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Subject: **Proposed Addition of Read and Write Attribute Commands to SPC-2**

Date: **4-May-00**

There are an increasing number of 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's Memory In Cartridge. For the purposes of this proposal, such storage components are generically referred to as *Medium Auxiliary Memory (MAM)*.

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

This proposal calls for additions to several SCSI standards. Since the commands are considered generic, SPC-3 seems the most appropriate place to put them. Since the commands will also need some additional fields defined when used with Medium Changers; these extensions are also defined for inclusion in SMC-2. Finally some tape specific 'attributes' are defined which should be included in a future version of SSC.

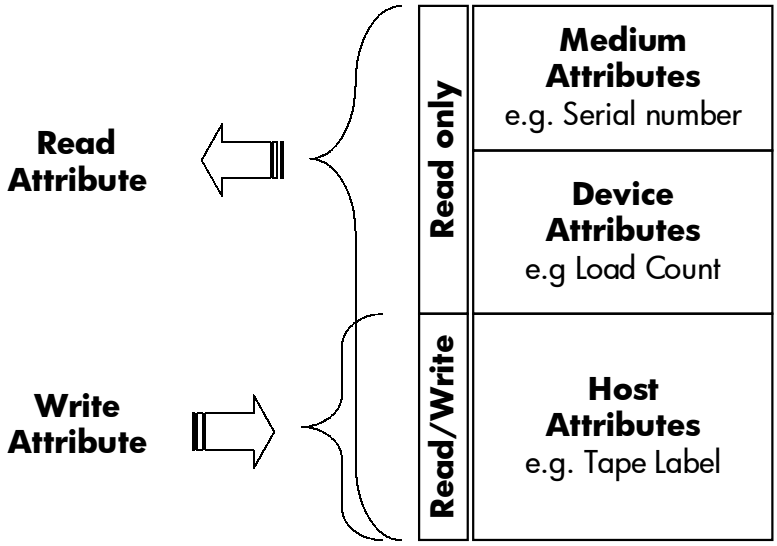
Summary:

- A new model for Media Auxiliary Memory has been defined
- Two new 16 Byte CDBs have been defined.
- New forms of parameter data called 'attributes' are defined.
- The follow new ASC/ASQ values are used
    - 55h/06h AUXILIARY MEMORY OUT OF SPACE
      A Write Attribute command is received and there is insufficient space in the MAM to store all of the attribute data.
    - 09h/10h LOGICAL UNIT NOT READY, AUXILIARY MEMORY NOT ACCESSIBLE
      A Write Attribute or Read Attribute command is received, and medium is present, but the MAM is not accessible for some indeterminate reason
    - 11h/12h AUXILIARY MEMORY READ ERROR
      A Read Attribute command could not be completed as the read process from the MAM failed (e.g. a bad checksum was encountered)
    - 0Ch/0Bh AUXILIARY MEMORY WRITE ERROR
      A Write Attribute command could not be completed as the write process to the MAM failed.

5.X Medium Auxiliary Memory

Several types of media (especially removable media) contain non-volatile memory (generically referred to as Medium Auxiliary Memory or MAM) that is used to store quickly accessible data describing the media and its contents.

This standard supports MAM with the READ ATTRIBUTE and WRITE ATTRIBUTE commands which are used to store and retrieve information in the MAM as a series of 'attributes'.



There are three types of attributes:

- Medium Attributes are 'hard coded' in the MAM during manufacture and store such data as a unique serial number.
- Device Attributes are maintained by the Device Server and store such data as Load Counts.
- Host Attributes are maintained by the application client and contain such information as a Tape Label or Backup Date.

Device and Medium Attributes can have the following states:

- **Read Only.** An application server can read the contents of the attribute, but cannot clear or change them using the WRITE ATTRIBUTE command.
- **Un-supported.** The device server does not support the attribute and will never return it in response to a Read Attribute command.

Host attributes can have the following states:

- **Read/write.** An attribute can be created in the MAM using the WRITE ATTRIBUTE command. When an attribute has been created on the MAM using WRITE ATRRIBUTE command, the contents may be altered using a subsequent WRITE ATTRIBUTE command. A Read/write attribute can be made non-existent again using a WRITE ATTRIBUTE command to set the attribute length for the attribute to zero.
- **Non-existent.** These attributes do not exist on the MAM until a WRITE ATTRIBUTE command is used to create them.

7.XX WRITE ATTRIBUTE command

The WRITE ATTRIBUTE command (see Table 1) allows an application client to write attribute values to Medium Auxiliary Memory (MAM).

Device servers that implement the WRITE ATTRIBUTE commands shall also implement the READ ATTRIBUTE command.

Application clients should issue READ ATTRIBUTE commands prior to using this command to discover what support the device server has for Medium Auxiliary Memory.

Table 1 - WRITE ATTRIBUTE command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPCODE (8Dh)							
1	Reserved (0)							
2	MSB Reserved for SMC-2 devices (0)							
3								LSB
4	Reserved for SMC-2 devices (0)							
5	VOLUME NUMBER							
6	Reserved (0)							
7	PARTITION NUMBER							
8	Reserved (0)							
9	Reserved (0)							
10	MSB PARAMETER LIST LENGTH							
11								
12								
13								LSB
14	Reserved (0)							
15	CONTROL							

The VOLUME NUMBER specifies a volume within the Medium Auxiliary Memory. The number of volumes of the MAM shall equal that of the attached multi-volume medium. If the medium only has a single volume, then this field shall be set to 0.

