TO: Distribution
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DATE: July 1, 1974
SUBJECT: Implementation of the IBM Standard Tape I/O Module

This MTB outlines the basic features and restrictions of the IBM Standard Tape I/O Module. This I/O module is implemented as an entry point in the ANSI Standard Tape I/O Module. However, it has its own user interface to allow for attachment options different from those of the ANSI Tape Module.

The implementation plan listed below shows which features the I/O module will support in each of its versions. After any given version of the I/O module is completed, we may install the I/O module to make the added features of that version available to users, or we may wait until later versions are completed before we install the module. The decision to install a particular version will be based on the viability of that version of the I/O module, and the expected completion schedule for the versions which follow.

Because the IBM Tape I/O Module is implemented as a part of the ANSI Tape I/O Module, there is a correspondence between the versions of the IBM I/O Module and the ANSI I/O Module, as follows:

IBM Tape Version One  ===>  ANSI Tape Version Two
IBM Tape Version Two  ===>  ANSI Tape Version Three

Appendix A of this MTB describes the basic strategy of the IBM I/O Module for blocking and deblocking records. MTB-090, which describes the implementation of the ANSI Standard Tape I/O Module, includes several appendices which are also pertinent to the IBM Standard Tape I/O Module. In particular, Appendix A of MTB-090 is a glossary of terms used in the implementation plan. Appendix C of MTB-090 defines the ASCII-to-EBCDIC conversion which the I/O module performs for label and file data. Appendix D of MTB-090 defines the general error recovery strategy for the hardware errors which can arise while processing a tape.

Please direct any comments on this MTB to Gary Dixon, at the above address. Mail comments to GDixon700 on the MIT Multics.

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VERSION ONE

Features Supported by This Version

1. I/O Switch Interfaces:
   a) Ios_ Interfaces: attach, read, write, detach
   b) Attachment Options:
      mode - read or write
      volume serial number - 6 characters
      data set name - 1 to 17 characters
      file sequence number
      record format - F, FB, V, VB, VBS, or U (1)
      record length (1)
      block size (1)
      file character code - EBCDIC or ASCII (1)
      file generation number
      file version number
      file expiration date (1) (2)
      not-yet-labelled (1) (3)
      density - 800 or 1600 (4)
   c) Detachment Disposals:
      leave, reread, rewind, or unload

2. Tape Labels:
   a) Standard OS Tape Labels, IBM GC28-6680-4.
   b) Tape Organizations:
      single-file volumes
      multi-file volumes

(1) This attachment option is valid only when writing a file.

(2) This version of the I/O module does not use the file expiration date to prevent rewriting of a file which has not expired. It merely allows the user to fill in the file expiration date field of the label to facilitate interchange of IBM tapes between operating systems which support IBM Standard Tapes. A future version of the I/O module will honor the file expiration date.

(3) If this option is not specified, the tape is assumed to have an IBM Standard volume label (VOL1), and at least one Beginning-of-File-Section header label (HDR1). These labels must be present to mount an IBM tape, or else the not-yet-labelled attachment option must be used.

(4) If this option is not specified, a recording technique of 9-track, 1600-bpi is assumed.
c) labels read:
   VOL1 HDR1 HDR2 EOF1 EOF2 EOV1 EOV2 (5)

d) labels written:
   VOL1 HDR1 HDR2 EOF1 EOF2

e) labels skipped on input:
   VOL2-VOLn HDR3-HDRn EOF3-EOFn EOV3-EOVn
   UHL1-UHLn UTL1-UTLn

f) label character code: EBCDIC (6)

g) label I/O technique: synchronous I/O (7)

h) label error recovery strategy:
   input: backspace-block/reread 10 times
   output: backspace-block/erase/rewrite 10 times

3. tape files:
a) standard:

b) record formats:
   F (fixed-length, unblocked records)
   FB (fixed-length, blocked records)
   V (variable-length, unblocked records)
   VB (variable-length, blocked records)
   VBS (variable-length, blocked, spanned records)
   U (undefined format records)

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(5) Since this version of the I/O module does not support multi-volume files, EOV1 and EOV2 labels are treated as EOF1 and EOF2 labels to allow the file sections of a multi-volume file to be treated as separate files. Multi-volume files will be fully supported in Version Two of this I/O module.

(6) The conversion from ASCII to EBCDIC is performed in two steps: (1) each 7-bit ASCII character (which is stored in the rightmost 7 bits of a 9-bit Multics byte) is converted to an 8-bit EBCDIC character (which is stored in the rightmost 8 bits of a Multics byte); (2) the Multics byte is then converted to an 8-bit tape frame by ignoring the leftmost bit of each byte. (Note that, on a 9-track tape, an 8-bit tape frame is stored in 8 of the tracks, and a parity bit for the tape frame is stored in the 9th track.) The ASCII/EBCDIC conversion performed in the first step is defined in Appendix C of MTB-090.

