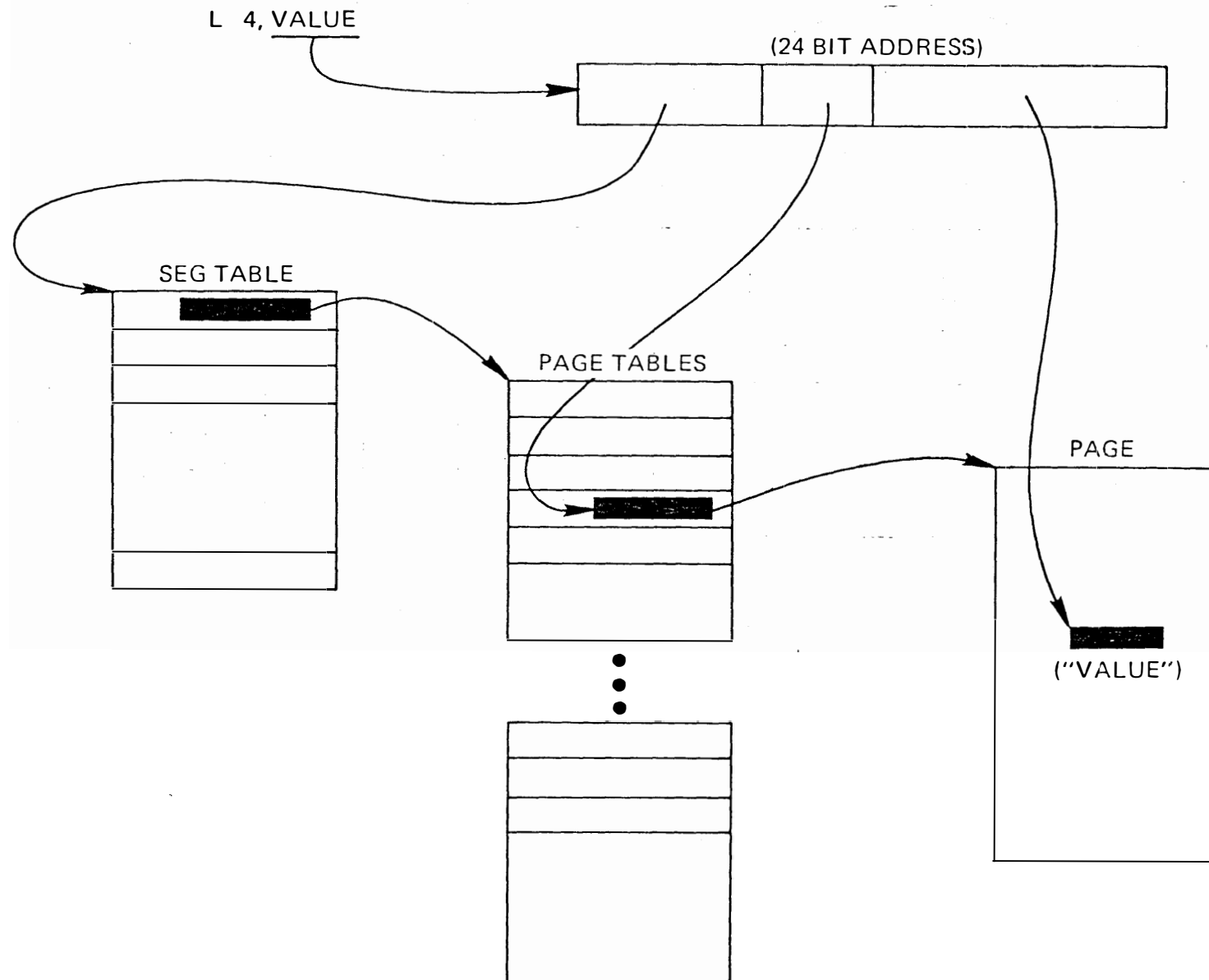


## VIRTUAL MACHINE STORAGE ADDRESSES

DYNAMIC ADDRESS TRANSLATION INTERPRETS  
THE EFFECTIVE ADDRESS AS:

|         |      |                   |
|---------|------|-------------------|
| SEGMENT | PAGE | PAGE DISPLACEMENT |
|---------|------|-------------------|

# DYNAMIC ADDRESS TRANSLATION

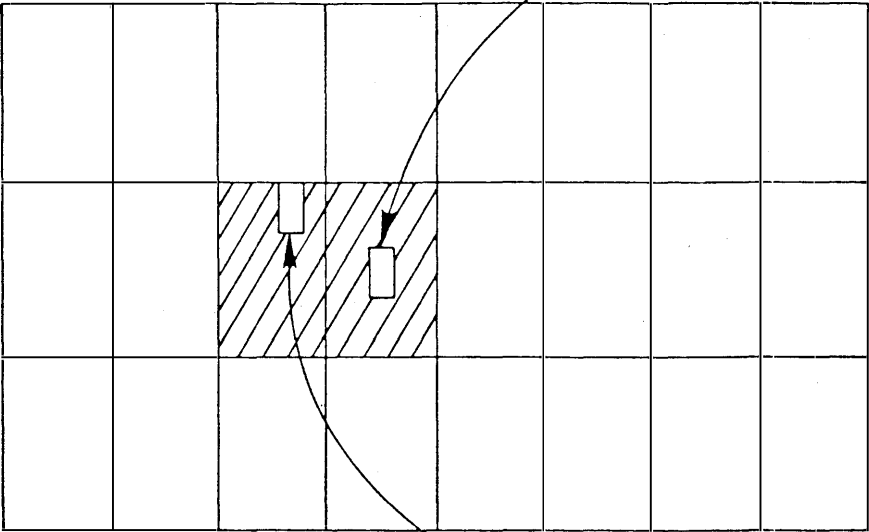


DEMAND PAGING

VIRTUAL MACHINE STORAGE

PROBLEM  
PROGRAM  
PAGES

OPERATING  
SYSTEM  
NUCLEUS  
PAGES



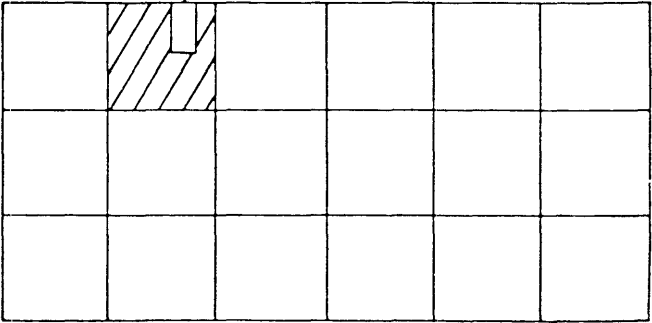
VALUE DS F

L 4, VALUE

REAL MACHINE STORAGE

PAGEABLE  
STORAGE

VM/370  
FIXED AREA

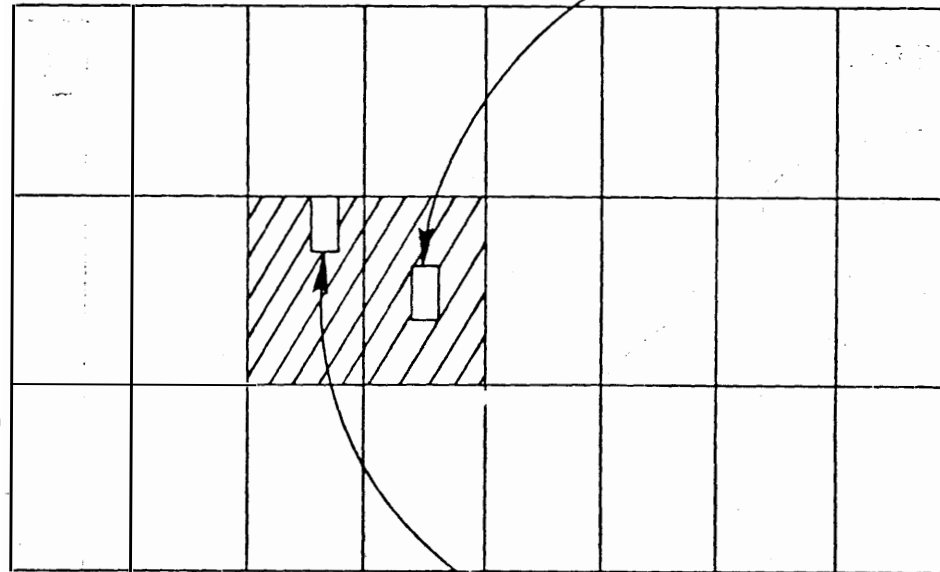


# DEMAND PAGING

VIRTUAL MACHINE STORAGE :

