INTERIM DRAFT – This revision reflects the intermediate notes taken during the October 3, 2008 con-call meeting.

To: INCITS Technical Committee T10
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Date: Oct 2, 2008
Subject: SBC-3 Thin Provisioning Commands

1) Revision history

Revision 0 (July 7, 2008) First revision (r0)

Revision 1 (Aug 22, 2008) Revision 1

Split the data path from the management path (create a new proposal for management path). Remove all pools and pool management constructs. This proposal now covers the data path only. Also use the already existing ATA TRIM terminology.

Revision 2 (Sept 5, 2008) Revision 2

Move text from the command clause to the model clause and clarify some language.

Revision 3 (Oct 2, 2008) Revision 3

Introduce LBA state machine with 2 states (hole and allocated) and descriptions of state changes. Remove references to application client and retaining or discarding data, and replace with LBA state changes. Change TRIM back to PUNCH

2) Related documents

spc4r16 – SCSI Primary Commands – 4
sbc3r15 – SCSI Block Commands – 3
ssc3r04a – SCSI Sequential Commands – 3
08-341r0 – Thin Provisioning Management Commands
T13/e07154r6 – ATA8-ACS2 accepted TRIM proposal

3) Overview

Traditional storage devices pre-allocate physical storage for every possible logical block. There is a fixed one-to-one relationship between the physical storage and the logical storage (every logical block is permanently mapped to a physical block). Generally speaking, the physical capacity of the device is always the same as the logical capacity of the device (plus spares if any). The READ CAPACITY command reports the usable number of logical blocks to the

application client. Historically, this has been referred to simply as the capacity of the device. These devices are fully provisioned.

Thinly provisioned devices also report the capacity in the READ CAPACITY command, but they do not allocate (or map) their physical storage in the same way that fully provisioned devices do. Thinly provisioned devices do not necessarily have a permanent one-to-one relationship between the physical storage and the logical storage. Thinly provisioned devices may report a different capacity (in the READ CAPACITY command), than their actual physical capacity. These devices often report a larger capacity than the actual physical capacity for storing user data.

One typical use of storage is a creation and deletion process. Files are created, possibly modified, and saved as new files (with the old one being deleted). Databases are created, where records are added, updated, and deleted.

Fully provisioned storage must allocate space to retain all possible data represented by every block described by the logical capacity (their physical capacity must be the same (or greater) than their reported logical capacity). These devices are always capable of receiving write data into the pre-defined and pre-allocated space.

Thinly provisioned devices may or may not pre-allocate space to retain write data. When a write is received, physical storage may be allocated from a pool of available storage to retain the write data and a mapping established between the location of that physical storage and the appropriate location within the logical capacity (a physical to LBA mapping). As long as this allocation and mapping process is successful, the write operates in the same way that it does on a fully provisioned storage device. However, if all the available physical capacity has been used, and no space can be allocated to retain the write data, the write operation must fail. This failure must have a new unique ASCQ.

In addition, to aid application clients it is desired to notify the client before it actually reaches the point when the failure occurs. These may return a RECOVERED ERROR status if the I/O could actually succeed (or a UNIT ATTENTION if the I/O needed to be retried to succeed). These are new types of status conditions to return to the application client, and as such need new ASCQ values to define these conditions. This is needed as part of the I/O path so that error recovery can be synchronized. Out of band techniques would not enable the needed synchronization for error recovery. For example, the application may be involved in notification of a storage administrator to take corrective action, or explicitly taking corrective action of its own. To synchronize that action with the I/O requires this be part of the I/O path.

Event	Sense Key	ASC/Q
Temporary lack of physical blocks	UNIT ATTENTION	SPACE

– write not done, retry required		ALLOCATION IN PROCESS
Persistent lack of physical blocks – write not done, retry will not help	HARDWARE ERROR	NO ADDITIONAL SPACE CAN BE ALLOCATED
Soft Threshold crossed – write not done, retry required	UNIT ATTENTION	PROVISIONING SOFT THRESHOLD REACHED (*)
Soft Threshold crossed – write done	RECOVERED ERROR	PROVISIONING SOFT THRESHOLD REACHED(*)
(*) – a unit attention condition is also established for the initiator port associated with every I_T nexus with the ASC/Q set to PROVISIONING SOFT THRESHOLD REACHED.		