(7) The error buffer and error order call entry points of tapeio_ are used to process tape labels so that output which is pending when a volume switch occurs can be preserved while the new volume is being mounted. The error buffer entry points of tapeio_ always perform synchronous I/O.

(8) The handling of errors which occur while processing labels is defined in more detail in Appendix D of MTB-090.
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(9) This limitation is imposed by the size of the wired-down, hardcore buffer from which the tape DCM writes, and into which it reads, tape blocks.

(10) VBS-format records may span several blocks and may, in general, have any length. The maximum record length of $131071$ (2**17 - 1) characters is a constraint imposed by the maximum value of the nelem and nelemt arguments of ios_, which are declared as fixed bin(17) integers.

(11) 9-bit Multics bytes, each containing an ASCII character in the rightmost 8 bits of a byte, are converted to 8-bit tape frames by ignoring the leftmost bit of each byte. (Note that, on a 9-track tape, an 8-bit tape frame is stored in 8 of the tracks, and a parity bit for the tape frame is stored in the 9th track.)

(12) Input/output of data is performed by the asynchronous interfaces of the tapeio_ subroutine.

(13) The handling of errors which occurring while reading or writing data blocks is defined in more detail in Appendix D of MTB-090.
5. **access control**
   No access control facilities are provided by the I/O module, either on a per volume or on a per file basis. Access control will be provided for tape volumes by the Tape Mount Package, when it is installed and used in a future version of the IBM Tape I/O Module.

6. **tape mounting and file positioning**
   At attachment time, the requested tape volume is
   mounted, if it is not already mounted from a previous
   attachment in the current process. If the tape had to
   be mounted, then its volume label is checked after
   performing the mount to insure that the operator has
   mounted the proper tape. The tape is then positioned
   to the requested file.
Features Supported by This Version

1. I/O Switch Interfaces:
   a) iox_interface:
      attach, open, read_record, write_record, read_length,
      position, control, close, and detach
   b) attachment options:
      volume serial number - 6 characters
      data set name - 1 to 17 characters
      file sequence number
      record format - F, FB, V, VB, VBS, or U (14)
      record length (14)
      block size (14)
      file character code (14)
      file generation number
      file version number
      file expiration date (15)
      option to extend (append data to) an existing file
      unregistered option (16) (17)
      not-yet-labelled option (16) (18)

(14) This attachment option is normally used only when writing a
     tape file. It may be used when reading a tape file to override
     the file description information which is usually obtained from
     the file labels.

(15) The file is regarded as "expired" when the current date is
     equal to or greater than the expiration date. When a file has
     expired, that file and the succeeding files of the file set may
     be overwritten; otherwise, overwriting is prevented. Note that,
     to be effective, the expiration date of a file must be less than
     or equal to the expiration date of those files in the file set
     which precede it. The I/O module attempts to enforce this
     restriction when the file expiration date is set.

(16) This option only has meaning for tapes which have not been
     registered with the Multics Tape Mount Package. The label
     characteristics and recording density of registered tapes is
     obtained from the tape's Volume Descriptor Segment (VDS). This
     information must be supplied for unregistered tapes at attach
     time.

(17) In the event that the Tape Mount Package has not been
     installed when Version Two of the I/O module is complete, use of
     the Tape Mount Package will be decoupled from Version Two, and
     included in a future version of the I/O module.

(18) This attachment option may only be used when writing a file.
density - 800 or 1600 (16) (19)
detachment disposal - leave, reread, rewind, or unload
DOS Standard Tape Format option
leading tape mark option (20)
c) opening modes:
sequential_input
sequential_output
d) control requests:
set user label processing subroutine
set block prefix processing subroutine
get detailed error information
get file description information
force volume switching
e) positioning:
skip to beginning of file
skip to end of file
skip forwards or backwards of a specified number of records

2. tape labels:
a) standard:
OST: OS Tape Labels, IBM GC28-6683-4.
DOS: DOS/V Tape Labels, IBM GC33-5374-0.
b) tape organization:
single-file volumes
multi-file volumes
multi-volume files
multi-file multi-volume volume sets
c) labels read:
OST: VOL1 HDR1 HDR2 EOF1 EOF2 EOV1 EOV2
DOS: VOL1 HDR1 EOF1 EOV1 (21)
d) labels written:
OST: VOL1 HDR1 HDR2 EOF1 EOF2 EOV1 EOV2
DOS: VOL1 HDR1 EOF1 EOV1
e) labels skipped on input:
OST: VOL2-VOLn HDR3-HDRn EOF3-EOFn EOV3-EOVn
UTL1-UTL8 UTL1-UTL8
DOS: VOL2-VOLn HDR2-HDRn EOF2-EOFn EOV2-EOVn
UTL1-UTL8 UTL1-UTL8

(19) If this option is not specified, then a recording technique of 9-track, 1600-bpi is assumed.