The PARTITION NUMBER specifies a partition within a volume. The number of partitions of the MAM shall equal that of the attached multi-partition medium. If the medium only has a single partition, then this field shall be set to 0.

If the combination of VOLUME NUMBER and PARTITION NUMBER is not valid within the device server then the command shall terminate with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST, and the additional sense data shall be set to INVALID FIELD IN CDB.

If any of the following conditions occur, the device server shall terminate the WRITE ATTRIBUTE command with CHECK CONDITION status, set the sense key to ILLEGAL REQUEST, set the additional sense data to INVALID FIELD IN PARAMETER LIST, and shall not change any attributes.

- If the application client attempts to write an attribute that has the READ ONLY bit (see 8.x) set to one when read with the READ ATTRIBUTE command;
- If the application client incorrectly sets the length of an attribute;
- If the application client sets any attribute to an unsupported value;

If a WRITE ATTRIBUTE command is sent with the length of an attribute set to zero, then one of the following actions shall occur.

-
- If the attribute is reported as read/write (READ ONLY=0) using the READ ATTRIBUTE command, then the attribute will be cleared. It will thus effectively no longer exist, i.e., shall not be returned in response to a READ ATTRIBUTE command and not reported with the READ ATTRIBUTE command, ATTRIBUTE LIST service action.

If there is not enough space to write the attributes to the Medium Auxiliary Memory, the device server shall terminate the WRITE ATTRIBUTE command with CHECK CONDITION status, set the sense key to ILLEGAL REQUEST, set the additional sense data to AUXILIARY MEMORY OUT OF SPACE, and shall not change any attributes.

If the Medium Auxiliary Memory is not accessible since there is no medium present, then the device server shall terminate the WRITE ATTRIBUTE command with CHECK CONDITION status, set the sense key to NOT READY, set the additional sense data to MEDIUM NOT PRESENT, and shall not change any attributes.

If, although medium is present, the Medium Auxiliary Memory is not accessible for some indeterminate reason then the device server shall terminate the WRITE ATTRIBUTE command with CHECK CONDITION status, set the sense key to MEDIUM ERROR, set the additional sense data to AUXILIARY MEMORY NOT ACCESSIBLE, and shall not change any attributes.

If the Medium Auxiliary Memory has failed (e.g. bad checksum) then the device server shall terminate the WRITE ATTRIBUTE command with CHECK CONDITION status, set the sense key to MEDIUM ERROR and set the additional sense data to AUXILIARY MEMORY WRITE ERROR.

The PARAMETER LIST LENGTH field specifies the length in bytes of the parameter list contained in the Data-Out Buffer. A PARAMETER LIST LENGTH of zero indicates that the Data-Out Buffer shall be empty. This condition shall not be considered as an error. The device server shall terminate the command with CHECK CONDITION status if the PARAMETER LIST LENGTH results in the truncation of any attribute. The sense key shall be set to ILLEGAL REQUEST, and the additional sense data shall be set to PARAMETER LIST LENGTH ERROR.

The parameter list shall have the format shown in Table 2. The attributes should be sent in ascending numerical order. If the attributes are not in order, the device server shall terminate the WRITE ATTRIBUTE command with CHECK CONDITION status, set the sense key to ILLEGAL REQUEST and the additional sense data to INVALID FIELD IN PARAMETER LIST. No attributes shall be changed.

The format of the attributes is described in 8.x.

Table 2 - Parameter data for WRITE ATTRIBUTE command

BYTE	Bit							
	7	6	5	4	3	2	1	0
0	MSB							
3				PARAMETER DATA LENGTH (n-3)				LSB
4 .. x				ATTRIBUTE #1				

..

m .. n	ATTRIBUTE #N

7.XX READ ATTRIBUTE command

The READ ATTRIBUTE command (see Table 3) allows an application client to read attribute values from Medium Auxiliary Memory (MAM).

Table 3 - READ ATTRIBUTE command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPCODE (8Ch)							
1	Reserved (0)			SERVICE ACTION				
2	MSB							
3				Reserved for SMC-2 devices (0)				LSB
4	Reserved for SMC-2 devices (0)							
5	VOLUME NUMBER							
6	Reserved (0)							
7	PARTITION NUMBER							
8	MSB							
9				FIRST ATTRIBUTE ID				LSB
10	MSB							
11								
12				ALLOCATION LENGTH				
13								LSB
14	Reserved (0)							
15	CONTROL							

If the Medium Auxiliary Memory is not accessible since there is no medium present, then the device server shall terminate the READ ATTRIBUTE command with CHECK CONDITION status, set the sense key to NOT READY and set the additional sense data to MEDIUM NOT PRESENT.

If, although medium is present, the Medium Auxiliary Memory is not accessible for some indeterminate reason then the device server shall terminate the READ ATTRIBUTE command with CHECK CONDITION status, set the sense key to MEDIUM ERROR, set the additional sense data to AUXILIARY MEMORY NOT ACCESSIBLE.

If the Medium Auxiliary Memory has failed then the device server shall terminate the READ ATTRIBUTE command with CHECK CONDITION status, set the sense key to MEDIUM ERROR, set the additional sense data to AUXILIARY MEMORY READ ERROR.

