THALES

Thales Luna PCIe HSM 7

PARTITION ADMINISTRATION GUIDE

Document Information

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PREFACE: About the Partition Administration Guide

This document describes the operational and administrative tasks you can perform to maintain the functionality and efficiency of your application partitions. It contains the following chapters:

> "Key Cloning" on page 60

> "Scalable Key Storage" on page 32

> "Per-Key Authorization" on page 57

> "Multifactor Quorum Authentication" on page 90

> "Initializing an Application Partition" on page 174

> "Partition Capabilities and Policies" on page 177

> "Partition Roles" on page 200

> "Migrating Keys to Your New HSM" on page 216

> "High-Availability Groups" on page 230

> "Partition Backup and Restore" on page 278

> "Slot Numbering and Behavior" on page 341

The preface includes the following information about this document:

> "Customer Release Notes" below

> "Audience" below

> "Document Conventions" on the next page

> "Support Contacts" on page 16

For information regarding the document status and revision history, see "Document Information" on page 2.

Customer Release Notes

The Customer Release Notes (CRN) provide important information about specific releases. Read the CRN to fully understand the capabilities, limitations, and known issues for each release. You can view the latest version of the CRN at www.thalesdocs.com.

Audience

This document is intended for personnel responsible for maintaining your organization's security infrastructure. This includes Luna HSM users and security officers, key manager administrators, and network administrators.

All products manufactured and distributed by Thales are designed to be installed, operated, and maintained by personnel who have the knowledge, training, and qualifications required to safely perform the tasks assigned to them. The information, processes, and procedures contained in this document are intended for use by trained and qualified personnel only.

It is assumed that the users of this document are proficient with security concepts.

Document Conventions

This document uses standard conventions for describing the user interface and for alerting you to important information.

Notes

Notes are used to alert you to important or helpful information. They use the following format:

> **NOTE** Take note. Contains important or helpful information.

Cautions

Cautions are used to alert you to important information that may help prevent unexpected results or data loss. They use the following format:

> **CAUTION!** Exercise caution. Contains important information that may help prevent unexpected results or data loss.

Warnings

Warnings are used to alert you to the potential for catastrophic data loss or personal injury. They use the following format:

> ****WARNING** Be extremely careful and obey all safety and security measures. In this situation you might do something that could result in catastrophic data loss or personal injury.**

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Command syntax and typeface conventions

Format	Convention
bold	The bold attribute is used to indicate the following: > Command-line commands and options (Type **dir /p**.) > Button names (Click **Save As**.) > Check box and radio button names (Select the **Print Duplex** check box.) > Dialog box titles (On the **Protect Document** dialog box, click **Yes**.) > Field names (**User Name**: Enter the name of the user.) > Menu names (On the **File** menu, click **Save**.) (Click **Menu** > **Go To** > **Folders**.) > User input (In the **Date** box, type **April 1**.)
italics	In type, the italic attribute is used for emphasis or to indicate a related document. (See the *Installation Guide* for more information.)
<variable>	In command descriptions, angle brackets represent variables. You must substitute a value for command line arguments that are enclosed in angle brackets.
[**optional**] [<optional>]	Represent optional **keywords** or <variables> in a command line description. Optionally enter the keyword or <variable> that is enclosed in square brackets, if it is necessary or desirable to complete the task.
{**a**|**b**|**c**} {<a>|<b>|<c>}	Represent required alternate **keywords** or <variables> in a command line description. You must choose one command line argument enclosed within the braces. Choices are separated by vertical (OR) bars.
[**a**|**b**|**c**] [<a>|<b>|<c>]	Represent optional alternate keywords or variables in a command line description. Choose one command line argument enclosed within the braces, if desired. Choices are separated by vertical (OR) bars.

Support Contacts

If you encounter a problem while installing, registering, or operating this product, please refer to the documentation before contacting support. If you cannot resolve the issue, contact your supplier or Thales Customer Support. Thales Customer Support operates 24 hours a day, 7 days a week. Your level of access is governed by the support plan negotiated between Thales and your organization. Please consult this plan for details regarding your entitlements, including the hours when telephone support is available to you.

