Internal Report No. 32

"IOXMTA -- Interrupt-Controlled Input/Output Executive for PDP-11/20"

by James W. Brown

Feb. 1972

IOXMTA

by

J. W. Brown

Feb. 1972

1. Abstract

IOXMTA is an extension of the DEC program IOX, which is an interrupt-controlled input/output processor which lends itself to device-independent I/O programming. In addition to the standard devices handled by IOX, IOXMTA provides extensive support for TM11/TU10 magnetic tape with up to eight tape drives. It also provides a few extended features for some of the standard devices.

1.1. Conventions

All numeric quantities in this writeup are octal representations, unless specified otherwise.

1.2. Related Documentation

The user must be familiar with the program IOX, which is described in the PDP-11 PAPER TAPE SOFTWARE PROGRAMMING HANDBOOK (DEC-11-GGPB-D). Reference is also made to the monitor SRLSYS, which is described in SPACE RADIATION LABORATORY INTERNAL REPORT NO. 33.

2. Commands

All of the IOX commands are implemented. In addition, IOXMTA includes the following:

2.1. FILE (command code = 6)

```
IOT
.WORD (address of desired file number)
.BYTE 6,SLOT
```

No buffer header is used. If the device INITed to the specified slot is not a magtape, this is a NO-OP. Otherwise the tape is spaced to the beginning of the requested file. If the position of the tape is unknown, it is rewound first. IOXMTA remembers the position of each logical tape unit, and updates it every time an EOF is read or written. If the position of a tape, or its selected unit number, is changed manually, an IOXMTA RESET or REWIND must be executed so that IOXMTA will know where the tape is. RESET causes IOXMTA to "forget" the position of all tape units, so subsequent FILE calls will force rewinds. If two successive EOFs are encountered while skipping the tape forward, it will be positioned between the two EOFs, and the internal EOM will be set. The file number at the address specified in the call will be changed to indicate the resulting position of the tape. A subsequent FILE call with a smaller file number will clear EOM, but no request for a larger file number will be honored unless the SEEK command is first executed to clear EOM.

Files are numbered starting with 1. File numbers less than or equal to zero will cause a fatal error call with error code equal 1. Control does not return to the user until the tape is positioned, so no WAITR is ever needed.

2.2. CORELOAD (command code = 15)

```
IOT
.WORD  (address of buffer header)
.BYTE  15,SLOT
.WORD  (address of first data byte)
```

This functions the same as the READ command, except that the data address is specified by the extra argument rather than being implied by the buffer header address. Formatted Binary mode is illegal with this command, and any attempt to use it will result in a fatal error, Code 5. The data address specified will be rounded down if it is odd.

2.3. COREDUMP (command code = 16)

```
IOT
.WORD  (address of buffer header)
.BYTE  16,SLOT
.WORD  (address of first data byte)
```

This is a write command, exactly analogous to the CORELOAD command (cf. para. 2.2).

2.4. OFFLINE (command code = 2Ø)

```
IOT
.WORD (address of two-word buffer header)
.BYTE 2Ø,SLOT
```

This commands the tape unit INITed to the specified slot to go offline. For this and the following non-transfer commands, a two-word "buffer header" may be used. The first word must be non-zero, or a NO-OP will result. The second word is used as a standard status/mode word, and

bits 2, 3, and 4 of the mode byte must be zero. Bits Ø, 1, and 7 are ignored, and bits 5 and 6 specify tape density (cf. para. 4). If these commands are used with any device other than magtape, a fatal error, Code 1, will result.

2.5. WRTEOF (command code = 23)

```
IOT
.WORD  (address of 2-word header)
.BYTE  23,SLOT
```

Write an EOF on the selected unit. Update the file number (internally) if it is known. EOM/EOF is not set.

2.6. SPFWD (command code = 24)

```
IOT
.WORD  (address of header)
.BYTE  24,SLOT
```

Space forward the number of records specified in the first word of the buffer header, but not past EOF (cf. para. 2.7.1.)

2.7. SPREV (command code = 25)

```
IOT
.WORD  (address of header)
.BYTE 25,SLOT
```

Space reverse the number of records specified in the first word of the buffer header, but not past EOF.

2.7.1. If either the SPFWD or SPREV command encounters an EOF, the tape is left positioned just beyond it, and the current file number is updated. EOF/EOM is set.

2.8. WRTXRG (command code = 26)

```
IOT
.WORD  (address of standard output buffer)
.BYTE  26,SLOT
```

This is identical to the WRITE command, except that the tape is written with extended interrecord gaps.

2.9. REWIND (command code = 27)

```
IOT
.WORD  (address of 2-word header)
.BYTE  27,SLOT
```

Rewind the selected unit. Set the internal file number to 1.

3. Device Codes

3.1. The standard IOX device codes 1-6 are used. Device 7 is undefined. No line printer is implemented, but it could be assigned to device 7 if the restriction that output device codes must be even is removed. Modifications would have to be made in the conflict byte tables also (they would have to be extended to words, as in IOXLPT).

3.2. Magnetic tape unit n is device n + 10, i.e., unit 3 is device 13, etc. Device 17 is the highest number implemented. All magtapes conflict (in the sense defined by IOX) with each other, since the controller can handle only one device at a time. Input or output can be performed on either even- or odd-numbered devices.