The service actions defined for the READ ATTRIBUTE command are shown in Table 4

Table 4 - READ ATTRIBUTE service action codes

Code	Name	Description
00h	ATTRIBUTE VALUES	Return attribute values.
01h	ATTRIBUTE LIST	Returns a list of attribute identifiers available (not non-existent)
02h	VOLUME LIST	Return a list of Volume Numbers available
03h	PARTITION LIST	Return a list of Partition Numbers available
04h	Reserved for SMC-2	
05h – 1Fh	Reserved	

The VOLUME NUMBER specifies a volume within the Medium Auxiliary Memory. The number of volumes of the MAM shall equal that of the attached multi-volume medium. If the media only has a single volume, then this field shall be set to 0.

The PARTITION NUMBER specifies a partition within a volume. The number of partitions of the MAM shall equal that of the attached multi-partition medium. If the medium only has a single partition, then this field shall be set to 0.

If the combination of VOLUME NUMBER and PARTITION NUMBER is not valid within the device server then the command shall terminate with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST, and the additional sense data shall be set to INVALID FIELD IN CDB.

The FIRST ATTRIBUTE ID specifies the identifier of the first attribute to be returned. If this identifier does not exist then the command shall terminate with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST, and the additional sense data shall be set to INVALID FIELD IN CDB.

The ALLOCATION LENGTH field in the CDB indicates how much space has been allocated for the returned parameter list. If the length is not sufficient to contain the entire parameter list, the first portion of the list shall be returned. This shall not be considered an error. If the remainder of the list is required, the application client should either send a new READ ATRRIBUTE command with a ALLOCATION LENGTH field large enough to contain the entire parameter list or use the FIRST ATTRIBUTE ID field to restrict the attributes returned.

7.XX.1 ATTRIBUTE VALUES service action

This service is used to read the attributes values for the PARTITION NUMBER and VOLUME NUMBER specified in the command, starting at FIRST ATTRIBUTE ID. The attributes shall be returned in ascending numerical order. Table 5 shows the format of the information returned by the device server in response to the ATTRIBUTE LIST service action.

Table 5 - Parameter data for ATTRIBUTE VALUES service action

BYTE	Bit							
	7	6	5	4	3	2	1	0
0	MSB							
3	AVAILABLE DATA (n-3)							LSB
4 .. x	ATTRIBUTE #1							

..

m .. n	ATTRIBUTE #N

The format of the attributes is described in 8.x.

7.XX.2 ATTRIBUTE LIST service action

This service action is used to retrieve all the identifiers of the available attributes (not non-existant) for the specified PARTITION NUMBER and VOLUME NUMBER. The FIRST ATTRIBUTE ID field in the CDB shall be ignored. The attribute identifiers shall be returned in ascending numerical order. Table 6 shows the format of the information returned by the device server in response to the ATTRIBUTE LIST service action.

Table 6 - Parameter data for ATTRIBUTE LIST service action

	BIT							
BYTE	7	6	5	4	3	2	1	0
0	MSB							
3	AVAILABLE DATA (n-3)							LSB
4	MSB							
5	ATTRIBUTE ID #1							LSB
	…							
n-1	MSB							
n	ATTRIBUTE ID #N							LSB

The AVAILABLE DATA field specifies the length in bytes of the following data. If the amount of parameter data sent to the application client is reduced due to insufficient allocation length, the AVAILABLE DATA field shall not be altered.

A two byte ATTRIBUTE IDis returned for each attribute available on the device server. See 8.x.1 for a description of the ATTRIBUTE ID values

7.XX.3 PARTITION LIST service action

This service action is used to report the number of partitions that the device server supports for the specified VOLUME NUMBER. The PARITION NUMBER and ATTRIBUTE fields in the CDB shall be ignored. Table 7 shows the format of the information returned by the device server in response to the PARTITION LIST service action.

Table 7 - Parameter data for PARTITION LIST service action

	BIT							
BYTE	7	6	5	4	3	2	1	0
0	MSB							
1	AVAILABLE DATA (2)							LSB
2	FIRST PARTITION NUMBER							
3	NUMBER OF PARTITIONS AVAILABLE							

The AVAILABLE DATA field specifies the length in bytes of the following data. If the amount of parameter data sent to the application client is reduced due to insufficient allocation length, the AVAILABLE DATA field shall not be altered.

The FIRST PARTITION NUMBER is the first Partition available on the specified VOLUME NUMBER. It is recommended that partition numbering start at 0.

The NUMBER OF PARTITIONS AVAILABLE indicates the number of Partitions available on the specified VOLUME NUMBER.

7.XX.4 VOLUME LIST service action

This service action is used to report the number of volumes that the device server supports. The VOLUME NUMBER, PARITION NUMBER and ATTRIBUTE fields in the CDB shall be ignored. Table 8 shows the format of the information returned by the device server in response to the VOLUME LIST service action.

Table 8 - Parameter data for VOLUME LIST service action

	BIT							
BYTE	7	6	5	4	3	2	1	0
0	MSB							
1	AVAILABLE DATA (2)							LSB
2	FIRST VOLUME NUMBER							
3	NUMBER OF VOLUMES AVAILABLE							

The AVAILABLE DATA field specifies the length in bytes of the following data. If the amount of parameter data sent to the application client is reduced due to insufficient allocation length, the AVAILABLE DATA field shall not be altered.

The FIRST VOLUME NUMBER specifies the first Volume. It is recommended that Volume numbering start at 0.

The NUMBER OF VOLUMES AVAILABLE indicates the number of Volumes available.