When the host no longer needs to retain the data (such as when a host file is deleted, or a database record is deleted), there is no specific action required by a fully provisioned device. However, a thinly provisioned device may benefit by knowing about this event and be able to return the physical blocks containing this "deleted" data to the pool of available blocks. Since the data has been deleted, the storage device need not retain the contents of those blocks. If those LBAs are accessed by an application client (a READ is done), the storage device would be free to return any data particular data (zeros, -1, etc). This "delete" function is done via the Trim command.

This proposal defines commands and error codes for the operation of thinly provisioned devices. The Trim command includes a method to supply a list of extent descriptors (LBA and length) to a device server.

Management functions will be presented in a separate proposal.

Existing text is shown in **BLACK**, new text is shown in **RED**, and comments (not to be included) are shown in **BLUE**.

Proposal:

4 Direct-access block device type model

4.1 Direct-access block device type model overview

SCSI devices that conform to this standard are referred to as direct-access block devices. This includes the category of logical units commonly referred to as rigid disks and removable rigid disks. MMC-4 is typically used by CD-ROM devices.

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This standard is intended to be used in conjunction with SAM-4, SPC-4, SCC-2, SES-2, and SMC-2.

Direct-access block devices store data for later retrieval in logical blocks. Logical blocks contain user data, may contain protection information accessible to the application client, and may contain additional information not normally accessible to the application client (e.g., an ECC). The number of bytes of user data contained in each logical block is the logical block length. The logical block length is greater than or equal to one byte and should be even. Most direct-access block devices support a logical block length of 512 bytes and some support additional logical block lengths (e.g., 520 or 4096 bytes). The logical block length does not include the length of protection information and additional information, if any, that are associated with the logical block. The logical block length is the same for all logical blocks on the medium.

Each logical block is stored at a unique LBA, which is either four bytes (i.e., a short LBA) or eight bytes (i.e., a long LBA) in length. The LBAs on a logical unit shall begin with zero and shall be contiguous up to the last logical block on the logical unit. An application client uses commands performing write operations to store logical blocks and commands performing read operations to retrieve logical blocks. A write operation causes one or more logical blocks to be written to the medium. A read operation causes one or more logical blocks to be read from the medium. A verify operation confirms that one or more logical blocks were correctly written and are able to be read without error from the medium.

Logical blocks are stored by a process that causes localized changes or transitions within a medium. The changes made to the medium to store the logical blocks may be volatile (i.e., not retained through power cycles) or non-volatile (i.e., retained through power cycles). The medium may contain vendor-specific information that is not addressable through an LBA. Such data may include defect management data and other device management information.

<…>

4.4 Logical Blocks

Logical blocks ~~are~~ may be stored on the medium along with additional information that the device server uses to manage storage and retrieval. The format of the additional information is defined by other standards or is vendor-specific and is hidden from the application client during normal read, write, and verify operations. This additional information may be used to identify the physical location of the blocks of data, the address of the logical block, and to provide protection against the loss of user data and protection information, if any (e.g., by containing ECC bytes).

The first LBA is zero. The last LBA is [n-1], where [n] is the number of logical blocks on the medium accessible by the application client. The READ CAPACITY (10) parameter data (see 5.12.2 and 5.13.2) RETURNED LOGICAL BLOCK ADDRESS field indicates the value of [n-1].

LBAs are no larger than 8 bytes. Some commands support only 4-byte (i.e., short) LOGICAL BLOCK ADDRESS fields (e.g., READ CAPACITY (10), READ (10), and WRITE (10)). If the capacity exceeds that accessible with short LBAs, then the device server returns a capacity of FFFF_FFFFh in response to a READ CAPACITY (10) command, indicating that:

a) the application client should enable descriptor format sense data (see SPC-4) in the Control mode page (see SPC-4) and in any REQUEST SENSE commands (see SPC-4) it sends; and
b) the application client should use commands with 8-byte LOGICAL BLOCK ADDRESS fields (e.g., READ CAPACITY (16), READ (16), and WRITE (16)).

