Proposal for Storage and Access of Data on Auxiliary Memory

Revision History

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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 Device Mandatory section to for upwards compatibility. • Load Count added to Device 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

4.0	9 April 1999	• Radical changes to Log Page 0Ah to accommodate Sony AIT compatibility:
		  • AIT Compatibility area added at parameter IDs 0000h-01FFh
		  • Existing MAM parameter IDs have been offset by 200h to accommodate the AIT Compatibility area below them
		• Media Auxiliary Memory Capacity Mode page (page code 1Dh) has been deleted. The total MAM Capacity is available as a parameter in the Media Mandatory area, and the MAM Space Remaining is now available as a parameter in the Device Mandatory area.
		• Added Media Manufacture Date parameter in the Media Mandatory area.
		• Device load history parameters added to Device Mandatory area

5.0	22 April 1999	Input from Sony following review of AIT Compatibility concept: • Media Manufacture Date in the Media Mandatory Area reduced from 12 to 8 bytes as is not necessary to record the time of day. • Non-AIT support for the AIT Compatibility area clarified, including addition of Appendix 1 to show the details of 'partially supported' parameters. • Support for Special Cartridges added to Media Mandatory Area. • Support for invertable (double-sided) media added to the Media Mandatory Area plus a new set of Alternate Volume parameters defined

		at location 8000h onwards. • Drive Mandatory Area renamed to Device Mandatory Area to reflect the technology independent nature of this proposal. • Number of device serial numbers held in the MAM reduced from 10 to 4. • Application Name parameter increased in length from 10 to 32 bytes. • Parameters added to the Device Mandatory Area for representing the total MBytes of data written, read, re-written and re-read. • TSD description added to Data Format section. • Test Localisation Identifier added to the Host Mandatory Area to allow non-English character sets to be identified. • PC bits in Log Sense and Log Select commands are now disregarded.
5.1	14 May 1999	Unnecessary 'padding' Reserved fields removed from parameter 15 in the AIT Compatibility Area (Appendix 1)
5.2	19 May 1999	• Increased 'Total Mbytes Written' and related parameters in the Device Mandatory Area from 4 bytes to 8 bytes to allow for future media capacities and maximum number of write passes. • "Data Percentage Re-written/Re-read" parameters in the Device Mandatory Area deleted due to lack of uniform interpretation across different media technologies. There are already TapeAlert flags defined as media condition indicators and these should be used instead. • Corrected minor typos prior to release to TapeAlert Working Group email reflector.
6.0	8 Sept 1999	Major revision to include new Read Attribute and Write Attribute SCSI commands in place of using Log Page 0Ah. • Title changed from "…Media Auxiliary Memory" to "…Auxiliary Memory" to reflect the widening of the scope of the new access method. • New Introduction and Overview text to explain the new scope. • Definitions and Assumptions sections added to introduce new terminology. • Inquiry command's Auxiliary Memory page Additional Page Length field increased from 2 bytes to 4 bytes. • Individual Attribute lengths extended from 1 byte to 2 bytes in the 'Log Page' format. • Command Descriptor Blocks for Read Attribute and Write Attribute commands added. • MAM Parameters section now renamed Attribute Set for Stream Device Media Auxiliary Memory, and placed in an appendix. • Attribute ID 0209h (Invertable Media Indicator) removed as this functionality is now covered by the addressing scheme for the new SCSI commands. • Vendor IDs now have NCITS reference. • Example of an address discovery sequence added.
6.01	9 Sept 1999	Minor release to correct some typos and omissions: • Changed target command set from 'SSC' to 'SPC' in Overview section. • Added explanation of Volumes and Partitions to Definitions section. • Modified Assumptions section to be consistent with Definitions section. • Minor wording changes to some CDB field definitions for clarity. • 'Data Reported' column added to Address Discovery table to clarify the end result of each operation. • Identifiers for cleaning cartridges and data cartridges in the Special Cartridge Identifier (Attribute ID 0206h) swapped over so that data cartridges have the default value of 00h. • Inadvertent references to Log commands removed from the introductory text to the MAM Host Mandatory Area and Host Vendor Unique Area.

References

Version 6.0 of this document has NCITS T10 SSC document reference T10/99-148r2

Introduction

There are an increasing number of storage devices and media types coming to market that incorporate small memory components that do not form part of the main data storage function. Examples of this include Cartridge Memory on LTO tape drive media and AIT Memory In Cartridge, and device usage information stored in E^2PROMs inside tape drives. For the purposes of this proposal, such storage components are generically referred to as *Auxiliary Memory*.

Currently there is no uniform method to access the data stored on Auxiliary Memory. Several manufacturers have launched proprietary standards for various technologies, but the lack of a standardised approach is hampering their widespread acceptance. This proposal outlines new SCSI commands and a common data format that will allow any host system to access and interpret data stored on Auxiliary Memory.