PROBLEM  
PROGRAM  
PAGES

OPERATING  
SYSTEM  
NUCLEUS  
PAGES



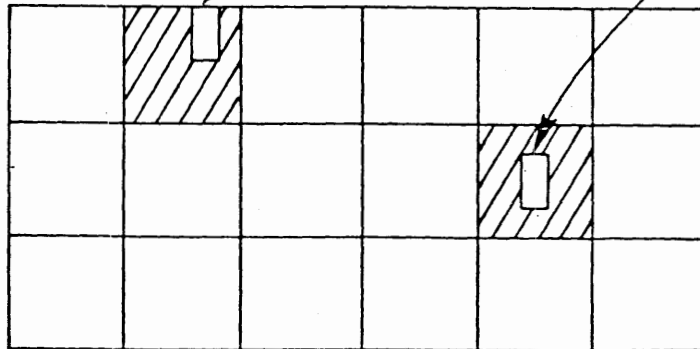
VALUE DS F

L 4, VALUE

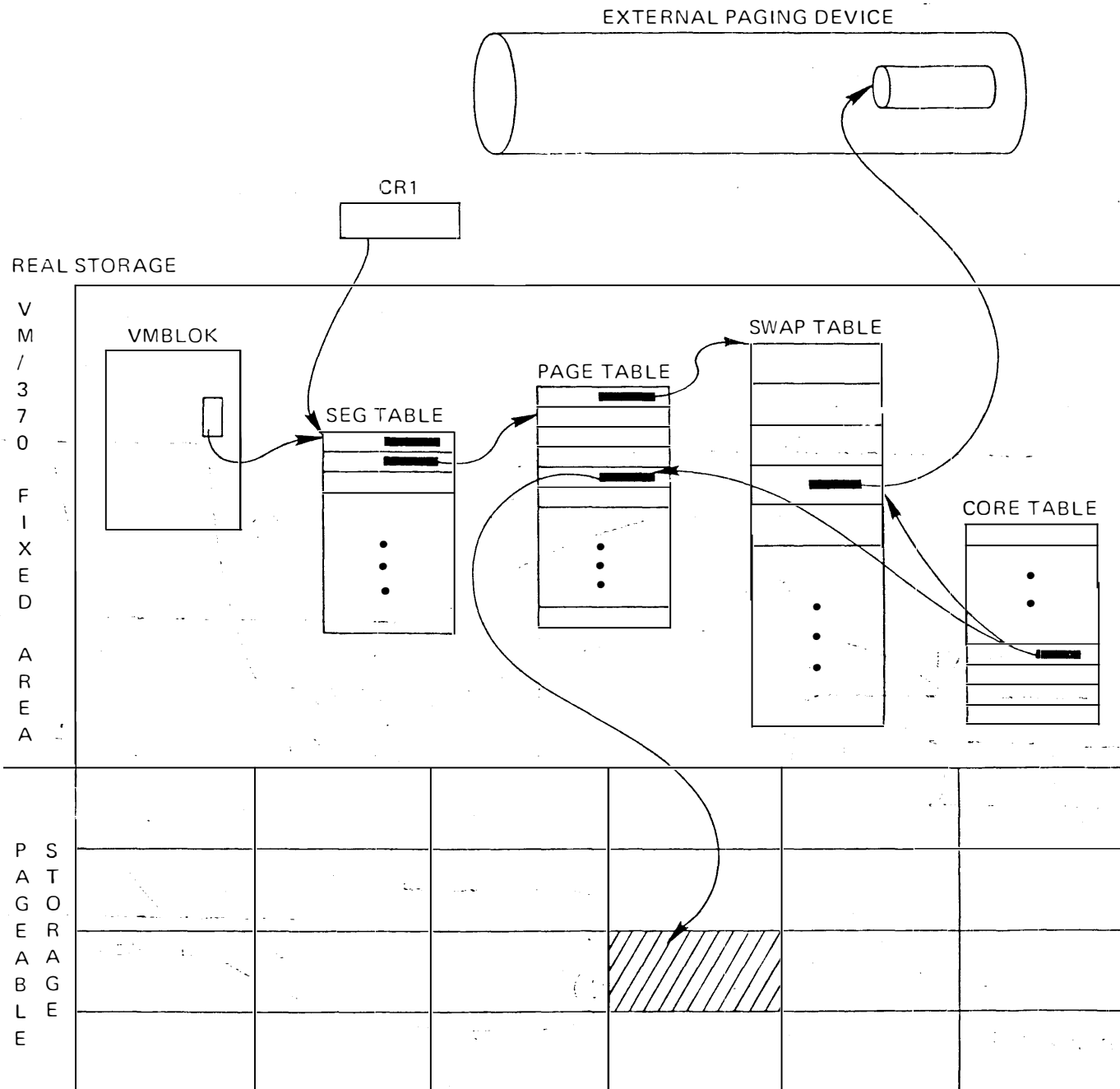
REAL MACHINE STORAGE

PAGEABLE  
STORAGE

VM/370  
FIXED AREA

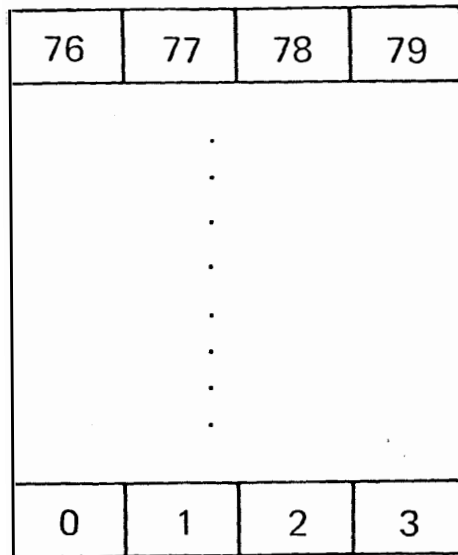


# STORAGE MANAGEMENT

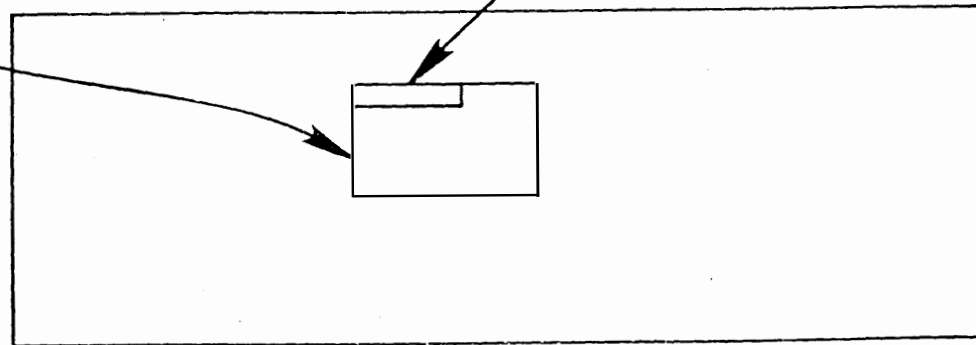
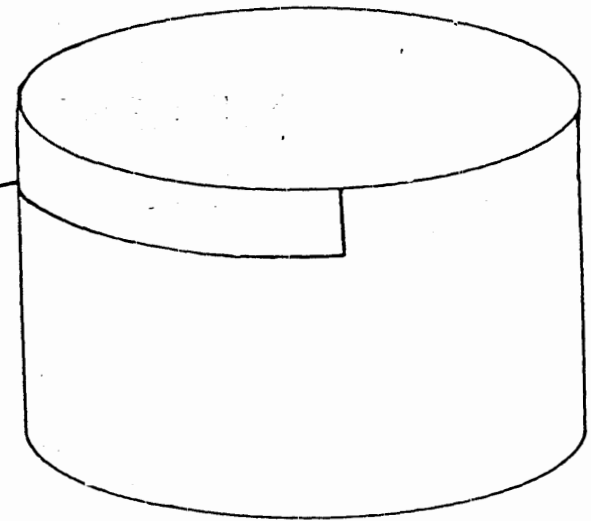


## VIRTUAL MACHINE IPL

VIRTUAL STORAGE

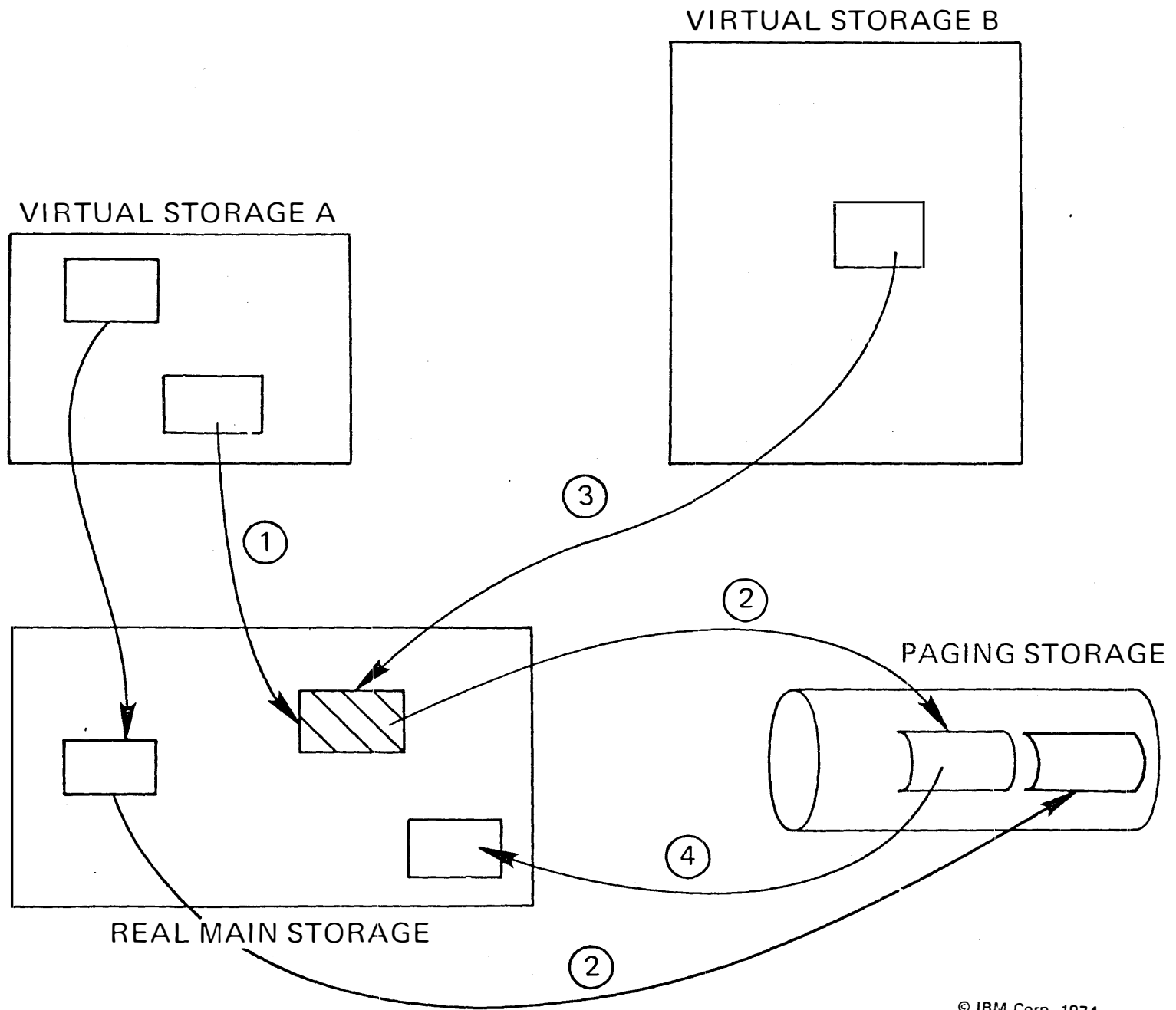


VIRTUAL IPL DEVICE



PAGEABLE STORAGE

© IBM Corp. 1974



## PAGE FRAME LISTS

- **USER LIST**
  - ALLOCATED TO USERS CURRENTLY, COMPETING FOR SYSTEM RESOURCES
- **FLUSH LIST**
  - ALLOCATED TO USERS DROPPED FROM DISPATCH LIST
- **FREE LIST**
  - AVAILABLE FOR ALLOCATION

## PAGE FRAME MOVEMENT

- USERLIST TO FLUSHLIST  
AT TIME SLICE END
- FLUSHLIST TO FREELIST  
TO REPLENISH FREELIST MINIMUM
- USERLIST TO FREELIST  
AT RE-IPL  
AT LOGOFF  
VIA DIAGNOSE  
TO REPLENISH FREELIST MINIMUM

## EXTERNAL SPACE ALLOCATION

- COMMON POOL OF SPACE FOR PAGING AND SPOOLING
- VARIABLE SPACE REQUIREMENTS
- DEMAND ALLOCATION BY CYLINDER
- PREFERRED PAGING DEVICES

