To: INCITS Technical Committee T10
From: Kevin Butt
Date: Monday, July 06, 2009 1:19 pm
Document: T10/08-391r5 — SSC-3: Resolution to LB IBM-L1

Revisions

08-391r0	(06 October 2008)	Initial revision. I do not believe this has completely resolved the issue yet, but there have been many edits and it is worth reviewing in the working group.
08-391r1	(06 April 2009)	Made information per I_T nexus into variable names and clarified the intent further.
08-391r2	(08 May 2009)	Incorporate changes from May SSC-3 WG feedback. NB that the change from I_T nexus to I_T_L nexus has raised an interesting - and potentially ugly - issue that needs clarified. Reviewers should search on “I_T_L nexus” and review.
08-391r3	(08 June 2009)	Incorporate feedback from June 08 Phone conference, make suggested changes
08-391r4	(16 June 2009)	Incorporate feedback from Curtis Ballard and additional changes.
08-391r5	(06 July 2009)	Incorporate feedback from 06 July SSC-3 WG phonce conference. This is the version approved as resolution to IBM Letter ballot comment L1.

Introduction

This proposal intends to resolve LB IBM-L~~2~~1:

> [4.2.21.11, p2] Add a new sentence after s1:
> The LOCK bit in the Set Data Encryption page is set to one to lock the I_T nexus that issued the SECURITY PROTOCOL OUT command to the set of data encryption parameters established at the completion of the processing of the command. A set of data encryption parameters are established and locked even if the ENCRYPTION MODE is set to DISABLE and the DECRYPTION MODE is set to DISABLE.

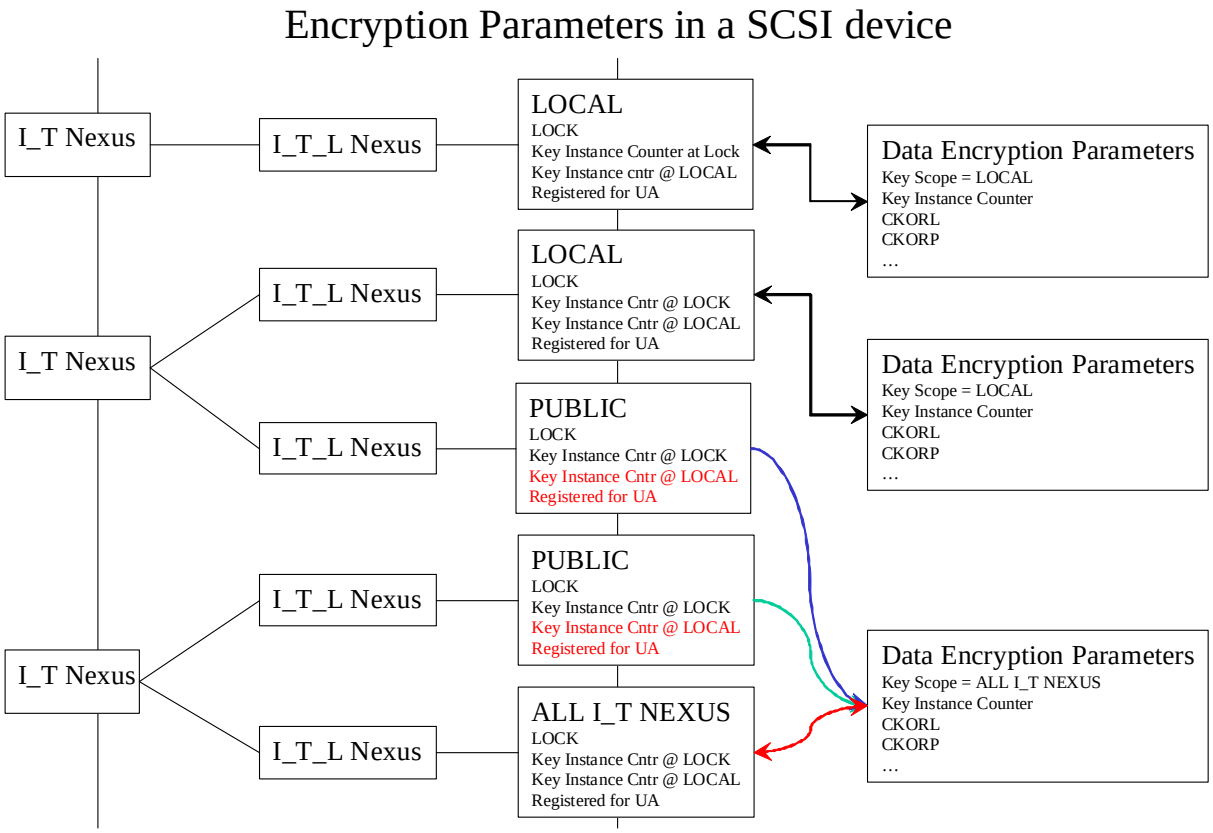
Proposal 08-266r0 (http://www.t10.org/ftp/t10/document.08/08-266r0.ppt) was reviewed in the past and the working group confirmed the LOCK bit is supposed to work as shown in that document. 08-266r0 was just a presentation to gain consensus and not a proposal. It is my intent to make a proposal that clarifies the intended usage of the LOCK bit as the usage is shown in 08-266r0. Unfortunately, 08-266r0 does not discuss the LOCK bit in relation to PUBLIC and encryption modes set to DISABLE.

When this issue was first raised there were a series of emails that went back and forth between Paul Entzel and me. This can be found in the reflector archives at http://www.t10.org/ftp/t10/t10r/2008/r0804021_f.htm

On further review of SSC-3 I find that Table 142 - SCOPE field values has as part of the description for PUBLIC the following: “All fields other than the SCOPE field and LOCK bit shall be ignored.”

The discussion of this topic, as well as the writing of this proposal, has been very confusing. This proposal needs close scrutiny to make sure it meets the intent of the LOCK bit and the data encryption scope. Paul Entzel believes the proposed solution in the actual letter ballot comment to be incorrect.I agree it is, at least incomplete. The interactions between the LOCK bit, the data encryption parameters and the saved information per I_T nexus are not clear and need to be clarified. These issues are all inter-related to the issue that drove the LB comment about the LOCK bit.

The following figure may help discuss the LOCK bit and what is required for it to function properly. Note that the red text in the figure are parameters that are not present in the specific case.



Proposal

4.2.21 Data encryption

4.2.21.1 Data encryption overview

A device compliant with this standard may contain hardware or software that is capable of encrypting and decrypting the data within logical blocks to provide security against unauthorized access to that data. The SECURITY PROTOCOL IN and SECURITY PROTOCOL OUT commands specifying the Tape Data Encryption security protocol (see *8.5.2 on 172* and *8.5.3 on 189*) provide a means for the application client to monitor and control the encryption and decryption processes within the device server. A device server that supports the SECURITY PROTOCOL OUT command shall also support the SECURITY PROTOCOL IN command.