NOTE 2 - If a command with a 4-byte LOGICAL BLOCK ADDRESS field accesses logical blocks beyond LBAs FFFF_FFFFh and fixed format sense data is used, there is no field in the sense data large enough to report the LBA of an error (see 4.14).

If a command is received that references or attempts to access a logical block not within the capacity of the medium, then the device server terminates the command with CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to LOGICAL BLOCK ADDRESS OUT OF RANGE. The device server may terminate the command before processing or after the device server has transferred some or all of the data.

The number of bytes of user data contained in a logical block is the logical block length. The parameter data returned by the device server in response to a READ CAPACITY command (see 5.12) describes the logical block length that is used on the medium. The mode parameter block descriptor (see 6.3.2) is used by an application client to change the logical block length in direct-access block devices that support changeable logical block lengths. The logical block length should be used to determine does not include the length of protection information and additional information, if any.

The location of a logical block on the medium is not required to have a relationship to the location of any other logical block. However, in a typical direct-access block device, the time to access a logical block at LBA [x+1] after accessing LBA [x] is often less than the time to access some other logical block. The time to access the logical block at LBA [x] and then the logical block at LBA [x+1] need not be less than time to access LBA [x] and then LBA [x+100]. The READ CAPACITY command issued with a PMI bit set to one may be useful in determining where longer access times occur.

4.4.1 Logical Block Provisioning

4.4.1.1 Provisioning Overview

Logical blocks are in one of two states. Figure b shows these states and transitions between the states. Figure a shows an example of logical blocks in these two states.

LBA 0	LBA 1	LBA 2	LBA 3	LBA 4	LBA 5	LBA 6	LBA 7	LBA 8	LBA 9	LBA 10
PB	PB	PB	PB	Hole	Hole	PB	PB	Hole	PB	PB

LBA 0	LBA 1	LBA 2	LBA 3	LBA 4	LBA 5	LBA 6	LBA 7	LBA 8	LBA 9	LBA 10	LBA 11
PB		PB		Hole		PB		PB		PB	

Figure a – Logical Block Holes

Replace PB with mapped, replace hole with unmapped in figure above

A mapped logical block has a known relationship to a physical block, an unmapped logical block has no relationship to a physical block specified by this standard. This standard specifies no relationship between… for an unmapped LB.

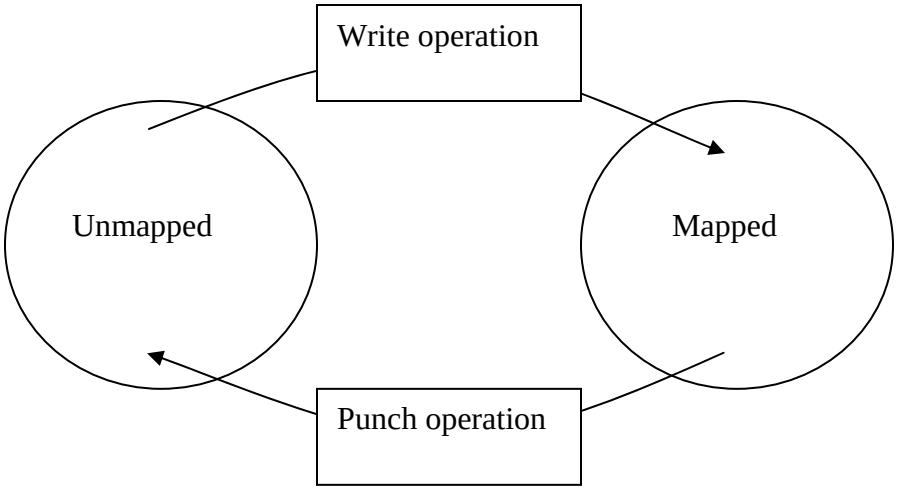

Figure b – Logical Block State Transitions

4.4.1.2 Mapped state

When in the Allocated state, an association exists between the LBA and a PB. Data and protection information read from a LBA in the allocated state shall be the data and protection information that was most recently written to that LBA. <add initial state – reading after format but before write>

4.4.1.2.1 Transition from Unmapped to Mapped

This transition shall occur when a successful write operation occurs. The transition of one LBA to the allocated state may also cause other LBAs to also transition to the allocated state (see figure a). A logical unit may cause a LBA to transition from unmapped to mapped for vendor specific reasons.