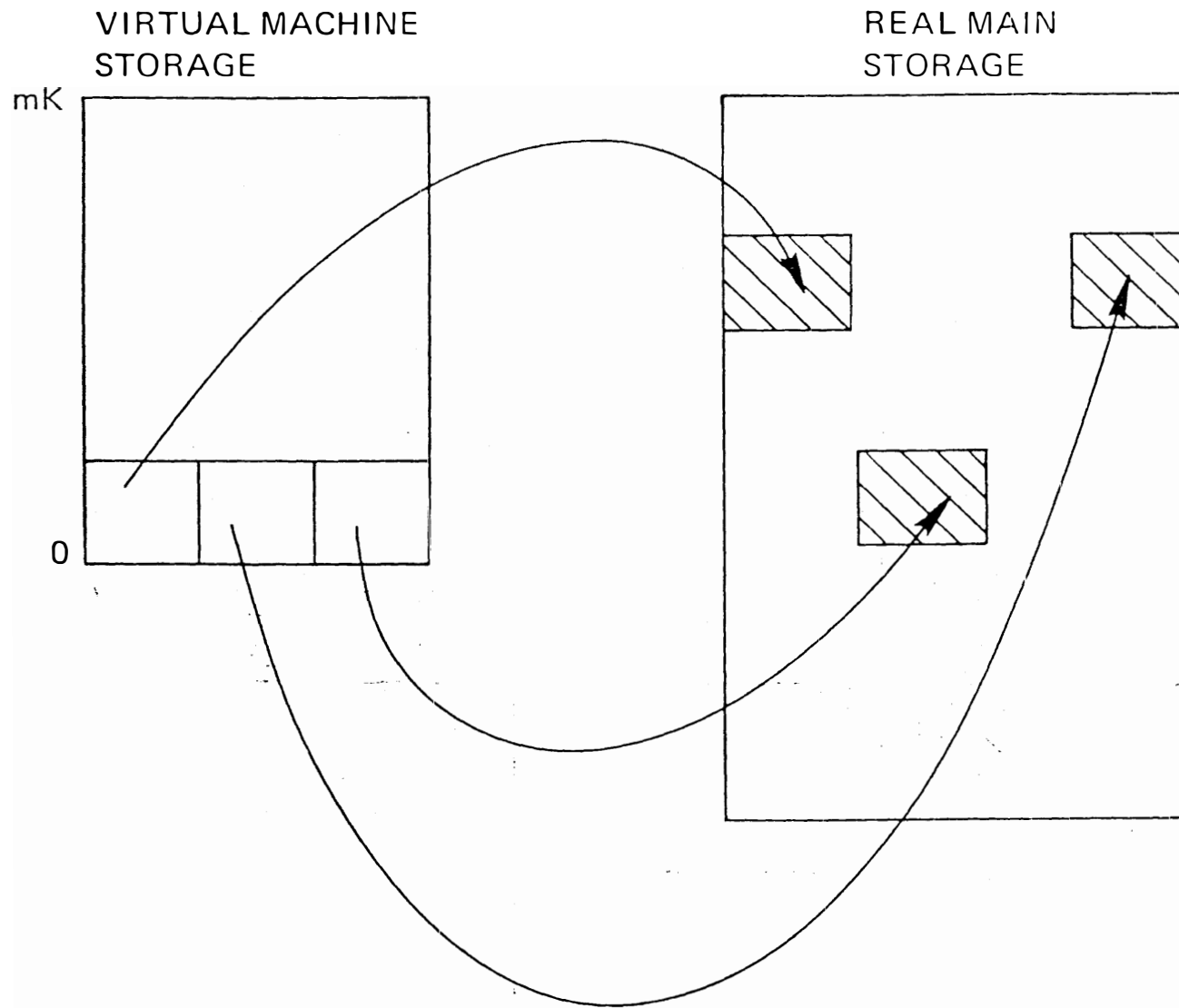
## EXTERNAL SLOT SELECTION

- UPWARD MIGRATION
- OPTIMIZE SEEK TIME
- DYNAMIC RELEASE

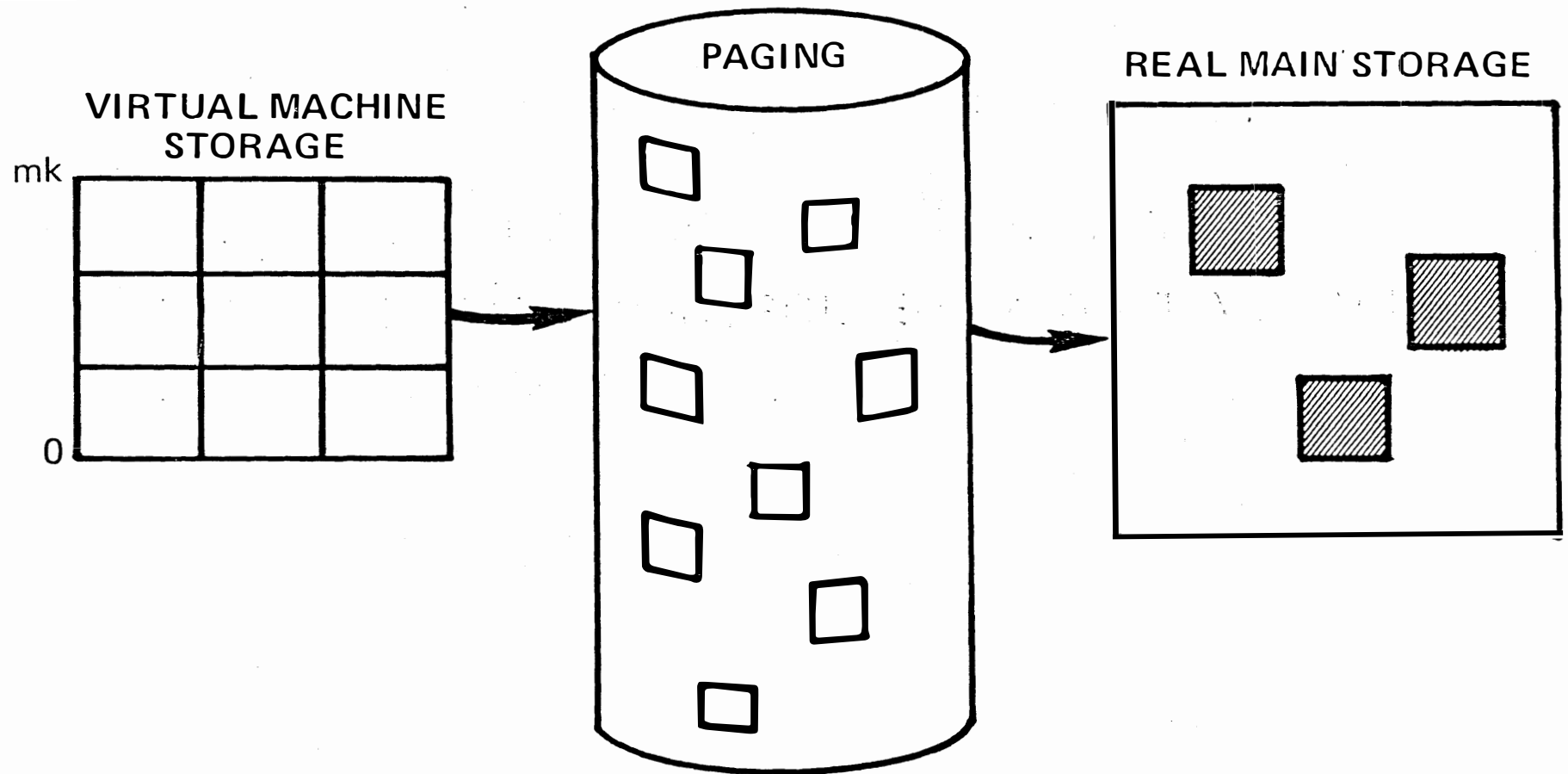
# PERFORMANCE OPTIONS FOR STORAGE MANAGEMENT

- LOCKED PAGES
- RESERVED PAGE FRAMES
- VIRTUAL = REAL

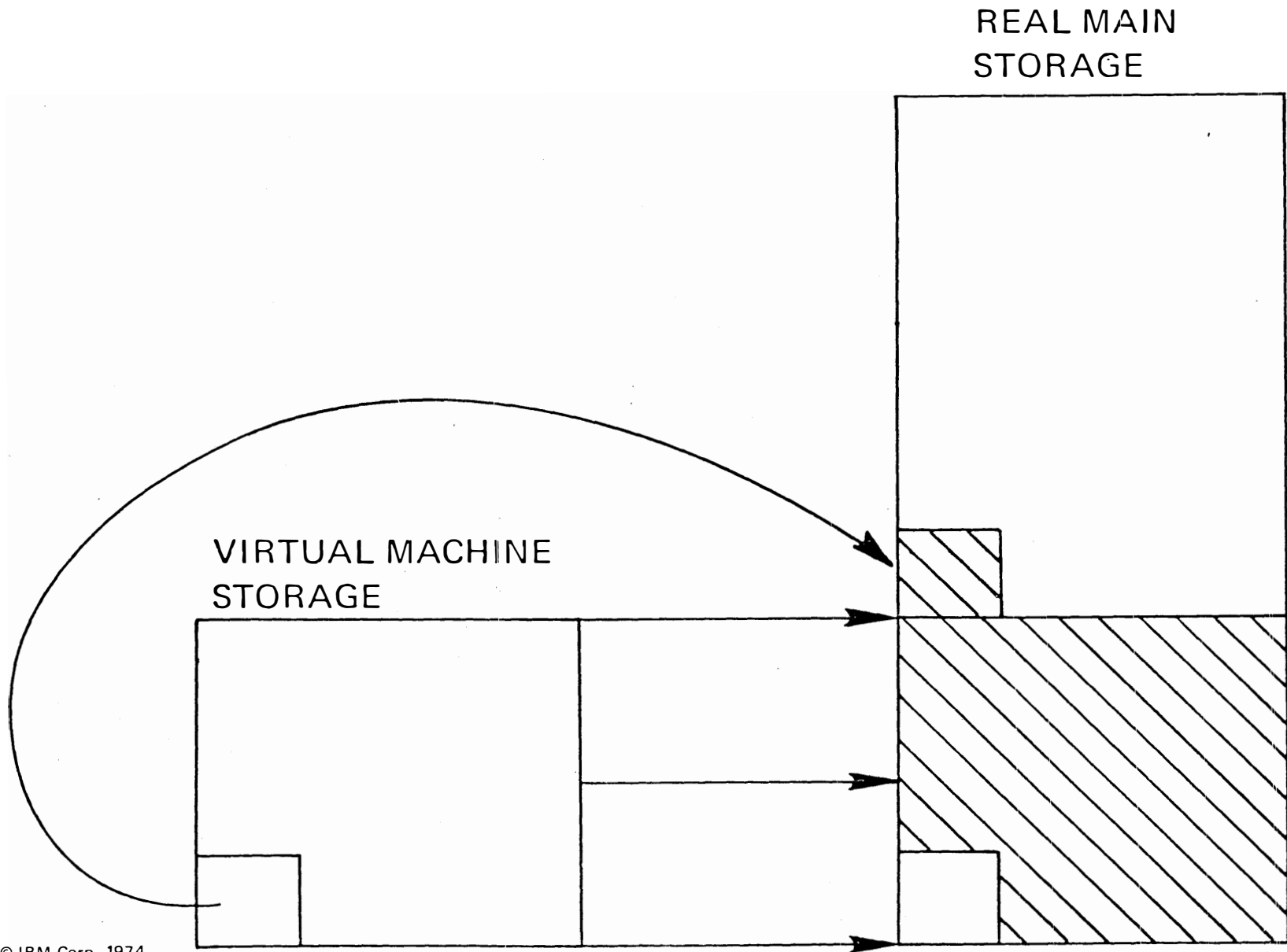