The SECURITY PROTOCOL OUT command specifying the Tape Data Encryption security protocol is used to set data encryption parameters. The SECURITY PROTOCOL IN command specifying the Tape Data Encryption security protocol is used to discover the type of data security features supported by the device server, the current configuration of data security features, and status of the encryption and decryption processes.

4.2.21.2 Encrypting data on the medium

The application client controls the data encryption process by use of the SECURITY PROTOCOL OUT command specifying the Tape Data Encryption security protocol. Data encryption shall be managed within the device server on a per I_T_L nexus basis. The data encryption process is enabled for an I_T_L nexus upon successful completion of a SECURITY PROTOCOL OUT command that sends a Set Data Encryption page *(see 8.5.3.2 on page 190)* with the ENCRYPTION MODE field set to ENCRYPT and with a valid key. If the data encryption

scope parameter for an I_T_L nexus is set to PUBLIC *(see 4.2.21.7)*, the data encryption process may be enabled by another I_T_L nexus that establishes a set of data encryption parameters with a ~~key scope~~ data encryption scope of ALL I_T NEXUS *(see 4.2.21.8)*.

If data encryption is enabled for an I_T_L nexus and the mounted volume supports the selected encryption algorithm at the current logical position, all logical blocks received by the device server from that I_T_L nexus as part of a WRITE(6) or WRITE(16) command shall be encrypted before being recorded on the medium. Filemarks are logical objects that shall not be encrypted.

If data encryption is enabled for an I_T_L nexus and the mounted volume does not support the selected encryption algorithm at the current logical position, then the device server shall terminate a WRITE(6) or WRITE(16) command with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to ENCRYPTION PARAMETERS NOT USEABLE.

If data encryption is enabled for an I_T_L nexus and the mounted volume does not support the selected encryption algorithm at the current logical position, then the device server may terminate a WRITE FILEMARKS(6) or WRITE FILEMARKS(16) command with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to ENCRYPTION PARAMETERS NOT USEABLE.

4.2.21.3 Reading encrypted blocks on the medium

Editors Note 1 - KDB: No changes in this section

4.2.21.4 Exhaustive-search attack prevention

Editors Note 2 - KDB: No changes in this section

4.2.21.5 Keyless copy of encrypted data

Editors Note 3 - KDB: No changes in this section

4.2.21.6 Managing keys within the physical device

To increase the security of keys, the data encryption parameters are volatile in the physical device and the data encryption keys are never reported to an application client. The physical device also may have limited resources for storage of keys.

A device server that supports encryption shall support at least one of the key formats that are defined in this standard *(see table 147)*.

A vendor-specific key reference is an identifier that is associated with a specific key. The method by which keys and their associated vendor-specific key references are made available to the device server is outside the scope of this standard. A device server that supports passing keys by vendor-specific key reference shall include the code for vendor-specific key reference format *(see table 147)* in the SUPPORTED KEY FORMATS LIST field in the Supported Key Formats page *(see 8.5.2.5)*.

The physical device shall release the resources used to save a set of data encryption parameters *(see 4.2.21.8)* under the following conditions:

a) the CKOD bit is set to one in the saved data encryption parameters and the volume is demounted;

b) the CKORL bit is set to one and the ~~key scope~~ data encryption scope is set to LOCAL in the saved data encryption parameters and the ~~I_T nexus~~I_T_L nexus that established the set of data encryption parameters loses its reservation;
c) the CKORL bit is set to one and the ~~key scope~~ data encryption scope is set to ALL I_T NEXUS in the saved data encryption parameters and the device server experiences a reservation loss *(see 3.1.56 on page 7)*;
d) the CKORP bit is set to one in the saved data encryption parameters and the device server processes a PERSISTENT RESERVE OUT command with a service action of either PREEMPT or PREEMPT AND ABORT;
e) a microcode update is performed on the device; or
f) a power on condition occurs.

The physical device may release the resources used to save a set of data encryption parameters if:

a) a volume is mounted that does not support data encryption using the algorithm specified by the algorithm index in the data encryption parameter; or
b) other vendor-specific events.

Editors Note 4 - DAP: data encryption parameter is ambiguous to me, need to specify the page/ descriptor.

If a device server processes a Set Data Encryption page with the ENCRYPTION MODE field set to DISABLE and DECRYPTION MODE field set to DISABLE or RAW, the physical device shall:

a) release any resources that it had allocated to store data encryption parameters for the ~~I_T nexus~~I_T_L nexus associated with the SECURITY PROTOCOL OUT command and shall change the contents of all memory containing a key value associated with the data encryption parameters that are released; and
b) establish a unit attention condition with the additional sense of DATA ENCRYPTION PARAMETERS CHANGED BY ANOTHER I_T NEXUS for all other ~~I_T nexus~~I_T_L nexus that has its registered for encryption unit attentions state set to one *(see 4.2.21.7)* and is affected by the loss of the key, (i.e., any ~~I_T nexus~~I_T_L nexus that is using a data encryption scope of PUBLIC ~~and sharing the keys~~ and the SCOPE in the Set Data Encryption page is set to ALL I_T NEXUS).

If a device server processes a Set Data Encryption page that includes a key and the SDK bit is set to zero, the device server shall establish a unit attention condition with the additional sense code set to DATA ENCRYPTION PARAMETERS CHANGED BY ANOTHER I_T NEXUS for all other ~~I_T nexus~~I_T_L nexus that have their registered for encryption unit attentions state set to one *(see 4.2.21.7)* and are affected by the change of the key (i.e., any ~~I_T nexus~~I_T_L nexus that is using a data encryption scope of PUBLIC ~~and sharing the key~~ and the SCOPE in the Set Data Encryption page is set to ALL I_T NEXUS), ~~at~~ and the physical device shall:

a) release all resources that it had allocated to store a key value set by a previous SECURITY PROTOCOL OUT command from that ~~I_T nexus~~I_T_L nexus and shall change the contents of all memory containing a key value associated with the data encryption parameters that are released; and
b) establish a set of data encryption parameters with the values from the Set Data Encryption page.

A physical device shall save at most one set of data encryption parameters with a ~~key scope~~ data encryption scope of ALL I_T NEXUS. If a device server processes a Set Data Encryption page with the SCOPE field set to ALL I_T NEXUS, the device server shall establish a unit attention condition with the additional sense code set to DATA ENCRYPTION PARAMETERS CHANGED BY ANOTHER I_T NEXUS for all other ~~I_T nexus~~I_T_L nexus that have their registered for encryption unit attentions state set to one *(see 4.2.21.7)* and are affected by the

change of the key (i.e. any ~~I_T nexus~~I_T_L nexus that is using a data encryption scope of PUBLIC ~~and sharing the key~~) and the physical device shall:

a) release any resources that it had allocated to store data encryption parameters with a ~~key scope~~ data encryption scope value of ALL I_T NEXUS and shall change the contents of all memory containing a key value associated with the data encryption parameters that are released; and
b) establish a set of data encryption parameters with the values from the Set Data Encryption page and a ~~key scope~~ data encryption scope value of ALL I_T NEXUS.

