Proposal for Storage and Access of Data on Media Auxiliary Memory

Ian Crighton
Hewlett-Packard

Revision History

Author: Ian Crighton
Phone: +44 117 9228339
Location: R&D, Hewlett-Packard Ltd, Bristol, UK
Email: ianc@bri.hp.com

Version	Date	Comment
A	9 Dec 1998	Initial release for review
0.9	26 Jan 1999	Release for HP internal review
1.0	1 Feb 1999	External release to TapeAlert Working Group
2.0	6 Mar 1999	Update following comments from Sony and Intellistor. Main changes: • "Media Fixed" MAM section renamed to "Media Mandatory" • Cartridge Serial Number parameter increased in length from 10 bytes to 32 bytes. • Media Length parameter format changed from ASCII to binary and reduced from 4 to 2 bytes. • Parameter Format Version parameter added to Drive Mandatory section to for upwards compatibility. • Load Count added to Drive Mandatory section. • Parameter sections increased in length (and renumbered) to allow greater flexibility. • Timestamp appended added to Date Last Written parameter. • "Media Vendor Unique" MAM section added.
3.0	16 Mar 1999	Added ANSI X3/T10 proposal reference number

References

ANSI X3/T10 SSC proposal reference T10/99-148r0

Please that this document constitutes a proposal. New SCSI identifiers shown, such as Log Page numbers, have not yet been approved.

Introduction

Small amounts (~4Kbytes currently) of re-writeable memory are currently being added to the removable media of several of the major tape technologies. Examples are Cartridge Memory (HP/Seagate/IBM LTO) and MIC (Sony AIT). Throughout this proposal Media Auxiliary Memory (MAM) will be used to refer to this memory.

Media Auxiliary Memory is typically used internally by the drives to speed up operations and increase reliability invisibly to application software. There are several scenarios, however, where it would be useful

for an application to be able to store and retrieve data from this memory in a standardized manner. Although this would require changes to the application, significant customer benefits will result.

No standard method has currently been defined to read and write this data. The aim of this document is to propose methods that can be used from both Media Changers and Tape Drives to achieve this aim. The proposal has also been designed to support future extension. Note however that the SCSI commands used do introduce an upper limit of 64KB (including overheads) for the amount of data returned.

This proposal makes no attempt to standardize the location or format of the data stored on the memory just the SCSI commands used to access it. Any such definitions will be technology dependent.

Overview

This proposal has several aims:

- Allow a unique tape serial number, stored in MAM, to be accessed from tape drives and suitably equipped libraries using standardized commands.
- Allow application-level label information to be accessed and used, in a standard manner, by libraries and tape drives.
- Allow software applications to use the MAM in a standard, extensible manner.

To allow this to happen, the following items have been defined.

- Tape drive commands to allow access and control over MAM contents.
  - A Vital Product Data Page has been defined for the Inquiry command to allow a subset of the available data to be accessed in a multi-initiator environment.
  - A Log page has been defined to allow the contents of the MAM to be read and changed.
  - A read-only Mode page has been defined to retrieve data about the size and remaining capacity of the MAM.
- An extension to the Read Element Status command has been defined to allow the MAM information for multiple media to be returned by a suitably equipped library.
- A parameter assignment structure which defines certain parameters and allows applications to define their own.

Data Representation

The data in the MAM will be represented as a set of parameters, each having a unique ID. This is a logical representation only and implies nothing about the physical representation of the data in the MAM. The following parameters have been defined and are split up into groups according to the source of changes or updates and whether they are optional or mandatory. The parameter data may be accessed by the SCSI commands shown later in this specification.

Media Mandatory

- Hard coded into cartridge at manufacture time.
- Parameters: 0h - 1FFh

ID	Parameter Name	#Bytes	Format	Comment	Notes
00h	Cartridge Manufacturer	8	ASCII	Vendor ID from SCSI Inquiry	1
01h	Cartridge Serial Number	32	ASCII	Alphanumeric string	1

02h	Media Length	2	Binary	Physical tape length in metres	1
03h	Media Type	2	Binary	Media Density Code	2
04h - 1FFh				Reserved	

Notes:
1. ASCII strings are padded with trailing spaces where necessary.
2. This is the same numeric Density Code as reported in the SCSI Mode Block Descriptor and Report Density Support command - this allows the media type to be detected. A value of zero indicates a cleaning cartridge.