## LOCKED PAGES



## RESERVED PAGE FRAMES



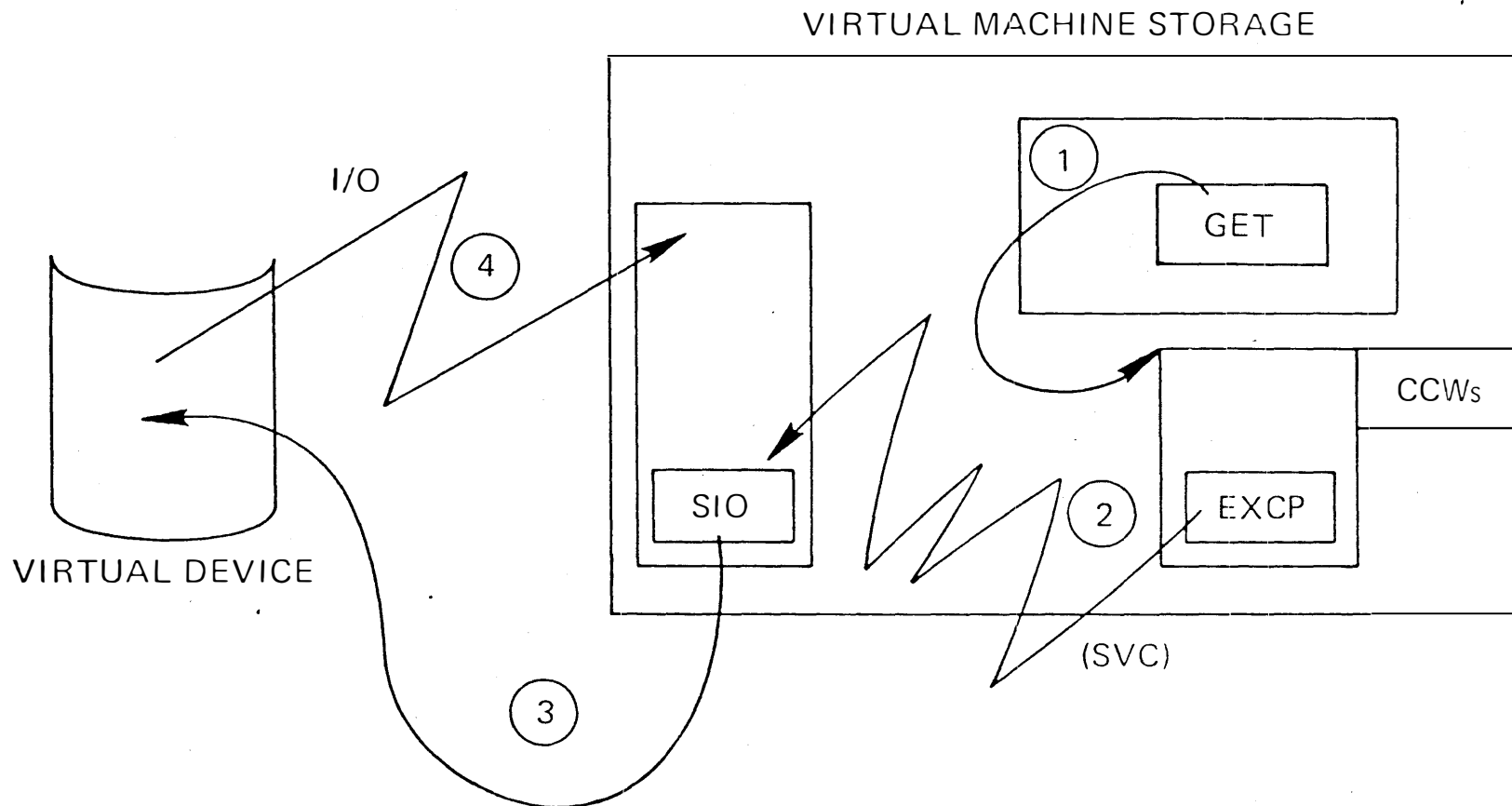
VIRTUAL = REAL



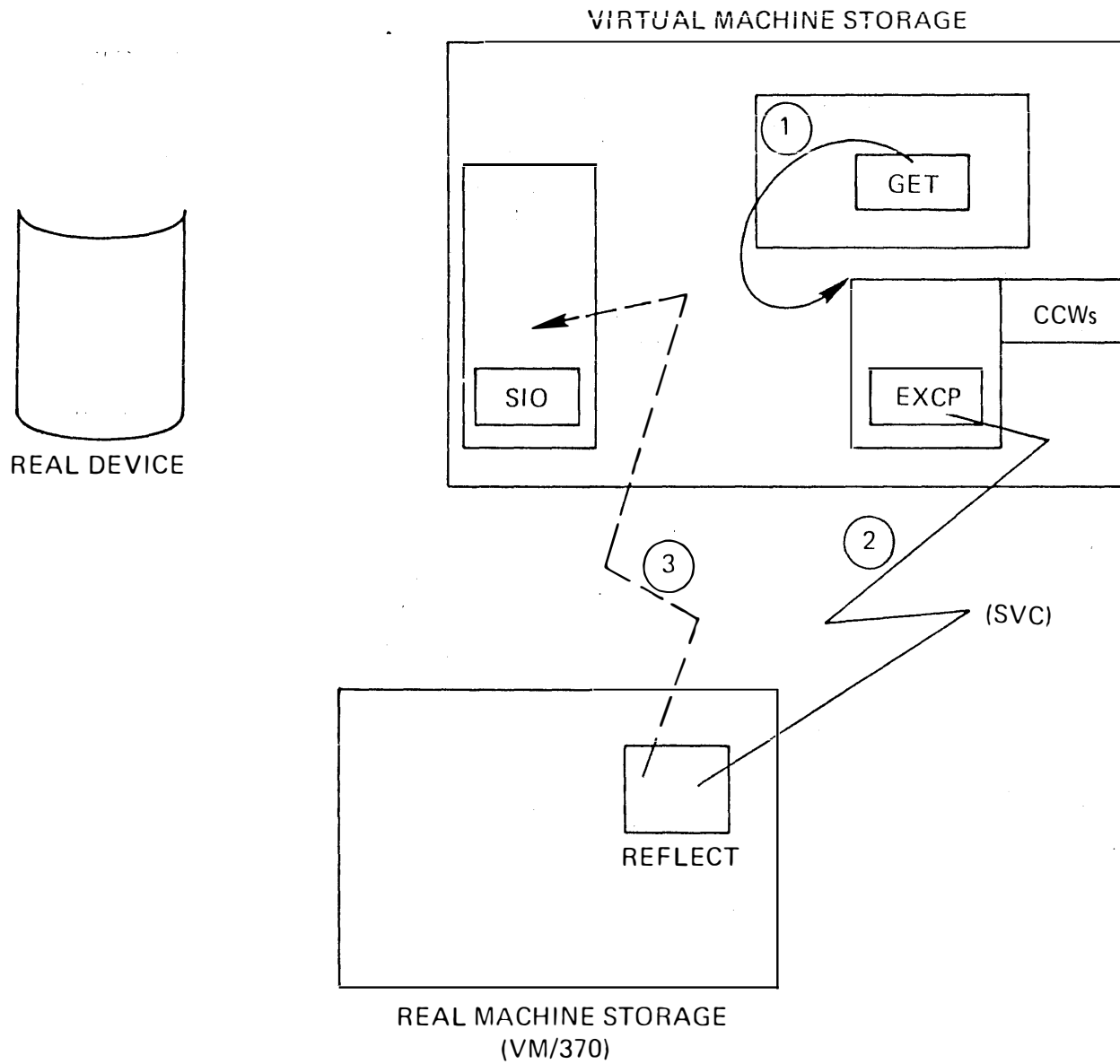
## VIRTUAL MACHINE I/O OPERATIONS

- I/O OPERATIONS INITIATED BY VIRTUAL MACHINE
- I/O ERROR RECOVERY CONTROLLED BY VIRTUAL MACHINE