Overview

This proposal is divided into two main parts:

- Device SCSI Commands details, including Command Descriptor Blocks for two new SCSI commands, *Write Attribute* and *Read Attribute* to provide access to data on Auxiliary Memory.

- An *Attribute Set* definition for the Media Auxiliary Memory of stream device media. Other Attribute Sets for other device types and media are not covered by this version of this proposal.

In addition, this proposal defines a Vital Product Data Page for the SCSI Inquiry command to allow a subset of the available Auxiliary Memory data to be accessed in a multi-initiator environment.

It is envisaged that the content of this proposal will become part of SSC (SCSI Stream Device Command Set), so that any device type may implement access to Auxiliary Memory.

Definitions

- *Auxiliary Memory (AM)* is a memory component that is part of a storage element or device. This memory is usually non-volatile and is independent of the main data storage area. Two types of Auxiliary Memory have been defined so far:
  - *Media Auxiliary Memory (MAM)* is associated with a data storage medium, for instance a tape cartridge. Some current examples are LTO-CM and AIT-MIC.
  - *Device Auxiliary Memory (DAM)* is associated with a device. Current examples are the E^2PROMs embedded in some tape drive mechanisms that log the drive usage and error conditions, for which there is currently no universal access method.

- Where more than one physical AM component is available on a device or storage medium, they will individually be known as *Volumes*. Each Volume must be independently addressable.

- Where a physical AM Volume is logically divided into parts that may each hold an Attribute Set, such sub-divisions will be known as *Partitions*.

- *Attributes* are the individual units of data stored in Auxiliary Memory. For instance, the Media Auxiliary Memory of a tape cartridge may contain an Attribute called "Load Count" that indicates how many times that the cartridge has been loaded. Each Attribute has a unique *Attribute ID* number whose meaning and interpretation will be defined by this proposal.

- An *Attribute Set* is a collection of Attributes that is applicable to a given SCSI device type. For instance, a tape drive will present a cartridge's Medium Auxiliary Memory data as an instance of the Attribute Set for SCSI Stream Device Media as defined by this proposal.

- *Write Attribute* and *Read Attribute* are new SCSI commands that permit access to Auxiliary Memory.

Assumptions

- A storage element (e.g. a tape cartridge) may possess zero, one or more Media Auxiliary Memory components. Each component must be independently addressable.

- A device (e.g. a tape drive) may possess zero, one or more Device Auxiliary Memory components. Each component must be independently addressable.

- Each AM component on a device or storage medium may possess one or more Volumes. Each Volume must be independently addressable.

- Each AM Volume may be divided into one or more Partitions. Each partition must be independently addressable.

- Where a medium changer device compliant with SCSI SMC implements Auxiliary Memory access commands, the element addressing scheme used by the commands must be consistent with those used by SMC. There should not be two different schemes for addressing a piece of media to move it, and addressing a piece of media to access its Auxiliary Memory.

- This access method should not preclude the use of a partition of a medium's main data storage area as a virtual Media Auxiliary Memory. For example, a tape drive reading a cartridge that possesses no E^2PROM memory chip may still implement Auxiliary Memory access commands and provide the required storage in a separate partition on the tape itself.

Deficiencies

This version of the proposal does not fully cover all exception/error conditions.

Device SCSI Commands

The following primary SCSI commands allow hosts to access the Auxiliary Memory attributes of a device, or of a medium loaded into a device:

- The *Write Attribute* command allows a host to write Attribute data to a device, or to media present in a device.
- The *Read Attribute* command allows a host to read Attribute data from a device, or from media present in a device.
- An *Inquiry* command Vital Product Data page allows a host to read a subset of the available Attributes from a device or media loaded into a device.

INQUIRY command

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

- Media Mandatory Attributes
- Host Mandatory Attributes

See the section on Attribute Sets for the definition of these Attributes. The intention of this page is to provide a means of returning information about the media in a multi-initiator environment such as a Storage Area Network where an Inquiry will be transparent to Unit Reservations.

Inquiry - Auxiliary Memory page 84h

Byte	Bit							
	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER (0)				PERIPHERAL DEVICE TYPE (1)			
1	PAGE CODE (84h)							
2	Reserved (0)							
3	ADDITIONAL PAGE LENGTH (n-6)							
4								
5								
6								
7 .. n	ATTRIBUTE LIST							

Notes on usage:
- If the device does not support access to AM data, an Inquiry command to access this page will be Check Conditioned as an ILLEGAL REQUEST.
- If the device supports access to AM data but the data is not available (e.g. MAM data is requested but a suitable cartridge is not currently loaded in the device), an Inquiry command to access this page will return a 'blank' page (i.e. an Additional Page Length of zero and no Attributes).
- The format of the Attribute list is identical for all SCSI commands shown in this proposal. See the section on Data Format for details.

