

Capability based Command Security

SCSI commands standard proposal

IBM

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Changes to SPC-4

Proposal 07-029 defines XCDB (extended CDB) format. This proposal is dependent on 07-029r3.

Legend for the text colors: **New text in blue.** ~~Removed text in red-strikethrough.~~ **Proposer's notes in green.**

Changes in revision 5:

- 1) Added Discriminator field in the Capability
- 2) Added optional use of Volume identifier in the capability, for use by SSC devices.
- 3) Adjusted to the new XCDB revision (07-029r3)

1 Definitions, symbols, abbreviations, and conventions

(These are additions to section 3 of SPC-4.)

1.1 Definitions

(These are additions to section 3.1 of SPC-4.)

1.1.1 Attack

The act of trying to bypass security controls on a system.

1.1.2 CbCS Capability

A descriptor that specifies defined access to a logical unit for specific commands. See 2.5.

1.1.3 CbCS capability key

The integrity check value (see 1.1.12) in a CbCS credential (see 1.1.4) returned by the CbCS management device server (see 1.1.6) in response to the RECEIVE CREDENTIAL command (see 7). See 2.2.1.2.

1.1.4 CbCS Credential

A data structure containing a capability that is protected by an integrity check value (see 1.1.12) that is sent to and used by an application client in order to grant defined access to a logical unit for specific commands. See 2.7.

1.1.5 CbCS management application client

An application client that manages secret keys (see 1.1.13) stored in logical units. See 2.2.2.

1.1.6 CbCS management device server

A device server that prepares CbCS credentials (see 1.1.4) in response to application client requests. See 0.

1.1.7 CbCS master key

A set of secret keys (see 1.1.13) that consist of a CbCS master authentication key (see 1.1.8) and a CbCS master generation key (see 1.1.9).

1.1.8 CbCS master authentication key

A secret key (see 1.1.13) used to generate integrity check values (see 1.1.12) for CbCS credentials (see 1.1.4) that grant access to commands that sets secret keys in logical units. See 2.8.

1.1.9 CbCS master generation key

A secret key (see 1.1.13) used to generate new CbCS working keys (see 1.1.11).

1.1.10 CbCS validation tag

The integrity check value in a credential sent by the application client in a CbCS extension (see 3). See 2.2.1.2.

1.1.11 CbCS working key

A secret key (see 1.1.13) that is used in generating integrity check values (see 1.1.12) for CbCS credentials (see 1.1.4) for commands other than those that sets secret keys in logical units. See 2.8.

1.1.12 Integrity check value

A value computed using an integrity algorithm (see 7.7.3.6.4 in 06-449r6), a secret key (see 1.1.13), and an identified set of data that protects the integrity of that identified set of data. See 2.7.

1.1.13 Secret key

A cryptographically generated value that is known only to a limited set of authorized entities. See 2.8.

1.1.14 Secure I_T nexus

An I_T nexus that relies on the security features of a service delivery subsystem to prevent attacks.

1.1.15 Security token

Pending definition: Random Nonce of at least 128 (or 256) bits which is generated by the device server for each I_T nexus at each creation of the I_T nexus.

1.2 Acronyms

CbCS Capability based Command Security

2 Capability based Command Security

{{This section should be merged into SPC-4 as section 5.13.x.8 – see 07-262r5}}

2.1 Overview

CbCS is a credential-based access control system. The security model is composed of the following components:

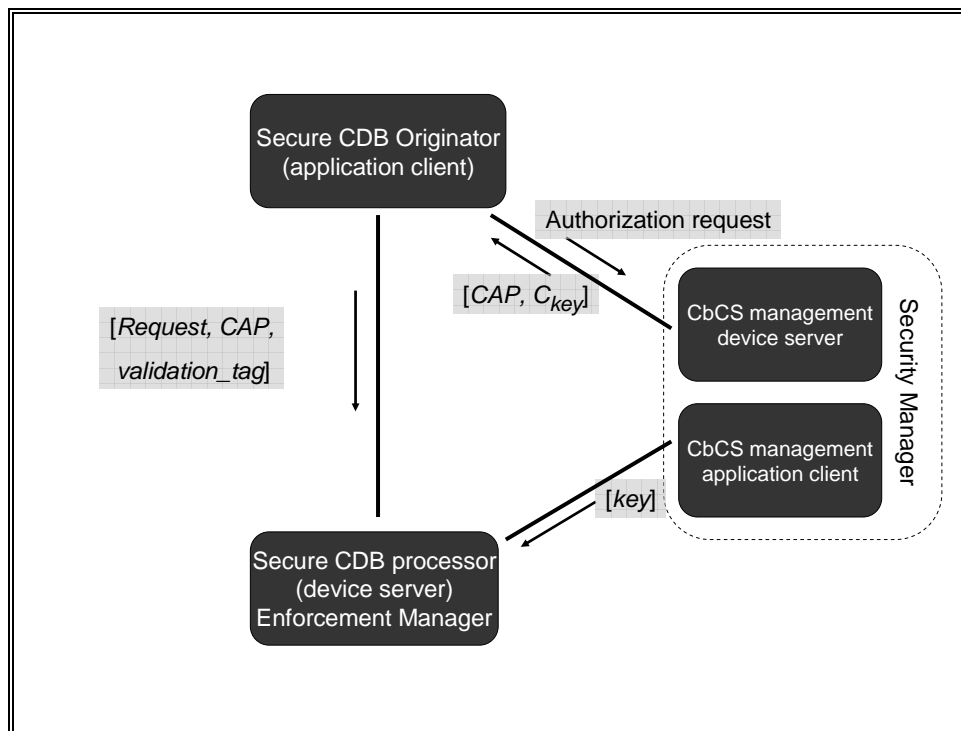
- a) A SCSI target device containing a secure CDB processor and an enforcement manager;
- b) SCSI initiator devices containing secure CDB originators; and
- c) A SCSI security manager device consisting of:
 - a. A CbCS management device server; and
 - b. A CbCS management application client.

The SCSI security manager device uses a decision database to obtain the authorization information required for deciding the type and duration of access granted to secure CDB originator to a given logical unit or volume (see SSC-3) within a SCSI target device. CbCS Credentials are prepared by the CbCS management device server based on the contents of that decision database.

Controlling access to a logical unit requires coordination between secret keys and security attributes set by the CbCS management application client and credentials generated by the CbCS management device server. The mechanism for coordination between the CbCS management device server and the CbCS management application client is not defined in this standard.

Figure 1 shows the flow of transactions between the components of a CbCS capable SCSI domain.

Figure 1 - The CbCS security model



The CbCS protocol enables centralized management of SCSI command security.

CbCS secures access to a logical unit or a volume (see SSC-3) by providing cryptographic integrity of credentials that are added to commands sent to the logical unit (See 2.7). This cryptographic integrity is based on mutual trust and secret key exchange between the CbCS management device server, CbCS management application client, and the enforcement manager (see 2.8).

Different levels of protection and security are achieved by using different security methods. The following security methods are defined by this standard:

- a) The BASIC security method provides protection against errors but does not prevent unauthorized access caused by means of malicious attacks (e.g., identity spoofing and network attacks); and
- b) The CAPKEY security method enforces application client authentication and provides cryptographic integrity of credentials. It protects against the following types of unauthorized access attacks:
 - A) Illegal use of credentials beyond their original scope and lifespan;
 - B) Forging or stealing credentials; and
 - C) Using malformed credentials;

Combined with a service delivery subsystem that has cryptographic message integrity, the CAPKEY security method also protects against the following types of unauthorized access attacks:

- A) Network errors and malicious message modifications; and
- B) Message replay attacks.

CbCS also supports rapid revocation of credentials, per SCSI target device and per logical unit.

The device server indicates that CbCS is applied to a logical unit by setting the CbCS bit to one in the Extended INQUIRY Data VPD page (see 4). If the CbCS bit is set to one, the logical unit shall support the following:

- a) Extended SCSI command (see 4.3.4.2 [07-029r3]);
- b) CbCS extension type (see 3);
- c) SECURITY PROTOCOL IN specifying the CbCS security protocol (see 5.1); and
- d) SECURITY PROTOCOL OUT specifying the CbCS security protocol (see 6.1).

2.2 Security Manager

The CbCS security manager manages access control of secure CDB originators to logical units or volumes (see SSC-3). It uses a decision database to obtain the authorization information required for deciding the type and duration of access granted to secure CDB originator to a given logical unit or volume (see SSC-3). It communicates with secure CDB originators to provide them CbCS credentials (see 2.2.1.2), and with enforcement managers (see 2.3) to provide them secret keys and security settings.

The CbCS security manager may be located and may communicate with secure CDB originators and enforcement managers in several manners, as specified in table x1 in 5.13.x.5 [07-262r5].

- a) If it is a SCSI device contained within the same SCSI domain as the secure CDB originator and the enforcement manager, it shall contain an application client and use it to communicate to the enforcement manager, and it shall contain a device server and use it to communicate with secure CDB originators.
- b) If it is an application client located in the same device as the secure CDB originators, it shall communicate to the enforcement manager via the SCSI domain's service delivery subsystem, and it may communicate with the secure CDB originators by means outside the scope of this standard.
- c) If it is a device server located in the same device as the secure CDB processor, it shall communicate to the secure CDB originators via the SCSI domain's service delivery subsystem, and it may communicate with the enforcement manager by means outside the scope of this standard.

The CbCS security manager's device server is called CbCS management device server. The CbCS security manager's application client is called CbCS management application client (see 2.2.2).

If the Security Manager is a SCSI device, it shall perform CbCS management using the CbCS management application client and the CbCS management device server as follows:

- e) The CbCS management device server provides access policy controls to secure CDB originators using policy-coordinated CbCS capabilities; and
- f) The CbCS management application client, in concert with the CbCS management device server, the Enforcement Manager, and the secure CDB processor prevents unsecured access to a logical unit or a volume (see SSC-3).

CbCS management is confined to the CbCS management application client and CbCS management device server. The communication of CbCS management information may occur in a manner outside the scope of this standard.

2.2.1 CbCS management device server

2.2.1.1 CbCS management device server overview

The secure CDB originator requests capabilities and CbCS capability keys from the CbCS management device server. A CbCS management device server returns a CbCS capability key (i.e., Cap-Key) with each CbCS credential giving the secure CDB originator access to a specific logical unit, and optionally to a volume (see SSC-3). The secure CDB originator sends the CbCS capability to that logical unit's secure CDB processor as part of a CbCS extended command allowing the secure CDB processor to authenticate the CbCS capability with an integrity check value (see 2.7.3, 2.7.4).

The CbCS management device server shall authenticate the secure CDB originator unless the BASIC security method is used (see 2.6.3). If the BASIC security method is used, then secure access between the secure CDB originator and the secure CDB processor is provided without requiring

authentication of the secure CDB originator by the enforcement manager. It is sufficient for the secure CDB processor to verify the CbCS capabilities sent by the secure CDB originator.

2.2.1.2 CbCS Credentials

The RECEIVE CREDENTIAL command is used to request a CbCS credential from the CbCS management device server (see 7).