- I/O ERRORS RECORDED BY VM/370

## EXPECTED I/O SEQUENCE

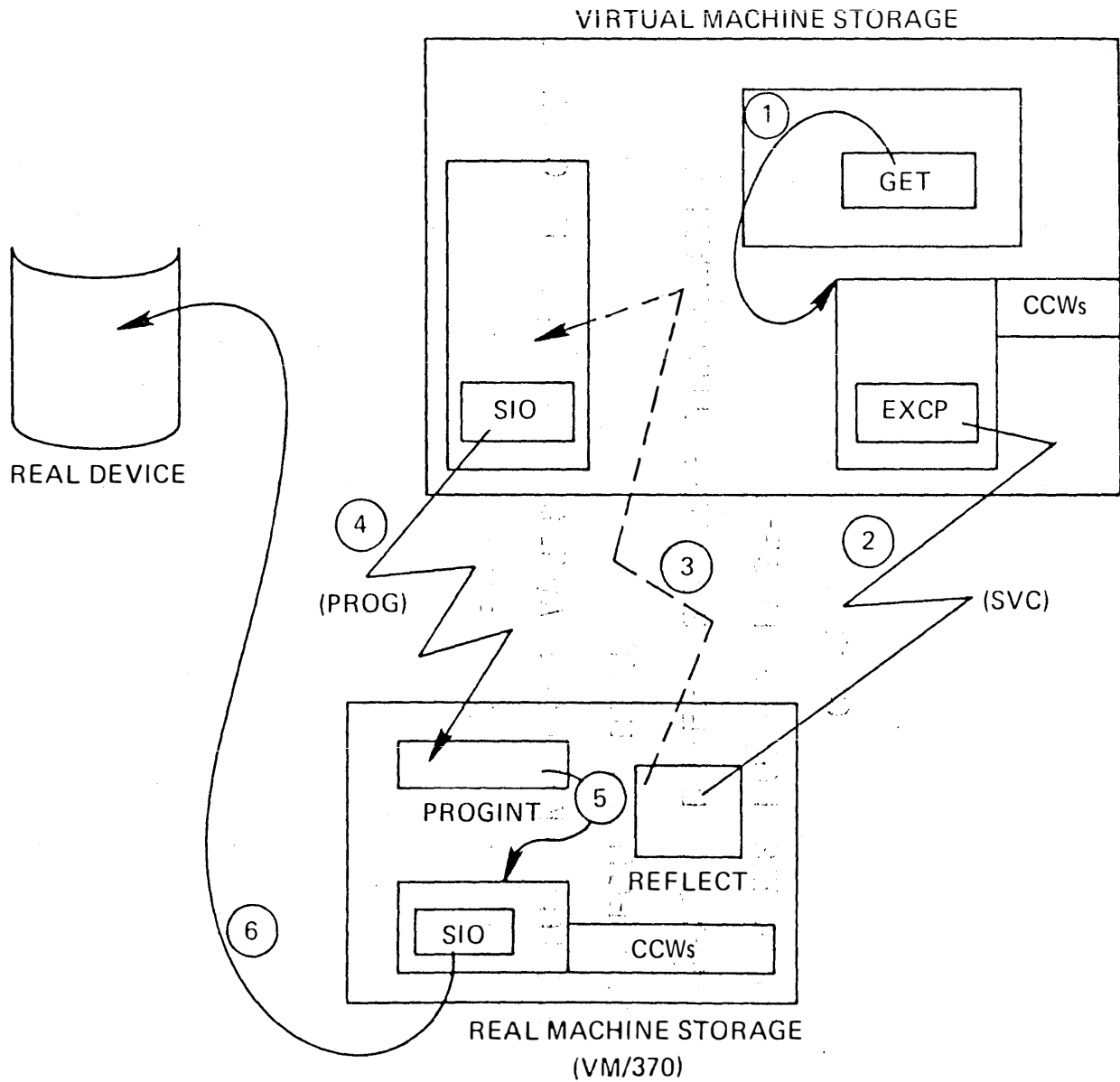


## INTERRUPT REFLECTION



I/O SEQUENCE

# INTERRUPT REFLECTION PROBLEM STATE EXECUTION

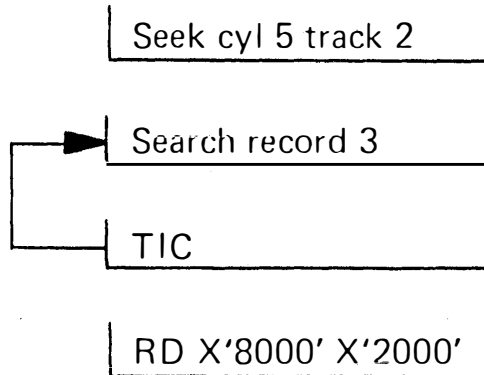


I/O SEQUENCE

## CCW TRANSLATION

### VIRTUAL MACHINE:

SIO X'191'