If a vendor-specific event occurs that changes or clears a set of data encryption parameters, the device server shall establish a unit attention condition with the additional sense of DATA ENCRYPTION PARAMETERS CHANGED BY VENDOR SPECIFIC EVENT for any ~~I_T nexus~~I_T_L nexus that has its registered for encryption unit attentions state set to one *(see 4.2.21.7)* and is affected by the change of the key.

4.2.21.7 ~~Saved information per I_T nexus~~Data encryption information per I_T_L nexus

If the device server supports data encryption it shall maintain I_T_L nexus data encryption information on a per I_T_L nexus basis. This I_T_L nexus data encryption information shall contain: ~~save the following information on a per I_T nexus basis:~~

a) ITL_scope - data encryption scope for this I_T_L nexus;
b) ITL_lock - lock value for this I_T_L nexus;
c) ITL_lock_key_instance_cnt - data encryption parameters key instance counter value at ~~lock~~ the time lock was set to one for this I_T_L nexus;
d) ~~key instance counter value assigned to the last key established by a Set Data Encryption page for this I_T nexus with a scope value of LOCAL and the SDK bit is set to zero;~~ and
e) ITL_encryption_UA_reg - registered for encryption unit attentions state for this I_T_L nexus.

Device servers shall support setting the ITL_scope to any value of data encryption scope supported in the data encryption parameters. A device server that supports data encryption shall support an ITL_scope value of PUBLIC.

~~The set of possible data encryption scope values for an I_T nexus is:~~

a) ~~PUBLIC;~~
b) ~~LOCAL; or~~
c) ~~ALL I_T NEXUS~~

~~If an I_T nexus data encryption scope is set to PUBLIC it indicates the physical device does not have a saved set of data encryption parameters that were established by that I_T nexus. Device servers that support encryption shall support an I_T nexus data encryption scope of PUBLIC.~~ If the ITL_scope for this I_T_L nexus is set to PUBLIC it indicates that the data encryption parameters with a data encryption scope of ALL I_T NEXUS shall be used for commands received through this I_T_L nexus.

When a device server successfully completes the processing of a Set Data Encryption page with a scope of PUBLIC through this I_T_L nexus the device server shall:

a) set the ITL_scope for this I_T_L nexus to PUBLIC;
b) set the ITL_lock for this I_T_L nexus to the value of the LOCK bit in the Set Data Encryption page;
c) set the ITL_lock_key_instance_cnt for this I_T_L nexus to:
   A) zero if the LOCK bit in data encryption page is set to zero; or
   B) the value of the data encryption parameters key instance counter in the ALL_I_T_L_NEXUS data encryption parameters if the LOCK bit in the Set Data Encryption page is set to one; and
d) set the ITL_encryption_UA_reg for this I_T_L nexus to one.

~~A device server shall set the data encryption scope for an I_T nexus to LOCAL when it successfully completes the processing of a Set Data Encryption page with a scope of LOCAL from that I_T nexus. The device server~~

~~shall only use the data encryption parameters established by the Set Data Encryption page with a scope of LOCAL for processing commands from the I_T nexus that established the parameters. A physical device shall revert to using default data encryption parameters for an I_T nexus that is configured with a data encryption scope of LOCAL if the resources used to save the data encryption parameters for the I_T nexus are released.~~When a command is received through an I_T_L nexus with an ITL_scope of LOCAL, the data encryption parameters with data encryption scope of LOCAL for that I_T_L nexus shall be used for processing commands. If the resources used to save a set of data encryption parameters for an I_T_L nexus are released, then the ITL_scope for that I_T_L nexus shall be set to PUBLIC.

When a device server successfully completes the processing of a Set Data Encryption page with a scope of LOCAL through this I_T_L nexus the physical device shall:

a) increment the physical device key instance counter associated with this I_T_L nexus;
b) create a set of data encryption parameters with a data encryption scope of LOCAL for this I_T_L nexus; and
c) set the data encryption parameters key instance counter to the value of the physical device key instance counter associated with this I_T_L nexus.

When a device server successfully completes the processing of a Set Data Encryption page with a scope of LOCAL through this I_T_L nexus the device server shall:

a) set the ITL_scope for this I_T_L nexus to LOCAL;
b) set the ITL_lock for this I_T_L nexus to the value of the LOCK bit in the Set Data Encryption page;
c) set the ITL_lock_key_instance_cnt for this I_T_L nexus to:
   A) zero if the LOCK bit in the Set Data Encryption is set to zero; or
   B) the value of the data encryption parameters key instance counter of the data encryption parameters with data encryption scope of LOCAL for this I_T_L nexus if the LOCK bit in the Set Data Encryption page is set to one; and
d) set the ITL_encryption_UA_reg for this I_T_L nexus to one.

~~A device server shall set the data encryption scope for an I_T nexus to ALL I_T NEXUS when it successfully completes the processing of Set Data Encryption page with a scope value of ALL I_T NEXUS from that I_T nexus. At most, one I_T nexus shall be assigned the data encryption scope of ALL I_T NEXUS. If the physical device releases resources used to store a set of data encryption parameters with a key scope of ALL I_T NEXUS, it shall change the data encryption scope for the I_T nexus that established that set of data encryption parameters to PUBLIC. Device servers that support encryption shall support an I_T nexus data encryption scope of ALL I_T NEXUS.~~ At most, one I_T_L nexus shall be assigned the data encryption scope of ALL I_T NEXUS. If the physical device releases resources used to store a set of data encryption parameters with a data encryption scope of ALL I_T NEXUS, it shall change the ITL_scope for the I_T_L nexus that established that set of data encryption parameters to PUBLIC. If a device server has a set of data encryption parameters with a data encryption scope of ALL I_T NEXUS and it successfully completes the processing of Set Data Encryption page with a scope value of ALL I_T NEXUS through a different I_T_L nexus than the one that established the set of data encryption parameters, the physical device shall change the ITL_scope for the I_T_L nexus that established the previous set of data encryption parameters to PUBLIC.

When a device server successfully completes the processing of a Set Data Encryption page with a scope of ALL I_T NEXUS through this I_T_L nexus the physical device shall:

a) increment the physical device key instance counter associated with this I_T_L nexus;
b) perform the actions described in 4.2.21.6 for when a Set Data Encryption page with a scope of ALL I_T NEXUS is received; and
c) set the data encryption parameters key instance counter to the value of the physical device key instance counter associated with this I_T_L nexus.

When a device server successfully completes the processing of a Set Data Encryption page with a scope of ALL I_T NEXUS through this I_T_L nexus the device server shall:

a) set the ITL_scope for this I_T_L nexus to ALL I_T NEXUS;
b) set the ITL_lock for this I_T_L nexus to the value of the LOCK bit in the Set Data Encryption page;
c) set the ITL_lock_key_instance_cnt for this I_T_L nexus to:
   A) zero if the LOCK bit in the Set Data Encryption page is set to zero; or
   B) the value of the data encryption parameters key instance counter of the data encryption parameters with data encryption scope of ALL I_T NEXUS if the LOCK bit in the Set Data Encryption page is set to one; and
d) set the ITL_encryption_UA_reg for this I_T_L nexus to one.