8.X Medium Auxiliary Memory Attribute Data

This clause describes the format of the attribute data sent with a WRITE ATTRIBUTE command, or returned in response to a READ ATTRIBUTE command. Using these commands Medium Auxiliary. Each attribute shall use the format described below.

The format shown in Table 9 is used only by the WRITE ATTRIBUTE and READ ATTRIBUTES commands, and implies nothing about the physical representation of the data in the Medium Auxiliary Memory.

Table 9 – Attribute format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	MSB			ATTRIBUTE ID				
1								LSB
2	READ ONLY			RESERVED (0)				FORMAT
3	MSB			ATTRIBUTE LENGTH (n-4)				
4								LSB
5 .. n	MSB			ATTRIBUTE VALUE				
								LSB

ATTRIBUTE ID is the binary identifier for a single attribute. See 8.x.1 for a description of attribute id values.

The READ ONLY bit specifies whether an attribute is read-only. If the READ ONLY bit is zero, the attribute may be changed by the WRITE ATTRIBUTES command. If the READ ONLY bit is one the WRITE ATTRIBUTES command shall not change the attribute. The value of the READ ONLY bit shall be ignored by the WRITE ATTRIBUTE command.

The FORMAT field specified the data format of the associated attribute. The possible values are in Table 10

Table 10 – FORMAT field values

Value	Name	Description
00h	BINARY	The attribute contains binary data.
01h	ASCII	ASCII attributes shall contain only graphic codes (i.e., code values 20h through 7Eh), shall be left-aligned (place any unused bytes at the end of the field (highest offset)) and the unused bytes shall be filled with space characters (20h).
02h	TEXT	The attribute contains textual data. The character set is as described in the TEXT LOCALISATION IDENTIFIER attribute in 8.X.1.3

The ATTRIBUTE LENGTH field specifies the length in bytes of the ATTRIBUTE VALUE field. Attributes defined by this standard include a specification for the contents of the ATTRIBUTE LENGTH field.

8.x.1 ATTRIBUTE ID values

The values in the ATTRIBUTE ID field are assigned according to the source of changes or updates as shown in Table 11.

Table 11 - Attribute Descriptions

Attribute Identifiers	Description
0000h – 03FFh	Device Common Attributes
0400h – 07FFh	Medium Common Attributes
0800h – 0BFFh	Host Common Attributes
0C00h – 0FFFh	Device Vendor Unique Attributes
1000h – 13FFh	Medium Vendor Unique Attributes
1400h – 17FFh	Host Vendor Unique Attributes
1800h - FFFFh	Reserved

Device servers shall accept and process a WRITE ATTRIBUTES command containing Host Common Attribute Identifier value (0800h - 0BFFh) or any Host Vendor Unique Attribute Identifier value (1400h - 17FFh). Host Common Attribute Identifier values may be checked for conformance to the requirements described in 8.x.1.3.

8.X.1.1 Device Common Attributes

The device server shall maintain and update the contents of these attributes within the MAM when it and the associated medium are present. All the attributes are read-only (READ ONLY = 1).

Table 12 - Device Common Attributes

ID	Attribute Name	#Bytes	Format
0000h	REMAINING CAPACITY IN PARTITION	8	Binary
0001h	MAXIMUM CAPACITY IN PARTITION	8	Binary
0002h	Reserved for SSC		
0003h	LOAD COUNT	8	Binary
0004h	MAM SPACE REMAINING	8	Binary
0005h	Reserved for SSC		
0006h	Reserved for SSC		
0007h	INITIALISATION COUNT	2	Binary
0008h – 020Ah	RESERVED		
020Ah	DEVICE MAKE/SERIAL NUMBER AT LAST LOAD	40	ASCII
020Bh	DEVICE MAKE/SERIAL NUMBER AT LOAD –1	40	ASCII
020Ch	DEVICE MAKE/SERIAL NUMBER AT LOAD –2	40	ASCII
020Dh	DEVICE MAKE/SERIAL NUMBER AT LOAD –3	40	ASCII
020Eh – 021Fh	RESERVED		
0220h	TOTAL MBYTES WRITTEN IN MEDIUM LIFE	8	Binary
0221h	TOTAL MBYTES READ IN MEDIUM LIFE	8	Binary
0222h	TOTAL MBYTES WRITTEN IN CURRENT/LAST LOAD	8	Binary
0223h	TOTAL MBYTES READ IN CURRENT/LAST LOAD	8	Binary
0224h – 033Fh	Reserved		
0340h	MEDIUM USAGE HISTORY	90	Binary
0341h	PARTITION USAGE HISTORY	60	Binary

ID	Attribute Name	#Bytes	Format
0342h – 03FFh	Reserved		

The REMAINING CAPACITY IN PARTITION and MAXIMUM CAPACITY IN PARTITION attributes are native capacities, assuming no data compression for the specified medium partition. This value is expressed in increments of 1048576 bytes (e.g., a value of one means 1048576 bytes, two means 2097152 bytes, etc.).

The LOAD COUNT attribute specifies how many times this medium has been fully loaded. This parameter should not be reset by any action of the device server.

The MAM SPACE REMAINING specifies the space currently free in the MAM. The total MAM capacity is reported in the MAM CAPACITY attribute defined in 8.1.X.2.

> *Note that it may not always be possible to utilize all of the free space in a given MAM implementation. Depending on the internal organization 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.*

The INITIALISATION COUNT attribute indicates the number of times that a device server has logically formatted the medium. This figure is cumulative over the life of the medium and shall never be reset.