If the CAPKEY security method is used, the enforcement manager shall validate each CbCS-extended command request to confirm that:

- a) The credential has not been tampered with (i.e., that the CbCS credential was generated by the CbCS management device server and includes an integrity check value generated using a secret key known only to the CbCS management device server, the CbCS management application client, and the enforcement manager);
- b) The credential was obtained from the CbCS management device server (i.e., the capability key associated with the credential provides a proper integrity check value for the command); and
- c) The requested SCSI command encapsulated in the received CDB is permitted by the capability in the credential (see 2.9).

If the BASIC security method is used, the secure CDB processor shall validate each command received from an application client to confirm that the requested SCSI command encapsulated in the received CDB is permitted by the CbCS capability in the CbCS credential (see 2.9).

A CbCS credential includes a CbCS capability and an integrity check value. The integrity check value in a CbCS credential returned by the CbCS management device server in response to the RECEIVE CREDENTIAL command (see 7) is used as the secret key to generate the integrity check value in a CbCS credential sent by the secure CDB originator in a CbCS extension (see 3).

The integrity check value in a CbCS credential returned by the CbCS management device server in response to the RECEIVE CREDENTIAL command is the CbCS capability key. The integrity check value in a CbCS credential sent by the secure CDB originator in a CbCS extension is the validation tag.

The validation tag allows the enforcement manager to validate a CbCS credential and determine if the CbCS capability has been tampered with (e.g., an application client that has just the CbCS capability but not the CbCS capability key is unable to generate CbCS credentials with a valid validation tag in the integrity check value). The CbCS credential may be delegated, if a secure CDB originator delegates both the CbCS capability and the CbCS capability key.

The CbCS capability keys are computed using secret keys that are shared between the CbCS management device server and the enforcement manager. The secret keys are managed by the SCSI security manager. The command integrity check values (i.e. the validation tags) are computed using CbCS capability keys.

2.2.2 CbCS management application client

The CbCS management application client sends secret keys and security settings to logical units.

The CbCS capability keys are computed using secret keys that are shared between the CbCS management device server and the enforcement manager. The secret keys are managed by the SCSI security manager. This standard defines SCSI commands the CbCS management application client may use to set and manage the secret keys stored in a logical unit or a well known logical unit (see 6.1).

2.3 Enforcement manager

The enforcement manager:

- a) receives secret keys (see 2.8) and other security settings (see 2.10) from the CbCS management application client; and
- b) validates SCSI commands sent by secure CDB originators.

The enforcement manager may be contained within the secure CDB processor, or within the SCSI target device. If the enforcement manager is contained within the secure CDB processor then, the secret keys and security settings it uses pertain to the logical unit (See 2.10). If the enforcement manager is contained within the SCSI target device then, the secret keys and security settings it uses pertain to the target device, and the security protocol well-known logical unit is used for the commands to set secret keys and security settings. (See 6.1.)

If the secret key is stored in a well known logical unit then the key is shared between all logical units within the target device but shall only be used by a logical unit if there has been no secret key assigned to that logical unit (i.e., a secret key assigned to a logical unit always overrides any secret key assigned to a well known logical unit).

2.4 Trust assumptions

After the logical unit is trusted (i.e., after a secure CDB originator authenticates that it is communicating with a specific logical unit), the secure CDB originator trusts the secure CDB processor and the enforcement manager to:

- a) deny any access attempt from any application client that is not authorized by the security manager; and
- b) deny access from any application client that does not perform the protocols and functions defined by this standard.

The CbCS management device server and the CbCS management application client are trusted after:

- a) the CbCS management device server is authenticated by the secure CDB originator; and
- b) the CbCS management application client is authenticated by the CbCS Enforcement Manager.

The CbCS management device server and the CbCS management application client are trusted to:

- a) Securely store long-lived secret keys;
- b) Grant credentials to secure CDB originators according to access control policies that are outside the scope of this standard; and
- c) Perform the defined security functions.

Entities that deliver SCSI commands to a secure CDB processor are not trusted. However, the CbCS security model is defined so that the secure CDB originator receives service from the secure CDB processor only after the secure CDB originator interacts with both the CbCS management device server and the secure CDB processor in ways that assure the propriety of the secure CDB originator.

CbCS management application client and CbCS management device server are trusted to protect CbCS capability keys from disclosure to unauthorized entities.

Communications between the CbCS management application clients, secure CDB originators, CbCS management device servers, and secure CDB processors are trusted based on the requirements shown in Table 1.

Table 1 - Communications trust requirement

Connection	Communication trust requirement
secure CDB originator <--> secure CDB processor	Cryptographic message integrity ^a
secure CDB originator <--> CbCS management device server	Cryptographic confidentiality and integrity
CbCS management application client <--> secure CDB processor	Cryptographic message integrity
CbCS management device server <--> CbCS management application client	Confidentiality and integrity
<p>Confidential communications are protected from eavesdropping by methods outside the scope of this standard.</p> <p>Cryptographic message integrity assures that the message received is the one that was sent (i.e., no tampering occurred). Messages in which tampering is detected shall be discarded.</p> <p>^a Cryptographic message integrity is sufficient for security of the CbCS access control. Confidentiality of the data transferred between the secure CDB originator and the secure CDB processor may be required to prevent passive network attacks and implemented by other means.</p>	

2.5 CbCS Capabilities

2.5.1 Overview

The CbCS extension (see 3) contains a CbCS capability descriptor that specifies the command functions (e.g., read, write, attributes setting and attributes retrieval) that the secure CDB processor is allowed to process in response to the encapsulated SCSI CDB.

The secure CDB processor shall validate that the requested functions are allowed by the CbCS capability based on:

- a) The type of functions; and
- b) The logical unit and optionally a volume (see SSC-3) mounted in that logical unit.

The policies that determine which CbCS capabilities are provided to which secure CDB originator are outside the scope of this standard.

The CbCS management device server shall deliver CbCS capabilities to secure CDB originators as follows:

- a) If the security method in use for the logical unit is BASIC (see 2.6.3), then the CbCS management device server may:
 - A) Allow secure CDB originators to prepare their own CbCS capabilities; or
 - B) Coordinate the preparation of CbCS capabilities for multiple secure CDB originators in response to requests;

or
- b) If a security method in use for the logical unit is CAPKEY (see 2.6.4), then the CbCS management device server shall prepare of CbCS capabilities by:
 - A) Requiring secure CDB originators to request CbCS credentials and CbCS capabilities; and
 - B) Preparing CbCS capabilities only in response to secure CDB originator requests.

A CbCS capability descriptor is included in a CbCS credential returned by the CbCS management device server in response to the RECEIVE CREDENTIAL command (see 7), and in CbCS extension parameters (see 3) to enable the CbCS Enforcement Manager to verify that the secure CDB originator is allowed to perform the command functions requested by the encapsulated CDB. The capability format is defined in 7.1.1.

The CbCS capability descriptor specifies:

- a) the security method to apply in validating the CbCS credential;
- b) the cryptographic parameters used in generating the CbCS credential integrity check value;
- c) an expiration time of the CbCS capability;
- d) a permission bit mask that specifies which command functions are authorized by the CbCS capability;
- e) a policy access tag which is used for CbCS credential revocation;
- f) an AUDIT field, that may be used in a vendor specific manner to limit the delegation or prevent leakage of the CbCS capability to other application clients;
- g) a designation descriptor that uniquely identifies a logical unit or volume (see SSC-3). If the CbCS capability applies to a well-known logical unit, the designation descriptor applies to the target device in which it resides; and
- h) a DISCRIMINATOR field which is used to guarantee uniqueness of credentials.

{{We should investigate whether we can combine the AUDIT field and the DISCRIMINATOR field into a single field and thus save CDB space. The point is that when the AUDIT field is used to limit delegation between application clients, it also discriminates between capabilities given to different application clients, so we only need to put a discriminating nonce if not used that way.}}

The CbCS capability expiration time, if used (see 7.1.1), requires synchronization between the clocks of the CbCS management device server and the enforcement manager. The method for synchronizing the clocks is outside the scope of this standard. If capability expiration time is used, the CbCS management device server should set capability lifetime that is at least an order of magnitude larger than the allowed deviation between the clocks. The protocol for synchronizing the clocks is not specified in this standard, however, the protocol should be implemented in a secure manner (e.g., it should not be possible for an adversary to set the clock in the SCSI device or in the secure CDB processor backwards to enable the reuse of expired CbCS credentials). The REPORT TIMESTAMP command and SET TIMESTAMP command extended with CbCS extension may be used by the CbCS management application client for this purpose.

The POLICY ACCESS TAG field, if used (see 7.1.1), is used for rapid revocation of credentials for a logical unit. It is a settable attribute of the logical unit. The value of the field in the CbCS capability shall match the value of the logical unit's attribute. The CbCS management device server shall set the CbCS CAPABILITY field to the current LU attribute value. The CbCS management application client may change the logical unit attribute value (see 6.1.2) in order to invalidate outstanding credentials.

In order to implement CbCS credential based on logical unit unique identifier, the same identifier type shall be:

- a) used in the CbCS decision database of the security manager (see 2.1);
- b) returned by the secure CDB processor in Device Identification VPD page (Inquiry page 83h);
- c) used by the secure CDB originator to identify the logical unit and request the corresponding CbCS credential from the CbCS management device server; and
- d) returned by the CbCS management device server in the CbCS capability in response to the secure CDB originator's CbCS credential request.

A CbCS management application client may block CbCS capability-based access to a logical unit by:

- a) changing the policy access tag attribute associated with a logical unit (see 6.1.2); or
- b) changing or invalidating the secret keys shared with the enforcement manager.

The Designation descriptor may be used to:

- a) uniquely identify a logical unit by specifying a Designation descriptor with the ASSOCIATION field set to 00b (see 7.6.3.1);
- b) uniquely identify a SCSI target device by specifying a Designation descriptor with the ASSOCIATION field set to 10b (see 7.6.3.1). The capability is then used in commands sent to a well-known logical unit; and
- c) uniquely identify a volume by specifying a medium auxiliary memory attribute (see 7.3.1) with type VOLUME IDENTIFIER to provide CbCS to volumes within sequential-access devices (see SSC-3 and SMC-3).

The DISCRIMINATOR field specifies a value that shall be used by the CbCS management device server to guarantee uniqueness of credentials. The CbCS management device server shall not return the same credential to two secure CDB originators. If multiple credentials are generated for multiple secure CDB originators, specifying identical values in all other fields (e.g., the same logical unit, the same permissions, the same expiration time) and signed with the same secret key, then the DISCRIMINATOR field shall be used to discriminate between the credentials. The same DISCRIMINATOR field value may be used in multiple credentials if the credential uniqueness requirement is satisfied.