~~By default, the device server shall set the saved I_T nexus parameters data encryption scope value to PUBLICand lock value to zero.~~ *Table 1* defines the values assigned to the I_T_L nexus data encryption information when a power on condition occurs.

Table {new}1 — Default I_T_L nexus data encryption information

Parameter	Value when a power on condition occurs
ITL_scope	PUBLIC
ITL_lock	zero
ITL_lock_key_instance_cnt	zero
ITL_encryption_UA_reg	zero

The ~~registered for encryption unit attentions state~~ ITL_encryption_UA_reg is a ~~single bit~~ state variable that indicates if the device server shall generate unit attention conditions related to encryption status for ~~the~~ this ~~I_T nexus~~I_T_L nexus. The device server shall set the ~~registered for encryption unit attentions state~~ ITL_encryption_UA_reg to one for ~~an~~ this ~~I_T nexus~~I_T_L nexus if the device server processes a:

a) SECURITY PROTOCOL IN command specifying the Tape Data Encryption protocol ~~from~~ through ~~the~~ this ~~I_T nexus~~I_T_L nexus; or
b) SECURITY PROTOCOL OUT command specifying the Tape Data Encryption protocol ~~from~~ through ~~the~~ this ~~I_T nexus~~I_T_L nexus.

The device server shall set the ~~registered for encryption unit attentions state~~ ITL_encryption_UA_reg to zero for an ~~I_T nexus~~I_T_L nexus if an I_T nexus loss occurs for that I_T_L nexus. The device server shall set the ~~registered for encryption unit attentions state~~ ITL_encryption_UA_reg to zero for all ~~I_T nexus~~I_T_L nexus if the device server processes a logical unit reset.

4.2.21.8 Data encryption parameters

A device server that supports data encryption shall have the ability to save the following information in the physical device as a set of data encryption parameters associated with the data encryption scope, and if the data encryption scope is LOCAL, then also to the I_T_L nexus through which the command is received when a Set Data Encryption page is processed:

a) for SCSI transport protocols where SCSI initiator device port names are required, the SCSI initiator device port name; otherwise, the SCSI initiator device port identifier;
b) indication of the SCSI target port through which the data encryption parameters were established;
c) ~~key scope~~ data encryption scope;
d) encryption mode;
e) decryption mode;

f) key;
g) supplemental decryption keys where supported;
h) algorithm index;
i) data encryption parameters key instance counter;
j) ~~LOCK bit~~
k) CKOD;
l) CKORL;
m) CKORP;
n) U-KAD;
o) A-KAD;
p) M-KAD;
q) nonce;
r) raw decryption mode disable where supported; and
s) check external encryption mode where supported.

A physical device may have limited resources for storage of sets of data encryption parameters (i.e., it may not have enough resources to store a unique set of data encryption parameters for every ~~I_T nexus~~I_T_L nexus that it is capable of managing). A physical device may release a previously established set of data encryption parameters when a Set Data Encryption page is processed and there are no unused resources available. The method of choosing which set of data encryption parameters to release is vendor specific. If the physical device does release a previously established set of data encryption parameters to free the resource, the device server shall establish a unit attention condition for every affected ~~I_T nexus~~I_T_L nexus *(see 4.2.21.6)* that has its registered for encryption unit attentions state set to one *(see 4.2.21.7)*. A physical device is not required to have separate resources to store data encryption parameters for every data encryption scope that is supported.

When resources to save a set of data encryption parameters are released, the value of each parameter in the set of data encryption parameters shall be set to a vendor-specific value.

When a power on condition occurs the data encryption parameters shall be set to vendor-specific values.

A device server that supports data encryption shall support ~~an encryption key~~ a data encryption scope value of ALL I_T NEXUS and the physical device shall have resources to save one set of data encryption parameters with this data encryption scope.

If the device server supports ~~an encryption key scope~~ a data encryption scope value of LOCAL, the physical device shall have resources to save one or more sets of data encryption parameters with this data encryption scope.

The data encryption parameters that shall be used for an ~~I_T nexus~~I_T_L nexus shall be established by the following order of precedence:

a) if the ~~data encryption scope~~ ITL_scope for the ~~I_T nexus~~I_T_L nexus is set to LOCAL or ALL I_T NEXUS *(see 4.2.21.7)*, the data encryption parameters set by the last Set Data Encryption page ~~from~~ processed through that ~~I_T nexus~~I_T_L nexus; or
b) if the ~~data encryption scope~~ ITL_scope for the ~~I_T nexus~~I_T_L nexus is set to PUBLIC:
   1) the data encryption parameters that have been saved by the physical device with a ~~key scope~~ data encryption scope of ALL I_T NEXUS if any data encryption parameters have been saved with this ~~key scope~~ data encryption scope; or
   2) the default data encryption parameters.

4.2.21.9 Data encryption capabilities

A physical device that supports data encryption shall have a set of data encryption capabilities. The set of data encryption capabilities determine the values reported through a SECURITY PROTOCOL IN command specifying the Tape Data Encryption security protocol and the Data Encryption Capabilities page *(see clause 8.5.2.4)*. The set of data encryption capabilities includes the set of data encryption algorithms supported by the physical device.

The set of data encryption capabilities includes some values which may be changed by a method beyond the scope of this standard. The capabilities that may be changed include:

a) the set of data encryption algorithms reported by the device server;
b) encryption capable;
c) decryption capable; and
d) other vendor-specific data encryption capabilities.

4.2.21.10 Key instance counters

The device server shall keep a counter for each ~~key~~ set of data encryption parameters that it is managing called the data encryption parameters key instance counter. The physical device shall keep a separate key instance counter called the physical device key instance counter. There may be a physical device key instance counter associated with each I_T_L nexus or there may be one global physical device key instance counter. All key instance counters shall be set to zero when a ~~power on~~ hard reset condition occurs. Any other event that sets, clears, or changes a parameter in a set of data encryption parameters, except the supplemental decryption keys, shall cause the physical device key instance counter associated with the I_T_L nexus ~~for that set of data encryption parameters~~ to be incremented. The value of the data encryption parameters key instance counter ~~associated with~~ of the currently selected ~~key~~ data encryption parameters for an ~~I_T nexus~~I_T_L nexus is reported in the Data Encryption Status page of the SECURITY PROTOCOL IN command. The key instance counters are 32 bits and shall roll over to zero when incremented past their maximum value.

4.2.21.11 Encryption mode locking

There are conditions outside of the control of an application client which cause the physical device to release the resources used to save the data encryption parameters *(see 4.2.21.6)* or change the data encryption parameters used to control the encryption of logical blocks. Each of these conditions cause the device server to establish a unit attention condition to report the change of operating mode, but the unit attention condition may not always be reported to the application client through protocol bridges and driver stacks.