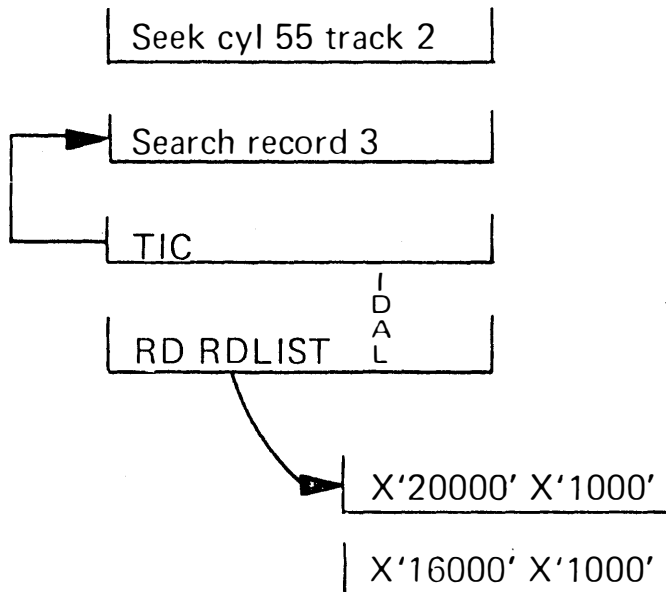


### DIRECTORY DESCRIPTION:

MDISK 191 2314 050 010 CMSVL1

### ACTUAL EXECUTION:

SIO X'290'



## PERFORMANCE CONSIDERATIONS FOR I/O MANAGEMENT

- DIAGNOSE INTERFACE

USED BY CMS

CP PERFORMS THE ERROR RECOVERY

VIRTUAL MACHINE WAITS UNTIL I/O IS COMPLETE

- VIRTUAL EQUALS REAL

BYPASSES BUFFER STORAGE TRANSLATION

BYPASSES BUFFER PAGE-INS

- VIRTUAL MACHINE CHANNEL MODE

BYTE MULTIPLEXOR

BLOCK MULTIPLEXOR

SELECTOR

VM / 370

RESTRICTIONS

## VM/370 RESTRICTIONS

- DYNAMICALLY MODIFIED CHANNEL PROGRAMS
- MINI-DISK RESTRICTIONS
  - MVT ISAM
  - IBCDASDI
- TIMING DEPENDENCIES
- CPU MODEL DEPENDENCIES
  - LOGOUT AREA
  - CPU ID
  - CHANNEL ID
- NO OTHER CPU SIMULATION

## VM/370 RESTRICTIONS (CONTINUED)

### - VM CHARACTERISTICS

- V=R I/O
- OS BTAM, OS QTAM, DOS QTAM, OS TCAM, OS/VS TCAM
- NUMBER OF PAGES FOR I/O < MAX USER PAGES
- NO READ DIRECT, WRITE DIRECT
- PSEUDO-TIMER DOESN'T RETURN INTERRUPT FROM SIO
- VM IPL WITH NO CLEAR
- DATA TRANSFER, MAXIMUM 2032 BYTES *from Virt Console*
- NO MORE THAN 73 VIRTUAL DEVICES  
(SPOOL)

ANY PHYSICAL DEVICE IS A REAL DEVICE,  
VIRTUAL DEVICES ARE SIMULATED BY VM.

## VM/370 RESTRICTIONS (CONTINUED)

### - CMS RESTRICTIONS

- MAXIMUM 246 CYLINDERS ON A 3330 *for MINIDISK*
- NO DEDICATED UNIT RECORD EQUIPMENT
- EXECUTING OS PROGRAM BY SIMULATION
- NO EXECUTION OF DOS OBJECT PROGRAMS
- DOES NOT CREATE, READ, WRITE DOS DATA SETS
- DOES NOT CREATE, WRITE OS DATA SETS
- CMS UNDER VM/370

P E R F O R M A N C E

T O O L S

## VM/370 PERFORMANCE TOOLS

- VM/370 MEASUREMENT FACILITY

LOAD INDICATORS

VM/MONITOR

- VM/STATISTICS GENERATING PACKAGE

## LOAD INDICATORS

FOR OPERATORS AND SYSTEMS STAFF

|          |        |        |
|----------|--------|--------|
| INDICATE | LOAD   |        |
|          | USER   | *      |
|          | QUEUES | USERID |
|          | I/O    |        |
|          | PAGING | WAIT   |
|          |        | ALL    |

FOR USERS

|          |      |   |
|----------|------|---|
| INDICATE | LOAD |   |
|          | USER | * |

ACNT COMMAND RESETS ALL LOAD ACCUMULATORS.

## LOAD INDICATORS

LOAD -- CPU TIME PERCENTAGE  
USERS IN QUEUE 1  
USERS IN QUEUE 2  
USE PERCENTAGE OF REAL STORAGE  
SCHEDULER CONTENTION RATIO

USER -- NUMBER USER'S PAGES RESIDENT  
USER'S WORKING SET SIZE  
PAGE READS  
PAGE WRITES  
VIRTUAL PAGES ON DISK PAGING SPACE  
VIRTUAL PAGES ON DRUM PAGING SPACE  
TOTAL VIRTUAL TIME  
TOTAL VIRTUAL AND SIMULATION TIME  
NON-SPOOLED I/O REQUESTS  
VIRTUAL CARDS READ  
VIRTUAL CARDS PRINTED  
VIRTUAL CARDS PUNCHED

## LOAD INDICATORS

FOR OPERATORS ONLY

|                |                                                           |
|----------------|-----------------------------------------------------------|
| QUEUES --      | ELIGIBLE OR QUEUE LISTS OCCUPIED<br>(E1, E2, Q1, Q2)      |
|                | STATUS INDICATORS<br>(RU, PG, IO, EX, PS)                 |
|                | NUMBER OF PAGES RESIDENT IN REAL<br>STORAGE (HEXADECIMAL) |
|                | WORKING SET IN PAGES (HEXADECIMAL)                        |
| I/O --         | USERS IN I/O WAIT                                         |
|                | ADDRESS OF REAL DEVICE                                    |
| PAGING WAIT -- | USER IDS IN PAGE WAIT                                     |
|                | NUMBER OF PAGE FRAMES ON DRUM AND<br>DISK                 |
| PAGING ALL --  | PAGE RESIDENCY DATA FOR ALL USERS                         |