2.5.2 CbCS Capability validation

The enforcement manager shall validate the CbCS capability descriptor included in the CbCS extension (see 3) and terminate any command that does not meet the following conditions with a CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB:

- a) The DESIGNATION TYPE field value is set to a valid value specified in Table 21;
- b) If the CAPABILITY EXPIRATION TIME field contains a non-zero value, then the CAPABILITY EXPIRATION TIME field value is greater than or equal to the current time value (i.e., the current number of milliseconds passed since midnight, 1 January 1970 UT);
- c) If the DESIGNATION TYPE field value is set to 1h (i.e., logical unit designation descriptor) then the designation descriptor matches the addressed logical unit, or the addressed target device in case a well-known logical unit is addressed;
- d) If the DESIGNATION TYPE field value is set to 2h (MAM Attribute descriptor), then the designation descriptor matches the MAM attribute of the volume residing in the addressed logical unit; **{{there is an issue with this on the tape side that needs to be addressed.}}**
- e) If the POLICY ACCESS TAG field in the CbCS capability descriptor contains a non-zero value, then the POLICY ACCESS TAG field value matches the Policy Access Tag of the addressed logical unit; and
- f) The encapsulated command is permitted by the PERMISSIONS BIT MASK field in the CbCS capability descriptor in the CDB.

2.6 Security Methods

2.6.1 Overview

This standard defines two security methods (see Table 2).

Table 2 - CbCS security methods

Method	Description	Without a secure I_T nexus	With a secure I_T nexus
BASIC	Protection against errors ^a	No protection against attacks	Service delivery subsystem integrity
CAPKEY	Protection against errors and attacks ^b	Verification of credentials, vulnerable to some network attacks	Verification of credentials and protection from service delivery subsystem attacks
^a The enforcement manager verifies the CbCS capability allows the command but does not verify the authenticity of the CbCS capability prior to allowing the secure CDB processor to process a command. ^b CAPKEY is based on the protocol presented and analyzed in [ACF+02]. CAPKEY verifies that the secure CDB originator rightfully obtained the credential it is presenting.			

2.6.2 General

If the secure CDB processor receives a command for a logical unit:

- a) that has CbCS enabled;
- b) the opcode field is set to 7Eh (i.e. Extended SCSI Command CDB); and
- c) the extension type is set to 00h (i.e. CbCS extension),

then the credential shall be validated before any other field in the CDB is validated.

If the secure CDB processor receives a command for a logical unit:

- a) that has CbCS enabled;
- b) the opcode is not 7Eh (i.e. not Extended SCSI Command CDB); and
- c) the received command requires authorization as described in 2.9,

then the command shall be terminated with a CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

If the secure CDB processor receives a command for a logical unit:

- a) that has CbCS enabled;
- b) the opcode is 7Eh (i.e. Extended SCSI Command CDB);
- c) the extensions do not include an extension type set to 00h (i.e. CbCS extension); and
- d) the encapsulated command requires authorization as described in 2.9,

then the command shall be terminated with a CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

2.6.3 The BASIC security method

The BASIC security method validates that the CbCS capability authorizes the encapsulated command for each CDB. It provides centrally-managed policy-driven command access control mechanism that enforces authorized access based on capabilities.

The BASIC security method does not validate the authenticity of the CbCS capability.

Preparing CbCS credentials for the BASIC security method does not require the knowledge of any secret keys and may be done by the secure CDB originator without coordination with the CbCS management device server. The CbCS capability descriptor (see 2.5, 7.1.1) is set with the SECURITY METHOD field set to BASIC. The integrity check value is set to zero.

The enforcement manager validates the CbCS capability as described in 2.5.2.

2.6.4 The CAPKEY security method

2.6.4.1 Overview

The CAPKEY security method provides centrally-managed policy-driven command access control mechanism that enforces authorized access based on capabilities. In addition, it assures the integrity and authenticity of the CbCS capability information in each command. It provides for security of commands delivered to the secure CDB processor. When used in conjunction with a secure service delivery subsystem, it provides additional protection against intrusion (see 2.1).

The integrity of the CbCS capability shall be validated before any other command processing is done, including CbCS capability validation.

Given a CbCS credential and a secure I_T nexus (see 1.1.14), the protocol ties the CbCS credential to the secure I_T nexus via a validation tag. The validation tag is computed by the secure CDB originator as $PRF(Cap-Key, SecurityToken)$,

Where:

PRF is a pseudorandom function.

Cap-Key is the CbCS capability key associated with the command (see 2.6.4.2).

SecurityToken identifies the communication channel and is unique to this the particular I_T nexus on which they communicate. It is a Random Nonce of at least 128 (or 256) bits which is generated by the device server for each I_T nexus at each creation of the I_T nexus (see 1.1.14).

An I_T nexus loss event or reset event (see SAM-4) shall cause the security token to change.

SecurityToken is chosen by the secure CDB processor. A secure CDB originator may request the value of the *SecurityToken* (see 5.1.5). The secure CDB processor compares the I_T nexus on which a request was received and its *SecurityToken*, and verifies that the validation tag attached to the request equals $PRF(Cap-Key, SecurityToken)$.

To ensure the request is authenticated by the secure CDB originator who obtained the CbCS credential, the CbCS capability key (*Cap-Key*) with which the validation tag $PRF(Cap-Key, SecurityToken)$ is computed depends on the CbCS capability.

CbCS capabilities and integrity check values may be reused as follows:

- a) The secure CDB originator may reuse the CbCS capability and *Cap-Key* on multiple commands for the same logical unit(s);
- b) The secure CDB originator is required to calculate the validation tag once per I_T_L nexus;

- c) The *Cap-Key* and validation tag shall be calculated the first time the secure CDB processor receives a given CbCS capability on a given I_T_L nexus and may be reused in processing every command received on the I_T_L nexus; and

2.6.4.2 Computing the CbCS capability key

When preparing CbCS credentials (see 2.7.2) and validating CbCS credentials (see 2.7.4), the CbCS capability key shall be computed by the CbCS management device server and the CbCS Enforcement Manager using:

- a) The algorithm specified in the INTEGRITY CHECK VALUE ALGORITHM field in the CbCS capability descriptor;
- b) If the value of the KEY VERSION field in the CbCS capability descriptor is nonzero, the secret key to be used is specified by the KEY VERSION field, otherwise the authentication master key is used as the secret key; and
- c) The CbCS capability descriptor as the input data.

The CbCS capability key is placed in the INTEGRITY CHECK VALUE field of the CbCS credential returned in the RECEIVE CREDENTIAL command.

2.6.4.3 Computing the validation tag

When preparing CbCS credentials (see 2.7.3), the validation tag shall be computed by the secure CDB originator using:

- 1) The algorithm specified in the INTEGRITY CHECK VALUE ALGORITHM field in the CbCS capability descriptor;
- 2) The CbCS capability key returned from the RECEIVE CREDENTIAL command in the INTEGRITY CHECK VALUE field;
- 3) The security token returned by the secure CDB processor in the CbCS Attributes page (see 5.1.5) as the input data.

The validation tag is placed in the INTEGRITY CHECK VALUE field of the CbCS credential passed by the secure CDB originator in the CbCS extension (see 3).

2.7 CbCS credentials

2.7.1 CbCS credentials overview

A CbCS credential authorizes specific access to a specific logical unit and optionally to a volume (see SSC-3) mounted in that logical unit. It consists of a CbCS capability and an integrity check value. The CbCS capability descriptor (see 2.5) identifies the logical unit or volume (see SSC-3) and specifies the specific access rights and parameters specifying how it shall be validated by the enforcement manager. The integrity check value authenticates the CbCS capability and is used for validation.

There are two types of CbCS credentials used in the CbCS protocol:

- a) A CbCS credential is transferred from the CbCS management device server to a secure CDB originator over a communications mechanism that meets the requirements specified in 0 with the CbCS credential being returned in response to the RECEIVE CREDENTIAL command (see 7); and
- b) A CbCS credential is transferred from the secure CDB originator to the secure CDB processor over a communications mechanism that meets the requirements specified in 0 with the credential being placed in the extension parameters of the CDB CbCS extension (see 3).

2.7.2 Preparing CbCS credentials by the CbCS management device server

In response to a request from a secure CDB originator, the CbCS management device server shall prepare and return a CbCS credential (see Table 19) as follows:

- 1) If the access controls policy does not authorize the secure CDB originator's request, no CbCS credential shall be returned to the requesting secure CDB originator (i.e. the CRED PRSNT bit (see 7.1)) in the returned parameter data shall be set to zero);
- 2) Prepare the CbCS capability and insert it in the CbCS credential as follows:
 - a. Shall set the SECURITY METHOD field to the value of the corresponding field in the Attributes CbCS page (see 5.1.5) of the logical unit for which the credential is requested;
 - b. Shall set the KEY VERSION field to the number of the working key used to compute the credential integrity check value;
 - c. Shall set the INTEGRITY CHECK VALUE ALGORITHM field to the value that specifies the algorithm used to compute all integrity check values related to this CbCS credential. The algorithm shall be one of those identified by the supported integrity check value algorithm attributes in the CbCS capabilities page (see 5.1.4) of the logical unit for which the credential is requested;
 - d. Shall set the CAPABILITY EXPIRATION TIME field to a value that is consistent with the CbCS policy;
 - e. May set the AUDIT field in a vendor specific manner;
 - f. Shall set the PERMISSIONS BIT MASK descriptor to a value that is consistent with the policy;
 - g. Shall set the POLICY ACCESS TAG field to a value that matches the POLICY ACCESS TAG attribute in the Attributes CbCS page (see 5.1.5) of the logical unit for which the CbCS credential is requested. The value zero may be used to prevent revocation by changing the policy access tag attribute of the logical unit;
 - h. Shall set the DESIGNATION TYPE field, and the Designation descriptor field to those of the logical unit or volume (see SSC-3) to which the credential is requested; and
 - i. If the security method in use is CAPKEY, then shall compute the CbCS capability key as described in 2.6.4.2, and place it in the INTEGRITY CHECK VALUE field in the CbCS credential. If the security method in use is BASIC, then shall set the INTEGRITY CHECK VALUE field to zero;

and
- 3) Return the CbCS credential to the secure CDB originator with the integrity check value serving as the CbCS capability key.

Security management commands issued by the CbCS management application client to the secure CDB processor require that the integrity check value is computed using the authentication CbCS master key rather than a CbCS working key. For a list of commands requiring use of the CbCS master key see 2.8.2. If the CbCS master key is used to compute the CbCS credential integrity check value then the KEY VERSION field in the CbCS capability descriptor shall be set to zero.

For CbCS credentials returned by the CbCS management device server in response to the RECEIVE CREDENTIAL command (see 7), only CbCS working keys shall be used in computing the INTEGRITY CHECK VALUE field.

2.7.3 Preparing CbCS credentials by the secure CDB originator

The secure CDB originator shall prepare the CbCS credential for sending it to the secure CDB processor in the CDB CbCS extension parameters as follows:

- a) If the CAPKEY security method is enabled, then copy the CbCS capability descriptor received from the CbCS management device server in response to the RECEIVE CREDENTIAL command into the CbCS capability descriptor parameter of the CDB CbCS extension. If the BASIC security method enabled, then prepare the CbCS capability descriptor in the CbCS capability descriptor parameter of the CDB CbCS extension (see 2.7.2); and
- b) If the CAPKEY security method is enabled, then compute the validation tag as described in 2.6.4.3 and place it in the INTEGRITY CHECK VALUE parameter of the CDB CbCS extension.