The DEVICE VENDOR/SERIAL NUMBER AT LAST LOAD, DEVICE VENDOR /SERIAL NUMBER AT LOAD –1, DEVICE VENDOR /SERIAL NUMBER AT LOAD –2 and DEVICE VENDOR /SERIAL NUMBER AT LOAD –3 attributes give a rolling history of the last four device servers in which the medium has been loaded. The format of the attributes is shown in Table 13.

Table 13 - DEVICE VENDOR/SERIAL NUMBER attribute format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	MSB							
7				VENDOR IDENTIFICATION				LSB
8	MSB							
39				PRODUCT SERIAL NUMBER				LSB

The VENDOR IDENTIFICATION field shall be the same value returned in the SCSI Inquiry command (see 7.5.1) by the device server.

The PRODUCT SERIAL NUMBER field contains a vendor-assigned serial number. If the product serial number is not available, the device server shall return ASCII spaces (20h) in this field.

The TOTAL MBYTES WRITTEN IN MEDIUM LIFE and TOTAL MBYTES READ IN MEDIUM LIFE attributes specify the total number of data bytes that are transferred to or from the medium surface (after any data compression has been applied) over the entire medium life. These figures are cumulative and shall never be reset. These values are expressed in increments of 1048576 bytes (e.g., a value of one means 1048576 bytes, two means 2097152 bytes, etc.).

The TOTAL MBYTES WRITTEN IN CURRENT/LAST LOAD and TOTAL MBYTES READ IN CURRENT/LAST LOAD are similar to the attributes above but apply to the current load (if the medium is currently loaded) or the last load (if the medium is currently unloaded). The device server should reset these attributes to zero when the medium is loaded. These values are expressed in increments of 1048576 bytes (e.g., a value of one means 1048576 bytes, two means 2097152 bytes, etc.).

The MEDIUM USAGE HISTORY attribute (Table 14) provides statistical counters for the entire medium. The value in each field is the sum of all partitions. If a field is not used it should be set to zero.

Table 14 - MEDIUM USAGE HISTORY attribute format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	MSB			CURRENT AMOUNT OF DATA WRITTEN				
5								LSB
6	MSB			CURRENT WRITE RETRY COUNT				
11								LSB
12	MSB			CURRENT AMOUNT OF DATA READ				
17								LSB
18	MSB			CURRENT READ RETRIES COUNT				
23								LSB
24	MSB			PREVIOUS AMOUNT OF DATA WRITTEN				
29								LSB
30	MSB			PREVIOUS WRITE RETRIES COUNT				
35								LSB
36	MSB			PREVIOUS AMOUNT OF DATA READ				
41								LSB
42	MSB			PREVIOUS READ RETRIES COUNT				
47								LSB
48	MSB			TOTAL AMOUNT OF DATA WRITTEN				
53								LSB
54	MSB			TOTAL WRITE RETRIES COUNT				
59								LSB
60	MSB			TOTAL AMOUNT OF DATA READ				
65								LSB
66	MSB			TOTAL READ RETRIES COUNT				
71								LSB
72	MSB			LOAD COUNT				
77								LSB
78	MSB			TOTAL CHANGE PARTITION COUNT				
83								LSB
84	MSB			TOTAL PARTITION INITIALIZE COUNT				
89								LSB

The CURRENT AMOUNT OF DATA WRITTEN specifies the amount of data physically written to the medium during this load of the medium. This value is expressed in increments of 1048576 bytes (e.g., a value of one means 1048576 bytes, two means 2097152 bytes, etc.).

The CURRENT WRITE RETRY COUNT specifies the total number of write retries during this load of the medium. The exact definition of the error counters is not part of this standard. These counters should not be used to compare products because the products may define errors differently.

The CURRENT AMOUNT OF DATA READ specifies the amount of data physically read from the medium during this load of the medium. This value is expressed in increments of 1048576 bytes (e.g., a value of one means 1048576 bytes, two means 2097152 bytes, etc.).

The CURRENT READ RETRIES COUNT specifies the number of times a read retry was performed during this load of the medium. The exact definition of the error counters is not part of this standard. These counters should not be used to compare products because the products may define errors differently.

The PREVIOUS AMOUNT OF DATA WRITTEN specifies the amount of data physically written to the medium during the previous medium load. This value is expressed in increments of 1048576 bytes (e.g., a value of one means 1048576 bytes, two means 2097152 bytes, etc.).

The PREVIOUS WRITE RETRY COUNT specifies the total number of write retries during the previous medium load. The exact definition of the error counters is not part of this standard. These counters should not be used to compare products because the products may define errors differently.

The PREVIOUS AMOUNT OF DATA READ specifies the amount of data physically read from the medium during the previous medium load. This value is expressed in increments of 1048576 bytes (e.g., a value of one means 1048576 bytes, two means 2097152 bytes, etc.).

The PREVIOUS READ RETRIES COUNT specifies the number of times a read retry was performed during the previous medium load. The exact definition of the error counters is not part of this standard. These counters should not be used to compare products because the products may define errors differently.

The TOTAL AMOUNT OF DATA WRITTEN specifies the total amount of data physically written to the medium since the last medium format. This value accumulates over the life of the medium but it is reset to zero after a medium format. This value is expressed in increments of 1048576 bytes (e.g., a value of one means 1048576 bytes, two means 2097152 bytes, etc.).