4.4.1.3 Unmapped state

When in the Hole state, no association exists between the LBA and a PB (see figure a). Data and protection information read from a LBA in the hole state shall be:

a) the data and protection information that was most recently written to that logical block,
b) data with all bits set to zero with protection information of FFFF_FFFF_FFFF_FFFF, or
c) data with all bits set to one with protection information of FFFF_FFFF_FFFF_FFFF.

Multiple read operations of a LBA in the hole state shall return the same data and protection information until a subsequent successful write operation occurs.

4.4.1.3.1 Transition from Mapped to Unmapped

This transition occurs when a successful punch operation occurs (see 4.4.1.5.2).

4.4.1.4 Full provisioning

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A fully provisioned logical unit ensures that a sufficient number of physical blocks are available to retain user data for all logical blocks within the logical units reported capacity (see 5.12 - READ CAPACITY (10) and 5.13 - READ CAPACITY(16)). Fully provisioned logical units provide a permanent association between logical blocks and physical blocks (see figures 2 and 3).

The initial state of logical blocks on a fully provisioned logical unit is allocated. Logical Blocks on fully provisioned logical units shall not transition out of the allocated state.

Glossary entry for MAPPED and unmapped – also search for other references elsewhere.

4.4.1.5 Thin Provisioning

4.4.1.5.1 Thin Provisioning Overview

A thin provisioned logical unit may report a capacity (see 5.12 - READ CAPACITY (10) and 5.13 - READ CAPACITY (16)) larger than the number of logical blocks available to store user data. A thin provisioned logical unit may or may not have sufficient physical blocks to retain user data transferred as a result of a write operation and storing the write data on the ~~non-volatile~~ medium.

The initial state of logical blocks on a thin provisioned logical unit is a hole (see figure b).

A device server that supports thin provisioning may also support a soft threshold value. The method of setting the soft threshold value is outside the scope of this standard.

Author's Note: add text for - must implement READ CAPACITY (16) (or where ever the TPE bit lives)

4.4.1.5.2 Punch Operation

Match "extents" with existing SPC/SBC usage. Replace punched w/unmapped. PUNCH operation does an unmap.

A ~~TRIM~~ PUNCH operation ~~indicates to the device server that the application client no longer needs the user data contents of a logical block.~~transitions one or more LBA extents to the unmapped state. ~~The user data and protection information contained in the blocks specified in the TRIM PARAMETER LIST of the TRIM command (5.x) may be discarded.~~ More than one physical block may be ~~trimmed~~ punched by each ~~TRIM~~ PUNCH LBA DESCRIPTOR. The data in all other logical blocks on the medium shall be preserved. ~~The user data and protection information read from an LBA that has been trimmed and has not been rewritten, shall be either:~~

~~a)any constant value (e.g., all zeros, all ones) with protection information of FFFF_FFFF_FFFF_FFFFh, or~~

~~b)~~a)~~the previous user data contents and protection information that existed prior to processing the TRIM command.~~

It is not an error for a ~~TRIM~~ PUNCH command to operate on an LBA that has already been ~~trimmed~~punched. ~~It is not an error for the device server to not discard user data and protection information contained in some or all of the specified LBAs <**Note:** case b in the above list>.~~

The device server is allowed to make different transitions for each logical block in the extent list.