2.7.4 Validating CbCS credentials by the enforcement manager

The enforcement manager shall validate CbCS credentials as follows:

- a) If the CAPKEY security method is enabled and the SECURITY METHOD field in the CbCS capability descriptor is other than CAPKEY, then the command shall be terminated with a CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB;
- b) If the CAPKEY security method is enabled, then:
 - a. Compute the CbCS capability key as described in 2.6.4.2;
 - b. Compute the validation tag as described in 2.6.4.3; and
 - c. Compare the computed validation tag with the INTEGRITY CHECK VALUE field in the CbCS extension parameters. If they don't match, then the command shall be terminated with a CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB;

and

- c) Verify the CbCS capability descriptor as described in 2.5.2.

2.8 Secret keys

2.8.1 Overview

All CbCS credentials are based on a secret key that is shared between the enforcement manager, the CbCS management application client that manages its security attributes, and the CbCS management device server that grants CbCS credentials to application clients. Keys shall be refreshed regularly.

Secret key management requirements are as follows:

- 1) The CbCS management application client should replace the logical unit's secret keys in a secure manner even if the I_T_L nexus it has with the logical unit is not secure;
- 2) The enforcement manager shall support multiple CbCS working keys; and
- 3) The CbCS management application client shall contain a random source for generating secret keys.

Each logical unit has a CbCS master key and a set of CbCS working keys assigned to it. A single set of secret keys may be shared among multiple logical units within a SCSI target device.

The CbCS working keys are used to generate the CbCS capability keys that are used by secure CDB originators to access logical units. CbCS working keys should be refreshed frequently (e.g., hourly). A

secret key refresh shall invalidate all CbCS credentials generated by that secret key. The enforcement manager shall support up to 16 refreshed versions of the secret key as valid (i.e., define multiple secret keys that are concurrently valid). The secret key version field in the CbCS capability is used to indicate which secret key shall be used in the validation process (see 7.1.1).

When setting a new secret key, the CbCS management application client assigns the secret key with a version number. The KEY VERSION field in the CbCS capability descriptor is set to the version number of the CbCS working key used in computing the CbCS capability key (see 7.1.1). The enforcement manager uses the KEY VERSION field to determine which secret key to use in validating a CbCS credential in a CbCS extended command (see 2.7.4).

A CbCS master generation key is used to generate working secret keys. A CbCS master authentication key is used to generate CbCS credentials for commands to set and refresh keys, and modify device security attributes. The CbCS master key (i.e., the pair of CbCS master generation key and CbCS master authentication key) may be refreshed. Refreshing the CbCS master key is accomplished by a Diffie-Hellman key exchange algorithm that ensures forward secrecy of the CbCS master key. This algorithm is carried over a sequence of commands as follows:

- 1) SECURITY PROTOCOL OUT command specifying the CbCS protocol and the Set Master Key, Seed Exchange page (6.1.4);
- 2) SECURITY PROTOCOL IN command specifying the CbCS protocol and the Set Master Key, Seed Exchange page (5.1.6); and
- 3) SECURITY PROTOCOL OUT command specifying the CbCS protocol and the Set Master Key, Change Master Key page (6.1.5).

Separate sets of the CbCS master key and the CbCS working keys may be used for each logical unit, or a single set may be used for all logical units served by a security protocol well-known logical unit's secure CDB processor as follows:

- 1) A single set of CbCS master keys and CbCS working keys is used by the enforcement manager through the SECURITY PROTOCOL well-known logical unit. This set of secret keys serves all the logical units within the SCSI target device;
- 2) A separate set of CbCS master keys and CbCS working keys is used for each logical unit within the SCSI target device; and
- 3) A single set of CbCS master keys and CbCS working keys is used by the enforcement manager through the SECURITY PROTOCOL well-known logical unit. In addition, a separate set of CbCS master key and CbCS working keys may be used for any logical unit within the SCSI target device. The single set of secret keys serves any logical unit that does not have its own set of keys.

2.8.2 Secret key usage in commands

Every CbCS credential prepared by the CbCS management device server includes an integrity check value field containing a CbCS capability key that is computed using either a CbCS working key or the CbCS master authentication key associated with the logical unit.

The CbCS authentication master key shall be used in preparing CbCS credentials for commands that set secret keys. For other commands, the secret key that shall be used is one of the CbCS working keys associated with the logical unit. The KEY VERSION field in the CbCS capability descriptor shall be set to a value that identifies that particular working key (see 7.1.1).

The following commands involve setting secret keys and require using the CbCS master authentication key for preparing the credential:

- a) SECURITY PROTOCOL OUT command specifying the CbCS security protocol and the Set Key page (see 6.1.3);

- b) SECURITY PROTOCOL OUT command specifying the CbCS security protocol and the Set Master Key, Seed Exchange page (see 6.1.4);
- c) SECURITY PROTOCOL IN command specifying the CbCS security protocol and the Set Master Key, Seed Exchange page (see 5.1.6); and
- d) SECURITY PROTOCOL OUT command specifying the CbCS security protocol and the Set Master Key, Change master Key page (see 6.1.5).

If the CbCS extended command is SECURITY PROTOCOL OUT command specifying the CbCS security protocol and the Set Master Key, Change Master Key page, then the secret key that shall be used is the next CbCS authentication master key computed after GOOD status has been returned by the SECURITY PROTOCOL IN command specifying the CbCS security protocol and the Set Master Key, Seed Exchange page.

2.8.3 Computing updated CbCS master generation keys and new CbCS authentication keys

When processing the commands that involve setting secret keys (i.e., the Set Key CbCS page (see 6.1.3) and the Set Master Key CbCS pages (see 6.1.4, 5.1.6, and 6.1.5)), the enforcement manager shall compute new CbCS master generation keys and CbCS working keys as follows:

- a) The algorithm specified in the INTEGRITY CHECK VALUE ALGORITHM field in the CbCS capability descriptor;
- b) The input secret key value shall be one of the following:
 - a) For a Set Key CbCS page (see 6.1.3), the CbCS master generation key; or
 - b) For a CbCS master key computed following the processing of the Set Master Key, Change Master Key CbCS page (see 6.1.5), the previous CbCS master generation key shall be used;

and

- c) The input data (i.e., seed) shall be one of the following:
 - a) For a Set Key CbCS page, the contents of the SEED field of the Set Key CbCS page; or
 - b) For a Set Master Key, Change Master Key CbCS page, the value computed after successful completion of the SECURITY PROTOCOL IN command specifying the Set Master Key, Seed Exchange CbCS page (see 5.1.6) and updated by the Set Master Key, Change Master Key CbCS page (see 6.1.5).

When processing the commands for setting the CbCS master key (i.e., the Set Master Key CbCS pages (see 6.1.4, 5.1.6, and 6.1.5)), the enforcement manager shall compute the new CbCS master authentication key as follows:

- a) The algorithm specified in the INTEGRITY CHECK VALUE ALGORITHM field in the CbCS capability descriptor;
- b) The input key value shall be the CbCS master generation key prior to processing the command; and
- c) The input data shall be the seed value computed (see 5.1.6) with the least significant bit changed as follows:
 - a) If the seed value least significant bit is zero, then the least significant bit shall be set to one; or

- b) If the seed value least significant bit is one, then the least significant bit shall be set to zero.

2.9 CbCS interactions with commands and task management functions

2.9.1 Association between commands and permission bits

The PERMISSIONS BIT MASK descriptor in the CbCS capability (see 2.5) specifies which command functions are allowed by this CbCS capability. When processing CbCS extension commands, the enforcement manager shall verify that the bits applicable to the encapsulated SCSI command are all set to one in the PERMISSIONS BIT MASK descriptor before processing the request specified by the CbCS extended SCSI command.

The associations between commands and permission bits are specified in this subclause for commands defined in this standard. Other SCSI command set standards may specify associations between commands and command functions pertaining to the specific device type.

If the secure CDB processor receives a command that requires CbCS extension (see 3) according to Table 3 or any device specific command set standard pertaining to the received command, and the command is not extended with CbCS extension, then the command shall be terminated with a CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to INVALID FIELD IN CDB.

If the secure CDB processor receives a command that does not require CbCS extension (see 3) according to Table 3 or any device specific command set standard pertaining to the received command, and the command is extended with CbCS extension, then the command may be processed by the device server.

Table 3 - Associations between commands and permissions

Command	Required Permissions						Permitted / Not allowed (a)
	DATA READ	DATA WRITE	ATTR READ	ATTR WRITE	SEC MGMT	RESRV	
ACCESS CONTROL IN							N
ACCESS CONTROL OUT							N
CHANGE ALIASES							P
EXTENDED COPY							N
INQUIRY							P
LOG SELECT			v				
LOG SENSE				v			
MANAGEMENT PROTOCOL IN							
MANAGEMENT PROTOCOL OUT							
MODE SELECT(6)				v			
MODE SELECT(10)				v			
MODE SENSE(6)			v				
MODE SENSE(10)			v				
PERFORM TASK MANAGEMENT FUNCTION					v		
PERSISTENT RESERVE IN			v				
PERSISTENT RESERVE OUT						v	
READ ATTRIBUTE			v				
READ BUFFER	TBD	TBD	TBD	TBD	TBD	TBD	TBD
READ MEDIA SERIAL NUMBER			v				

	Required Permissions						
RECEIVE COPY RESULTS							V
RECEIVE CREDENTIAL							P
RECEIVE DIAGNOSTIC RESULTS			v				
REPORT ALIASES			v				
REPORT IDENTIFYING INFORMATION			v				
REPORT LUNS							P
REPORT PRIORITY			v				
REPORT SUPPORTED OPERATION CODES							P
REPORT SUPPORTED TASK MANAGEMENT FUNCTIONS							P
REPORT TARGET PORT GROUPS							P
REPORT TIMESTAMP			v				
REQUEST SENSE			v				
SECURITY PROTOCOL IN (per security protocol)							
Security protocol information (00h)			v				
Defined by TCG (01h – 06h)							?TBD
CbCS (07h)					v		
Tape Data Encryption (20h)					v		
Authentication in Host Attachments of Transient Storage Devices (EEh)					v		
ATA Device Server Password Security (EFh)					v		
SECURITY PROTOCOL OUT (per security protocol)							
Defined by TCG (01h – 06h)							?TBD
CbCS (07h)					v		
Tape Data Encryption (20h)					v		
Authentication in Host Attachments of Transient Storage Devices (EEh)					v		
ATA Device Server Password Security (EFh)					v		
SEND DIAGNOSTIC				v			
SET IDENTIFYING INFORMATION				v			
SET PRIORITY				v			
SET TARGET PORT GROUPS							
SET TIMESTAMP				v	v		
TEST UNIT READY							
WRITE ATTRIBUTE				v			
WRITE BUFFER	TBD	TBD	TBD	TBD	TBD	TBD	TBD
<p>^(a) N - The command shall not be processed by a secure CDB processor within a logical unit that has the CbCS bit set to one in the extended inquiry data</p> <p>P - The command is permitted to be processed by the secure CDB processor, no permissions are required for it.</p> <p>v – In order for the secure CDB processor to process the requested command, the permission bit must be set in the PERMISSIONS BIT MASK field in the CAPABILITY descriptor field of a CbCS extension descriptor extending the requested command.</p>							

2.9.2 Task management functions

The command security model, and CbCS in particular, does not cover task management function security. SCSI system may still be exposed to task management function based attacks (e.g., denial of service attacks by malicious SCSI initiator device aborting tasks in unauthorized manner).