The TOTAL WRITE RETRIES COUNT specifies the total number of write retries since the last medium format.. This count accumulates over the life of the medium but it is reset to zero after a medium format. The exact definition of the error counters is not part of this standard. These counters should not be used to compare products because the products may define errors differently.

The TOTAL AMOUNT OF DATA READ specifies the total amount of data physically read from the medium since the last medium format. This value accumulates over the life of the medium but it is reset to zero after a medium format. This value is expressed in increments of 1048576 bytes (e.g., a value of one means 1048576 bytes, two means 2097152 bytes, etc.).

The TOTAL READ RETRIES COUNT specifies the number of times a read retry was performed since the last medium format.. The exact definition of the error counters is not part of this standard. These counters should not be used to compare products because the products may define errors differently. This count accumulates over the life of the medium but it is reset to zero after a medium format.

The LOAD COUNT specifies the number of loads since the last medium format. This count accumulates over the life of the medium but it is reset to zero after a medium format.

The TOTAL CHANGE PARTITION COUNT specifies the number of times that switches between partitions have been performed on the medium. This count accumulates over the life of the medium but it is reset to zero after a medium format.

The TOTAL PARTITION INITIALIZE COUNT specifies number of times that any of the partitions on the medium have been erased. This count accumulates over the life of the medium but it is reset to zero after a medium format.

The PARTITION USAGE HISTORY attribute (Table 15) provides statistical counters for the partition specified in the CDB PARTITION NUMBER field. If a field is not used it should be set to zero.

Table 15 - PARTITION USAGE HISTORY

Byte	Bit							
	7	6	5	4	3	2	1	0
0	MSB	CURRENT AMOUNT OF DATA WRITTEN						LSB

3	
4	MSB CURRENT WRITE RETRY COUNT
7	LSB
8	MSB CURRENT AMOUNT OF DATA READ
11	LSB
12	MSB CURRENT READ RETRIES COUNT
15	LSB
16	MSB PREVIOUS AMOUNT OF DATA WRITTEN
19	LSB
20	MSB PREVIOUS WRITE RETRIES COUNT
23	LSB
24	MSB PREVIOUS AMOUNT OF DATA READ
27	LSB
28	MSB PREVIOUS READ RETRIES COUNT
31	LSB
32	MSB TOTAL AMOUNT OF DATA WRITTEN
35	LSB
36	MSB TOTAL WRITE RETRIES COUNT
39	LSB
40	MSB TOTAL AMOUNT OF DATA READ
43	LSB
44	MSB TOTAL READ RETRIES COUNT
47	LSB
48	MSB LOAD COUNT
51	LSB
52	MSB CHANGE PARTITION COUNT
55	LSB
56	MSB PARTITION INITIALIZE COUNT
59	LSB

The CURRENT AMOUNT OF DATA WRITTEN, CURRENT WRITE RETRY COUNT, CURRENT AMOUNT OF DATA READ, CURRENT READ RETRIES COUNT, PREVIOUS AMOUNT OF DATA WRITTEN, PREVIOUS WRITE RETRIES COUNT, PREVIOUS AMOUNT OF DATA READ, PREVIOUS READ RETRIES COUNT, TOTAL AMOUNT OF DATA WRITTEN, TOTAL WRITE RETRIES COUNT, TOTAL AMOUNT OF DATA READ, TOTAL READ RETRIES COUNT, LOAD COUNT fields are as defined for MEDIUM USAGE HISTORY except that they refer to the partition identified by the CDB PARTITION NUMBER field rather than the whole medium.

The CHANGE PARTITION COUNT specifies the number of times that the partition identified by the CDB PARTITION NUMBER field has been switched to. This count accumulates over the life of the medium but it is reset to zero after a medium format.

The PARTITION INITIALIZE COUNT specifies the number of times that the partition identified by the CDB PARTITION NUMBER field has been initialized. This count accumulates over the life of the medium but it is reset to zero after a medium format.

8.X.1.2 Medium Common Attributes

These attributes are hard coded into the MAM at manufacture time. The attributes defined are shown in Table 16. All the attributes are read-only (READ ONLY = 1).

Table 16 - Medium Common Attributes

ID	Attribute Name	#Bytes	Format
0400h	MEDIUM MANUFACTURER	8	ASCII

0401h	MEDIUM SERIAL NUMBER	32	ASCII
0402h	Reserved for SSC		
0403h	Reserved for SSC		
0404h	Reserved for SSC		
0405h	Reserved for SSC		
0406h	MEDIUM MANUFACTURE DATE	8	ASCII
0407h	MAM CAPACITY	8	Binary
0408h	MEDIUM TYPE	1	Binary
0409h	MEDIUM TYPE INFOMATION	2	Binary
040Ah – 07FFh	Reserved		

The MEDIUM MANUFACTURER field should contain a value listed in the vendor identification list (see Annex D).

The MEDIUM SERIAL NUMBER identifies the manufacturer's serial number for the medium.

The MEDIUM MANUFACTURE DATE specifies the date of manufacture of the medium. The format is YYYYMMDD.

The MAM CAPACITY 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 that is inaccessible to the application client.

The MEDIUM TYPE and MEDIUM TYPE INFORMATION attributes give information about non-data media and other types of media. The MEDIUM TYPE INFORMATION attribute is interpreted according to the type of medium indicated by the MEDIUM TYPE. Defined values are shown in Table 17.

