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SUBJ: A Full Character-Set Modification to the 1401

Introduction

In order to provide a facility for offline printing of "full" character-set files, the 1401 at Project MAC has been modified. This note describes the hardware and software system which enables a CTSS user to utilize the modified 1401.

Traditionally, the 1401 has been used for (among other things) printing CTSS files off-line. The user of CTSS is provided with the RQUEST command to indicate to the Disk Editor that a file is to be printed. The Disk Editor, a privileged background job (able to use the file system as well as non-CTSS tapes), creates a "print tape" containing reformatted images of files which were requested. This tape is printed at the 1401 by the special dual-printer program MIDSP4.

This system, while adequate in other ways, restricts the user to the 48-character H-type BCD set of most current IBM equipment, thus, CTSS users with 12-bit files have been unable to get their files printed off-line. The development of Multics and the concomitant proliferation of ASCII files, which also cannot be printed on the 1401, has transformed an annoyance into a bottleneck.

We have, then, the following objectives:

1. A convenient mechanism must be provided for some CTSS users to request the off-line printing of full-character-set files.

2. The plan chosen should cause a minimum of interference with MAC operations, and should cause no modification to procedures in effect at the Computation Center.

3. It should be possible to create tapes on the GE-635 for printing on the 1401. This ability is needed until the full-character-set printer for the 645 is delivered.

It is beyond the scope of this note to describe the alternatives which were evaluated or to justify the solution which has been chosen. Briefly, the chosen solution has three major parts:

1. Modifications to the MAC 1401.
2. A special 1401 program to print ASCII file-system format tapes.
3. A 7094 disk-editor-like program

Modifications to the MAC 1401

The major modification made to our 1401 was the installation on printer "A" of a print chain cartridge adapter capable of holding either the standard 48-character chain or a special 120-character chain. When the standard chain is installed, the 1401 operates normally; but when the special chain is installed, the 1401 senses the presence of the chain, and

1. Prints differently, The word-mark bit in the print band becomes significant, so that there are 128 possible codes instead of 64.

2. Changes the operation of the tape op codes slightly.

Interchanging chains is tricky, but can be done in about a minute by a trained operator. The maximum printing speed with the special chain is 272 lines/minute instead of 600.

The 1401 Program

A special 1401 program ASCPT, has been written to print standard file-system format tapes (433 wds/physical record, etc.) containing standard header and trailer labels but ASCII character stream data. Briefly, the program

a) Treats each 3 1401 characters (6-bit bytes) as representing a pair of ASCII characters, and decodes them.

b) Checks each ASCII character to see if it is a graphic, a control, or unprintable character.

c) Interprets control characters.

d) Enters graphics into the print buffer.

The assumption is made that the file is close to canonical form (MSPM BC.2.02), although some variations are tolerated, and some legal canonical streams are not handled correctly (those involving hlf and hlr, for instance).

The following actions are taken on the control characters:

010 BS Save the previous character in an "auxiliary print band", and set the line pointer so that the next character will go in the vacated spot. Set an "overstrike waiting" switch, which will cause both bands to be printed when the end of the line is seen.

011 HT Move the line pointer to the right until the line pointer is 1 modulo 10. (The line pointer points to the space where the next character will go in the line.)

012 NL Move down one line; print either one or two printbands with space suppression; clear print bands, reset switches and set line pointer to 1.

013 VT Write out partial line; skip to channel 6 on carriage tape. Do not reset line.pointer.

014 FF Write out partial line; skip to chamel 1 on carriage tape. Do not reset line pointer.

021 RHT Take the next character modulo 128 as a count of positions to move the line pointer to the right.

023 RVT Write out partial line. Take next character modulo 128 as a count of lines to move the paper up. Do not reset line pointer.

003 ETX Assume no more characters in file. Write out last line, and attempt to read tape mark. (If this character appears in a physical record not followed by a tapemark, the program will become confused.)