Customer Support Portal

The Customer Support Portal, at https://supportportal.thalesgroup.com, is where you can find solutions for most common problems and create and manage support cases. It offers a comprehensive, fully searchable database of support resources, including software and firmware downloads, release notes listing known problems and workarounds, a knowledge base, FAQs, product documentation, technical notes, and more.

> **NOTE** You require an account to access the Customer Support Portal. To create a new account, go to the portal and click on the **REGISTER** link.

Telephone

The support portal also lists telephone numbers for voice contact (Contact Us).

CHAPTER 1: V0 and V1 Partitions

Luna HSM Firmware 7.7.0 and newer preserve the traditional keys-in-hardware mode of operation and improve on it with fixes and security updates, while also adding the option to securely store more keys than will fit inside a crypto module. Traditional support of Luna features is retained in what we call version zero (V0) partitions, to distinguish from version one (V1) partitions that do the following:

> Implement "Scalable Key Storage" on page 32 to securely externally store and manage keys in vastly greater quantities than can fit inside a crypto module.

> Conform with FIPS SP 800-131A (revised).

> Comply with current and anticipated Common Criteria and eIDAS requirements (including "Per-Key Authorization" on page 57).

Partition type ==> Firmware 7.7.0 and newer	V0	V1
Description ==>	> Continues the Luna tradition of "keys always in hardware", for ongoing compatibility with existing applications and use-cases	> Adds the ability to store large numbers of keys safely within the security perimeter of the HSM in a database or file system, > Adds Per-Key Authorization capability, > ... both for RSS and other applications.

After updating to Luna HSM Firmware 7.7.0 or newer, any pre-existing partition becomes a V0 partition. If you create new partitions after the firmware update, the default is V0 with a further option to convert to V1 if there is ever a need. V0 partitions preserve your content, allow your applications to continue functioning with those partitions as they always did, and leverage the benefits of new fixes and security updates introduced with the newer firmware. To access the new features mentioned above, V0 partitions must be converted to V1 partitions after the update to Luna HSM Firmware 7.7.0 or newer. A summary of the origin of each partition type is provided in "The Origin of Each Partition Type" on the next page. For more information about converting V0 partitions to V1, refer to "Converting Partitions from V0 to V1 or V1 to V0" on page 29.

> **NOTE** V0 partitions have been designed to preserve as much compatibility as possible with your existing applications, while setting some necessary infrastructure for Luna HSM Firmware 7.7.0 features and future developments. However, the conversion of pre-existing partitions to V0 has implications for the firmware update process that must be considered before updating to Luna HSM Firmware 7.7.0 or newer. If you have not updated your Luna HSM to Luna HSM Firmware 7.7.0 or newer but plan to do so, Thales recommends reading Special Considerations for Luna HSM Firmware 7.7.0 and Newer before updating and reading the information in this section.

This section is of interest

- to customers who already have HSMs in operation and are looking to upgrade to Luna HSM Firmware 7.7.0 or newer, where possible, or
- to anyone wanting to know what differences in behavior to expect if you elect to change from the default V0 partition type to V1.

Version 7.x hardware can accept upgraded firmware, discussed in this section, and works best in conjunction with

- Luna HSM Client 10.3.0 or newer

You might be looking to migrate existing keys and objects from their application partitions to updated partitions, both for older HSM generations being supplanted, and for current hardware being updated.

The ability to migrate keys and objects from pre-firmware 7.7 to new partitions is preserved. Some new administrative commands, and new options to pre-existing commands, have been added. Any API changes are as transparent as possible to maintain the function of existing customer and partner applications.

The Origin of Each Partition Type

This section describes the origin of pre-firmware 7.7.0, V0, and V1 partitions.

Pre-Firmware 7.7.0 Partition

This is any partition on a Luna HSM from Luna 5.x and 6.x, and including Luna 7.x from firmware version 7.0 up to (but not including) version 7.7.0.

> **NOTE** When older Luna models like 5.x and 6.x are involved in migration of key material to Luna 7.x, there might be additional restrictions on the older units, such that firmware update paths must be followed before interaction with Luna 7.x HSMs is possible.
>
> Be aware also that applications making use of older HSMs might have created and used outdated key-types and cryptographic mechanisms that are not accepted (or are allowed only restricted use) by newer HSM versions, especially in FIPS-compliant operation.