Table 17 – MEDIUM TYPE

MEDIUM TYPE	**Meaning**	**MEDIUM TYPE INFORMATION**
00h	Data medium	Reserved
01h	Cleaning medium	Maximum number of cleaning cycles permitted
02h-7Fh	Reserved	Reserved
80h	Write-once medium	Reserved
81h-FFh	Reserved	Reserved

8.X.1.3 Host Common Attributes

Application clients may use the READ ATTRIBUTE and WRITE ATTRIBUTE commands to maintain the attributes shown in Table 18. All the attributes are read/write (READ ONLY = 0).

Table 18 - Host Common Attributes

ID	Attribute Name	#Bytes	Format
0800h	APPLICATION VENDOR	8	ASCII
0801h	APPLICATION NAME	32	ASCII
0802h	APPLICATION VERSION	8	ASCII
0803h	USER MEDIUM TEXT LABEL	160	Text
0804h	DATE & TIME LAST WRITTEN	12	ASCII
0805h	TEXT LOCALISATION IDENTIFIER	1	Binary
0806h	BARCODE	32	ASCII
0807h	OWNING HOST TEXTUAL NAME	80	Text
0808h	MEDIA POOL	160	Text
0809h	PARTITION USER TEXT LABEL	16	ASCII
080Ah	LOAD/UNLOAD AT PARTITION	1	Binary
080Bh – BFFh	Reserved		

The APPLICATION VENDOR attribute identifies the manufacturer of the application client (e.g. backup program). The APPLICATION VENDOR field should contain a value listed in the vendor identification list (see Annex D).

> *NOTE: It is intended that this field provide a unique vendor identification of the vendor who wrote the Host Common attributes. In the absence of a formal registration procedure, T10 maintains a list of vendor identification codes in use. Vendors are requested to voluntarily submit their identification codes to T10 to prevent duplication of codes (see Annex D).*

The APPLICATION NAME identifies the name of the application client.

The APPLICATION VERSION identifies the version of the application client.

The USER MEDIUM TEXT LABEL is the user level identifier for the medium.

The DATE & TIME LAST WRITTEN specifies when the application client last wrote to the MAM. The format for the string is YYYYMMDDHHMM using a 24-hour time format

The TEXT LOCALISATION IDENTIFIER defines the character set used for attributes with a text format. The identifier has the format shown in Table 19.

Table 19 – TEXT LOCALISATION IDENTIFIER

00h	No code specified (ASCII)
01h	ISO/IEC 8859-1 (Europe, Latin America)
02h	ISO/IEC 8859-2 (Eastern Europe)
03h	ISO/IEC 8859-3 (SE Europe/miscellaneous)
04h	ISO/IEC 8859-4 (Scandinavia/Baltic)
05h	ISO/IEC 8859-5 (Cyrillic)
06h	ISO/IEC 8859-6 (Arabic)
07h	ISO/IEC 8859-7 (Greek)
08h	ISO/IEC 8859-8 (Hebrew)
09h	ISO/IEC 8859-9 (Latin 5)
0Ah	ISO/IEC 8859-10 (Latin 6)
0Bh- 7Fh	Reserved
80h	ISO/IEC 10646 (Unicode)
81h	ISO/IEC 10646 -1, Amendment no. 2 (UTF-8)
82h–FFh	Reserved

The BARCODE attribute allows an application server to store the contents of a Barcode associated with the medium in the MAM.

The OWNING HOST TEXTUAL NAME attribute indicates the host server from which that USER MEDIUM TEXT LABEL originates.

The MEDIA POOL attribute indicates the MEDIA POOL to which this medium belongs

The VOLUME USER TEXT LABEL is a variable length attribute that is the user level identifier of the volume.

The PARTITION USER TEXT LABEL is a user level identifier for the partition specified in the CDB PARTITION NUMBER field

The LOAD/UNLOAD AT PARTITION attribute indicates whether the media can be loaded or unloaded at the Partition specified in the CDB PARTITION NUMBER field. If loads/unloads are enabled for the specified partition, the value of this parameter shall be 1h. If loads/unloads are not enabled for the specified partition, the value of this parameter shall be 0h. If LOAD/UNLOAD AT PARTITION is disabled, then loads/unloads are performed at the beginning of the media instead of at the specified partition. If this attribute is not set by a host then the default action will be to load/unload at the beginning of media.

Addendum 1 – Proposed Additions to SMC-2

In order to fully support MAM in libraries and jukeboxes, it is proposed to add the concept of element addressability to the SPC-2 WRITE ATTRIBUTE and READ ATTRIBUTE commands as follows:

WRITE ATTRIBUTE command

The WRITE ATTRIBUTE command (see Table 20) allows an application client to write attribute values to Medium Auxiliary Memory (MAM).

Table 20 - WRITE ATTRIBUTE command

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

The ELEMENT ADDRESS specifies the element where the MAM currently resides (as part of a medium). This might mean, for example, a MAM inside a medium residing in a storage element or a MAM inside a medium residing in a data transfer element. Note that this field forms an additional location qualifier hierarchically superior to VOLUME NUMBER and PARTITION NUMBER.

The ELEMENT TYPE CODE values are defined in Table 9 (of SMC).

All other fields are as defined in SPC-2.