Drive Mandatory

- Must be maintained by the tape drive
- Parameters: 200h - 2FFh

ID	Parameter Name	#Bytes	Format	Comment	Notes
200h	Parameter Format Version	2	Binary	Specification ref.	4
201h	Main Partition Remaining Capacity	4	Binary	In MBytes	1
202h	Main Partition Maximum Capacity	4	Binary	In MBytes	1
203h	TapeAlert Flags	8	Binary	One bit per flag	2
204h	Load Count	4	Binary		
205h - 2FFh				Reserved	

Notes:
1. Native capacities - assumes no data compression.
   If the drive implements additional partitions, capacity information for these partitions should be placed in the Drive Vendor Unique section.
2. This field provides a means of reporting the state of the TapeAlert flags for the previous load of the tape. Each TapeAlert flag occupies one bit (Flag 1 = MSB, Byte 1, Flag 64 = LSB, Byte 8). The bits indicate all the TapeAlert flags that were set during the previous load, i.e. the bits are 'sticky' for the load
3. Also note that tape drives will generally maintain additional media information in their MAM implementations. Although information such as media load count may be retained in the MAM for use by the drive, this will generally be accessible by existing means such as Tape Log information by a Log Sense operation: It does not need to be made available as a MAM parameter in this specification.
4. The Parameter Format Version is a reference for the specification to which the parameter format is compliant. The contents of this parameter are not yet defined, but it may be release number of the ANSI specification which will be derived from this document. This will allow new parameter formats to be defined in the future.

Host Mandatory

- Must be maintained by the software application using the Log Select command
- Can be cleared using the PCR bit in the Log Select command
- Parameters: 300h - 3FFh

ID	Parameter Name	#Bytes	Format	Comment	Notes
300h	Application Vendor	8	ASCII	Vendor ID from SCSI Inquiry	
301h	Application Name	10	ASCII	Alphanumeric string	1

302h	Application Version	8	ASCII	Alphanumeric string	1
303h	Application Media Text Label	100	ASCII	Null terminated string	
304h	Date & Time Last Written	12	ASCII	Format: YYYYMMDDHHMM	
305h - 3FFh				Reserved	

Notes:
1: ASCII strings are padded with trailing spaces where necessary.

Media Vendor Unique (Optional)

- These parameters allow additional vendor unique information to be stored by the cartridge manufacturer.
- Parameters: 400h - 4FFh

ID	Parameter Name	#Bytes	Format	Comment	Notes
400h - 4FFh				Unique to media vendor	

Drive Vendor Unique (Optional)

- These parameters allow vendor unique information to be stored by the drive. For example, it could include information about additional media partitions created by the drive when it formats a cartridge.
- Parameters: 500h - 7FFh

ID	Parameter Name	#Bytes	Format	Comment	Notes
500h - 7FFh				Unique to drive vendor	

Host Vendor Unique (Optional)

- These parameters are intended to allow software applications to read and write their own parameters.
- They are written using the Log Select command and are removed using the PCR bit of the Log Select Command
- The main restriction on their use will be MAM capacity remaining after the mandatory and Drive Vendor Unique usage. This can be determined using the Media Auxiliary Memory Capacity Mode page.
- Parameters: 800h - FFFFh

ID	Parameter Name	#Bytes	Format	Comment	Notes
800h - FFFFh				Unique to software vendor	

Data Format

The general method for reporting the parameter information will be via SCSI commands using the standard Log page parameter format:

	7	6	5	4	3	2	1	0
0	Parameter Code							
1								
2	DU	DS(0)	TSD(0)	ETC(0)	TMC(0)		LBIN	LP(1)
3	Parameter Length (n-3)							
4 .. n	Parameter Value							

The fields in the descriptor are:

- **DU** (Disable Update): When parameters are read using the Log Sense command, this field indicates whether the host can change the contents of the field.
- **DS** (Disable Save): This field indicates that the drive will maintain the saving of data itself. Note that the host needs to set the SP bit in a Log Select command otherwise a Check Condition will result.
- **ETC** and **TMC**: concerned with counter thresholds, not applicable to MAM.
- **LBIN**: indicates whether the field contains ASCII or Binary data. If *zero* the parameter consists of ASCII characters, if *one* the parameter consists of binary data.
- **LP** (List Parameter): this field indicates whether the parameter is a counter or a list parameter. All the fields for the MAM are list parameters and so this must be set to *one*.