4. Tape Density

Bits 5 and 6 of the mode byte are interpreted as the tape density bits for 7-track tape. Their complement is used to form the command which

is sent to the tape controller. They are ignored for non-magtape operations. Their significance is:

MODE BYTE	DENSITY (decimal bytes/inch)
ØØØ	8ØØ bpi 9 track or 7 track coredump
Ø4Ø	8ØØ bpi 7 track
1ØØ	556 bpi "
14Ø	2ØØ bpi "

These may be ORed with the data mode bits (bits Ø and 1) and the echo-suppress bit (bit 7, which is ignored in magtape operations). Bits 2, 3, and 4 must be zero. The density bits will always be cleared at return from IOXMTA. They must be reset before each call.

5. Error Returns

5.1. The byte at BUFFER+3 is the standard IOX status byte. In addition to the standard bit assignments, IOXMTA uses the following for magtape only:

1) Bit 3 on means parity error (PAE), cyclic redundancy error (CRE), or bad tape error (BTE).
2) Bit 4 on means illegal command (ILC) or bus grant late (BGL). EOM (bit 6) is also set when this occurs.

5.2. The long line truncation error (bits Ø and 1) is set when a magtape record length error (RLE) occurs.

5.3. On any magtape error, the tape status register (MTS) is dumped in binary on the teletype. If the error is an ILC or BGL, IOXMTA also types:

PRESS CONT WHEN READY.

and then halts. When the condition that caused the problem is corrected,

press CONT on the console, and execution will resume. It is up to the calling program to test the ILC bit in the buffer status byte, and reexecute the command which failed.

6. Miscellaneous Magtape Considerations

6.1. If an attempt is made to write a record (on magtape) which is shorter than 16 (decimal) bytes, the record will be filled out to that length with trailing zeroes. If an attempt is made to read into a buffer shorter than 16 (decimal) bytes, a record of that length will be read into an intermediate buffer, and as many characters as will fit will be transferred to the user buffer. On a formatted ASCII read, if the last character transferred to the user buffer is not a linefeed or a formfeed, it will be changed to a linefeed, and the truncation error bits will be set.

6.2. On formatted binary reads and writes, the buffer size must be at least one byte larger than the byte count to allow for the checksum byte. Failure to provide for this will cause a fatal error, code Ø.

6.3. Nulls and rubouts are <u>not</u> suppressed on ASCII I/O.

6.4. The high-order bit of each byte in the buffer is forced to zero on ASCII I/O.

6.5 On a formatted binary read, if an all-zero record is read, the mode error bit will be set, and the user byte count will be set to 1.

6.6 Only one magtape record is ever read or written for each IOXMTA call. This means, for example, that the buffer will not necessarily contain a linefeed after a formatted ASCII read.

7. Extended Features.

7.1. Paging is caused when a formfeed is output to the teleprinter in formatted ASCII mode. The pages are 64 (decimal) lines long. Linefeeds are output until an integer multiple of 64 (decimal) lines separate successive formfeeds.

7.2. On formatted ASCII input from the keyboard, a formfeed is echoed as two linefeeds.

7.3. On ASCII input from the low-speed reader, the CTRL-S (XOFF) character is interpreted as end-of-record and end-of-file. It is echoed as ↑S (up-arrow,S).

7.4. If CTRL-C is typed on the keyboard, IOXMTA checks location 4Ø to see if it contains a HALT. If it does, CTRL-C is ignored. Otherwise, IOXMTA assumes a monitor exists, echoes ↑C (up-arrow,C), and jumps to location Ø.

7.5 Slots 1Ø-17 have been added. These are automatically INITed to devices 1Ø-17, respectively, by the IOXMTA RESET command, but may be INITed to any device by the INIT command.

ADDENDUM to SRL Internal Report #32 5 Oct. 72

IOXMTA VØØ9 DECUS No. 11-63B JWB

The following patches should be made to convert IOXMTA VØØ9A to VØØ9B:

LOCATION	OLD	NEW
xx5562	5227	2Ø7
xx5732	xx5526	xx554Ø

Where xx is determined by the memory size for which IOXMTA is assembled:

SIZE	xx
12K	Ø4
16K	Ø6
2ØK	1Ø

etc.

These changes will affect error handling. Paragraphs 5.1 and 5.3 should be changed to indicate that the Bus Grant Late (BGL) error will be treated like a parity error rather than an illegal command:

5.1.1. BGL will set status byte bit 3 rather than bit 4.

5.3.1. The HALT will occur only for ILC, not for BGL.

ADDENDUM #2 to SRL Internal Report #32 3 Nov 72

IOXMTA VØ1ØA JWB

Operating System Release 3

2.3.1. New Command: COREX (code = 17)

```
IOT
.WORD  (address of  buffer header)
.BYTE  17,SLOT
.WORD  (address of first data byte)
```

This is identical to the COREDUMP command, except that the record is written with an extended interrecord gap.

8. The patches specified in ADDENDUM #1 (page 9) are obsolete. Paragraphs 5.1.1. and 5.3.1. remain valid.