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Subject: **Proposed Addition of Read and Write Attribute Commands to SPC-2**
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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 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 their 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. Since the commands are considered generic, SPC seems the appropriate place to put them. The commands will need some additional fields defined when used with Medium Changers, these extensions are also defined for inclusion in SMC-2.

Summary:

- Two new 16 Byte CDBs have been defined.
- A new concept of attributes has been 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
  - 3/11h/12h AUXILIARY MEMORY READ ERRORA Read Attribute command could not be completed as the read process from the MAM failed (e.g. a bad checksum was encountered)
  - 3/0Ch/0Bh AUXILIARY MEMORY WRITE ERROR
    A Write Attribute command could not be completed as the write process to the MAM failed.

7.XX WRITE ATTRIBUTE command

The WRITE ATTRIBUTE command (see Table 1~~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 mirror 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 mirror 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 sets any attribute that is not changeable by the device server to a value other than its current value;
- If the application client incorrectly sets the length of a attribute;

- If the application client sets any attribute to an unsupported value;

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.
(EDITORS NOTE: Note new ASC/ASQ)

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.
(EDITORS NOTE: Note new ASC/ASQ)

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, set the additional sense data to BAD AUXILIARY MEMORY, and shall not change any attributes.
(EDITORS NOTE: Note new ASC/ASQ)

The PARAMETER LIST LENGTH field specifies the length in bytes of the parameter list that shall be 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~~Table 2~~. The attributes shall be sent in ascending numerical order.

Table 2~~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							

The format of the attributes is shown in Table 9~~Table 9~~.

7.XX READ ATTRIBUTE command

The READ ATTRIBUTE command (see Table 3~~Table 3~~) allows an application client to read attribute values to 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 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	MSB FIRST ATTRIBUTE ID							
9								LSB
10	MSB ALLOCATION LENGTH							
11								
12								
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 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~~ READ 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.
(EDITORS NOTE: Note new ASC/ASQ)

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 BAD AUXILIARY MEMORY, and shall not change any attributes.
(EDITORS NOTE: Note new ASC/ASQ)

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

Table 44 - READ ATTRIBUTE service action codes

Code	Name	Description
00h	ATTRIBUTE VALUES	Return attribute values.
01h	ATTRIBUTE LIST	Returns a list of attribute identifiers available from device server.

02h	VOLUME LIST	Return a list of Volume Numbers available from the device server.
03h	PARTITION LIST	Return a list of Partition Numbers available from the device server.
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 mirror 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 mirror 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 retrieved. 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 reserved 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 action is the ‘normal’ use of the READ ATTRIBUTE command and 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~~Table 5~~ shows the format of the information returned by the device server in response to the ATTRIBUTE LIST service action.

Table 5~~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 shown in Table 9~~Table 9~~.

7.XX.2 ATTRIBUTE LIST service action

This service action is used to retrieve all the identifiers of the available attributes for the specified PARTITION NUMBER and VOLUME NUMBER. The attribute identifiers shall be returned in ascending numerical order. Table 6~~Table 6~~ shows the format of the information returned by the device server in response to the ATTRIBUTE LIST service action.

Table 6~~6~~ - Parameter data for ATTRIBUTE LIST service action

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

Two byte of information are returned for each attribute available on the device server.

The AVAILABLE DATA field specifies the length in bytes of the following data. The remaining bytes in the report are each of the ATTRIBUTE ID values the device server has available.

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. Table 7~~Table 7~~ shows the format of the information returned by the device server in response to the PARTITION LIST service action.

Table 7~~7~~ - Parameter data for PARTITION LIST service action

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

The AVAILABLE DATA field specifies the length in bytes of the following data.

The FIRST PARTITION NUMBER is the first Partition available on the specified VOLUME NUMBER. It is recommended that Volume 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. Table 8~~Table 8~~ shows the format of the information returned by the device server in response to the VOLUME LIST service action.

Table 88 - Parameter data for VOLUME LIST service action

BYTE	BIT							
	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.
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 on the MAM/medium.

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 Memory attributes shall be transferred as a sequence in numerical order keyed from the ATTRIBUTE ID. Each attribute shall use the format described below.

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

Table 99 – Attribute format

Byte	Bit							
	7	6	5	4	3	2	1	0
0	MSB			ATTRIBUTE ID				
1								LSB
2	RESERVED (0)						READ ONLY	BINARY
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 Table 10~~Table 10~~ for details of how the identifiers are assigned

The READ ONLY bit specifies whether an attribute is read-only or not. The attribute is read-only if set and cannot be changed using the WRITE ATTRIBUTE command. The device server shall ignore the value of this bit for a WRITE ATTRIBUTE command.