The LOCK bit in the Set Data Encryption page is set to one to lock the set of data encryption parameters established at the completion of the processing of the command to the ~~I_T nexus~~I_T_L nexus ~~that~~ through which ~~issued~~ the SECURITY PROTOCOL OUT command was issued. ~~to the set of data encryption parameters established at the completion of the processing of the command~~. The set of data encryption parameters ~~I_T nexus~~ remains locked to that I_T_L nexus ~~set of data encryption parameters and key instance counter value~~ until a hard reset condition occurs or another SECURITY PROTOCOL OUT command including a Set Data Encryption page ~~from~~ through the same ~~I_T nexus~~I_T_L nexus is processed.

If the device server processes a WRITE(6) or WRITE(16) command ~~for~~ through an ~~I_T nexus~~I_T_L nexus that has its ITL_lock variable set to one, ~~is locked to a set of data encryption parameters and key instance counter,~~ and the key instance counter value has changed since the time it was locked (i.e., the data encryption parameters key instance counter does not equal the ITL_lock_key_instance_cnt for this I_T_L nexus), the device server shall terminate the command with CHECK CONDITION status, with the sense key set to DATA PROTECT, and the additional sense code set to DATA ENCRYPTION KEY INSTANCE COUNTER HAS CHANGED. All subsequent WRITE(6) and WRITE(16) commands shall also be terminated in this manner until a hard reset condition occurs or a SECURITY PROTOCOL OUT command including a Set Data Encryption page ~~from~~ through the same ~~I_T nexus~~I_T_L nexus is processed.

Editors Note 5 - DAP: Review all (red) text in this subclause with respect to data vs logical block and I_T nexus vs I_T_L nexus.

Editors Note 6 - KDB: No changes in the rest of this clause.

8.5 Security protocol parameters

8.5.1 Security protocol overview

Editors Note 7 - KDB: No changes in this section

8.5.2 SECURITY PROTOCOL IN command specifying Tape Data Encryption security protocol

Editors Note 8 - KDB: No changes in this section

8.5.2.1 SECURITY PROTOCOL IN command specifying Tape Data Encryption security protocol overview

Editors Note 9 - KDB: No changes in this section

8.5.2.2 Tape Data Encryption In Support page

Editors Note 10 - KDB: No changes in this section

8.5.2.3 Tape Data Encryption Out Support page

Editors Note 11 - KDB: No changes in this section

8.5.2.4 Data Encryption Capabilities page

Editors Note 12 - KDB: No changes in this section

8.5.2.5 Supported Key Formats page

Editors Note 13 - KDB: No changes in this section

8.5.2.6 Data Encryption Management Capabilities page

Table 2 specifies the format of the Data Encryption Management Capabilities page.

Table 2 — Data Encryption Management Capabilities page

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1				PAGE CODE (0012h)				(LSB)
2	(MSB)							
3				PAGE LENGTH (12)				(LSB)
4	Reserved							LOCK_C
5	Reserved					CKOD_C	CKORP_C	CKORL_C
6	Reserved							
7	Reserved					AITN_C	LOCAL_C	PUBLIC_C
8				Reserved				
15								

The LOCK_C bit shall be set to one if the device server supports the LOCK bit in the Set Data Encryption page. The LOCK_C bit shall be set to zero if the device server does not support the LOCK bit in the Set Data Encryption page.

The CKOD_C bit shall be set to one if the device server supports the CKOD bit in the Set Data Encryption page. The CKOD_C bit shall be set to zero if the device server does not support the CKOD bit in the Set Data Encryption page.

The CKORP_C bit shall be set to one if the device server supports the CKORP bit in the Set Data Encryption page. The CKORP_C bit shall be set to zero if the device server does not support the CKORP bit in the Set Data Encryption page.

The CKORL_C bit shall be set to one if the device server supports the CKORL bit in the Set Data Encryption page. The CKORL_C bit shall be set to zero if the device server does not support the CKORL bit in the Set Data Encryption page.

The AITN_C bit shall be set to one if the device server supports a ~~scope~~data encryption scope of ALL I_T NEXUS. The AITN_C bit shall be set to zero if the device server does not support a ~~scope~~ data encryption scope of ALL I_T NEXUS.

The LOCAL_C bit shall be set to one if the device server supports a ~~scope~~ data encryption scope of LOCAL. The LOCAL_C bit shall be set to zero if the device server does not support a ~~scope~~ data encryption scope of LOCAL.

The PUBLIC_C bit shall be set to one if the device server supports a ~~scope~~ data encryption scope of PUBLIC. The PUBLIC_C bit shall be set to zero if the device server does not support a ~~scope~~ data encryption scope of PUBLIC.

8.5.2.7 Data Encryption Status page

Table 3 specifies the format of the Data Encryption Status page.

Table 3 — Data Encryption Status page

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)			PAGE CODE (0020h)				
1								(LSB)
2	(MSB)			PAGE LENGTH (n-3)				
3								(LSB)
4	I_T NEXUS SCOPE			Reserved		~~KEY SCOPE~~ DATA ENCRYPTION SCOPE		
5	ENCRYPTION MODE							
6	DECRYPTION MODE							
7	ALGORITHM INDEX							
8	(MSB)			KEY INSTANCE COUNTER				
11								(LSB)
12	Reserved	PARAMETERS CONTROL			VCELB	CEEMS		RDMD
13				Reserved				
23								
24				KEY-ASSOCIATED DATA DESCRIPTORS LIST				
n								

The I_T NEXUS SCOPE field shall contain the value from the data encryption scope saved for the ~~I_T nexus~~I_T_L nexus on which this command was received *(see 4.2.21.7 on page 57)*.

The ~~KEY SCOPE~~ DATA ENCRYPTION SCOPE field shall contain the value from the ~~key scope~~ data encryption scope in the saved data encryption parameters currently associated with the ~~I_T nexus~~I_T_L nexus on which this command was received *(see 4.2.21.8 on page 58)*.

The ENCRYPTION MODE field shall contain the value from the encryption mode in the saved data encryption parameters currently associated with the ~~I_T nexus~~I_T_L nexus on which this command was received *(see 4.2.21.8 on page 58)*.

The DECRYPTION MODE field shall contain the value from the decryption mode in the saved data encryption parameters currently associated with the ~~I_T nexus~~I_T_L nexus on which this command was received *(see 4.2.21.8 on page 58)*.

The ALGORITHM INDEX field shall contain the value from the algorithm index in the saved data encryption parameters currently associated with the ~~I_T nexus~~I_T_L nexus on which this command was received *(see 4.2.21.8 on page 58)*. If the ENCRYPTION MODE field and the DECRYPTION MODE field are both set to DISABLE, the value in the ALGORITHM INDEX field is undefined.