For example, the Application Name parameter (parameter 302h) would be returned as:

```
Byte 0:      03h              Parameter Code MSB
Byte 1:      02h              Parameter Code LSB
Byte 2:      01h              Descriptor ('control byte')
Byte 3:      0Ah              Parameter length = 10
Bytes 4-13:  "ACMEbackup"     Parameter value
```

Tape Drive SCSI Commands

The following Primary and Stream Device (Sequential Access) SCSI commands allow the host to access the MAM parameters via the tape drive into which the cartridge is currently loaded:

- The ***Inquiry*** command may be used to recover a subset of the available parameters.
- ***Log Sense*** and ***Log Select*** commands may be used to read all of the available parameters and write the re-writeable parameters.
- ***Mode Sense*** and ***Mode Select*** may be used to access the MAM configuration page that stores information on the size and usage of the MAM.

Using these commands, MAM parameters will generally be returned as a sequence of parameters in numerical order keyed from the Parameter ID. Each parameter will be individually formatted using the Log

page format shown in the 'Data Format' section of this document. Reserved mandatory parameters and unused or undefined optional parameters are not returned.

Inquiry Command

A Vital Product Data Page (page code 84h) will be used to return a subset of the parameters available from the MAM. The subset will be:

- Media Mandatory parameters
- Host Mandatory parameters

The intention of this page is to provide a means of returning information about the media in a multi-initiator environment where an Inquiry will be transparent to Unit Reservations.

Inquiry - Media Auxiliary Memory page

	7	6	5	4	3	2	1	0
0	Peripheral Qualifier (0)				Peripheral Device Type (1)			
1	Page code (84h)							
2	Reserved							
3	Additional Page Length (n-3)							
4 .. n	Parameters							

Notes on usage:

- If the drive does not support access to MAM data, an Inquiry command to access this page will be Check Conditioned as an ILLEGAL REQUEST.
- If the drive supports access to MAM data but a suitable cartridge is not currently loaded in the drive, an Inquiry command to access this page will return a 'blank' page (i.e. an Additional Page Length of zero and no Parameters).

Log Sense/Select Commands

The SCSI Log Sense and Log Select commands are used as general-purpose commands to read and change the parameters in the MAM.
The format of the commands will be as described in the SCSI-3 specification. Command-specific parameters are as follows:

Log Sense

- **SP** (Save Parameters): Must be set to 0 for this page, otherwise ILLEGAL REQUEST/INVALID FIELD IN CDB is returned.
- **PPC** (Parameter Pointer Control): Must be set to 0 for this page, otherwise ILLEGAL REQUEST/INVALID FIELD IN CDB is returned.
- **Page Code:** Should be set to 0Ah for the Media Auxiliary Memory Information page.
- **PC** (Page Control): See the table below for a full definition of the usage of the Page Control bits:

PC	SCSI-3 Definition	Data Returned
00b	Current threshold value	For a counter, the maximum value it can count to
01b	Current cumulative value	For a counter, its current value

10b	Default threshold value	For a counter, the maximum value it can count to
11b	Default cumulative value	For a counter, the value it would have after a reset

For alphanumeric strings, the string will be returned regardless of the setting of the PC bits.
All the parameters will be returned in numerical order keyed from the Parameter ID.

Log Select

- **SP** (Save Parameters): Must be set to 1 for this page, otherwise ILLEGAL REQUEST/INVALID FIELD IN CDB is returned.
- **PCR** (Parameter Code Reset): If this field is set then all the host changeable fields will be cleared as follows (provided that the Parameter List Length is zero):
  - Host Mandatory parameters will be cleared to ASCII space characters. The Application Label will have a Null as the first character.
  - Any Host Vendor Unique parameters will be erased and will no longer be returned by the Log Sense command.

  The Parameter List Length must be set to zero for the logs to be cleared in this way.

- **PC** (Page Control): See the table below for a full definition of the usage of the Page Control bits.

PC	SCSI-3 Definition	Action
00b	Threshold value	None
01b	Cumulative value	Parameter value is written to the MAM *
10b	Default threshold value	None
11b	Default cumulative value	Parameter value is written to the MAM *

* Provided that the PCR bit is *zero* and the specified parameters are actually writeable.

- **Parameter List Length**: If this is non-zero then the host may send Log pages to the drive in the data out phase.

Writing data to the MAM
In order for the host to write data to the MAM, a formatted Media Auxiliary Memory Log page must be sent using the Log Select command - see below for format details. Note that not all of the MAM parameters need to be sent to the drive, just the ones that the host wishes to change. However, all parameters sent should be in ascending numerical order keyed from the Parameter ID.

If new Host Vendor Unique parameters are sent to the drive for which there is no space then ILLEGAL REQUEST/ LOG LIST CODES EXHAUSTED will be returned.