NOTE: Read only attributes are intended to expose information about the medium and it's usage to the application client. The contents of these attributes are maintained by the device server or hard-coded during manufacture. If the device server does not support an attribute, it shall not be returned in response to a READ ATTRIBUTE command and not reported with the READ ATTRIBUTE command, ATTRIBUTE LIST service action

Read/write attributes are created on the MAM by the application client using the WRITE ATTRIBUTE command and are intended to provide a means for the application client to store information on the MAM in a vendor neutral format. Once created by the application client, they shall be returned in response to a READ ATTRIBUTE command or READ ATTRIBUTE command, ATTRIBUTE LIST service action.

The BINARY bit specifies whether the field contains ~~ASCII~~ Text or Binary data. If zero the attribute is, unless otherwise indicated, ~~is~~ a string
of ASCII graphic codes (i.e., code values 20h through 7Eh), if one the attribute consists of binary data.

The ATTRIBUTE LENGTH field specifies the length in bytes of the following data.

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

- If the attribute is reported as read only (READ ONLY=1) using the READ ATTRIBUTE command, the device server shall terminate the command with CHECK CONDITION status. The sense key shall be set to ILLEGAL REQUEST, and the additional sense data shall be set to WRITE PROTECTED.

- 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.

The contents of the ATTRIBUTE VALUE field shall depend on the value of the ATTRIBUTE ID and are defined in the following clauses. They are split up into *sections* according to the source of changes or updates. The attribute sections are shown in Table 10~~Table 10~~.

Table 10~~10~~ - Attribute Sections

Attribute Identifiers	Maximum Number of Attributes	Section
0000h – 03FFh	1024	Device Common Section
0400h – 07FFh	1024	Medium Common Section
0800h – 0BFFh	1024	Host Common Section
0C00h – 0FFFh	1024	Device Vendor Unique Section
1000h – 13FFh	1024	Medium Vendor Unique Section
1400h – 17FFh	1024	Host Vendor Unique Section
1800h - FFFFh		Reserved

All ASCII strings are padded with trailing spaces where necessary.

8.X.1.1 Device Common Section

The device server should maintain this section. The attributes defined are shown in Table 11~~Table 11~~. All the attributes are read-only (READ ONLY = 1).

Table 11~~11~~ - Device Common Attributes

ID	Attribute Name	#Bytes	Format
0000h	REMAINING CAPACITY IN PARTITION	8	Binary
0001h	MAXIMUM CAPACITY IN PARTITION	8	Binary
0002h	TAPEALERT FLAGS	8	Binary
0003h	LOAD COUNT	8	Binary
0004h	MAM SPACE REMAINING	8	Binary
0005h	ASSIGNING ORGANISATION	8	ASCII
0006h	FORMATTED DENSITY CODE	1	Binary
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

ID	Attribute Name	#Bytes	Format
0222h	TOTAL MBYTES WRITTEN IN CURRENT/LAST LOAD	8	Binary
0223h	TOTAL MBYTES READ IN CURRENT/LAST LOAD	8	Binary
0224h – 033Fh	Reserved		
0340h	LOAD/UNLOAD AT PARTITION	1	Binary
0341h	MEDIUM USAGE HISTORY	90	Binary
0342h	PARTITION USAGE HISTORY	64	Binary
0343h – 03FFh	Reserved		

The REMAINING CAPACITY IN PARTITION and MAXIMUM CAPACITY IN PARTITION attributes are native capacities in Mbytes, assuming no data compression for the specified medium partition.

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 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 medium common section. 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 ASSIGNING ORGANISATION field contains eight bytes of ASCII data identifying the organization responsible for the specifications defining the values in the FORMATTED DENSITY CODE attribute. The data shall be left aligned within this field. The ASCII value for a space (20h) shall be used if padding is required. The ASSIGNING ORGANIZATION field should contain a value listed in the vendor identification list (see Annex D). The use of a 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 in the medium common section (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.

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. This allows library controllers or application software to correlate medium

condition with medium load history in order to identify device servers that may be causing medium problems. The first 8 bytes are the VENDOR IDENTIFICATION field from the SCSI Inquiry command (see 7.5.1). The organization associated with the VENDOR IDENTIFICATION is responsible for ensuring that the remainder of the identifier field is unique.