WRITE ATTRIBUTE command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPCODE (8Ah)							
1	Reserved (0)				ELEMENT TYPE CODE			
2	ELEMENT ADDRESS							
3								
4	Reserved (0)							
5	VOLUME NUMBER							
6								
7	PARTITION NUMBER							
8	Reserved (0)							
9	Reserved (0)							
10								
11	ALLOCATION LENGTH							
12								
13								
14								
15	CONTROL							

READ ATTRIBUTE command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPCODE (8Bh)							
1	ReptTypes	ReptElmts	ReptVols	ReptParts	ELEMENT TYPE CODE			
2	ELEMENT ADDRESS							
3								
4	Reserved (0)							
5	VOLUME NUMBER							
6								
7	PARTITION NUMBER							
8	Reserved (0)							
9	FIRST ATTRIBUTE ID							
10								
11	ALLOCATION LENGTH							
12								
13								
14								
15	CONTROL							

ELEMENT TYPE CODE specifies the type of Auxiliary Memory being addressed. The Element Type Code values are identical to those used in SMC:

1 Medium Transport Element (e.g. a library picker arm)
2 Storage Element (e.g. a storage slot in a library)
3 Import/Export Element (e.g. an operator access port in a library)
4 Data Transfer Element (e.g. a tape drive)

This allows the host to specify the type of Auxiliary Memory to be accessed when there is more than one type available on the target device. For instance, if a Write Attribute command is directed to a tape drive, then an Element Type Code of 4 will access the Device Auxiliary Memory component(s) present in the tape drive mechanism. Alternatively, if an Element Type Code of 2 is used, then the tape drive will access the Media Auxiliary Memory component(s) of the cartridge currently loaded in the drive.

REPTTYPES, REPTELMTS, REPTVOLS, and REPTPARTS are reporting flags that allow the host to determine the configuration of the Auxiliary Memory components available at the target. See the section *Address Discovery Mechanism* for a full explanation of the use of these flags.

ELEMENT ADDRESS is the address of the element containing the Auxiliary Memory that the host wishes to address. Typically, only medium changer devices will support element addressing in a comprehensive manner. Some examples:

- If the command is sent to a medium changer device then the Element Address will be identical to that used to address the same element in an SMC command. For example, if the first storage slot in a library device has element address 7, then address 7 may be used in Read/Write Attribute commands to access the Media Auxiliary Memory of the medium in that slot.

- If the command is sent to a stream device then, depending on the value of the Element Type Code field, the command will either access the Media Auxiliary Memory of the currently loaded medium, or the Device Auxiliary Memory of the drive itself.

VOLUME NUMBER specifies the physical Auxiliary Memory component to be accessed when there is more than one of the same type available. For instance, if a piece of dual-sided media contains two Media Auxiliary Memory components (one for each side), then the Volume Number allows the two to be distinguished.
A Volume Number of zero will always specify the default Auxiliary Memory component. If the target device supports access to only one Auxiliary Memory component then this field must be set to zero. In the limited case of dual-sided media, the alternate volume will have a Volume Address of 1.

PARTITION NUMBER specifies sub-divisions within an Auxiliary Memory volume. If an Auxiliary Memory volume contains more than one instance of an Attribute Set, then the Partition Number allows each set to be accessed individually. Each Auxiliary Memory component may only contain instances of Attribute Sets for one Element Type. For instance, if the medium in a tape cartridge is formatted into two logical partitions, then the Media Auxiliary Memory may optionally also be formatted into two logical partitions, each containing an Attribute Set for stream device media.

FIRST ATTRIBUTE ID is the number of the first attribute that the host wishes to receive in response to a Read Attribute command.

ALLOCATION LENGTH represents the number of data bytes to be transferred. For the Write Attribute command this is the total length of the Attribute list to be sent with the command by the host. For the Read Attribute command it is maximum length of the Attribute list sent from the target that will be accepted by

the host. For future extensibility, this field allows for data lengths up to 4.2GB. Note that this length includes Attribute header bytes that make up the 'Log page' format for each Attribute.

Address Discovery Mechanism

The reporting flags in the Read Attribute CDB allow the host to determine the number and configuration of the Auxiliary Memory components available on the target device. The meanings of the flags are:

- REPTTYPES requests the reporting of the Element Type Codes available on the device.
- REPTELMTS requests the reporting of the Element Addresses available for each Element Type.
- REPTVOLS requests the reporting of the Volume Numbers available at each Element Address.
- REPTPARTS requests are reporting of the Partition Numbers available on each Volume Number.

