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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 GDixon.P00 on the MIT Multics.

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

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(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: (8.)
        input: backspace-block/reread   10 times
        output: backspace-block/erase/rewrite   10 times

3.   tape files:
    a) standard:
        OS Data Management Services Guide, IBM GC27-3746-2.
    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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           c) maximum block size:   8192 characters (9)
           d) record length limits:
                  F-format:
                      record_length = block_size
                  FB-format:
                      record_length = x: mod(block_size, x) = 0
                  V-format:
                      record_length = block_size - 4
                  VB-format:
                      record_length ≤ block_size - 4
                  VBS-format:
                      record_length = x: 1 ≤ x ≤ 131071 (10)
                  U-format:
                      record_length = block_size
           e) encoding technique:
                  EBCDIC character code (6)
                  ASCII (11)
           f) I/O technique:  asynchronous I/O (12)
           g) error recovery strategy: (13)
                  input:    backspace-block/reread        10 times
                  output:   backspace-block/erase/rewrite  10 times

4.    recording techniques:
              9-track, 800-bpi density
              9-track, 1600-bpi density
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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 occuring 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.

VERSION TWO

Features Supported by This Version

1.   I/O Switch Interfaces:
     a) iox_ interfaces:
          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)

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(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:
    OS: OS Tape Labels, IBM GC28-6680-4.
    DOS: DOS/VS 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:

OS:	VOL1	HDR1	HDR2	EOF1 EOF2	EOV1	EOV2
DOS:	VOL1	HDR1		EOF1	EOV1	(21)

  d) labels written:

OS:	VOL1	HDR1 HDR2	EOF1 EOF2	EOV1 EOV2
DOS:	VOL1	HDR1	EOF1	EOV1

  e) labels skipped on input:

OS:	VOL2-VOLn	HDR3-HDRn	EOF3-EOFn	EOV3-EOVn
		UHL1-UHL8	UTL1-UTL8	
DOS:	VOL2-VOLn	HDR2-HDRn	EOF2-EOFn	EOV2-EOVn
		UHL1-UHL8	UTL1-UTL8	

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(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.

            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.
              DOS: DOS/VS Data Management Guide, GC33-5372-2.
        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:
                            record_length = x: $1 \le x \le 1048576$ (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:
            OS: VOL2-VOLn   HDR3-HDRn   EOF3-EOFn   EOV3-EOVn
                             UHL1-UHL8   UTL1-UTL8
            DOS: VOL2-VOLn   HDR2-HDRn   EOF2-EOFn   EOV2-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 (mod(18,4) ≠ 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 mod(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:

block_size = x: 20 ≤ x ≤ 8192 and mod(x,4) = 0

Note that the IBM Tape I/O Module can read blocks of any
length, even if mod(length,4) ≠ 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.