V0 Partition

Any pre-existing partition, when HSM firmware is updated to version 7.7.0 or newer, becomes a V0 partition.

Any new partition, created using the default partition type (**-version** option) of the command "partition create" (in lunacm).

Any partition created on a firmware-7.7.0 (or newer) HSM, by an older client that does not know about the V0 / V1 distinction, is always V0.

The V0 status is a partition policy (#41).

V1 Partition

Any partition created with the [non-default] V1 option selected in the command "partition create" (in lunacm) becomes a V1 partition.

A V0 partition (whether created as V0 or a pre-existing partition that got upgraded with 7.7.0 firmware) can be converted to a V1 partition, without losing any contained objects. Do this by changing Policy 41 to value 1.

The Effects of Each Partition Type on HSM and Partition Functionality

The following sections describe how various aspects of HSM and application-partition functionality are affected by upgrading and by creating new partitions with the relevant creation-time options.

Partition Policy Considerations

Pre-firmware 7.7.0 Partition

There are no special considerations for pre-existing partitions, created with earlier firmware. Behavior with respect to Partition Policies is unchanged.

V0 Partition and V1 Partition

Partition policy 41 - Partition version

> Defaults to version zero (partition V0)
  - when a new partition is created on a firmware 7.7.0 (or newer) HSM
  - when a partition already exists on a pre-7.7.0 HSM that is then updated to firmware 7.7.0 (or newer)

> Becomes version one (partition V1)
  - when **-version 1** is specified as a new partition is created on a firmware 7.7.0 (or newer) HSM
  - when lunacm command **partition changepolicy -policy 41 -value 1** is issued

> V0 partition contents are preserved if/when policy 41 is set to version 1 (convert V0 partition to V1)

> The V1 status persists for the life of the partition unless command partition **changepolicy -policy 41 -value 0** is issued
  - which reverts the partition to V0, and
  - all partition contents are erased, and
  - Scalable Key Storage and Per-Key Authorization are disabled.

> Some other policies are also interdependent with the partition version status. See "Partition Capabilities and Policies" on page 177 3, 7, 31, 32, and 40.

General HSM Behavior

Pre-firmware 7.7.0 Partition

There are no special considerations for pre-existing partitions, created with earlier firmware. Behavior with respect to cloning, backup, etc. is unchanged.

V0 Partition

Behavior defaults to V0 behavior, where keys reside in hardware.

Keys can be archived to a Backup HSM or shared for purposes of redundancy and load-balancing in an HA environment, but only when securely cloned among HSMs within the same encryption domain.

Your historic applications and integrations are supported.

V1 Partition

V1 option adds key export capability when you need to support larger numbers of keys than will fit inside an HSM, yet they must remain within the secure cryptographic boundary ("Scalable Key Storage" on page 32)

The exported keys are always encrypted by a master key (SMK) that remains within an HSM and can be securely copied only to another HSM that shares the same cryptographic domain.

Admin Partition Behavior with Pre-7.7.0 HSM / Pre-10.3.0 Client

Older client software (example 7.4 or 10.2.0) cannot create a V1 partition on an HSM with firmware 7.7.0 or newer.

Similarly, if a V1 partition is created on a 7.7.0 (or newer) Network HSM appliance and linked to an older Client, the client can see the remote partition, but cannot initialize or use the V1 partition. (Expect error CKR_ACCESS_ID_INVALID)

Client must be version 10.3.0 or newer to create and work with V1 partitions (see ** at the bottom of this page).

Cloning

Pre-firmware 7.7.0 Partition

There are no special considerations for pre-existing partitions, created with earlier firmware. Behavior with respect to cloning, Key Export etc. is unchanged.

V0 Partition

When an HSM's firmware is updated to version 7.7.0 or newer, any existing partitions become V0, and all contents are updated.

Keys/objects that have newer attributes, unknown to the older firmware, can be cloned if the newer attributes are at default value (unset), allowing them to be dropped by the older, receiving HSM. If a newer security-related attribute has been set, then the object is not cloned to an older HSM that is not aware of the attribute.

Keys can be imported from a pre-7.x HSM (5.x or 6.x) into a V0 partition on the firmware 7.7.0 (or newer) HSM, just as you would any object.