4.4.1.5.3 Resource Exhaustion Considerations

If a write command is received and a temporary lack of physical block resources prevents the logical unit from storing the write data on the ~~non-volatile~~ medium, then the device server shall terminate the command with the sense key set to ~~UNIT ATTENTION~~ NOT READY and the additional sense code set to SPACE ALLOCATION IN PROCESS. The recommended application client recovery action is to issue the command again at a later time.

If a write command is received and a persistent lack of physical block resources prevents the logical unit from storing the write data on the ~~non-volatile~~ medium, then the device server shall terminate the command with the sense key set to ~~HARDWARE ERROR~~ DATA PROTECT and the additional sense code set to NO ADDITIONAL SPACE CAN BE ALLOCATED<change this name>. Application client recovery actions for this status are outside the scope of this standard.

If a write command is received that causes the number of available logical block resources to drop below the soft threshold value ~~and the device server is not capable of storing the write data on the non-volatile medium~~, then the device server shall terminate the command and establish a unit attention condition for the initiator port associated with every I_T nexus with the additional sense code set to PROVISIONING SOFT THRESHOLD REACHED. The recommended application client recovery action is to issue the command again.

~~If a write command is received that causes the number of available logical block resources to drop below the soft threshold value and the device server is capable of storing the write data on the non-volatile medium, then the device server shall perform the operation and complete the command with CHECK CONDITION status with the sense key set to RECOVERED ERROR <**Note:** One reviewer has requested to drop the distinction between success/failed operations that cross the threshold and always fail the I/O and use UNIT ATTENTION.> and the additional sense code set to THIN PROVISIONING SOFT THRESHOLD REACHED. The device server shall also establish a unit attention condition for the initiator port associated with every I_T nexus other than the I_T nexus on which the command that caused the number of available logical block resources to drop below the soft threshold value was received, with the additional sense code set to PROVISIONING SOFT THRESHOLD REACHED.~~

~~If the number of available "logical block resources" drops below the soft threshold value and then increases above the soft threshold value before the PROVISIONING SOFT THRESHOLD REACHED additional sense code is returned to the application client, the device server shall not report PROVISIONING SOFT THRESHOLD REACHED.~~

4.4.1.5.4 Thin Provisioning and Protection Information

If protection information is enabled, the device server shall use a default value of FFFF_FFFF_FFFF_FFFFh as the protection information for ~~the specified~~ logical blocks that ~~have been discarded~~are in the hole state.

4.5 Physical blocks

A physical block is a set of data bytes on the medium accessed by the device server as a unit. A physical block may contain:

a) a portion of a logical block (i.e., there are multiple physical blocks in the logical block)(e.g., a physical block length of 512 bytes with a logical block length of 2 048 bytes);
b) a single complete logical block; or
c) more than one logical block (i.e., there are multiple logical blocks in the physical block)(e.g., a physical block length of 4 096 bytes with a logical block length of 512 bytes).

Each physical block includes additional information not normally accessible to the application client (e.g., an ECC) that the device server uses to manage storage and retrieval.

If the device server supports the COR_DIS bit and/or the WR_UNCOR bit in a WRITE LONG command (see 5.35 and 5.36), then the device server shall have the capability of marking individual logical blocks as containing pseudo uncorrectable errors with correction enabled (see 3.1.45) or with correction disabled (see 3.1.46).

Logical blocks may or may not be aligned to physical block boundaries. A mechanism for establishing the alignment is not defined by this standard.

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5. x ~~TRIM~~ PUNCH command

5. x. 1 ~~TRIM~~ PUNCH command overview

The ~~TRIM~~ PUNCH command shall be implemented by device servers supporting Thin Provisioning (see 4.4.1.5~~2~~). The ~~TRIM~~ PUNCH command (see table x.1) provides information to the device server that may be used by the device server to ~~perform device optimizations on~~transition specified ranges of blocks to the hole state. ~~The method or algorithms used to perform such optimizations are not specified in this standard.~~

Table x.1 – ~~TRIM~~ PUNCH Command

Bit / Byte	7	6	5	4	3	2	1	0
0	OPERATION CODE (42h)							
1	Reserved							
2	Reserved							
3	Reserved							
4	Reserved							
5	Reserved							
6	Reserved							
7	PARAMETER LIST LENGTH							
8								
9	Control							

The OPERATION CODE field is defined in SPC-4 shall be set to the value defined in table x.1.