The TOTAL MBYTES WRITTEN IN MEDIUM LIFE and TOTAL MBYTES READ IN MEDIUM LIFE attributes specify the total number of Mbytes of data that are transferred to or from the medium over the entire medium 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 application client's. For example, if a new medium is loaded into a sequential access device server then the application client writes 100MBytes, rewinds and then writes 100MBytes again, then the TOTAL MBYTES WRITTEN IN MEDIUM LIFE shall be 200MBytes. This figure must not incorporate data compression, i.e. it must represent the amount of data actually written to the medium surface.

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 as soon as a medium is loaded.

The LOAD/UNLOAD AT PARTITION attribute indicates whether loads/unloads are enabled for the Partition specified in the command.

The MEDIUM USAGE HISTORY attribute (Table 12~~Table 12~~) 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 1212 - MEDIUM USAGE HISTORY

Byte	Bit 7	6	5	4	3	2	1	0
0	MSB	ATTRIBUTE ID (0341H)						
1								LSB
2	RESERVED (0)						READ ONLY	BINARY
3	ATTRIBUTE LENGTH (90)							
4	MSB	CURRENT AMOUNT OF DATA WRITTEN						
9								LSB
10	MSB	CURRENT WRITE RETRY COUNT						
15								LSB
16	MSB	CURRENT AMOUNT OF DATA READ						
21								LSB
22	MSB	CURRENT READ RETRIES COUNT						
27								LSB
28	MSB	PREVIOUS AMOUNT OF DATA WRITTEN						
33								LSB
34	MSB	PREVIOUS WRITE RETRIES COUNT						
39								LSB
40	MSB	PREVIOUS AMOUNT OF DATA READ						
45								LSB
46	MSB	PREVIOUS READ RETRIES COUNT						
51								LSB
52	MSB	TOTAL AMOUNT OF DATA WRITTEN						
57								LSB
58	MSB	TOTAL WRITE RETRIES COUNT						
63								LSB
64	MSB	TOTAL AMOUNT OF DATA READ						
69								LSB
70	MSB	TOTAL READ RETRIES COUNT						
75								LSB
76	MSB	LOAD COUNT						
81								LSB
82	MSB	TOTAL CHANGE PARTITION COUNT						
87								LSB
88	MSB	TOTAL PARTITION INITIALIZE COUNT						
93								LSB

The CURRENT AMOUNT OF DATA WRITTEN specifies the amount of data (in MB) physically written to the medium during this load of the medium.

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 (in MB) physically read from the medium during this load of the medium.

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 (in MB) physically written to the medium during the previous medium load.

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 (in MB) physically read from the medium during the previous medium load.

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 (in MB) 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.

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 (in MB) 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.

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 13~~Table 13~~) provides statistical counters for the partition specified in the CDB. If a field is not used it should be set to zero.

Table 1313 - PARTITION USAGE HISTORY

Byte	Bit							
	7	6	5	4	3	2	1	0
0	MSB	ATTRIBUTE ID (0342H)						
1								LSB
2	RESERVED (0)						READ ONLY	BINARY
3	ATTRIBUTE LENGTH (64)							
4	MSB	CURRENT AMOUNT OF DATA WRITTEN						
7								LSB
8	MSB	CURRENT WRITE RETRY COUNT						
11								LSB
12	MSB	CURRENT AMOUNT OF DATA READ						
15								LSB
16	MSB	CURRENT READ RETRIES COUNT						
19								LSB
20	MSB	PREVIOUS AMOUNT OF DATA WRITTEN						
23								LSB
24	MSB	PREVIOUS WRITE RETRIES COUNT						
27								LSB
28	MSB	PREVIOUS AMOUNT OF DATA READ						
31								LSB
32	MSB	PREVIOUS READ RETRIES COUNT						
35								LSB
36	MSB	TOTAL AMOUNT OF DATA WRITTEN						
39								LSB
40	MSB	TOTAL WRITE RETRIES COUNT						
43								LSB
44	MSB	TOTAL AMOUNT OF DATA READ						
47								LSB
48	MSB	TOTAL READ RETRIES COUNT						
51								LSB
52	MSB	LOAD COUNT						
55								LSB
56	MSB	CHANGE PARTITION COUNT						
59								LSB
60	MSB	PARTITION INITIALIZE COUNT						
63								LSB
64	MSB	PARTITION ATTRIBUTE						
67								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 specified partition rather than the whole medium.

The CHANGE PARTITION COUNT specifies the number of times that the current partition 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 current partition has been initialized. This count accumulates over the life of the medium but it is reset to zero after a medium format.

The contents of the PARTITION ATTRIBUTE are vendor dependant.