2.10 Security attributes

{{George – This section does not compute. It seems to contain several inconsistent references to device servers in relation to SA. Also, how is this supposed to tie into the SA section that is already in SPC?}}

{{Sivan: We have to update the references. Basically the SA creation draft added some crypto building blocks common to SA creation and CbCS. E.g. “integrity algorithms”}}

Device servers supporting CbCS may support one or more of the following security attributes:

- a) SCSI target device based;
- b) logical unit based;
- c) changeable; or
- d) non-changeable.

Device servers may support the following security attributes:

- a) only SCSI target device based;
- b) only logical unit based; or
- c) both.

If a device server supports both target based security attributes and a logical unit based security attributes and receives both target based security attributes and a logical unit based security attributes, then the logical unit based security attribute overrides the target based security attribute on that device server.

SCSI target device attributes are queried and modified through the SECURITY PROTOCOL well-known logical unit (see 8.5 [spc4r11])

Table 4 specifies the CbCS attributes.

Table 4 - CbCS attributes

Security attribute name	Length (bytes)	SCSI target device or logical unit specific	Application client settable
Supported security methods	n*2	SCSI target device	No
Default security method	2	SCSI target device	Yes
Security method	2	SCSI target device/Logical unit	Yes
Supported integrity check value algorithms	n*4	SCSI target device	No
Supported DH groups	n*4	SCSI target device	No
Clock	6	SCSI target device	Yes
CbCS master key identifier	8	SCSI target device / Logical unit	No ^d
CbCS working key identifier	16*8	SCSI target device / Logical unit	No ^d
LU initial policy access tag	4	SCSI target device	Yes
Policy access tag	4	Logical unit	Yes
Security token	Not defined ^c	Logical unit ^b	No

Security attribute name	Length (bytes)	SCSI target device or logical unit specific	Application client settable
^b	The security token returned by the device server is unique to the I_T nexus on which the security token is returned.		
^c	The security token length is specific to the implementation of secure channel for the I_T nexus		
^d	The secret key identifier is set by the application client when a new secret key is generated as described in 6.1.3 and 6.1.5. It is not settable by means of setting CbCS security attributes described in 6.1.2		

The supported security methods attribute is used by the device server to report its supported security methods. See 2.6.

The default security method attribute is the security method the device server shall apply to a newly created CbCS logical unit, if a security method is not specified at logical unit creation time. The default security method shall be one of the supported security methods.

The supported integrity check value algorithms security attribute is used by a device server to report its supported integrity check value algorithms. Integrity check value algorithms shall be used to compute integrity check values. See 7.7.3.6.4 Table x36 in 06-449r8.

The supported DH group security attribute is used by a device server to report the DH groups it supports for the Diffie-Hellman key exchange with the application client that is processed as part of setting a new CbCS master key (see 6.1.4). See 7.7.3.6.5 Table x38 in 06-449r8.

The clock security attribute shall contain the current time in use by the device server represented as the count of the number of milliseconds elapsed since midnight, 1 January 1970 UT.

The LU initial policy access tag security attribute specifies the initial value for the policy access tag for a newly created logical unit. The initial value for this attribute shall be set to FFFF FFFFh (see 2.5).

The policy access tag security attribute specifies the expected non-zero contents of the POLICY ACCESS TAG field in any capability that allows access to this logical unit (see 2.5).

Setting and querying security attributes are used by the application client by issuing the SECURITY PROTOCOL IN command and SECURITY PROTOCOL OUT command with the CbCS security protocol (see 5.1, 6.1).

3 CbCS extension

{{Editor's note: I'm not sure where exactly this section should be added in SPC-4.}}

{{Editor's note: This section is based on 07-029r3}}

The CbCS extension allows the application of CbCS to a SCSI command using the parameters specified in this subclause.

Support for CbCS extension type is mandatory if the CbCS bit in extended INQUIRY data (see 4) is set to one.

The extended CDB may be any CDB defined in any SCSI command set standard.

Table 5 - CbCS extension descriptor format

Bit Byte	7	6	5	4	3	2	1	0
0	EXTENSION TYPE (00h)							

Bit Byte	7	6	5	4	3	2	1	0
1	Reserved							
3								
4	CbCS capability descriptor							
94								
96	INTEGRITY CHECK VALUE							
159								

The CbCS capability descriptor is defined in 7.1.1.

The CbCS capability descriptor and the INTEGRITY CHECK VALUE field shall be prepared by the secure CDB originator as described in 2.7.3.

The enforcement manager shall validate the CbCS capability descriptor and the INTEGRITY CHECK VALUE field as described in 2.7.4.

4 Extended INQUIRY Data VPD page

[Change in 7.6.4 Extended INQUIRY Data VPD page]

The Extended INQUIRY Data VPD page (see table 361) provides the application client with a means to obtain information about the logical unit.

Table 361 — Extended INQUIRY Data VPD page

Bit Byte	7	6	5	4	3	2	1	0
0	PERIPHERAL QUALIFIER			PERIPHERAL DEVICE TYPE				
1	PAGE CODE (86h)							
2	Reserved							
3	PAGE LENGTH (3Ch)							
4	Reserved		SPT			GRD_CHK	APP_CHK	REF_CHK
5	Reserved			GROUP_SUP	PRIOR_SUP	HEADSUP	ORDSUP	SIMPSUP
6	Reserved					COR_DSUP	NV_SUP	V_SUP
7	Reserved							LUICLR
8	Reserved							CbCS
9	Reserved							
63								

<Unchanged text here>

A Capability based Command Security (CbCS) bit set to one indicates that the logical unit has CbCS (see 2). A CbCS bit set to zero indicates that the logical unit does not support CbCS.

5 Changes in SECURITY PROTOCOL IN command

[Changes in section 6.29 SECURITY PROTOCOL IN command]

6.29.1 SECURITY PROTOCOL IN command description

Table 186 — SECURITY PROTOCOL field in SECURITY PROTOCOL IN command

Code	Description	Reference
00h	Security protocol information	6.29.2
01h - 06h	Defined by the TCG	3.1.128
07h	CbCS	6.29.3 (5.1)
08h - 1Fh	Reserved	
20h	Tape Data Encryption	SSC-3
21h - EDh	Reserved	
EEh	Authentication in Host Attachments of Transient Storage Devices	IEEE P1667
EFh	ATA Device Server Password Security	TBD
F0h - FFh	Vendor Specific	

5.1 CbCS SECURITY PROTOCOL

(New section in SPC-4: 6.29.3)

5.1.1 Overview

(New section in SPC-4: 6.29.3.1)

The SECURITY PROTOCOL IN command specifying the CbCS protocol requests the device server to return the security attributes of the:

- a) logical unit; or
- b) SCSI target device that contains the addressed SECURITY PROTOCOL well-known logical unit.

The SECURITY PROTOCOL IN command supports CbCS pages that may be requested one at a time. An application client requests a CbCS page by using a SECURITY PROTOCOL IN command with the SECURITY PROTOCOL field set to 07h (i.e., CbCS protocol) and the SECURITY PROTOCOL SPECIFIC field set to the requested CbCS page code.

The SECURITY PROTOCOL SPECIFIC field (see Table 6) specifies the CbCS pages.

Table 6 – SECURITY PROTOCOL SPECIFIC field

Code	Description	Support	Reference
0000h	SECURITY PROTOCOL IN supported CbCS page	M	5.1.2
0001h	SECURITY PROTOCOL OUT supported CbCS page	M	5.1.3

Code	Description	Support	Reference
0002h-000Fh	Reserved		
0010h	Capabilities CbCS page	M	5.1.4
0011h	Attributes CbCS page	M	5.1.5
0012h	Set Master Key, Seed Exchange CbCS page	M	5.1.6
0013h – FFFFh	Reserved		
Support key: M – Mandatory for device servers that support CbCS. O – Optional			

5.1.2 SECURITY PROTOCOL IN supported CbCS page

(New section in SPC-4: 6.29.3.2)

Table 7 specifies the format of the SECURITY PROTOCOL IN supported CbCS page.

Table 7 - SECURITY PROTOCOL IN supported CbCS page

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)	PAGE CODE (0000h)						(LSB)
1								
2	(MSB)	PAGE LENGTH (n-3)						(LSB)
3								
4	(MSB)	SECURITY PROTOCOL IN supported CbCS page (first)						(LSB)
5								
		.						
		.						
		.						
n-1	(MSB)	SECURITY PROTOCOL IN supported CbCS page (last)						(LSB)
n								

The SECURITY PROTOCOL IN supported CbCS page shall contain a list of all of the CbCS pages the device server supports for the SECURITY PROTOCOL IN command specifying the CbCS protocol in ascending order beginning with page code 0000h.

5.1.3 SECURITY PROTOCOL OUT supported CbCS page

(New section in SPC-4: 6.29.3.3)

Table 8 specifies the format of the SECURITY PROTOCOL OUT supported CbCS page.

Table 8 - SECURITY PROTOCOL IN supported CbCS page format

Bit Byte	7	6	5	4	3	2	1	0

Bit Byte	7	6	5	4	3	2	1	0	
0	(MSB)	PAGE CODE (0001h)							
1								(LSB)	
2	(MSB)	PAGE LENGTH (n-3)							
3								(LSB)	
4	(MSB)	SECURITY PROTOCOL IN supported CbCS page (first)							
5								(LSB)	
n-1	(MSB)	SECURITY PROTOCOL IN supported CbCS page (last)							
n								(LSB)	

The SECURITY PROTOCOL OUT supported CbCS page shall contain a list of all of the CbCS pages that the device server supports for the SECURITY PROTOCOL OUT command specifying the CbCS protocol in ascending order.

5.1.4 Capabilities CbCS page

(New section in SPC-4: 6.29.3.4)

Table 9 specifies the format of the Capabilities CbCS page.