When cloning objects from HSM firmware earlier than 7.7.0 into V0 partition, the size of the object increases. As such, synchronization from partition in pre-7.7.0-firmware HSM to V0 partition may fail due to storage limitation.

V1 Partition

When a new V1 partition is created, or when a V0 partition is converted to V1,

> Objects cannot be cloned from a V0 partition or from a pre-7.7.0 partition into a V1 partition, and

> objects cannot be cloned from a V1 partition to a non-V1 partition.

> **NOTE** For older Luna versions, or situations where only cloning protocol version one (CPv1) is available, the library attempts to perform the individual actions of a cloning operation in sequence on the respective partitions, opening and closing a separate session for each object to be copied. If the policies and partition types on the source and target partitions are incompatible, the **partition clone** command (or an attempted HA synchronization) can fail with a message like CKR_DATA_LEN_RANGE while trying to clone. This can occur if a key object from the source partition is a different size than an equivalent object expected by the target.
>
> **UPDATE**: Using Luna HSM Firmware 7.8.0 and newer, when a cloning negotiation agrees on the use of CPv4, a call to clone multiple keys/objects launches a *single session for all the requested objects*, rather than opening and closing individual sessions for each object. The above portion of this note about mismatched sizes remains valid.

Objects can be cloned, unwrapped, or legacy-SKS-inserted, directly to a V1 partition (i.e., SIMinsert) - note that cloning in such case is a one-way operation; V1 partitions perform outbound cloning only for SMKs.

SMK (SKS Master Key)

Pre-firmware 7.7.0 Partition

This is not applicable before firmware 7.7.0, because SKS and therefore the SMK do not exist in Luna HSM version 7 prior to firmware 7.7.0.

V0 Partition

Each V0 partition has a unique Primary SMK generated when the Crypto Officer role logs in for the first time, but it cannot be seen or used while the partition is in V0 state. However, that SMK is in place, in case you ever change partition policy 41 to make the current partition a V1 partition.

V1 Partition

Each V1 partition has a unique Primary SMK generated when the Crypto Officer role logs in for the first time, but it can also accept a replacement Primary SMK via cloning (such as when joining a partition to an existing HA group)

Each V1 partition also has additional SMK slots or holding areas for:

> Rollover SMK,

> SMKs from earlier-model HSMs,

> FM SMK for partitions with Functionality Modules enabled.

The Primary SMK secret is used to extract and to insert keys/objects; all other SMK secrets can be used only to insert keys/objects.

Behavior at Partition Level

Pre-firmware 7.7.0 Partition

There are no special considerations for pre-existing partitions, created with earlier firmware. Behavior with respect to cloning, backup, HA, etc., is unchanged.

V0 Partition

Whether pre-existing and updated, or newly created, V0 partitions should be generally indistinguishable from previous-firmware partitions -- continuing to work with your applications -- with provisos mentioned below. Cloning or Export/Import function as expected:

> from older versions (pre-firmware 7.7),

> to-or-from V0 partitions (firmware 7.7.0 or newer),

> but not back to older-version partitions.

Client versions earlier than 10.3 do not support expression of V0/V1 partition types (policy 41) for Partition Policy Template (PPT)

> **partition showPolicies -exportTemplate** does not report V0/V1 partition policy.

> **partition init -label** <somelabel> **-applytemplate** <template file> supports management of V0/V1 partition template correctly.

> Partition initialization without V0/V1 partition policy succeeds with correct default value (V0).

V1 Partition

Only the SKS Master Key (the SMK) is cloned from partition to partition, or from HSM to HSM for HA or for Backup/Restore. All other objects are encrypted with the SMK and Extracted for external storage or retrieved from external storage and inserted for use within the HSM.

Structure of Partition

Pre-firmware 7.7.0 Partition

There are no special considerations for pre-existing partitions, created with earlier firmware. Structure is unchanged until you update firmware to version 7.7.0 or newer.

V0 Partition

Partition structure is generally as for pre-7.7.0 partition, but with some updated overhead taking up some space; a completely filled pre-7.7.0 partition would need more room for objects after migration/firmware-update, but this is taken care of by partition size increases, as needed, during firmware update. The increase is enabled by an increase in available memory that is also part of the update process (see below).

V1 Partition

When a new partition is created at V1 or a V0 partition is converted to V1, the new structural overhead applies, including the space allotted for Primary and other SMKs.