By setting each of these flags in turn in a series of Read Attribute commands, the host may 'walk' the hierarchical tree of available data. As each flag is set, the target device will examine the other fields in the CDB to determine the type of data being requested, according to the following table:

Reporting Flags				Address Fields				Data Reported
ReptTypes	ReptElmts	ReptVols	ReptParts	ELEMENT TYPE CODE	ELEMENT ADDRESS	VOLUME NUMBER	PARTITION NUMBER	
1	0	0	0	X	X	X	X	Element Type info
0	1	0	0	as specified	X	X	X	Element Address info
0	0	1	0	as specified	as specified	X	X	Volume Number info
0	0	0	1	as specified	as specified	as specified	X	Partition Number info
0	0	0	0	as specified	as specified	as specified	as specified	Attribute Sets

X = don't care (field ignored)

When any reporting flag is set, the returned data format from the device will be unique to the type of data being requested. In these cases, the 'Log page' model shown in the *Data Format* section of this proposal will not be used. The returned data formats for these special situations are:

REPTTYPES - Report the Element Type Codes available on the device:

	7	6	5	4	3	2	1	0
0	1 (Element Type Code 1)				Reserved (0)			AVAIL
1	2 (Element Type Code 2)				Reserved (0)			AVAIL
2	3 (Element Type Code 3)				Reserved (0)			AVAIL
3	4 (Element Type Code 4)				Reserved (0)			AVAIL

AVAIL shows whether elements of that Element Type Code are available on the device: A *zero* means that no elements of that Element Type Code are available; a *one* indicates that one or more elements of that type are available.

REPTELMTS - Report the number of Element Addresses available for the specified Element Type Code:

	7	6	5	4	3	2	1	0
0	FIRST ELEMENT ADDRESS							
1								
2	NUMBER OF ELEMENTS AVAILABLE							
3								

FIRST ELEMENT ADDRESS is the address of the first element available of the specified Element Type Code.
NUMBER OF ELEMENTS AVAILABLE indicates the number of elements available of the specified Element Type Code.

The Element Addresses themselves will be always be contiguous. If the SMC command set is also supported by the device, then the Element Addresses must be consistent with it.

REPTVOLS - Report the number of Volumes available at the specified Element Address:

	7	6	5	4	3	2	1	0
0								
1				FIRST VOLUME NUMBER				
2								
3				NUMBER OF VOLUMES AVAILABLE				

FIRST VOLUME NUMBER is the number of the first Volume at the specified Element Address.
NUMBER OF ELEMENTS AVAILABLE indicates the number of Volumes available at the specified Element Address.

REPTPARTS - Report the number of Partitions available on the specified Volume Number:

	7	6	5	4	3	2	1	0
0				FIRST PARTITION NUMBER				
1				NUMBER OF PARTITIONS AVAILABLE				

FIRST PARTITION NUMBER is the number of the first Partition available on the specified Volume Number.
NUMBER OF ELEMENTS AVAILABLE indicates the number of Partitions available on the specified Volume Number.

After the reporting flag sequence has been completed, the host may clear all flags and send a final Read Attribute command to retrieve the Attribute Set for each Type/Element/Volume/Partition combination.

See Appendix 2 for an example of an address discovery sequence.

Data Format

The format of the data sent with a Write Attribute command, or returned in response to a Read Attribute command, will be the basic SCSI 'Log Page' format. Using these commands, AM Attributes will generally be returned as a sequence in numerical order keyed from the Attribute ID. Each Attribute will be individually formatted using the Log page format shown below. Reserved mandatory Attributes, unused or undefined optional Attributes, and Attributes that have been cleared are not to be returned.

This is a logical representation only and implies nothing about the physical representation of the data in the Auxiliary Memory.

	7	6	5	4	3	2	1	0
0	ATTRIBUTE ID							
1								
2	DU	DS(0)	TSD(0)	ETC(0)	TMC(0)		LBIN	LP(1)
3	ATTRIBUTE LENGTH (n-4)							
4								
5 .. n	ATTRIBUTE VALUE							

ATTRIBUTE ID is the binary identifier for a single Attribute. The meaning of the Attribute ID shall be according to the Attribute Set defined in this standard for the Device Type being addressed.

DU (Disable Update): When Attributes are read using the Read Attribute command, this indicates whether the host may subsequently modify the Attribute Value. This effectively indicates whether an Attribute is read-only or not.

DS (Disable Save): Data in Attribute Memory is always saved by definition, so this field must always be set to zero in a Write Attribute command.

TSD (Target Save Disable): This will always be set to zero as the device will save Attribute values automatically, and this functionality cannot be disabled.

ETC and TMC are concerned with counter thresholds and are not applicable to AM.

LBIN: indicates whether the field contains ASCII or Binary data. If *zero* the Attribute consists of ASCII characters, if *one* the Attribute consists of binary data.

LP (List Parameter) indicates whether the Attribute is a counter or a list parameter. All the fields for the AM are list parameters and so this must be set to *one*.