8.X.1.2 Medium Common Section

These attributes are hard coded into the MAM at manufacture time. The attributes defined are shown in Table 14~~Table 14~~. All the attributes are read-only (READ ONLY = 1).

Table 14~~14~~ - Medium Common Attributes

ID	Attribute Name	#Bytes	Format
0400h	MEDIUM MANUFACTURER	8	ASCII
0401h	MEDIUM SERIAL NUMBER	32	ASCII
0402h	MEDIUM LENGTH	4	Binary
0403h	MEDIUM WIDTH	4	Binary
0404h	ASSIGNING ORGANISATION	8	ASCII
0405h	MEDIUM DENSITY CODE	1	Binary
0406h	MEDIUM MANUFACTURE DATE	8	ASCII
0407h	MAM CAPACITY	8	Binary
0408h	SPECIAL MEDIUM IDENTIFIER	1	Binary
0409h	SPECIAL MEDIUM INFORMATION	2	Binary
040Ah	MEDIUM AUXILIARY MEMORY REVISION	2	Binary
040Bh – 07FFh	Reserved		

The MEDIUM MANUFACTURER field contains eight bytes of ASCII data identifying the organization responsible for the manufacturing the medium. The data shall be left aligned within this field. The ASCII value for a space (20h) shall be used if padding is required. The MEDIUM MANUFACTURER 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* MEDIUM MANUFACTURER *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).*

The MEDIUM SERIAL NUMBER identifies the manufacturer's serial number for the medium. The ASCII value for a space (20h) shall be used if padding is required.

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 field 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 field contains eight bytes of ASCII data identifying the organization responsible for the specifications defining the values in the MEDIUM DENSITY CODE attribute. The data shall be left aligned within this field. The ASCII value for a space (20h) shall be used if padding is

required. The ASSIGNING ORGANIZATION 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* 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).*

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

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 SPECIAL MEDIUM IDENTIFIER and SPECIAL MEDIUM INFORMATION attributes give information about non-data medium and other special types of media. The SPECIAL MEDIUM INFORMATION attribute is interpreted according to type of medium indicated by the Special Medium Identifier. Defined values are shown in Table 15~~Table 15~~.

Table 15~~15~~ - Special Medium Information

Special Medium Identifier	Meaning	Interpretation of Special Medium 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

The format of the MEDIUM AUXILIARY MEMORY REVISION is not specified in this standard.

8.X.1.3 Host Common Section

The Host section is the primary means of allowing separation or portability of media between different software applications and platforms. The application client shall maintain this area using the READ ATTRIBUTE and WRITE ATTRIBUTE commands. The attributes defined are shown in Table 16~~Table 16~~. All the attributes are read/write (READ ONLY = 0).

Table 16~~16~~ - Host Common Attributes

ID	Attribute Name	#Bytes	Format
0800h	APPLICATION VENDOR	8	ASCII
0801h	APPLICATION NAME	32	ASCII
0802h	APPLICATION VERSION	8	ASCII
0803h	~~APPLICATION~~ USER MEDIUM TEXT LABEL	160	~~ASCII~~Text
0804h	DATE & TIME LAST WRITTEN	12	ASCII
0805h	TEXT LOCALISATION IDENTIFIER	3	Binary

0806h	BARCODE	32	ASCII
0807h	~~SERVER~~ OWNING HOST TEXTUAL NAME~~NAME~~	~~50~~80	~~ASCII~~Text
0808h	MEDIA POOL	~~50~~160	~~ASCII~~Text
0809h	VOLUME ~~APPLICATION~~ USER TEXT LABEL	N/A	~~Binary~~Text
080Ah	PARTITION ~~APPLICATION~~ USER TEXT LABEL MAP	32	Binary
080Bh	PARTITION ~~APPLICATION~~ USER TEXT LABEL	N/A	~~ASCII~~Text
080Ch – BFFh	Reserved		

~~All of the following strings are padded with trailing spaces where necessary.~~

The APPLICATION VENDOR field contains eight bytes of ASCII data identifying ~~the organization identifies~~ the manufacturer of the application client (e.g. backup program). The data shall be left aligned within this field. The ASCII value for a space (20h) shall be used if padding is required. 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 APPLICATION VENDOR responsible for writing the rest of the attributes in this section and the 8.X.1.6 Host Vendor Unique Section. 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 ~~APPLICATION~~ USER MEDIUM TEXT LABEL is the user level identifier for the medium. It is a null terminated string using the character encoding defined by the TEXT LOCALISATION IDENTIFIER. The data shall be left aligned within this field~~ Note that this attribute is fixed at 150 bytes in size, so 150 bytes should always be sent.~~
~~.~~

The DATE & TIME LAST WRITTEN specifies when the application client last wrote to the medium. The format for the string is YYYYMMDDHHMM.