The KEY INSTANCE COUNTER field contains the value of the key instance counter *(see 4.2.21.10 on page 59)* assigned to the key indicated by the ~~KEY SCOPE~~ DATA ENCRYPTION SCOPE field value.

The PARAMETERS CONTROL field specifies information on how the data encryption parameters are controlled. The PARAMETERS CONTROL field values are specified in *table 4*.

Table 4 — PARAMETERS CONTROL field values

Code	Description
000b	Data encryption parameters control is not reported.
001b	Data encryption parameters are not exclusively controlled by external data encryption control.
010b	Data encryption parameters are exclusively controlled by the sequential-access device server.
011b	Data encryption parameters are not exclusively controlled by the automation/drive interface device server.
100b	Data encryption parameters are not exclusively controlled by a management interface.
101b-111b	Reserved

If the VCELB_C bit is set to one in the Data Encryption Capabilities page, then the volume contains encrypted logical blocks (VCELB) bit shall be set to one when a mounted volume contains an encrypted logical block. The VCELB bit shall be set to zero if:

a) the mounted volume does not contain any encrypted logical blocks;
b) there is no volume mounted; or
c) the VCELB_C bit in the Data Encryption Capabilities page is set to zero.

The raw decryption mode disabled (RDMD) bit shall be set to one if the device server is configured to mark each encrypted record as disabled for raw read operations based on the RDMC_C value and the raw decryption mode disable parameter in the saved data encryption parameters currently associated with the ~~I_T nexus~~I_T_L nexus on which the command was received *(see 4.2.21.7 on page 57)*.

The check external encryption mode status (CEEMS) field shall contain the value from the check external encryption mode parameter in the saved data encryption parameters currently associated with the ~~I_T nexus~~I_T_L nexus on which the command was received *(see 4.2.21.7 on page 57)*.

If the ENCRYPTION MODE field and the DECRYPTION MODE field are both set to DISABLE, the KEY-ASSOCIATED DATA DESCRIPTORS LIST field shall not be included in the page.

If either the ENCRYPTION MODE field or the DECRYPTION MODE field is set to a value other than DISABLE, the KEY-ASSOCIATED DATA DESCRIPTORS LIST field shall contain data security descriptors (see 8.5) describing attributes assigned to the key defined by the I_T NEXUS SCOPE and ~~KEY SCOPE~~ DATA ENCRYPTION SCOPE fields at the time the key was established in the device server. If more than one key associated descriptor is included, they shall be in order of increasing value of the DESCRIPTOR TYPE field. Descriptors shall be included as defined by the following paragraphs.

An unauthenticated key-associated data descriptor *(see 8.5.4.3)* shall be included if an unauthenticated key-associated data descriptor was included when the key was established in the device server. The AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the U-KAD value associated with the key.

An authenticated key-associated data descriptor *(see 8.5.4.4)* shall be included if an authenticated key-associated data descriptor was included when the key was established in the device server. The AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the A-KAD value associated with the key.

A nonce value descriptor *(see 8.5.4.5)* shall be included if a nonce value descriptor was included when the key was established in the device server. The AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the nonce value associated with the key. A nonce value descriptor may be included if no nonce value

descriptor was included when the key was established in the device server. In this case, the KEY DESCRIPTOR field shall be set to the nonce value established by the device server for use with the selected key.

A metadata key-associated data descriptor (see *8.5.4.6 on 39*) shall be included if the metadata key-associated data descriptor was included when the data encryption parameters were established. The KEY DESCRIPTOR field shall contain the M-KAD value associated with the key.

Editors Note 14 - KDB: No Changes in the rest of the clauses between here.

8.5.3 SECURITY PROTOCOL OUT command specifying Tape Data Encryption security protocol

8.5.3.1 SECURITY PROTOCOL OUT command specifying Tape Data Encryption security protocol overview

The SECURITY PROTOCOL OUT command specifying the Tape Data Encryption security protocol (i.e., 20h) is used to configure the data security methods in the device server and on the medium. The command supports a series of pages that are sent individually. An application client requests to send a page by using a SECURITY PROTOCOL OUT command with the SECURITY PROTOCOL field set to Tape Data Encryption security protocol and the SECURITY PROTOCOL SPECIFIC field set to the page code requested.

The SECURITY PROTOCOL SPECIFIC field *(see table 5)* specifies the type of page that the application client is sending.

Table 5 — SECURITY PROTOCOL SPECIFIC field values

Code	Description	Reference
0000h-000Fh	Reserved	
0010h	Set Data Encryption page	8.5.3.2
0011h	SA Encapsulation page	*8.5.3.3 on 37*
0012h-002Fh	Reserved	
0030h-003Fh	Restricted	ADC-3
0040h-FEFFh	Reserved	
FF00h-FFFFh	Vendor specific	

If the SECURITY PROTOCOL SPECIFIC field is set to a reserved or unsupported value, the device server shall terminate the command with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

8.5.3.2 Set Data Encryption page

8.5.3.2.1 Set Data Encryption page overview

Table 6 specifies the format of the Set Data Encryption page.

Table 6 — Set Data Encryption page

Bit / Byte	7	6	5	4	3	2	1	0
0	(MSB)							
1	PAGE CODE (0010h)							(LSB)
2	(MSB)							
3	PAGE LENGTH (m-3)							(LSB)
4	SCOPE			Reserved				LOCK
5	CEEM		RDMC		SDK	CKOD	CKORP	CKORL
6	ENCRYPTION MODE							
7	DECRYPTION MODE							
8	ALGORITHM INDEX							
9	KEY FORMAT							
10	Reserved							
17								
18	(MSB)							
19	KEY LENGTH (n-19)							(LSB)
20	KEY							
n								
n+1	KEY-ASSOCIATED DATA DESCRIPTORS LIST							
m								

The PAGE LENGTH field specifies the number of bytes of parameter data to follow. If the page length value results in the truncation of any field, the device server shall terminate the command with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

The SCOPE field *(see table 7)* specifies the ~~scope~~ data encryption scope of the data encryption parameters. Support for data encryption scope values of PUBLIC and ALL I_T NEXUS are mandatory for device servers that support the Set Data Encryption page.

Table 7 — SCOPE field values

Code	Name	Description
0	PUBLIC	All fields other than the scope field and LOCK bit shall be ignored. The ~~I_T nexus~~I_T_L nexus shall use data encryption parameters that are shared by other ~~I_T nexus~~I_T_L nexuses. If no ~~I_T nexus~~I_T_L nexuses are sharing data encryption parameters, the device server shall use default data encryption parameters.
1	LOCAL	The data encryption parameters are unique to the ~~I_T nexus~~I_T_L nexus associated with the SECURITY PROTOCOL OUT command and shall not be shared with other ~~I_T nexus~~I_T_L nexuses.
2	ALL I_T NEXUS	The data encryption parameters shall be shared with all ~~I_T nexus~~I_T_L nexuses that are presented on logical units that implement tape data encryption (see 4.2.22).
3-7		Reserved

See *4.2.21.11 on 60* for a description of the LOCK bit.