Also, some keys can have new/additional attributes necessary to satisfy newer crypto and security standards.

Objects in a Partition

Pre-firmware 7.7.0 Partition

Object characteristics and behavior are unchanged until you update firmware to version 7.7.0 or newer.

V0 Partition

Memory allotment is increased (from pre-7.7) to allow increased partition size, all pre-existing keys and all new keys receive new attributes (if applicable to key type) but those attributes are not used for anything in V0 partitions (see * at the bottom of this page).

> **NOTE** The doubling of the memory allotted to partitions does not double the key capacity of partitions. It increases headroom to allow for increases in the data space required by keys, to accommodate new features and abilities, and does not alter published baselines for key capacity.

V1 Partition

Memory allotment is increased (from pre-7.7) to allow increased partition size. There are no pre-existing keys in new V1 partitions, and all new keys receive the new attributes.

> **NOTE** The doubling of the memory allotted to partitions does not double the key capacity of partitions. It increases headroom to allow for increases in the data space required by keys, to accommodate new features and abilities, and does not alter published baselines for key capacity.

Memory

Pre-firmware 7.7.0 Partition

Memory availability and usage are unchanged until you update firmware to version 7.7.0 or newer.

V0 Partition and V1 Partition

Size limit with FW version< 7.7.0	New size limit after upgrading to FW version >= 7.7
2 MB	4 MB
16 MB	32 MB
32 MB	64 MB

Example after mid-size update:

```
Partition Storage:
                    Total Storage Space:  3306327
                    Used Storage Space:   0
                    Free Storage Space:   3306327
                    Object Count:         0
                    Overhead:             15560
```

> **NOTE** The doubling of the memory allotted to partitions does not double the key capacity of partitions. It increases headroom to allow for increases in the data space required by keys, to accommodate new features and abilities, and does not alter published baselines for key capacity.

In summary, if you could store X-number of a given size of keys on your partition or HSM, then you can still store them all after 7.7.0 f/w update. The increase, at each allotment level was chosen to accommodate increased partition overhead and object size changes, plus some extra just in case (see * at the bottom of this page).

Behavior at Key Level

Pre-firmware 7.7.0 Partition

Key object characteristics and behavior are unchanged until you update firmware to version 7.7.0 or newer.

V0 Partition and V1 Partition

Some key types and algorithms might have constraints on the allowed uses of some older key and algorithm types and sizes, due to changes in the security and threat environments over time.

Check the latest mechanism summary tables in the SDK.

As with any firmware version update, some key types might be newly added, and some existing key types might have attributes that are used differently from previous. Where this might become apparent is when keys are replicated in an HA group with a mix of HSM firmware versions - for example, an existing application might attempt to make use of key sizes that are recognized as too small and of low security by group members with newer firmware, or a newer application might make use of newer attributes that are not recognized by older firmware (see Per-key Authorization, below, for example).

Partition Policy Template

Pre-firmware 7.7.0 Partition

partition showPolicies -exportTemplate generates a template file containing current policy settings

partition init -label <label> **-applytemplate** <template file> applies an existing template with the contained policy settings

V0 Partition

Both commands behave the same as in previous versions. V0 partitions have some policies that do not exist in pre-7.7.0 partitions. As long as none of the policies in your template conflict with the state of a new policy, your pre-existing templates should work correctly. Any policy that is not mentioned in a template is set to its default value when the template is applied.

If there is a mismatch between template policies and the default values of newer or dependent policies, then the attempt to apply the old policy would fail with CKR_FAILED_DEPENDENCIES.

You have the option to edit a policy file before applying it, to add newer policies.

V1 Partition

The default for new partition creation with firmware 7.7.0 (or newer) is a V0 partition. You could apply your PPT to creating a V1 partition only by pre-editing the policy template file to include setting policy 41 to a value of 1.

See also the lists of dependencies below the table at "Partition Capabilities and Policies" on page 177.

Per-Key Authorization

Pre-firmware 7.7.0 Partition

This is a new feature with firmware 7.7.0 and has no bearing on partitions at earlier firmware versions.