The TEXT LOCALISATION IDENTIFIER defines the format of the text held in some of the textual attributes in the host common section. The identifier has the format shown in

Table 1717 – TEXT LOCALISATION IDENTIFIER

Byte	Bit							
	7	6	5	4	3	2	1	0
0	MSB							
1				COUNTRY CODE				LSB
3	MSB			MINOR CODE				LSB

The COUNTRY CODE indicates the language of the textual attributes, the MINOR CODE provides for different encoding schemes. The defined values for these fields are given in **Table 18~~Table 18~~** and **Table 19~~Table 19~~**

Table 18~~18~~ – COUNTRY CODE IDENTIFIER

0000h	no code specified
0001h	English
0021h	French
0031h	German
0022h	Spanish
015Fh	Portuguese
0051h	Japan
0052h	Korean
0056h	Simplified Chinese
0376h	Taiwanese

Table 19~~19~~ - MINOR CODE IDENTIFIER

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	Reserved

If 000000h is returned for this attribute then the application client can assume that the encoding of all text attributes is plain ASCII.

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 ~~SERVER NAME~~ attribute indicates the host server from which that USER MEDIUM TEXT LABEL ~~APPLICATION TEXT LABEL~~ originates. It is a null terminated string using the character encoding defined by the TEXT LOCALISATION IDENTIFIER. The data shall be left aligned within this field.

The MEDIA POOL attribute indicates the MEDIA POOL to which this medium belongs. It is a null terminated string using the character encoding defined by the TEXT LOCALISATION IDENTIFIER. The data shall be left aligned within this field.

The VOLUME ~~APPLICATION~~ USER TEXT LABEL is a variable length attribute that is the user level identifier ~~application text label~~ of the volume. It is a null terminated string using the character encoding defined by the TEXT LOCALISATION IDENTIFIER.

The PARTITION ~~APPLICATION~~ USER TEXT LABEL MAP is an array of 256 bits (32 bytes) where each bit represents a partition number. Bit zero, byte 31 represents partition zero and bit 7, byte 0 represents partition 255. A bit value of one indicates that a Partition Application Text Label exists.

The PARTITION ~~APPLICATION~~ USER TEXT LABEL is a variable length attribute that is the user level identifier ~~application text label~~ of the partition. It is a null terminated string using the character encoding defined by the TEXT LOCALISATION IDENTIFIER.

8.X.1.4 Device Vendor Unique Section

These attributes allow vendor unique information to be stored by the device server. They will be maintain by the device server and will be indicated as read only (READ ONLY=1) to the application client. The attributes defined are shown in Table 20~~Table 20~~.

Table 20~~20~~ - Device Vendor Unique Attributes

ID	Attribute Name	#Bytes	Format
0C00h – 0FFFh	Unique to device vendor		

8.X.1.5 Medium Vendor Unique Section

This section exposes as attributes any data hard-coded in the MAM at manufacture time that application clients may need access to. Such access must be provided by arrangement with specific device vendors and will be indicated as read only (READ ONLY=1) to the application client. The attributes defined are shown in Table 21~~Table 21~~.

Table 21~~21~~ - Medium Vendor Unique Attributes

ID	Attribute Name	#Bytes	Format
1000h – 13FFh	Unique to medium vendor		

8.X.1.6 Host Vendor Unique Section

This section provides attributes that can be used by the application client for vendor specific purposes. The application client shall maintain this area using the READ ATTRIBUTE and WRITE ATTRIBUTE commands. The attributes defined are shown in Table 22~~Table 22~~. All the attributes are read/write (READ ONLY = 0).

Table 22~~22~~ - Host Vendor Unique Attributes

ID	Attribute Name	#Bytes	Format
1400h – 17FFh	Unique to software vendor		

Addendum – 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 23~~Table 23~~) allows an application client to write attribute values to Medium Auxiliary Memory (MAM).

Table 23~~23~~ - 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 24~~Table 24~~) 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 24~~24~~ - 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-2 except for the addition shown in Table 25~~Table 25~~.

Table 25~~25~~ - 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-2.

ELEMENT LIST service action

This service action is used to retrieve all of the element addresses containing an accessible MAM. Table 26~~Table 26~~ 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 2626 - Parameter data for ELEMENT LIST service action

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