ATTRIBUTE LENGTH is the length (in bytes) of the Attribute that follows it. If a Write Attribute command is sent with an Attribute Length of zero, then the device shall disregard the value in the Attribute Value field. The Attribute will thus be cleared in the following way, provided that the Attribute is actually writeable:

- Mandatory Attributes will be reset to default values; all zeros in the case of binary Attributes; all space characters in the case of ASCII Attributes.
- Optional Attributes will be cleared so that they no effectively no longer exist, i.e. they will not be returned in response to a Read Attribute command.

Example
The Application Name attribute (Attribute ID 0501h) might be returned as:

```
Byte 0:       05h                }
Byte 1:       01h                }  Attribute ID = 0501h
Byte 2:       01h                Descriptor ('control byte')
Byte 3:       00h                }
Byte 4:       20h                }  Attribute Length = 32
Bytes 5-35:  "ACME Backup    "   Attribute Value (padded with trailing spaces)
```

Attribute Sets

In concept, the following Attribute Sets have been defined:
- Attribute Set for stream device Media Auxiliary Memory
- Attribute Set for stream device Device Auxiliary Memory
- Attribute Set for block device Media Auxiliary Memory
- Attribute Set for block device Device Auxiliary Memory
- Attribute Set for medium changer device Device Auxiliary Memory

Note that may be a multiplicity of physical routes to access some types of Auxiliary Memory. Some examples:

- Both a tape drive (conforming to SSC) and a library controller (conforming to SMC) may have access to the same Media Auxiliary Memory components on cartridges present in a tape library.
- A tape library may have access to the Device Auxiliary Memories of its embedded tape drives, while the same Device Auxiliary Memories are also accessible through the drives' own external interfaces.

It is thus envisaged that these Attribute Set definitions will be part of SPC and not part of individual device standards such as SSC and SMC.

For this proposal, only the Attribute Set for Stream Device Media Auxiliary Memory is presented - see Appendix 1.

Appendix 1: Attribute Set for Stream Device Media Auxiliary Memory

The following Attributes have been defined and are split up into *areas* according to the source of changes or updates and whether they are optional or mandatory. The attribute data may be accessed by the SCSI commands shown later in this specification. The attribute areas are:

Attribute IDs	Maximum Number of Attributes	Area Name	Support in AIT media	Support in non-AIT media
0000h - 01FFh	512	Multi-partition Area	Mandatory	Optional
0200h - 03FFh	512	Media Mandatory Area	Mandatory	Mandatory
0400h - 04FFh	256	Device Mandatory Area	Mandatory	Mandatory
0500h - 05FFh	256	Host Mandatory Area	Mandatory	Mandatory
0600h - 06FFh	256	Media Vendor Unique Area	Optional	Optional
0700h - 09FFh	768	Device Vendor Unique Area	Optional	Optional
0A00h - 7FFFh	30208	Host Vendor Unique Area	Optional	Optional

Multi-partition Area

- Provided for compatibility with Sony's existing MIC format for AIT media, and other multi-partition devices that wish to follow the AIT model.

- Support by non-AIT devices is optional, but a guideline is given for default values for use by devices that wish to maintain compatibility with existing AIT application software. Devices that do not support this Area will not return any Attributes in the 0001h - 01FFh Attribute ID range.

ID	Attribute Name	#Bytes	Format	Support by Non-AIT drives	Notes
0001h	Memory Logical Format	2	Binary	all FFh	
0002h	Device Configuration bits	2	Binary	all 00h	
0003h	Available Free Byte Count	2	Binary	yes	1
0004h	User Volume Note size	2	Binary	all 00h	
0005h	Reserved	8	Binary	all 00h	
0006h	Cassette Serial Number	36	ASCII	partial	2
0007h - 0013h	Reserved	36 per attribute		all 00h	
0014h	User Partition Note Map	32	Binary	all 00h	
0015h	Accumulative System Log	62	Binary	partial	2
0016h	Volume Information	94	Binary	partial	2
0017h	Element Address	4	Binary	all 00h	
0018h	User Partition Note size for Partition #0	2	Binary	all 00h	
0019h	User Partition Note size for Partition #1	2	Binary	all 00h	
(0018+n)h	User Partition Note size for Partition #n	2	Binary	all 00h	3

Notes:

1. **Available Free Byte Count**: This is identical to the "MAM Space Remaining" attribute in the Device Mandatory area.
2. **Cassette Serial Number, Accumulative System Log, Volume Information**: See Appendix 3 for full details of guidelines for partial support of these attributes.
3. An AIT device supporting 256 partitions will return attributes up to ID 0117h. A device supporting only one partition will return attributes up to ID 0017h.
4. Where a hex value is shown in the "Support by Non-AIT Devices" column, this is the fixed value that non-AIT drives should optionally return. Note that attributes having a value of 00h must actually be returned - they cannot be omitted from a list of returned attributes.

Media Mandatory Area

- Hard coded into MAM at cartridge manufacture time.

- All attributes are read-only.