Table 9 – Capabilities CbCS page format

Bit Byte	7	6	5	4	3	2	1	0	
0	(MSB)	PAGE CODE (0010h)							
1								(LSB)	
2	(MSB)	PAGE LENGTH ($i*2+j*2+k*2+8$)							
3								(LSB)	
4	GKS	LUKS	GSMS	LUSMS	Reserved				
5	Reserved								
6	Number of supported security methods (i)								
7								(LSB)	
8	SUPPORTED SECURITY METHOD (first)								
9								(LSB)	
$i*2+6$	SUPPORTED SECURITY METHOD (last)								

Byte \ Bit	7	6	5	4	3	2	1	0
$i*2+7$	(LSB)							
$i*2+8$	Number of supported integrity check value algorithms (j)							
$i*2+9$								
$i*2+10$	SUPPORTED INTEGRITY CHECK VALUE ALGORITHM (first)							
$i*2+13$								
	⋮							
$i*2+j*4+6$	SUPPORTED INTEGRITY CHECK VALUE ALGORITHM (last)							
$i*2+j*4+9$								
$i*2+j*4+10$	Number of supported D-H groups (k)							
$i*2+j*4+11$								
$i*2+j*4+12$	SUPPORTED D-H GROUP (first)							
$i*2+j*4+15$								
	⋮							
$i*2+j*4+k*4+8$	SUPPORTED D-H GROUP (last)							
$i*2+j*4+k*4+11$								

A Global Keys Support (GKS) bit set to one specifies that the device server supports a single CbCS master key and a set of CbCS working keys for the SCSI target device. A GKS bit set to zero specifies that the device server does not support single CbCS master key and a set of CbCS working keys for the SCSI target device.

A Logical Unit Keys Support (LUKS) bit set to one specifies that the device server supports separate sets of the CbCS master key and the CbCS working keys for each logical unit. A LUKS bit set to zero specifies that the device server does not support separate sets of the CbCS master key and the CbCS working keys for each logical unit.

A Global Security Method Support (GSMS) bit set to one specifies that the SCSI target device that contains this logical unit supports global security method (i.e., contains a SECURITY PROTOCOL well known logical unit). A GSMS bit set to zero specifies that the device server requires the security methods to be assigned to each logical unit.

A Logical Unit Security Method Support (LUSMS) bit set to one specifies that the device server supports per-logical unit security method. A LUSMS bit set to zero specifies that the device server does not support per-logical unit security method.

The SUPPORTED SECURITY METHOD fields contain coded values of the security methods (see 2.6) supported by the device server. The coded values are specified in Table 22.

The SUPPORTED INTEGRITY CHECK VALUE ALGORITHM fields contain coded values of the algorithm to compute integrity check values supported by the device server (see 2.7). The coded values are specified in 7.7.3.6.4Table x36 in 06-449r8.

The SUPPORTED DH GROUP attributes contain coded values identifying the supported values in the DH_GROUP field of Set Master Key, Seed Exchange page (see 6.1.4). The coded values are specified in 7.7.3.6.5 Table x38 in 06-449r8.

5.1.5 Attributes CbCS page

(New section in SPC-4: 6.29.3.5)

Table 10 specifies the format of the Attributes CbCS page.

Table 10 - Attributes CbCS page format

Byte	Bit	7	6	5	4	3	2	1	0	
0	(MSB)	PAGE CODE (0010h)								
1										(LSB)
2	(MSB)	PAGE LENGTH (n-3)								
3										(LSB)
4	(MSB)	SECURITY METHOD								
5										(LSB)
6	(MSB)	POLICY ACCESS TAG								
9										(LSB)
10		MASTER KEY IDENTIFIER								
17										(LSB)
18		WORKING KEY IDENTIFIER 0								
25										(LSB)
		.								
		.								
		.								
138		WORKING KEY IDENTIFIER 15								
145										(LSB)
146	(MSB)	CLOCK								
151										(LSB)
152		Reserved								
153		SECURITY TOKEN LENGTH								
154		SECURITY TOKEN								
n										(LSB)

If the addressed logical unit is the SECURITY PROTOCOL well-known logical unit:

- a) the SECURITY METHOD field is the security method that shall be assigned by the W-LUN's device manager to a new logical unit within the SCSI target device;

- b) the POLICY ACCESS TAG field is the initial policy access tag that shall be assigned by the W-LUN's device server to a new logical unit within the SCSI target device;
- c) if the device server does not support global security method (i.e., the GSMS bit is set to zero in the Capabilities CbCS page), then the SECURITY METHOD field is undefined; and
- d) if the device server does not support global keys (i.e., the GKS bit is set to zero in the Capabilities CbCS page), then the MASTER KEY IDENTIFIER field and all the WORKING KEY IDENTIFIER fields should contain FFFF FFFFh

If the addressed logical unit is not the SECURITY PROTOCOL well-known logical unit:

- a) the SECURITY METHOD field is the current security method used for the addressed logical unit;
- b) the POLICY ACCESS TAG field is the current policy access tag assigned to the addressed logical unit;
- c) if the device server does not support per-logical unit security method (i.e., the LUSMS bit is set to zero in the Capabilities CbCS page), then the SECURITY METHOD field is undefined; and
- d) if the device server does not support per-logical unit keys (i.e., the LUKS bit is set to zero in the Capabilities CbCS page), the MASTER KEY IDENTIFIER field and all the WORKING KEY IDENTIFIER fields should contain FFFF FFFFh.

Security methods are described in detail in 2.6.

Secret keys are described in 2.8.

If secret keys are supported for the addressed logical unit, the values of those fields are as follows:

- a) The MASTER KEY IDENTIFIER field shall contain the key identifier value from the most recent successful SECURITY PROTOCOL OUT command specifying the CbCS security protocol and the Set Master Key, Change Master Key page (see 6.1.5). If that command has never been processed, then the MASTER KEY IDENTIFIER field shall contain FFFF FFFEh; and
- b) Each KEY IDENTIFIER field contains the key identifier value from the most recent successful SECURITY PROTOCOL OUT command specifying the CbCS security protocol and the Set Key page, with the KEY VERSION field set to the pertinent key (0-15) (see 6.1.3). If a secret key is invalid (e.g., never set, invalidated by a Set Master Key, Change Master Key page, or invalidated by a Set Key page), the pertinent KEY IDENTIFIER field should contain 0000 0000h.

The CLOCK field shall contain the current time in use by the device server represented as the count of the number of milliseconds elapsed since midnight, 1 January 1970 UT.

{{Editor's Note: The clock field may be usable for other purposes. Perhaps it can be moved to a more generic place, e.g. mode page...}}

The SECURITY TOKEN field (see 1.1.14) contains a value that is unique to the I_T nexus or I_T_L nexus on which the SECURITY PROTOCOL IN command was sent. See 2.6.4.

If the SECURITY METHOD field value is BASIC, then the MASTER KEY IDENTIFIER field, the KEY IDENTIFIER fields and the SECURITY TOKEN field are undefined.

5.1.6 Set Master Key, Seed Exchange CbCS page

(New section in SPC-4: 6.29.3.6)

Table 11 specifies the format of the Set Master Key, Seed Exchange CbCS page.

Table 11 - Set Master Key, Seed Exchange CbCS page format

Bit Byte	7	6	5	4	3	2	1	0	
0	(MSB) PAGE CODE (0012h)								(LSB)
1									
2	(MSB) PAGE LENGTH (n-3)								(LSB)
3									
4									
n	DH DATA								

If a SECURITY PROTOCOL IN command specifying Set Master Key, Seed Exchange CbCS page is received and no SECURITY PROTOCOL OUT command specifying Set Master Key, Seed Exchange CbCS page (see 6.1.4) has been completed successfully on the same I_T_L nexus during the past ten seconds, the command shall be terminated with a CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to INVALID FIELD IN CDB.

A device server that receives a SECURITY PROTOCOL OUT command specifying Set Master Key, Seed Exchange CbCS page on one I_T_L nexus may terminate the command with a CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to SYSTEM RESOURCE FAILURE if any of the following command processing is incomplete on a different I_T_L nexus:

- SECURITY PROTOCOL OUT command specifying Set Master Key, Seed Exchange CsCB page (see 6.1.4);
- SECURITY PROTOCOL IN command specifying Set Master Key, Seed Exchange CsCB page (see 5.1.6); or
- SECURITY PROTOCOL OUT command specifying Set Master Key, Change Master Key CbCS page (see 6.1.5).

The DH DATA field contains the device server DH_data computed as follows:

- A random number, y , is generated having a value between zero and DH_prime minus one observing the requirements in RFC 1750; and
- The device server DH_data is equal to $DH_generator^y$ modulo DH_prime .

The $DH_generator$ and DH_prime values are identified by the Diffie-Hellman group specified in the DH GROUP field in the most recent SECURITY PROTOCL OUT command specifying the Set Master Key, Seed Exchange page (see 6.1.4) that was received on the same I_T_L nexus.

After GOOD status has been returned for SECURITY PROTOCOL OUT command and before the SECURITY PROTOCOL OUT command specifying the Set Master Key, Change Master Key page is processed, the next CbCS authentication master key and next CbCS generation master key shall be computed as described in 2.8.3, using a seed value that is the concatenation of the following:

- $DH_generator^{xy}$ modulo DH_prime ; and
- The whole content of the Device Identification VPD page (83h) returned from the addressed logical unit for the INQUIRY command (see 7.6.3 [spc4r09]).

The value of $[DH_generator^{xy} \text{ modulo } DH_prime]$ is computed by the device server using the formula $[(DH_generator^x \text{ modulo } DH_prime)^y \text{ modulo } DH_prime]$, where $[DH_generator^x \text{ modulo } DH_prime]$ is

the content of the DH DATA field in the last SECURITY PROTOCL OUT command specifying the Set Master Key, Seed Exchange page (see 6.1.4) that was received on the same I_T_L nexus.

{{Editor's note: Proof for $(DH_generator^x \text{ modulo } DH_prime)^y \text{ modulo } DH_prime = DH_generator^{xy} \text{ modulo } DH_prime$:

Claim: $(g^x \text{ mod } p)^y \text{ mod } p = g^{xy} \text{ mod } p$

Proof:

Denote $g^x = a*p + b$, where a is in integer and $0 \leq b < p$

1. Thus, $g^x \text{ mod } p = b$, and so $(g^x \text{ mod } p)^y \text{ mod } p = b^y \text{ mod } p$

2. $g^{xy} \text{ mod } p = (a*p + b)^y \text{ mod } p$. Ppening $(a*p + b)^y$ we get a list of addends in which all addends but one are divisible by p. the only addend which is not divided by p is b^y and so

$$g^{xy} \text{ mod } p = b^y \text{ mod } p$$

}}

6 Changes in SECURITY PROTOCOL OUT command

[Changes in section 6.30 SECURITY PROTOCOL OUT command]

<Unchanged text here>

The SECURITY PROTOCOL field (see table 191) specifies which security protocol is being used.

Table 191 — SECURITY PROTOCOL field in SECURITY PROTOCOL OUT command

Code	Description	Reference
00h	Reserved	
01h - 06h	Defined by the TCG	3.1.128
07h	CbCS	
08h - 1Fh	Reserved	
20h	Tape Data Encryption	SSC-3
21h - EDh	Reserved	
EEh	Authentication in Host Attachments of Transient Storage Devices	IEEE P1667
EFh	ATA Device Server Password Security	TBD
F0h - FFh	Vendor Specific	

6.1 CbCS SECURITY PROTOCOL

(New section in SPC-4: 6.30.1)

6.1.1 Overview

The SECURITY PROTOCOL OUT command specifying CbCS protocol is used to configure the CbCS secret keys and attributes in the device server.