MONITOR

DISPLAY „

ENABLE

PERFORM  
RESPONSE  
SCHEDULE  
USER  
INSTSIM  
DAS TAP  
SEEKS  
SYSPROF

INTERVAL

NNNNN

SEC ,  
MIN

START

CPTRACE  
TAPE

RADDR

MODE

## VM/MONITOR

### RECORD FOLLOWING EVENTS

EXTERNAL INTERRUPTS  
SVC INTERRUPTS  
PROGRAM INTERRUPTS  
MACHINE CHECK INTERRUPTS  
I/O INTERRUPTS  
FREE STORAGE REQUESTS  
RELEASE OF FREE STORAGE  
ENTRY INTO SCHEDULER  
QUEUE DROP  
RUN USER REQUESTS  
START I/O  
UNSTACK I/O INTERRUPTS  
STORING A VIRTUAL CSW  
TEXT I/O  
HALT DEVICE  
UNSTACK IOBLOK OR TRQBLOK  
NCP BTU

## MONITOR COMMAND

MONITOR

DISPLAY

ENABLE

PERFORM  
RESPONSE  
SCHEDULE  
USER  
INSTSIM  
DASTAP  
SEEKS  
SYSPROF

INTERVAL

NNNNN

SEC  
MIN

START

CPTRACE  
TAPE

RADDR

MODE 800  
MODE 1600  
MODE 6250

STOP

CPTRACE  
TAPE

## VM/STATISTICS GENERATING PACKAGE

REDUCTION OF DATA FROM VM/370 MEASUREMENT FACILITY.

SUMMARIZATION TECHNIQUES.

FORMAT AND PRINT TRACE DATA.

VM/SGP

PROGRAM GENERATOR

USES PL/1 LANGUAGE

STATISTICAL ANALYSIS

MEANS

VARIANCES

STANDARD DEVIATIONS

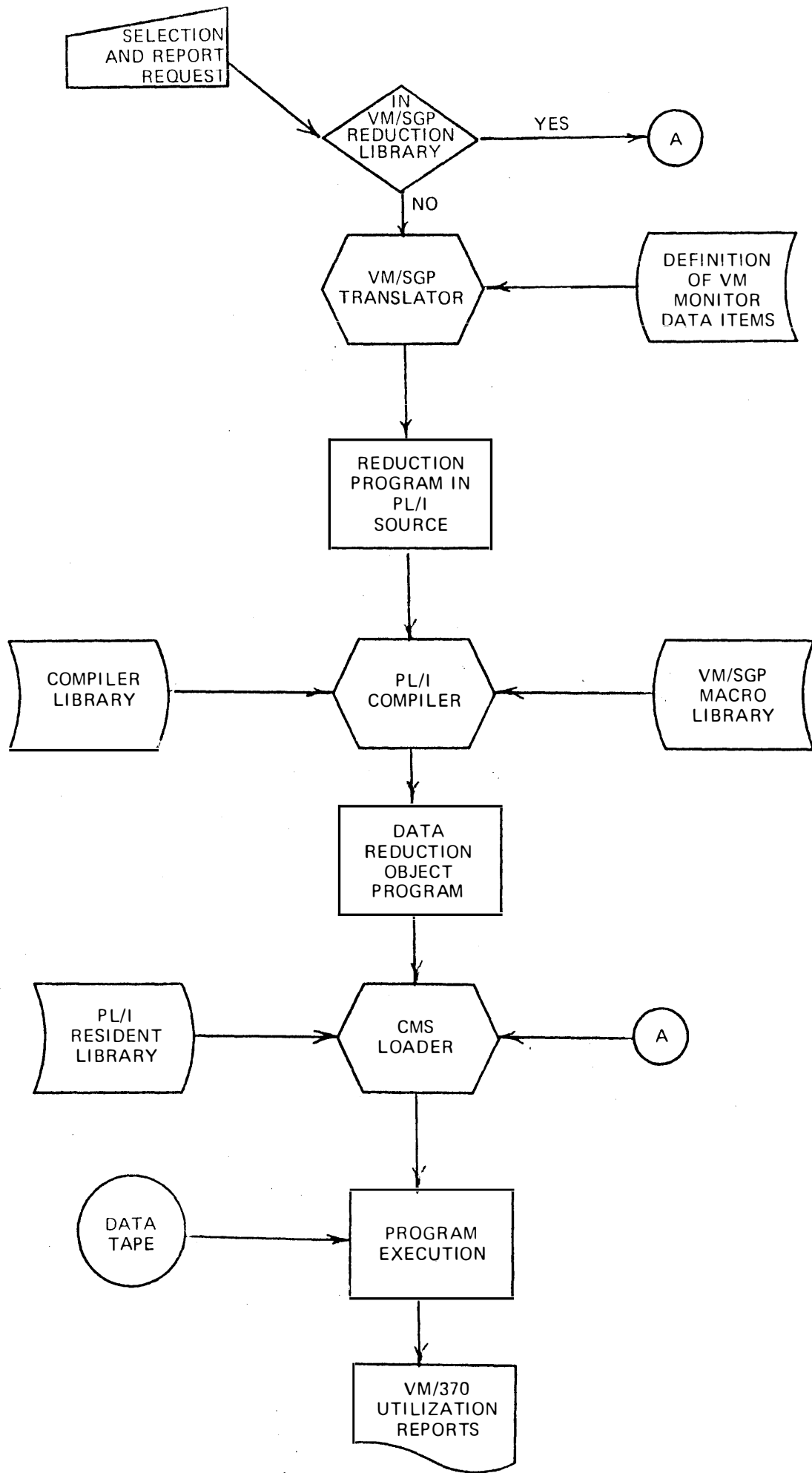
DISTRIBUTIONS

ACCUMULATIVE HISTORY

HARDWARE UTILIZATION

SOFTWARE PERFORMANCE

USER LOAD



The flow to produce data reduction programs for the VM/370 Measurement Facility using VM/SGP.

## VM/SGP

### SIMPLE KEYWORD USAGE

PERCENT\_\_CPU

PAGING\_\_RATE

USERS\_\_LOGGED

MEAN

MIN

MAX

TOTAL

```
REQUIRE (CLASS__NUMBER = 4, &CODE__NUMBER = 0) &  
         (USERID = 'ABC') &  
         ('10.00.00' <= TIME<= '12.00.00');
```

S Y S T E M

I N T E G R I T Y

## VM/370 INTEGRITY

- EIGHT-CHARACTER USER ID
- EIGHT-CHARACTER PASSWORD
- MINI-DISK PASSWORD
- STORE AND FETCH PROTECTION
- CP COMMAND PRIVILEGE CLASS

OS/360 AND VM/370  
SECURITY/INTEGRITY COMPARISON

- OS/360
  - SINGLE ADDRESS SPACE
  - ADDRESS SPACE PARTITIONED
  - PROTECTED BY STORAGE KEYS
  - USERS ACCESS THEIR OWN REGION
  - CONTROL BLOCKS MANAGE USES AND RESOURCES
  - MANY SVR CONTROL BLOCKS IN USER REGIONS
  - MANY PORTIONS OF OS EXECUTED IN USER REGIONS

OS/360 AND VM/370  
SECURITY/INTEGRITY COMPARISON (CONTINUED)

- VM/370
  - CP CONTROLS THE REAL RESOURCES
  - CMS IS ONE-USER OPERATING SYSTEM
  - CP CREATES VIRTUAL MEMORY FOR EACH USER
  - VIRTUAL MEMORY CODE NOT INTERFERED BY CP
  - NO COMMON CP AND USER ACCESS METHOD
  - I/O OF VM MAPPED INTO REAL I/O SUBSYSTEM
  - MINI-DISK MAPPED INTO REAL DISK PACK