ID	Attribute Name	#Bytes	Format	Comment	Notes
0200h	Cartridge Manufacturer	8	ASCII	Vendor ID	1, 4
0201h	Cartridge Serial Number	32	ASCII	Alphanumeric string	1
0202h	Media Length	2	Binary	Physical tape length in metres	
0203h	Media Type	2	Binary	Media Density Code	2
0204h	Media Manufacture Date	8	ASCII	Format: YYYYMMDD	
0205h	MAM capacity	4	Binary	In bytes	3
0206h	Special Cartridge Identifier	1	Binary	For cleaning cartridges etc.	5
0207h	Special Cartridge Information	2	Binary	Info about special cartridges	5
0208h - 03FFh				Reserved	

Notes:
1. ASCII strings are padded with trailing spaces where necessary.
2. **Media Type**: 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 will be returned for a cleaning cartridge.
3. **MAM Capacity**: This is the total capacity of the MAM, in bytes, at manufacture time. It does not indicate the free space of a 'blank' MAM as some of the MAM space may be reserved for device-specific use which is inaccessible to the host.
4. **Cartridge Manufacturer**: Vendor IDs are as defined by NCITS.
   See http://www.symbios.com/x3t10/lists/2vid.htm
5. **Special Cartridge Identifier**: Identifies non-data cartridges and other special types of cartridge.
   Special Cartridge Information: Provides additional information about special cartridge types. This attribute must be interpreted according to type of cartridge indicated by the Special Cartridge Identifier. Defined values are:

Special Cartridge Identifier	Meaning	Interpretation of Special Cartridge Information
00h	Data cartridge	Reserved
01h	Cleaning cartridge	Maximum number of cleaning cycles permitted
02h-7Fh	Reserved	Reserved
80h	Write-once cartridge	Reserved
81h-FFh	Reserved	Reserved

Device Mandatory Area

- Must be maintained by the device.

ID	Attribute Name	#Bytes	Format	Comment	Notes
0400h	Attribute Set Format Version	2	Binary	Specification ref.	4
0401h	Main Partition Remaining Capacity	4	Binary	In MBytes	1
0402h	Main Partition Maximum Capacity	4	Binary	In MBytes	1
0403h	TapeAlert Flags	8	Binary	One bit per flag	2
0404h	Load Count	4	Binary	For this cartridge	7
0405h	MAM Space Remaining	4	Binary	In bytes	6
0406h	Initialised Format	2	Binary	Density Code	8
0407h	Initialisation Count	2	Binary	Cumulative for life	9
0408h - 0409h	Reserved				
040Ah	Device Make/Serial Number At Last Load	40	ASCII		5
040Bh	Device Make/Serial Number At Load -1	40	ASCII		5
040Ch	Device Make/Serial Number At Load -2	40	ASCII		5
040Dh	Device Make/Serial Number At Load -3	40	ASCII		5
040Eh - 041Fh	Reserved				
0420h	Total MBytes Written In Media Life	8	Binary		10
0421h	Total Mbytes Read In Media Life	8	Binary		10
0422h	Total Mbytes Written In Current/Last Load	8	Binary		11
0423h	Total Mbytes Read In Current/Last Load	8	Binary		11
0424h - 04FFh				Reserved	

Notes:
1. **Maximum/Remaining Capacities**: These are native capacities and assume no data compression. If the device implements additional partitions, capacity information for these partitions should be placed in the Device Vendor Unique section.
2. **TapeAlert Flags**: This field provides a means of reporting the state of the TapeAlert flags for the <u>previous</u> 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. (Note deleted).
4. **Attribute Set Format Version:** This is a reference for the specification to which the Attribute Set data format is compliant. This will have the value 01h for the first NCITS-approved release of this proposal. This will allow new Attribute Set formats to be defined in the future.
5. **Device make/serial number at previous loads**: This is a rolling history of the last four drives in which the cartridge has been loaded. This allows library controllers or application software to correlate media condition with drive load history in order to identify drives that may be causing media problems. The first 8 bytes are the Device Manufacturer ID, and the last 32 bytes are the Device Serial Number. Both fields should be padded with trailing spaces where necessary. Device Manufacturer IDs are defined by NCITS - see http://www.symbios.com/x3t10/lists/2vid.htm
6. **MAM Space Remaining**: This is the space currently free in the MAM. The *total* MAM capacity is reported in the Media Mandatory area. Note that it may not always be possible to utilise all of the free space in a given MAM implementation. Depending on the internal organisation of the memory and the software that controls it, fragmentation issues may mean that certain attribute sizes might not be fully accommodated as the MAM nears its maximum capacity.