The PARAMETER LIST LENGTH field specifies the length in bytes of the ~~TRIM~~ PUNCH PARAMETER LIST that shall be transferred from the application client to the device server. A PARAMETER LIST LENGTH of zero specifies that no data shall be transferred.

~~<**Note:** 16 bits = FFFFh bytes or FFEh (4,094) LBA range descriptors>~~

The contents of the CONTROL byte are defined in SAM-4.

5. x. 2 ~~TRIM~~ PUNCH parameter list

The ~~TRIM~~ PUNCH parameter list (see table x.3) contains an eight-byte parameter list header followed by a ~~TRIM~~ PUNCH DESCRIPTOR LIST containing one or more ~~TRIM~~ PUNCH LBA DESCRIPTOR fields.

Table x.3 – ~~TRIM~~ PUNCH parameter list

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
7								
~~TRIM~~ PUNCH DESCRIPTOR LIST								
8	~~TRIM~~ PUNCH LBA DESCRIPTOR							
23								
…	…							
n-15	~~TRIM~~ PUNCH LBA DESCRIPTOR							
n								

The ~~TRIM~~ PUNCH DESCRIPTOR LIST contains a list of LBA ranges to be operated on. The ~~TRIM~~ PUNCH LBA DESCRIPTOR is described in table x.4. The LBAs in the PUNCH DESCRIPTOR LIST shall be in ascending order.

Table x.4 – ~~TRIM~~ PUNCH LBA DESCRIPTOR

Bit / Byte	7	6	5	4	3	2	1	0
0	Reserved							
3								
4	LBA							
11								
12	LBA COUNT							
15								

<…> STOP HERE

5.13 READ CAPACITY (16) command

5.13.1 READ CAPACITY (16) command overview

The READ CAPACITY (16) command (see table 46) requests that the device server transfer parameter data describing the capacity and medium format of the direct-access block device to the data-in buffer. This command is mandatory if the logical unit supports protection information (see 4.17) and is optional otherwise. This command is implemented as a service action of the SERVICE ACTION IN operation code (see A.2). This command may be processed as if it has a HEAD OF QUEUE task attribute (see 4.12).

Table 46 – READ CAPACITY (16) command

Bit	7	6	5	4	3	2	1	0

Byte								
0	OPERATION CODE (9Eh)							
1	Reserved				Service Action (10h)			
2	(MSB) LOGICAL BLOCK ADDRESS							
9								(LSB)
10	(MSB) ALLOCATION LENGTH							
13								(LSB)
14	Reserved							PMI
15	Control							

The OPERATION CODE field and SERVICE ACTION field are defined in SPC-4 and shall be set to the values defined in table 46.

See the READ CAPACITY (10) command (see 5.12) for definitions of the LOGICAL BLOCK ADDRESS field and the PMI bit.

The ALLOCATION LENGTH field specifies the maximum number of bytes that the application client has allocated for returned parameter data. An allocation length of zero indicates that no data shall be transferred. This condition shall not be considered as an error. The device server shall terminate transfers to the data-in buffer when the number of bytes specified by the ALLOCATION LENGTH field have been transferred or when all available data has been transferred, whichever is less. The contents of the parameter data shall not be altered to reflect the truncation, if any, that results from an insufficient allocation length.

The contents of the CONTROL byte are defined in SAM-4.

5.13.2 READ CAPACITY (16) parameter data

<move to Extended INQUIRY – 13, READ CAP – 10, INQ – 9>

The READ CAPACITY (16) parameter data is defined in table 47. Any time the READ CAPACITY (16) parameter data changes, the device server should establish a unit attention condition as described in 4.7.