(20) Check for and skip a leading tape mark on a DOS non-labelled tape volume.

(21) Since HDR2, EOF2, and EOV2 labels are not normally present on DOS standard labelled tapes, the user must specify the file description information (record format, record length, block size, and file character code) in the attachment options for DOS tapes.
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f) label character code: same as Version One
g) label I/O technique: same as Version One
h) label error recovery strategy: same as Version One
i) overriding file description information:
   input: override the file description information
   which is normally obtained from the HDR2 label
   by using the appropriate attachment options

3. tape files:
a) standard
   OS: OS Data Management Services Guide,
       IBM GC27-3746-2.
b) record formats: same as Version One
c) maximum block size: same as Version One
d) record length limits:
   same as Version One, except:
   VBS-format:
   \[ \text{record\_length} = x \times 1 \leq x \leq 1048576 \] (22)
e) encoding technique: same as Version One
f) I/O technique: same as Version One
h) error recovery strategy: same as Version One

4. recording technique: same as Version One

5. access control:
   Access control is provided by the Tape Mount Package,
   which provides one ACL per tape volume. This ACL is
   stored as the extended ACL on the tape volume's Volume
   Descriptor Segment (VDS). (17)

6. tape mounting and file positioning:
   At open time, the volume will be mounted automatically,
   if not already mounted from a previous attachment, and
   will be positioned automatically to the requested file.

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(22) The maximum record length of S-format records is 1048576
    (256 * 1024 * 4) characters. This constraint is based upon the
    size of the largest possible buffer (a 256K segment) which can
    hold a record.
FEATURES NOT SUPPORTED BY ANY PLANNED VERSION

1. I/O Switch Interfaces:
   a) No plans to support opening modes, other than sequential_input and sequential_output.

2. Tape labels:
   a) No plans to read or write the following optional labels:
      OSI VOL2-VOLn HDR3-HDRn EOF3-EOFn EOFV3-EOVn
      UHL1-UHL8 UTL1-UTL8
      DOSI VOL2-VOLn HDR2-HDRn EOF2-EOFn EOFV2-EOVn
      UHL1-UHL8 UTL1-UTL8
   b) No plans to support label encoding techniques, other than EBCDIC character code.
   c) No plans to support mixed character codes within labels.
   d) No plans to support labels consisting only of upper-case EBCDIC letters.

3. Tape files:
   a) No plans to support binary encoding of data.
   b) No plans to support the use of mixed character codes within a single file.
   c) No plans to support BCD character code or character codes other than EBCDIC or ASCII.

4. Recording techniques:
   No plans to support 7-track tapes; no plans to support 9-track tapes at densities other than 800- and 1600-bpi

5. Access control:
   a) No plans to support tape volume access control through the accessibility field of the VOL1 volume label.
   b) No plans to support tape file access control through the accessibility field of the file labels.
APPENDIX A
STRATEGY FOR PADDING RECORDS AND BLOCKS

This appendix summarizes the strategy used by the IBM Tape I/O Module to pad records and blocks. Padding is required: (1) because the tape DCM requires that blocks to be written on tape begin and end on a word boundary (i.e., that they are a multiple of 4 characters in length); and (2) because the smallest block which can be read from a tape by an IBM tape drive is 18 tape frames (or characters) in length.

An EBCDIC or ASCII space character is used as the pad character, depending on which character code was specified for the data. Pad characters are included within the records in each of the OS and DOS record formats, rather than merely being appended to the end of a block, because OS/370 does not allow any pad characters which are not part of a record. Therefore, padding may alter the contents of some of the records which are written out.

Two types of padding are performed. The first type is the padding of short blocks out to the minimum block size of 20 characters \( \text{mod}(18,4) \neq 0 \). The second type is to pad each block to be a multiple of 4 characters in length (including all Block Descriptor Words (BDWs) and Record Descriptor Words (RDWs)). Pad characters are added to the last (or only) record of each block. (Note that pad characters will never be added to the end of any but the last record segment of a spanned record because all record segments but the last are block size - 4 characters long, and \( \text{mod}(\text{block size}, 4) = 0 \).

As an additional precaution to insure that the user is aware of this padding, the IBM Tape I/O Module enforces the following restriction on the value of block size attachment options specified by the user when writing a tape:

\[
\text{block size} = x \times 20 \leq x \leq 8192 \text{ and } \text{mod}(x, 4) = 0
\]

Note that the IBM Tape I/O Module can read blocks of any length, even if \( \text{mod}(\text{length}, 4) \neq 0 \). This allows the I/O module to read any OS/370 or DOS/VS Standard Labelled Tape, and with Version Two of the I/O module, read any OS/370 or DOS/VS Non-Labelled Tape.