READ ATTRIBUTE command

The READ ATTRIBUTE command (see Table 21) allows an application client to read attribute values to Medium Auxiliary Memory (MAM) and also to discover what MAM exists at the device server,

Table 21 - READ ATTRIBUTE command

Byte	Bit							
	7	6	5	4	3	2	1	0
0	OPCODE (8Ch)							
1	Reserved (0)			SERVICE ACTION				
2	MSB ELEMENT ADDRESS							
3	LSB							
4	ELEMENT TYPE CODE							
5	VOLUME NUMBER							
6	Reserved (0)							
7	PARTITION NUMBER							
8	MSB FIRST ATTRIBUTE ID							
9	LSB							
10	MSB ALLOCATION LENGTH							
11								
12								
13	LSB							
14	Reserved (0)							
15	CONTROL							

The ELEMENT ADDRESS specifies the element where the MAM currently resides (as part of a medium). This might mean, for example, a MAM inside a medium residing in a storage element or a MAM inside a medium residing in a data transfer element. Note that this field forms an additional location qualifier hierarchically superior to VOLUME NUMBER and PARTITION NUMBER.

The ELEMENT TYPE CODE values are defined in Table 9 (of SMC).

The service actions defined for the READ ATTRIBUTE command are as described in SPC-3 except for the addition shown in Table 22.

Table 22 - READ ATTRIBUTE service action codes

Code	Name	Description
04h	ELEMENT LIST	Return a list of elements containing MAM

All other fields are as defined in SPC-3.

ELEMENT LIST service action

This service action is used to retrieve all of the element addresses containing an accessible MAM. Table 23 shows the format of the information returned form the device server in response to the service action.

NOTE: Since all the element addresses shall contain an accessible MAM, the list of elements returned (of the same ELEMENT TYPE CODE) may be non-contiguous.

The FIRST ELEMENT ADDRESS field identifies the first element of type ELEMENT TYPE CODE contained in the medium changer. The ELEMENT TYPE CODE values are defined in Table 9.
The NUMBER OF ELEMENTS field defines the total number of those elements contained in the medium changer.

Table 23 - Parameter data for ELEMENT LIST service action

BYTE	BIT 7	6	5	4	3	2	1	0
0	MSB							
3	AVAILABLE DATA (n-3)							LSB
4	ELEMENT TYPE CODE							
5	MSB							
6	FIRST ELEMENT ADDRESS							LSB
7	MSB							
8	NUMBER OF ELEMENTS							LSB
	…							
n-4	ELEMENT TYPE CODE							
n-3	MSB							
n-2	FIRST ELEMENT ADDRESS							LSB
n-1	MSB							
N	NUMBER OF ELEMENTS							LSB

Addendum 2 – For inclusion In a Future Version of SSC.

The following tape-specific attributes are specified:

Device Common Attributes

ID	Attribute Name	#Bytes	Format
0002h	TAPEALERT FLAGS	8	Binary
0005h	ASSIGNING ORGANISATION	8	ASCII
0006h	FORMATTED DENSITY CODE	1	Binary

The TAPEALERT FLAGS attribute provides a means of reporting the state of the TapeAlert flags for the previous load of the medium. 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.

The ASSIGNING ORGANISATION field data identifies the organization responsible for the specifications defining the values in the FORMATTED DENSITY CODE attribute. The ASSIGNING ORGANIZATION field should contain a value listed in the vendor identification list (see Annex D). The use of specific vendor identification, other than the one associated with the device is allowed.

> *NOTE: It is intended that this field provide a unique vendor identification of the FORMATTED DENSITY CODE attribute. In the absence of a formal registration procedure, T10 maintains a list of vendor identification codes in use. Vendors are requested to voluntarily submit their identification codes to T10 to prevent duplication of codes (see Annex D).*

If the device server formats the medium into a format other than the one indicated in the MEDIUM DENSITY CODE attribute (e.g. for compatibility with a previous generation format), then the FORMATTED DENSITY CODE indicates the DENSITY CODE of the format chosen (see 8.3.2.1). Otherwise this attribute shall be the same as the MEDIUM DENSITY CODE.

Medium Common Attributes

ID	Attribute Name	#Bytes	Format
0402h	MEDIUM LENGTH	4	Binary
0403h	MEDIUM WIDTH	4	Binary
0404h	ASSIGNING ORGANISATION	8	ASCII
0405h	MEDIUM DENSITY CODE	1	Binary

The MEDIUM LENGTH attribute indicates the length of the medium in meters. A value of 00h indicates that the length of the medium is undefined.

The MEDIUM WIDTH attribute indicates the width of the medium supported by this density. This field has units of tenths of millimeters. The value in this field shall be rounded up if the fractional value of the actual value is greater than or equal to 0.5. The MEDIUM WIDTH field may vary for a given density depending on the mounted medium. A value of 00h indicates that the width of the medium is undefined.

The ASSIGNING ORGANISATION attribute identifies the organization responsible for the specifications defining the values in the MEDIUM DENSITY CODE attribute.. The ASSIGNING ORGANIZATION field should contain a value listed in the vendor identification list (see Annex D of SPC).

> *NOTE: It is intended that this field provide a unique vendor identification of the* MEDIUM DENSITY CODE *attribute. In the absence of a formal registration procedure, T10 maintains a*

list of vendor identification codes in use. Vendors are requested to voluntarily submit their identification codes to T10 to prevent duplication of codes (see Annex D of SPC).

The MEDIUM DENSITY CODE is the same numeric DENSITY CODE as reported in the SCSI Mode Block Descriptor (see 8.3.2.1).