Log Sense/Select - Page Format

	7	6	5	4	3	2	1	0
0	Media Auxiliary Memory Information page (0Ah)							
1	Reserved							
2	Page Length (n-3)							
3								
Log Parameters								
4 .. x+3	First MAM Parameter (Length x)							
…..								

n-y+1 .. n	Last MAM Parameter (Length y)

If a Log Sense/Select command specifying the Media Auxiliary Memory Information page is sent and there is no media installed in the drive, the command will be Check Conditioned and the Sense data will be NOT READY / MEDIUM NOT PRESENT.

Mode Sense/Select Commands

Information concerning the capacity and utilization of the MAM will be returned via a new **read only** Mode page - the Media Auxiliary Memory Capacity page (page code 1Dh). The format of this page will be:

Mode Select - Media Auxiliary Memory Capacity page

	7	6	5	4	3	2	1	0
0	PS	Rsvd	Page Code (1Dh)					
1	Additional Page Length (0Ch)							
2	MAM Capacity							
3								
4								
5								
6	Space Used							
7								
8								
9								
10	Space Remaining							
11								
12								
13								

- **MAM Capacity**. The total capacity of the MAM in bytes.
- **Space Used**: The total amount of space currently used for parameter or other storage, in bytes.
- **Space Remaining**. The remaining space left in bytes. This space is available for storage of Host Vendor Unique parameters.

If a Mode Sense/Select command specifying the Media Auxiliary Memory Capacity page is sent and there is no media installed in the drive, the command will be Check Conditioned and the Sense data will be NOT READY / MEDIUM NOT PRESENT.

Media Changer SCSI Commands

The following Medium Changer SCSI commands allow the host to access the MAM parameters from compatible cartridges stored in a library equipped with a MAM reader:

Read Element Status Command

The following bullets should be read in conjunction with the SCSI-3 Read Element Status command definition:

- For backwards compatibility with existing software applications, legacy media labels (e.g. those currently represented by physical barcode labels) will be returned as the Primary Volume Tag.
- For backwards compatibility also, the Cartridge Manufacturer ID and Cartridge Serial Number parameters will be returned as the Alternate Volume tag.
- The command format has been modified to include a new Extended Tag (ExtTag) field, since neither the Primary nor Alternate Volume Tag fields can return the quantity of data available in typical MAM implementations. The ExtTag data is returned at the end of the existing SCSI-3 element data.
- All the MAM Parameters will be returned in numerical order keyed from the Parameter ID.

Read Element Status - Command Format

	7	6	5	4	3	2	1	0
0	Operation Code (B8h)							
1	Reserved			VolTag	Element Type Code (4)			
2	Starting Element Address							
3								
4	Number of Elements							
5								
6	Reserved					ExtTag	CurData	DVCID
7	Allocation Length							
8								
9								
10	Reserved							
11	Control							

Note the addition of the ExtTag field. This instructs the Media Changer to return Extended Volume Tag information. This applies to Storage Element Descriptors only. With the ExtTag bit is set, the format of the Element Status Page (including its Storage Element Descriptors) in the returned data is as shown below.

Read Element Status - Element Status Page Format

	7	6	5	4	3	2	1	0
0	Element Type Code (02 for Storage Elements)							
1	PVolTag	AVolTag	EVolTag	Reserved				
2	Element Descriptor Length							
3								
4	Reserved							
5	Byte Count of Descriptor Data (this page, y-7)							
6								
7								
8	Element Descriptors							
y								

Read Element Status - Storage Element Descriptor

	7	6	5	4	3	2	1	0
0	Element Address							
1								
2	Reserved				Access	Except	RSVD	Full
3	Reserved							
4	Additional Sense Code							
5	Additional Sense Code Qualifier							
6	Reserved							
7								
8								
9	Svalid	Invert	Reserved					
10	Source Storage Element Address							
11								
…								
36 bytes	Primary Volume Tag (field omitted if PVolTag = 0)							
36 bytes	Alternate Volume Tag (field omitted if AVolTag = 0)							
…								
1 byte	Reserved				Code Set (0)			
1 byte	Reserved				Identifier Type (0)			
1 byte	Reserved							
1 byte	Identifier Length (x)							
x bytes	Identifier							
…								
to end	MAM Parameters (field omitted if EVolTag = 0) *[see note 1]*							

Notes:
1. All MAM parameters will be returned in the standard SCSI Log page format shown in the ‘Data Format’ section of this document.