7. **Load Count**: The number of times that this cartridge has been loaded (and threaded, where applicable) into a tape drive. This value is cumulative: It shall not be reset if the media is logically reformatted by a tape drive.
8. **Initialised Format**: If the tape drive formats the media into a format other than the one indicated in the Media Type attribute in the Media Mandatory Area (e.g. for compatibility with a previous generation format), then this attribute indicates the SCSI Density Code of the format chosen.
9. **Initialisation Count**: Indicates the number of times that the medium has been logically formatted by a tape drive. This figure is cumulative over the life of the media and shall never be reset.
10. **Total MBytes Written/Read in Media Life**: This is the total number of MBytes of data transferred to or from the media over the entire media life. These figures are cumulative and must never be reset. Note that the amount of data must be measured from the device/media interface's point of view, not the host's. For example, if a new cartridge is loaded into a drive then the host writes 100MBytes, rewinds and then writes 100MBytes again, then the Total MBytes Written in Media Life will be 200MBytes. This figure must not incorporate data compression, i.e. it must represent the amount of data actually written to the media surface. Additionally, if the device decides to re-write any data (for example, following a bad read-after-write resulting from a localised media defect), then the amount of re-written data must also be added to this count.
11. **Total Mbytes Written/Read In Current/Last Load**: As above, but for the current load (if the cartridge is currently loaded) or the last load (if the cartridge is currently unloaded). The drive should reset these attributes to zero as soon as a cartridge is loaded.

Host Mandatory Area

- The Host Mandatory area is the primary means to allow separation or portability of media between different software applications and platforms.
- Must be maintained by the software application using the Read Attribute command

ID	Attribute Name	#Bytes	Format	Comment	Notes
0500h	Application Vendor	8	ASCII	Vendor ID	4
0501h	Application Name	32	ASCII	Alphanumeric string	1
0502h	Application Version	8	ASCII	Alphanumeric string	1
0503h	Application Media Text Label	100	ASCII	Null terminated string	2
0504h	Date & Time Last Written	12	ASCII	Format: YYYYMMDDHHMM	
0505h	Text Localisation Identifier	2	Binary	See note	3
0506h - 05FFh				Reserved	

Notes:
1. ASCII strings are padded with trailing spaces where necessary.
2. **Application Version**: Note that this is a fixed-length attribute - 100 bytes of data must always be returned.
3. **Text Localisation Identifier**: This defines the format of the text held in the textual attributes in the Host Mandatory Area. The two bytes are:

MS Byte	LS Byte
Country Code 00h = no code specified 81h = Japan other codes are yet to be defined	Minor Code 00h = no code specified 01h = JIS (old) code 02h = JIS (new) code 03h = Shift JIS code 04h = EUC code 05h = IBM EBCDIC

	06h = Unicode
	07h - FFh are Reserved

If 0000h is returned for this attribute then the host must assume that the encoding of all text fields is plain ASCII and the language is English.

4. **Application Vendor**: Vendor IDs are defined by NCITS - see
   http://www.symbios.com/x3t10/lists/2vid.htm

Media Vendor Unique Area (Optional)

- This area exposes as attributes any data hardcoded in the MAM at manufacture time that hosts may need access to. Such access must be provided by arrangement with specific device vendors.

ID	Attribute Name	#Bytes	Format	Comment	Notes
0600h - 06FFh				Unique to media vendor	

Device Vendor Unique Area (Optional)

- These attributes allow vendor unique information to be stored by the device. For example, it could include information about additional media partitions created by the device when it formats a cartridge.

ID	Attribute Name	#Bytes	Format	Comment	Notes
0700h - 09FFh				Unique to device vendor	

Host Vendor Unique Area (Optional)

- These attributes are intended to allow software applications to read and write their own Attributes.
- They are written using the Write Attribute command, and may removed/destroyed using the Write Attribute command with an Attribute Length of zero.
- The main restriction on their use will be MAM capacity remaining after the mandatory and Device Vendor Unique usage. This can be determined using the MAM Space Remaining attribute in the Device Mandatory area.

ID	Attribute Name	#Bytes	Format	Comment	Notes
0A00h - 7FFFh				Unique to software vendor	

Appendix 2: Example of an Address Discovery Sequence

This shows an example of a sequence of Read Attribute commands sent by a host in order to determine the configuration of the Auxiliary Memory components on a device. The example uses a target device that is a tape drive which supports access to Media Auxiliary Memory on its loaded cartridge.