Table 8 describes the values for the check external encryption mode (CEEM) field..

Table 8 — CEEM field values

Code	Description
00b	Vendor specific
01b	Do not check the encryption mode that was in use when the block was written to the medium.
10b	On read and verify commands, check the encryption mode that was in use when the block was written to the medium. Report an error if the block was written in EXTERNAL mode *(see 4.2.21.5 on page 54)*.
11b	On read and verify commands, check the encryption mode that was in use when the block was written to the medium. Report an error if the block was written in ENCRYPT mode *(see 4.2.21.5 on page 54)*.

The device server shall terminate the SECURITY PROTOCOL OUT command with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER DATA if the CEEM field is set to either 10b or 11b, and:

a) the DECRYPTION MODE field is set to DISABLE; or
b) the EAREM bit in the algorithm descriptor *(see Editors Note 11 - KDB:)* for the algorithm specified by the ALGORITHM INDEX field is set to zero.

The raw decryption mode control (RDMC) field specifies if the device server shall mark each encrypted block written to the medium as disabled for read operations in raw mode (i.e., read operations with the decryption

mode set to RAW). The RDMC field shall be ignored if the ENCRYPTION MODE field is not set to ENCRYPT. *Table 9* specifies the values for the RDMC field when the ENCRYPTION MODE field is set to ENCRYPT.

Table 9 — RDMC field values

Code	Description
00b	The device server shall mark each encrypted block per the default setting for the algorithm *(see table 129)*.
01b	Reserved
10b	The device server shall mark each encrypted block written to the medium in a format specific manner as enabled for raw decryption mode operations.
11b	The device server shall mark each encrypted block written to the medium in a format specific manner as disabled for raw decryption mode operations.

The device server shall terminate the command with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST and the additional sense key set to INVALID FIELD IN PARAMETER DATA if:

a) the ENCRYPTION MODE field is set to ENCRYPT;
b) the RDMC field is set to 10b or 11b; and
c) the RDMC_C field in the algorithm descriptor for the encryption algorithm selected by the value in the ALGORITHM INDEX field is set to 1h, 6h, or 7h.

If the supplemental decryption key (SDK) bit is set to one, the key sent in this page shall be added to the set of data encryption parameters used by the device server for the selected scope. The KEY INSTANCE COUNTER shall not be incremented for supplemental decryption keys. The ENCRYPTION MODE and LOCK fields shall be ignored and the DECRYPTION MODE shall match the current setting for this scope. If the DECRYPTION MODE does not match the current settings for this scope, the device server shall terminate the command with CHECK CONDITION status and set the sense key to ILLEGAL REQUEST and the additional sense code to INVALID FIELD IN PARAMETER LIST.

If the physical device does not currently have a saved set of data encryption parameters associated with the ~~I_T nexus~~I_T_L nexus that sent the Set Data Encryption page or the ~~scope~~ data encryption scope or decryption mode values do not match the values in that set of saved data encryption parameters, the device server shall terminate the command with CHECK CONDITION status and set the sense key to ILLEGAL REQUEST and the additional sense code to INVALID FIELD IN PARAMETER LIST.

If the SDK bit is set to one and the SDK_C field is set to zero in the Data Encryption Algorithm descriptor field that matches the ALGORITHM INDEX in the Data Encryption capabilities page, the device server shall terminate the command with CHECK CONDITION status and set the sense key set ILLEGAL REQUEST and the additional sense code to INVALID FIELD IN PARAMETER LIST.

If the device server is processing a Set Data Encryption page with the SDK bit set to one and does not have the resource available to store this key the device server shall terminate the command with CHECK CONDITION status and set the sense key to ILLEGAL REQUEST and the additional sense code to MAXIMUM NUMBER OF SUPPLEMENTAL DECRYPTION KEYS EXCEEDED. Any previously saved supplemental decryption keys shall not be affected by this error.

If the SDK bit is set to zero, the key sent in this page shall be the key used for both encryption and decryption. Any keys that have been previously stored by the device server shall be removed from memory. See *4.2.21.6 on 56*.

If the clear key on demount (CKOD) bit is set to one the physical device shall set the data encryption parameters to default values upon completion of a volume demount. If the CKOD bit is set to zero, the demounting of a volume shall not affect the data encryption parameters. If the CKOD bit is set to one and there is no volume mounted, the device server shall terminate the command with CHECK CONDITION status and set the sense key to ILLEGAL REQUEST and the additional sense code to INVALID FIELD IN PARAMETER DATA.

If the clear key on reservation preempt (CKORP) bit is set to one the physical device shall set the data encryption parameters to default values when a persistent reservation is preempted (i.e., a PERSISTENT RESERVE OUT command specifying a service action of PREEMPT or PREEMPT AND ABORT is processed). If the CKORP bit is set to zero, a preemption of a persistent reservation shall not affect the data encryption parameters. If the CKORP bit is set to one and there is no persistent reservation in effect for the ~~I_T nexus~~I_T_L nexus associated with the SECURITY PROTOCOL OUT command, the device server shall terminate the command with CHECK CONDITION status and set the sense key to ILLEGAL REQUEST and the additional sense code to INVALID FIELD IN PARAMETER DATA.

If the clear key on reservation loss (CKORL) bit is set to one the physical device shall set the data encryption parameters to default values on a reservation loss *(see 3.1.56 on page 7)*. If the CKORL bit is set to zero, a reservation loss shall not affect the data encryption parameters. If the CKORL bit is set to one and there is no reservation in effect for the ~~I_T nexus~~I_T_L nexus associated with the SECURITY PROTOCOL OUT command, the device server shall terminate the command with CHECK CONDITION status and set the sense key to ILLEGAL REQUEST and the additional sense code to INVALID FIELD IN PARAMETER DATA.

Table 10 specifies the values for the ENCRYPTION MODE field.

Table 10 — ENCRYPTION MODE field values

Code	Name	Description
0h	DISABLE	Data encryption is disabled.
1h	EXTERNAL	The data associated with the WRITE(6) and WRITE(16) commands has been encrypted by a system that is compatible with the algorithm specified by the ALGORITHM INDEX field.
2h	ENCRYPT	The device server shall encrypt all data that it receives for a WRITE(6) or WRITE(16) command using the algorithm specified in the ALGORITHM INDEX field and the key specified in the KEY field.
3h-Fh		Reserved

Table 11 specifies the values for the DECRYPTION MODE field. See *4.2.21.3 on 53* for configuration and exception condition requirements.