The command supports CbCS pages that may be sent one at a time. An application client requests to send a CbCS page by using a SECURITY PROTOCOL OUT command with the SECURITY PROTOCOL field set to 07h (CbCS protocol) and the SECURITY PROTOCOL SPECIFIC field set to the CbCS page code requested.

The SECURITY PROTOCOL SPECIFIC field (see Table 12) specifies the type of CbCS page that the application client is sending.

Table 12 - SECURITY PROTOCOL SPECIFIC field values

Code	Description	Support	Reference
0000h – 0010h	Reserved		
0011h	Set Attributes CbCS page	O	6.1.2
0012h	Set Key CbCS page	M	6.1.3
0013h	Set Master Key, Seed Exchange CbCS page	M	6.1.4
0014h	Set Master Key, Change Master Key CbCS page	M	6.1.5
0015h – FFFFh	Reserved		
Support key: M – Mandatory for device servers that support the CbCS protocol O – Optional			

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.

6.1.2 Set attributes CbCS page

(New section in SPC-4: 6.30.1.2)

Table 13 specifies the format of the Set Attributes CbCS page.

Table 13 – Set Attributes CbCS page format

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) PAGE CODE (0011h) (LSB)							
1								
2	(MSB) PAGE LENGTH (6) (LSB)							
3								
4	(MSB) SECURITY METHOD (LSB)							
5								
6	(MSB) POLICY ACCESS TAG (LSB)							
9								

The PAGE LENGTH field indicates the number of bytes of parameter data to follow. If the page length value is any value other than 6, 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 SECURITY METHOD field specifies the security method to apply to the addressed logical unit (see 2.6). The SECURITY METHOD field shall be set to:

- a) the reserved value FFFFh to specify no change shall be made to the current security method;
- b) a value equal to the current security method shall not be considered an error; and
- c) a value that does not match any of the supported security methods reported in the Capabilities CbCS page (see 5.1.4), shall cause the device server to terminate the SECURITY PROTOCOL OUT command with CHECK CONDITION status and set the sense key to ILLEGAL REQUEST and the additional sense code to INVALID FIELD IN PARAMETER DATA.

The list of coded values of security methods is defined in Table 22.

The POLICY ACCESS TAG field specifies a new policy access tag for the addressed logical unit. The value set to 0000 0000h specifies no change shall be made to the current policy access tag value. If the addressed logical unit is the SECURITY PROTOCOL well-known logical unit and the POLICY ACCESS TAG field contains any value other than 0000 0000h, the device server shall terminate the SECURITY PROTOCOL OUT command with CHECK CONDITION status and set the sense key to ILLEGAL REQUEST and the additional sense code to INVALID FIELD IN PARAMETER DATA.

This command shall be authorized and shall be sent extended by a CbCS extension (see 3).

6.1.3 Set Key CbCS page

(New section in SPC-4: 6.30.1.3)

Table 14 specifies the Set Key CbCS page format.

Table 14 - Set Key CbCS page format

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) PAGE CODE (0012h)							
1	(LSB)							
2	(MSB) PAGE LENGTH (30)							
3	(LSB)							
4	Reserved							
5	Reserved				KEY VERSION			
6	(MSB) KEY IDENTIFIER							
13	(LSB)							
14	(MSB) SEED							
33	(LSB)							

The KEY VERSION field specifies the key version to be updated.

The KEY IDENTIFIER field specifies a unique identifier to be associated with the new secret key. The secret key identifier value shall be associated with the attribute specified in the Attributes CbCS page (see 5.1.5).

The SEED field contains a random number generated from a good source of entropy (e.g., as described in RFC 1750).

The updated secret key value shall be computed as described in 2.8.3.

This command shall be authorized and shall be sent extended with CbCS extension (see 3).

6.1.4 Set Master Key, Seed Exchange CbCS page

(New section in SPC-4: 6.30.1.4)

Table 15 specifies the Set Master Key, Seed Exchange CbCS page format.

Table 15 - Set Master Key CbCS page format

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB) PAGE CODE (0013h) -----							
1	----- (LSB)							
2	(MSB) PAGE LENGTH (n-3) -----							
3	----- (LSB)							
4	(MSB) DH GROUP -----							
5	----- (LSB)							
6	(MSB) DH DATA LENGTH -----							
9	----- (LSB)							
10	DH DATA -----							
n	-----							

A device server that receives a SECURITY PROTOCOL OUT command specifying Set Master Key, Seed Exchange CbCS page on one I_T_L nexus may terminate the command with a CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to SYSTEM RESOURCE FAILURE if any of the following command processing is incomplete on a different I_T_L nexus:

- SECURITY PROTOCOL OUT command specifying Set Master Key, Seed Exchange CsCB page (see 6.1.4);
- SECURITY PROTOCOL IN command specifying Set Master Key, Seed Exchange CsCB page (see 5.1.6); or
- SECURITY PROTOCOL OUT command specifying Set Master Key, Change Master Key CsCB page (see 6.1.5).

The DH GROUP field contains the Diffie-Hellman group (see 7.7.3.6.5 in 06-449r6) that identifies the DH_generator value and DH_prime value to be used in the seed exchange. If the value in the DH GROUP field is not listed in one of the SUPPORTED D-H GROUP fields in the Capabilities CbCS page (see 5.1.4), then the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

The DH DATA LENGTH field specifies the number of bytes of the DH DATA field.

The DH_DATA field contains the DH data and is computed as follows:

$$\text{DH data} = \text{DH_generator}^x \text{ modulo DH_prime}$$

Where:

X is a value between zero and DH_prime minus one as defined in RFC 1750; *{{This needs to be put in ISO format}}*

DH_generator is defined by the DH GROUP field; and

DH_prime is defined by the DH GROUP field.

6.1.5 Set Master Key, Change Master Key CbCS page

(New section in SPC-4: 6.30.1.5)

Table 16 specifies the format of the Set Master Key, Change Master Key CbCS page.

Table 16 - Set Master Key, Change Master Key CbCS page format

Bit Byte	7	6	5	4	3	2	1	0
0	(MSB)	PAGE CODE (0014h)						(LSB)
1								
2	(MSB)	PAGE LENGTH (n-3)						(LSB)
3								
4	(MSB)	KEY IDENTIFIER						(LSB)
11								
6	(MSB)	APPLICATION CLIENT DATA LENGTH (k-9)						(LSB)
9								
10		APPLICATION CLIENT DH DATA						
k								
k+1	(MSB)	DEVICE SERVER DATA LENGTH (n-(k+4))						(LSB)
k+4								
k+5		DEVICE SERVER DH DATA						
n								

If a SECURITY PROTOCOL OUT command specifying Set Master Key, Change Master Key CbCS page is received and no SECURITY PROTOCOL IN command specifying Set Master Key, Seed Exchange CbCS page has completed successfully on the same I_T_L nexus during the past ten seconds, the command shall be terminated with a CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to INVALID FIELD IN CDB.

A device server that receives a SECURITY PROTOCOL OUT command specifying Set Master Key, Change master Key CbCS page on one I_T_L nexus may terminate the command with a CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set

to SYSTEM RESOURCE FAILURE if any of the following command processing is incomplete on a different I_T_L nexus:

- a) SECURITY PROTOCOL OUT command specifying Set Master Key, Seed Exchange CsCB page (see 6.1.4);
- b) SECURITY PROTOCOL IN command specifying Set Master Key, Seed Exchange CsCB page (see 5.1.6); or
- c) SECURITY PROTOCOL OUT command specifying Set Master Key, Change Master Key CsCB page (see 6.1.5).

The KEY IDENTIFIER field specifies a unique identifier to be associated with the new CbCS master key. The secret key identifier value shall be placed into the MASTER KEY IDENTIFIER field in the Attributes CbCS page (see 5.1.5) before the command completes.

Table 17 specifies special secret key identifiers that shall not be used when setting secret keys. Any value not listed in the table is permitted for use by the application client when setting secret keys.

Table 17 – Special secret key identifiers

Value	Description
0000 0000h	A secret key that was never set or was invalidated
FFFF FFFEh	An initial secret key set by the device server
FFFF FFFFh	Pertinent secret key is not supported by the device server

If the value of the KEY IDENTIFIER field contains a value that is listed in Table 17, then the command shall be terminated 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 APPLICATION CLIENT DATA LENGTH field specifies the number of bytes that follow in the APPLICATION CLIENT DH DATA field.

The APPLICATION CLIENT DH_DATA field contains the DH_data from the last SECURITY PROTOCOL OUT command specifying CbCS Set Master Key, Seed Exchange CbCS page on the same I_T_L nexus on which this command was received.

The DEVICE SERVER DATA LENGTH field contains the length in bytes of the DEVICE SERVER DH DATA field.

The DEVICE SERVER DH DATA field contains the device server DH_data from the last SECURITY PROTOCOL IN command specifying Set Master Key, Seed Exchange CbCS page on the same I_T_L nexus on which this command was received.

If the content of the APPLICATION CLIENT DATA LENGTH field of the SECURITY PROTOCOL OUT commands Set Master Key, Seed Exchange CbCS page does not match the content of the:

- a) DH DATA LENGTH field in a SECURITY PROTOCOL OUT Set Master Key, Seed Exchange CbCS page that was processed on this I_T_L nexus since a I_T nexus loss event, logical unit reset event, or reset event (see SAM-4);
- b) DH DATA field in a SECURITY PROTOCOL OUT Set Master Key, Seed Exchange CbCS page that was processed on this I_T_L nexus since a I_T nexus loss event, logical unit reset event, or reset event;
- c) PAGE LENGTH field in a SECURITY PROTOCOL IN Set Master Key, Seed Exchange CbCS page that was processed on this I_T_L nexus since a I_T nexus loss event, logical unit reset event, or reset event; or

- d) DH DATA field in a SECURITY PROTOCOL IN Set Master Key, Seed Exchange CbCS page that was processed on this I_T_L nexus since a I_T nexus loss event, logical unit reset event, or reset event,

then the command shall be terminated with CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN PARAMETER LIST.

{{George – from here}}

On successful completion of a SECURITY PROTOCOL OUT command specifying the CbCS protocol and the Set Master Key, Change Master Key CbCS page, the device server shall:

- Replace the CbCS authentication master key with the next CbCS authentication master key computed after the return of GOOD status for the most recent SECURITY PROTOCOL IN command specifying the CbCS protocol and the Set Master Key, Seed Exchange CbCS page (see 5.1.6);
- Replace the CbCS generation master key with the next CbCS generation master key computed after the return of GOOD status for the most recent SECURITY PROTOCOL IN command specifying the CbCS protocol and the Set Master Key, Seed Exchange CbCS page; and
- Invalidate all the CbCS working keys on the logical unit.

For every secret key that is invalidated by this command, the associated key identifier attribute shall have its attribute set to zero.