1. Discover the types of elements supported on the device
Read Attribute command sent:

	7	6	5	4	3	2	1	0
0	OPCODE (8Bh)							
1	1	0	0	0	ELEMENT TYPE CODE			
2								
3								
4	Reserved (0)							
5								
6								
7	PARTITION NUMBER							
8	Reserved (0)							
9								
10								
11								
12								
13								
14								
15	CONTROL							

- Set ReptTypes = 1
- All other fields ignored

Returned data:

	7	6	5	4	3	2	1	0
0		1 (Element Type Code 1)			Reserved (0)			0
1		2 (Element Type Code 2)			Reserved (0)			1
2		3 (Element Type Code 3)			Reserved (0)			0
4		4 (Element Type Code 4)			Reserved (0)			0

- Element Type Code 2 is available = access to MAM on removable media is supported

2. Discover the element addresses of each element type
Read Attribute command sent:

	7	6	5	4	3	2	1	0
0	OPCODE (8Bh)							
1	0	1	0	0	2			
2								
3								
4	Reserved (0)							
5								
6								
7	PARTITION NUMBER							
8	Reserved (0)							
9								
10								
11								
12								
13								
14								
15	CONTROL							

- Set ReptElmts = 1
- Element Type Code = 2; requesting element addresses for the loaded media
- All other fields ignored

Returned data:

	7	6	5	4	3	2	1	0
0								
1								
2								
4								

- One element is available and has address "0"

3. Discover the volume numbers at each element address

Read Attribute command sent:

	7	6	5	4	3	2	1	0
0	OPCODE (8Bh)							
1	0	0	1	0		2		
2								
3								
4	Reserved (0)							
5								
6								
7	PARTITION NUMBER							
8	Reserved (0)							
9								
10								
11								
12								
13								
14								
15	CONTROL							

- Set ReptVols = 1
- Element Address = 0; requesting volumes available on the MAM
- All other fields ignored

Returned data:

	7	6	5	4	3	2	1	0
0								
1								
2								
4								

- One volume is available and has Volume Number "0"

4. Discover the partition numbers on each volume

Read Attribute command sent:

	7	6	5	4	3	2	1	0
0	OPCODE (8Bh)							
1	0	0	0	1		2		
2								
3								
4	Reserved (0)							
5								
6								
7	PARTITION NUMBER							
8	Reserved (0)							
9								
10								
11								
12								
13								
14								
15	CONTROL							

- Set ReptParts = 1
- Element Address = 0; Volume Number = 0; requesting partition information

Returned data:

	7	6	5	4	3	2	1	0
0	0 (FIRST PARTITION NUMBER)							
1	**1 (NUMBER OF PARTITIONS AVAILABLE)**							

- One partition is available and has Partition Number "0"

5. Get the Attribute Set for the MAM discovered

A final Read Attribute command may now be sent with all the reporting flags cleared. Using the Element Type Code, Element Address, Volume Number and Partition Number discovered for the single MAM available, the Attribute Set that it contains will now be reported in full.

Appendix 3: Guidelines for the Support of Attributes in the Multi-partition Area

For use by non-AIT drives, details are shown here of optional support for Attributes in the Multi-partition Area that will allow limited backwards compatibility with existing software applications that support AIT drives. Note that the byte numbers shown are relative to the beginning of each Attribute - they do not represent absolute byte positions in the returned data.

Attribute 0006h: Cassette Serial Number

	7	6	5	4	3	2	1	0
0	Attribute ID (0006h)							
1								
2	DU	DS(0)	TSD(0)	ETC(0)	TMC(0)		LBIN	LP(1)
3	Parameter Length (36)							
4-35	**Cartridge Serial Number** *(duplicate of Media Mandatory attribute 0201h)*							
36	Manufacturer ID (0)							
37	Secondary ID (0)							
38	Checksum (0)							
39	Reserved (0)							

Attribute 0015h: Accumulative System Log

	7	6	5	4	3	2	1	0
0	Attribute ID (0015h)							
1								
2	DU	DS(0)	TSD(0)	ETC(0)	TMC(0)		LBIN	LP(1)
3	Attribute Length (62)							
4-7	Current Number of Groups Written (0)							
8-11	Current RAW Retries (0)							
12-15	Current Number of Groups Read (0)							
16-19	Current C3 ECC Retries (0)							
20-23	Previous Number of Groups Written (0)							
24-27	Previous RAW Retries (0)							
28-31	Previous Number of Groups Read (0)							
32-35	Previous C3 ECC Retries (0)							
36-39	Total Number of Groups Written (0)							
40-43	Total RAW Retries (0)							
44-47	Total Number of Groups Read (0)							
48-51	Total C3 ECC Retries (0)							
52-55	**Load Count** *(duplicate of Device Mandatory attribute 0404h)*							
56-59	Access Count (0)							
60-63	Update Replace Count (0)							
64-65	Reserved (0)							

Attribute 0016h: Volume Information

	7	6	5	4	3	2	1	0
0	Attribute ID (0016h)							
1								
2	DU	DS(0)	TSD(0)	ETC(0)	TMC(0)		LBIN	LP(1)
3	Attribute Length (94)							
4-23	Eject Position (0)							
24-27	Reel Diameter (0)							
28	Reserved (0)							
29-31	**Initialisation Count** *(duplicate of Device Mandatory attribute 0407h)*							
32	System Log Location (0)							
33	Last Partition Number (0)							
34-65	Volume Information Table (0)							
66-97	Reserved (0)							