Table 47 – READ CAPACITY (16) parameter data

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB) RETURNED LOGICAL BLOCK ADDRESS							
7								(LSB)
8	(MSB) LOGICAL BLOCK LENGTH IN BYTES							
11								(LSB)
12	TPE	Reserved				P_TYPE		PROT_EN
13	Reserved					LOGICAL BLOCKS PER PHYSICAL BLOCK EXPONENT		
14	Reserved		(MSB) LOWEST ALIGNED LOGICAL BLOCK ADDRESS					

15	(LSB)
16 31	Reserved

The RETURNED LOGICAL BLOCK ADDRESS field and LOGICAL BLOCK LENGTH IN BYTES field of the READ CAPACITY (16) parameter data are the same as the in the READ CAPACITY (10) parameter data (see 5.12). The maximum value that shall be returned in the RETURNED LOGICAL BLOCK ADDRESS field is FFFF_FFFF_FFFF_FFFEh.

The protection type (P_TYPE) field and the protection enable (PROT_EN) bit (see table 48) indicate the logical unit's current type of protection.

Table 48 — P_TYPE field and PROT_EN bit

PROT_EN	P_TYPE	Description
0	xxxb	The logical unit is formatted to type 0 protection (see 4.17.2.2).
1	000b	The logical unit is formatted to type 1 protection (see 4.17.2.3).
1	001b	The logical unit is formatted to type 2 protection (see 4.17.2.4).
1	010b	The logical unit is formatted to type 3 protection (see 4.17.2.5).
1	011b - 111b	Reserved

The LOGICAL BLOCKS PER PHYSICAL BLOCK EXPONENT field is defined in table 49.

Table 49 — LOGICAL BLOCKS PER PHYSICAL BLOCK EXPONENT field

Code	Description
0	One or more physical blocks per logical block [a]
n > 0	2^n logical blocks per physical block
[a] The number of physical blocks per logical block is not reported.	

The TPE bit set to one indicates that this logical unit implements Thin Provisioning (see 4.4.1.2).

The LOWEST ALIGNED LOGICAL BLOCK ADDRESS field indicates the LBA of the first logical block that is located at the beginning of a physical block (see 4.5).

NOTE 14 - The highest LBA that the lowest aligned logical block address field supports is 3FFFh (i.e., 16383).

<…>

6.4 Vital product data (VPD) parameters

6.4.1 VPD parameters overview

<…>

6.4.2 Block Limits VPD page

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The Block Limits VPD page (see table 132) provides the application client with the means to obtain certain operating parameters of the logical unit.

Table 132 — Block Limits VPD page

Byte \ Bit	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER			PERIPHERAL DEVICE TYPE				
1	PAGE CODE (B0h)							
2	Reserved							
3	PAGE LENGTH (10h)							
4	Reserved							
5								
6	(MSB) OPTIMAL TRANSFER LENGTH GRANULARITY							
7								(LSB)
8	(MSB) MAXIMUM TRANSFER LENGTH							
11								(LSB)
12	(MSB) OPTIMAL TRANSFER LENGTH							
15								(LSB)
16	(MSB) MAXIMUM PREFETCH XDREAD XDWRITE TRANSFER LENGTH							
19								(LSB)

<...>

The MAXIMUM TRANSFER LENGTH field indicates the maximum transfer length in blocks that the device server accepts for a single ORWRITE command, READ command, VERIFY command, WRITE command, WRITE AND VERIFY command, XDWRITEREAD command, or XPWRITE command. The MAXIMUM TRANSFER LENGTH field also indicates the maximum transfer length in bytes/LOGICAL BLOCK LENGTH IN BYTES (see 5.12.2) of the TRIM parameter list. <**Note:** To find the maximum transfer length in bytes of the TRIM parameter list, multiply this value by the LOGICAL BLOCK LENGTH IN BYTES. This was suggested by a host O/S team – any comments?> Requests for transfer lengths exceeding this limit result in CHECK CONDITION status with the sense key set to ILLEGAL REQUEST and the additional sense code set to INVALID FIELD IN CDB. A MAXIMUM TRANSFER LENGTH field set to zero indicates that there is no reported limit on the transfer length.

Replace this with a new method to specify the maximum number of LBAs that can be trimmed in any one operation.