Table 11 — DECRYPTION MODE field values

Code	Name	Description
0h	DISABLE	Data decryption is disabled. If the device server encounters an encrypted logical block while reading, it shall not allow access to the data.
1h	RAW	Data decryption is disabled. If the device server encounters an encrypted logical block while reading, it shall pass the encrypted block to the host without decrypting it. The encrypted block may contain data that is not user data.
2h	DECRYPT	The device server shall decrypt all data that is read from the medium when processing a READ(6), READ(16), READ REVERSE(6), READ REVERSE(16), or RECOVER BUFFERED DATA command or verified when processing a VERIFY(6) or VERIFY(16) command. The data shall be decrypted using the algorithm specified in the ALGORITHM INDEX field and the key specified in the KEY field.
3h	MIXED	The device server shall decrypt all data that is read from the medium that the device server determines was encrypted when processing a READ(6), READ(16), READ REVERSE(6), READ REVERSE(16), or RECOVER BUFFERED DATA command or verified when processing a VERIFY(6) or VERIFY(16) command. The data shall be decrypted using the algorithm specified in the ALGORITHM INDEX field and the key specified in the KEY field. If the device server encounters unencrypted data when processing a READ(6), READ(16), READ REVERSE(6), READ REVERSE(16), RECOVER BUFFERED DATA, VERIFY(6), or VERIFY(16) command, the data shall be processed without decrypting.
4h-Fh		Reserved

If the physical device is not capable of distinguishing encrypted blocks from unencrypted blocks using the algorithm specified in the ALGORITHM INDEX field and the DECRYPTION MODE field is set to MIXED, the device server shall terminate the command with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER DATA.

If the ENCRYPTION MODE field is set to ENCRYPT and the KEY LENGTH field is set to zero, the device server shall terminate the command with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER DATA.

If the DECRYPTION MODE field is set to DECRYPT or MIXED and the KEY LENGTH field is set to zero, the device server shall terminate the command with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER DATA.

The ALGORITHM INDEX field indicates which of the encryption algorithms reported by the SECURITY PROTOCOL IN command Data Encryption Capabilities pages shall be used to encrypt and decrypt data. If the algorithm specified in the ALGORITHM INDEX field is disabled, then the deevice server shall terminate the command with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to ENCRYPTION ALGORITHM DISABLED.

If a volume is mounted and the combination of the ENCRYPTION MODE, DECRYPTION MODE, and ALGORITHM INDEX fields is not valid for the mounted volume or current logical position, the device server shall terminate the command with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the addition sense code set to INVALID FIELD IN PARAMETER DATA.

The KEY FORMAT field specifies the format of the value in the KEY field. Values for the KEY FORMAT field are specified in *table 12*.

Table 12 — KEY FORMAT field values

Code	Description	Reference
00h	The KEY field contains the key to be used to encrypt or decrypt data.	b)
01h	The KEY field contains a vendor-specific key reference.	*8.5.3.2.3 on 33*
02h	The KEY field contains the key wrapped by the device server public key.	*8.5.3.2.4 on 34*
03h	The KEY field contains a key that is encrypted using ESP-SCSI.	*8.5.3.2.5 on 36*
04h-BFh	Reserved	
C0h-FFh	Vendor specific	

Editors Note 15 - DAP: Would like to use the term logical block instead of data throughout the security text. Make the change but keep in mind it may be better to use encrypted block in some instances.

The KEY LENGTH field specifies the length of the KEY field in bytes.

If the ENCRYPTION MODE field is set to ENCRYPT the device server shall save the key-associated descriptors in the KEY-ASSOCIATED DATA DESCRIPTORS LIST field and associate them with every logical block that is encrypted with this key by the device server.

If the ENCRYPTION MODE field is set to EXTERNAL the device server shall save the key-associated descriptors in the KEY-ASSOCIATED DATA DESCRIPTORS LIST field and associate them with every logical block that is written using the data encryption parameters established by this command.

If more than one key-associated data descriptor is specified in the Set Data Encryption page, they shall be in increasing numeric order of the value in the DESCRIPTOR TYPE field.

The device server shall terminate the command with CHECK CONDITION, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST if:

a) key-associated descriptors are included in the KEY-ASSOCIATED DATA DESCRIPTORS LIST field;
b) DECRYPTION MODE field is not set to RAW; and;
c) the ENCRYPTION MODE field is not set to:
   A) EXTERNAL; or
   B) ENCRYPT.

An unauthenticated key-associated data descriptor *(see 8.5.4.3)* may be included if any unauthenticated key-associated data is to be associated with logical blocks encrypted with the algorithm and key. The AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the U-KAD value associated with the encrypted block. The device server shall terminate the command with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER DATA if the UKADF bit is set to one in the data encryption algorithm descriptor, the ENCRYPTION MODE field is set to ENCRYPT, and:

a) the length of the KEY DESCRIPTOR field is not equal to the value in the MAXIMUM UNAUTHENTICATED KEY-ASSOCIATED BYTES field of the data encryption algorithm descriptor; or
b) the parameter data does not contain an unauthenticated key-associated data descriptor.

An authenticated key-associated data descriptor *(see 8.5.4.4)* may be included if any authenticated key-associated data is to be associated with logical blocks encrypted with the algorithm and key. The AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the A-KAD value associated with the encrypted

block. The device server shall terminate the command with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER DATA if the AKADF bit is set to one in the data encryption algorithm descriptor, the ENCRYPTION MODE field is set to ENCRYPT, and:

a) the length of the KEY DESCRIPTOR field is not equal to the value in the MAXIMUM AUTHENTICATED KEY-ASSOCIATED BYTES field of the data encryption algorithm descriptor; or
b) the parameter data does not contain an authenticated key-associated data descriptor.

If a nonce value descriptor *(see 8.5.4.5)* is included and the algorithm and the device server supports application client generated nonce values, the value in the KEY DESCRIPTOR field shall be used as the nonce value for the encryption process. If a nonce value descriptor is included and the encryption algorithm or the device server does not support application client generated nonce values, the device server shall terminate the command with CHECK CONDITION, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST. If the encryption algorithm or the device server requires an application client generated nonce value and a nonce value descriptor is not included, the device server shall terminate the command with CHECK CONDITION, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INCOMPLETE KEY-ASSOCIATED DATA SET. If a nonce value descriptor is included, the AUTHENTICATED field is reserved. The KEY DESCRIPTOR field shall contain the nonce value associated with the encrypted block.

A metadata key-associated data descriptor (see *8.5.4.6 on 39*) may be included if the DECRYPTION MODE field is set to RAW and the encryption algorithm requires any metadata key-associated data to be associated with encrypted logical blocks read when the DECRYPTION MODE field is set to RAW.

A metadata key-associated data descriptor (see *8.5.4.6 on 39*) shall be included if the ENCRYPTION MODE field is set to EXTERNAL and the encryption algorithm requires any metadata key-associated data to be associated with logical blocks written when the ENCRYPTION MODE field is set to EXTERNAL.

The device server shall terminate the command with CHECK CONDITION, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST if an M-KAD is included and:

a) the ENCRYPTION MODE field is not set to EXTERNAL and the DECRYPTION MODE field is not set to RAW; or,
b) the encryption algorithm specified by the ALGORITHM INDEX field does not support M-KAD.