004 EOT This non-Multics character will cause the 1401 program to halt. Pressing "start" will cause printing to continue

All other non-graphic characters will be ingored. In particular, the following Multics characters have no effect:

CR BEL BBS BRS
HLF HLR

Lines longer than 132 characters will have only the first 132 printed, and no warning will be given. No page-overflow checking is done; the program will print right over the perforations on the paper.

The program stops after reading a file trailer label. Pressing start will cause the next file to be printed. When the EOLT label is read, the tape is unloaded, and the program is ready for another tape.

The ASCII Output Routine

A 7094 program has been written to perform the following functions:

1. Discover what files, if any, should be printed.

2. Mount a tape, write all files to be printed out onto the tape as a single file, and dismount the tape.

3. Perform a certain amount of checking on each file, inserting octal-escape sequences for characters the 1401 can't handle, breaking lines too long to be printed with a concealed new-line character, and inserting form-feed characters every time a page has been filled.

4. Head each file with a message identifying the requester, the file, and so forth.

This program, ASCED SAVED, is intended to be run by a special privileged user who is logged in periodically on FIB.

The program reads the file ASCII RQST, which contains entries of the form:

```
PB    PG     N1   N2    F1    F2
```

Each file to be printed will be preceded by a line of the form:

```
PB   PG   D1    T1   N1   N2  X  wds created D2  T2 - in F1  F2 by A
```

where D1, T1 are the date and time of the output run; X is the length of the file in words; D2,T2 are the date and time the file was created; and A is the author of the file.

Files whose class name is "RUNOFF" are simply copied after the heading is written. Other files are processed as in (3) above to insure their print-ability. (Note: EOT characters will be removed by the program, unless the second name is RUNOFF.)

Requesting ASCII Printing

The RQASCI command will cause requests for off-line printing of ASCII files to be communicated to the ASCII output routine. The user types

RQASCI N1 N2 N3 N4 ...

to request printing of files N1 N2, N3 N4, etc., RQASCI simply writes an entry, of the form described above, into a file named ASCII RQUEST, which must be a write-only link to a link to ASCII RQST in the directory of the editor. The command must be privileged, since ASCII RQST is in private mode to prevent security breaches. The PERMIT mechanism takes care of administrative control of use of the facility.

Creating ASCII Files

Besides the standard Multics tools for creating ASCII files, two other methods are of special interest. An addition has been made to the RUNOFF command, enabling a user to have RUNOFF create an ASCII file instead of typing. The user types

RUNOFF NAME 'PRINT' -'PAGE' N1

and the file NAME RUNOFF is written.

12ASCI SAVED in M1416 CMFL04

will convert a line-marked 12-bit file to an ASCII stream file.
(Ref:

Appendix - Timing

The current 1401 program comes nowhere near the possible speed of 272 lines per minute, due to the difficult character translation it must perform. It is very computation-bound, and its speed depends on the length of the lines to be printed. EPL and EPLBSA programs in general print at about 120 lines per minute; output from RUNOFF slows the machine down to something like 60 LPM.

Full-character-set printing could be speeded up by either of the following steps:

1. Purchase of additional core storage for the 1401 and a reworking of the present very cramped 1401 program.

2. Moving the character translation from the 1401 to the 7094, and construction of a new 1401 program.

Moving the character translation to the 7094 would involve changing the 7094 program to do the following:

1) Handle all carriage-positioning information, including printing with space suppression if backspaces are found.

2) Translate ASCII to 1401 chain-position code, inserting word-separator characters (35 octal) before those codes which must have word marks on the 1401, and insert record marks (72 octal) between lines.

The 1401 program would be quite simple. This is a sketch of the inner loop:

```
LOOP   MCM   0,200          One line to print band.
       SAR   LOOP+4         Set up next move.
       L     200,200,1      Special CP, set wm's.
       B     WRITE          Carriage ctl, print.
       C     LOOP+4,TOP     is end-of-rec?
       BU    LOOP           No, go on.
       B     READ           Read next rec.
       SBR   LOOP+4,BGN     Set up move.
       B     LOOP           and go.
```