The next CbCS authentication master key computed after the return of GOOD status for the most recent SECURITY PROTOCOL IN command specifying the CbCS protocol and the Set Master Key, Seed Exchange CbCS page (see 5.1.6) shall be used to compute the capability key for this command.

{{George – to here needs to be put into the model section}}

7 RECEIVE CREDENTIAL command

[A new sub-section in section 6 of SPC-4]

The RECEIVE CREDENTIAL command (see Table 18) allows the application client to receive a CbCS credential for use in the CbCS extension (see 3).

Table 18 - RECEIVE CREDENTIAL CDB format

Bit Byte	7	6	5	4	3	2	1	0	
0	OPERATION CODE (7Fh)								
1	CONTROL								
2	Reserved								
6									
7	ADDITIONAL CDB LENGTH (18h or 3Dh)								
8	(MSB)	SERVICE ACTION (1800h)						(LSB)	
9									
10	(MSB)	ALLOCATION LENGTH						(LSB)	
11									

Bit Byte	7	6	5	4	3	2	1	0
12	Designation descriptor							
31								
32	MAM Attribute							
68								

If a RECEIVE CREDENTIAL command is received before a SECURITY PROTOCOL IN command has completed successfully on the same I_T_L nexus as the RECEIVE CREDENTIAL command was received with the following field settings:

- a) SECURITY PROTOCOL field set to xxh (i.e., IKEv2-SCSI); and
- b) the SECURITY PROTOCOL SPECIFIC field set to 0103h (i.e., Authentication step),

then the command shall be terminated with a CHECK CONDITION status, the sense key set to NOT READY, and the additional sense code set to LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED.

If before a SECURITY PROTOCOL IN command has completed successfully on the same I_T_L nexus as the RECEIVE CREDENTIAL command was received with the following field settings:

- a) SECURITY PROTOCOL field set to xxh (i.e., IKEv2-SCSI);
- b) the SECURITY PROTOCOL SPECIFIC field set to 0102h (i.e., Key Exchange step); and
- c) the SCSI Cryptographic Algorithms payload contains a cryptographic algorithm descriptor of type Encryption Algorithm (ENCR) (i.e., ALGORITHM TYPE 01h) and identifier other than ENCR_NULL (i.e., ALGORITHM IDENTIFIER other than 0000 000Bh),

then the command shall be terminated with a CHECK CONDITION status, the sense key set to NOT READY, and the additional sense code set to LOGICAL UNIT NOT READY, INITIALIZING COMMAND REQUIRED.

{{Editor's note: The above paragraph is based on 06-449 and depends on it. Basically it asserts that a successful authenticated and encrypted SA has been created.}}

The ALLOCATION LENGTH field is defined in 4.3.4.6 [spc4r11].

The format of the Designation descriptor field is defined in Table 346 [spc4r11]. The size of the Designation descriptor shall not exceed 24 bytes. The DESIGNATOR TYPE field value shall be set to 3h (NAA). If the DESIGNATOR TYPE field contains any value other than 3h (NAA), this command shall be terminated with a CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

The MAM Attribute field is optional. The format of the MAM Attribute field is specified in 7.3.1 [spc4r11]. If the MAM Attribute field is present and the ATTRIBUTE IDENTIFIER within the MAM Attribute contains any value other than 0008h (VOLUME IDENTIFIER), this command shall be terminated with a CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

7.1 RECEIVE CREDENTIAL parameter data

The RECEIVE CREDENTIAL parameter data is defined in Table 19.

Table 19 - Credential format

Bit Byte	7	6	5	4	3	2	1	0
0	CRED PRSNT	Reserved			CREDENTIAL FORMAT (1h)			
1	Reserved							
2	(MSB)	CREDENTIAL LENGTH (n-3)						-----
3	-----							(LSB)
4	(MSB)	CAPABILITY LENGTH (k-5)						-----
5	-----							(LSB)
6	CbCS capability descriptor							
k	-----							
k+1	(MSB)	INTEGRITY CHECK VALUE LENGTH (n-(k+4))						-----
k+4	-----							(LSB)
k+5	INTEGRITY CHECK VALUE							
n	-----							

If the Credential Present (CRED PRSNT) bit is set to zero, no CbCS credential shall be returned, and the rest of the parameter data is undefined. If the Credential Present (CRED PRSNT) bit is set to one, a CbCS credential is returned in the parameter data.

The CREDENTIAL FORMAT field specifies the format of the CbCS credential. It shall be set to 1h.

The CREDENTIAL LENGTH field indicates the length in bytes of the rest of the data (i.e. the CbCS credential) that follows.

The CAPABILITY LENGTH specifies the length in bytes of the CbCS capability descriptor field.

The format of the CbCS capability descriptor is defined in 7.1.1.

INTEGRITY CHECK VALUE LENGTH specifies the length of the INTEGRITY CHECK VALUE field.

The INTEGRITY CHECK VALUE field contains a value that the application client shall use for preparing CbCS credentials (see 2.7.3).

7.1.1 CbCS capability format

The format of the CbCS capability descriptor is defined in Table 20.

Table 20 - Capability descriptor format

Bit Byte	7	6	5	4	3	2	1	0
0	DESIGNATION TYPE				KEY VERSION			
1	SECURITY METHOD							
2	(MSB)	INTEGRITY CHECK VALUE ALGORITHM						-----
5	-----							(LSB)

Bit Byte	7	6	5	4	3	2	1	0	
6	(MSB) CAPABILITY EXPIRATION TIME								
11									(LSB)
12	AUDIT								
31									
32	PERMISSIONS BIT MASK descriptor								
35									
36	(MSB) POLICY ACCESS TAG								
39									(LSB)
40	Designation descriptor								
75									
76	DISCRIMINATOR								
91									

The DESIGNATION TYPE field (see Table 21) specifies the format of the Designation descriptor

Table 21 – DESIGNATION TYPE field

Code	Description	Reference
0h	Reserved	
1h	Logical unit designation descriptor	7.6.3.1 Table 346
2h	MAM Attribute descriptor	7.3.1 Table 278
3h - Fh	Reserved	

If the CAPABILITY FORMAT field contains any value other than the ones defined in Table 21, then this command shall be terminated with a CHECK CONDITION status, with the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

The KEY VERSION field specifies which secret key, from the set of CbCS working keys, is being used to compute the integrity check value.

The SECURITY METHOD field should be set a valid CbCS security method (see Table 22). The CbCS security methods are described in detail in 2.6.

Table 22 – The CbCS Security methods

Code	Security Method	Description
0000h	BASIC	No security (see 2.6.3)
0001h	CAPKEY	Integrity of CbCS capabilities (see 2.6.4)
0002h – 0FFFh	Reserved	

1000h – FFFEh	Vendor specific	
FFFFh	Reserved	

The INTEGRITY CHECK VALUE ALGORITHM field specifies the algorithm used to compute the integrity check value for this CbCS capability (see 2.7). It shall be set to a value defined in Table x27 in 06-449r6.

The CAPABILITY EXPIRATION TIME field specifies expiration time of the CbCS capability. The time is the number of milliseconds that have elapsed since midnight, 1 January 1970 UT. If the CAPABILITY EXPIRATION TIME field is non-zero and is less than the current time set in the device server when processing the command, the command shall be terminated with a CHECK CONDITION status, the sense key set to ILLEGAL REQUEST, and the additional sense code set to INVALID FIELD IN CDB.

If the CAPABILITY EXPIRATION TIME field contains zero, the capability has no expiration time.

The AUDIT field contains a vendor specific value.

The PERMISSIONS BIT MASK descriptor (see Table 23) specifies the permissions allowed by this CbCS capability. More than one permissions bit may be set. The device server shall verify that the bits applicable to the encapsulated command are all set to one in the PERMISSIONS BIT MASK descriptor before performing the encapsulated SCSI command.

The association of command functions to SCSI commands is defined in 2.9.1 for commands defined in this standard. Associations for specific command sets are defined in the specific command set standards.

In Table 23 byte 0 and byte 1 specify the command functions for all SCSI commands. In Table 23 byte 2 and byte 3 may be used by a device type specific command set standard to specify command functions unique to the device type. Other command set standards shall not override the definition of Table 23 byte 0 and byte 1 as defined in this standard. The associations between the command functions specified in the permissions bit mask descriptor and SCSI commands defined in this standard are specified in 2.9.1.

{{George – define a name for all these bits and use that rather than the byte/bits locations in the table.}}

Table 23 – PERMISSIONS BIT MASK descriptor

Bit Byte	7	6	5	4	3	2	1	0
0	DATA READ	DATA WRITE	ATTR READ	ATTR WRITE	SEC MGMT	RESRV	Reserved	
1	Reserved							
2	For device type specific use							
3								

A DATA READ bit set to zero indicates the encapsulated SCSI command has no read permission. A DATA READ bit set to one indicates the encapsulated SCSI command has read permission.

A DATA WRITE bit set to zero indicates the encapsulated SCSI command has no write permission. A DATA WRITE bit set to one indicates the encapsulated SCSI command has write permission.

An attribute read (ATTR READ) bit set to zero indicates the encapsulated SCSI command has no attribute read permission. A ATTR READ bit set to one indicates the encapsulated SCSI command has attribute read permission.

An attribute write (ATTR WRITE) bit set to zero indicates the encapsulated SCSI command has no attribute write permission. A ATTR WRITE bit set to one indicates the encapsulated SCSI command has attribute write permission.

A security management (SEC MGMT) bit set to zero indicates the encapsulated SCSI command has no security management permission. A SEC MGMT bit set to one indicates the encapsulated SCSI command has security management permission.

A reservation (RESRV) bit set to zero indicates the encapsulated SCSI command has no persistent reservation permission. A RESRV bit set to one indicates the encapsulated SCSI command has persistent reservation permission.

If the POLICY ACCESS TAG field contains a value other than zero, the policy access tag attribute of the logical unit (see 5.1.5) is compared to the POLICY ACCESS TAG field contents as part of verifying the capability. If the POLICY ACCESS TAG field contains zero, then no comparison is made to the policy access tag attribute of the logical unit.

If the non-zero value in the CDB POLICY ACCESS TAG field is not identical to the value in the policy access tag attribute of the logical unit (see 5.1.5), then the command shall be terminated with a CHECK CONDITION status, the sense key shall be set to ILLEGAL REQUEST, and the additional sense code shall be set to INVALID FIELD IN CDB.

The format of the Designation descriptor field is defined by the value of the DESIGNATION TYPE field. The size of the Designation descriptor shall not exceed 36 bytes.

The DISCRIMINATOR field is used in a vendor specific way to provide uniqueness of the Capability descriptor structure (see 2.5.1).

8 Misc. changes

8.1 Change in C.3.5 Variable length CDB service action codes

The variable length CDB service action codes assigned by this standard are shown in table C.8.

Service Action Code	Description
1800h	RECEIVE CREDENTIAL
1801h – 1FFFh	Reserved

8.2 Change in Table 48 — Commands for all device types

In section 6.1, add the RECEIVE CREDENTIAL command to table 48.

9 References

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