V0 Partition

Partition Policy 40 Enable Per-key Authorization Data defaults to 0 (zero, or off) for V0 partitions, and cannot be turned on. V0 partitions do not immediately provide per-key authentication data or attributes upon conversion to this partition version and key objects received from partitions on other HSMs (7.x-pre-7.7.0 HSMs, as well as 5.x and 6.x HSMs) come into the partition without auth data.

V1 Partition

Partition Policy 40 Enable Per-key Authorization Data defaults to 1 (one, or on) for V1 partitions, and can be turned off for performance.

Relevant keys have attributes, and are automatically assigned the CKA_AUTH_DATA attribute, that allow HSM owner to provide individual users access to specific keys for Sole Ownership and Control, such as in Remote Signing and Sealing applications.

Special considerations apply when importing key objects without per-key auth data into a Luna 7.7.0+ partition that enforces per-key authentication. For more information, refer to Migration Scenarios for Per-Key Auth.

Multifactor Quorum Authentication

Pre-firmware 7.7.0 Partition

Behavior of partitions at earlier firmware versions continues as-is (except see exceptions in next paragraph, if PEDs are updated).

V0 Partition and V1 Partition

- Luna PEDs with firmware 2.7.4 or 2.9.0 or newer can function with Luna HSM 7.7.0 and newer HSMs that have been updated for compliance with eIDAS/Common Criteria and NIST 800-56A standards.
- When an HSM is at firmware version 7.7.0 or newer, it verifies that any connecting PED is at PED firmware 2.7.4 or firmware 2.9.0, or the HSM refuses the connection and issues an error.
- The RPV of an orange PED key, created with PED firmware 2.7.4 or 2.9.0 against a firmware 7.7.0 HSM has additional features compared to previous RPV, necessary for current authentication standards.

> PEDs with firmware older than 2.7.4 or 2.9.0 can do the following:
  - Use a newer RPV, which was created with PED firmware 2.7.4 or 2.9.0 against a Luna HSM with firmware 7.7.0. However, the PED remains unaware of the newer security components.
  - Duplicate a newer RPV onto another orange key while only imprinting the older security components; that is, the newer security components are lost. The duplicated RPV can then be used with pre-firmware-7.7.0 HSMs, but since the newer security components are missing, the 'duplicate' orange key (and any copy of it) cannot be used with HSMs at version 7.7.0 or newer.

> For Remote PED operation,
  - any blank RPK must first be provisioned with new Critical Security Parameters (CSP) via a local PED connection;
  - the content of a previously provisioned orange Remote PED Key (RPK) with old CSP must be migrated to new CSP. The same is true for a newer-style RPV that had the newer security components stripped by copying with a non-updated PED, as described above. For more information, refer to Migrating Existing Orange Remote PED Keys.
  - When the ped vector init' command raises the PED prompt about "reuse an existing keyset?", this will lead to RPK migration (old to new).

> For Local PED, the local-connection handshake is now similar to that being used for updated, improved-security connections with Remote PED.

Client Software Interaction

Pre-firmware 7.7.0 Partition
Newer client software can include commands and options that are not applicable to partitions in older-firmware HSMs.

V0 Partition
Older client software (example 7.4) can create only a V0 partition on an HSM with firmware 7.7.0 or newer (see ** at the bottom of this page).

V1 Partition
Older client software (example 7.4 or 10.2.0) cannot create a V1 partition on an HSM with firmware 7.7.0 or newer.

Similarly, if a V1 partition is created on a 7.7.0 (or newer) Network HSM appliance and linked to an older Client, the client can see the remote partition, but cannot initialize or use the V1 partition. (Expect error CKR_ACCESS_ID_INVALID)

Client must be version 10.3.0 or newer to create and work with V1 partitions (see ** at the bottom of this page).

Client-Mediated High Availability

Pre-firmware 7.7.0 Partition
HA behaves as it always has, for pre-7.7.0 HSMs.

V0 Partition

Generally as-is (backward compatible) except for any provisos around permissibility of certain mechanisms and key sizes, such as in FIPS mode, and the usual considerations where an HA group should have all members at the same firmware .

Migration must be done via Luna Backup HSM while any application partitions on an HSM being updated to firmware 7.7.0 (or newer) must be removed from any HA group, at the time. The partitions can become members of HA groups after all are at the newer version.

Key/object replication among HA group members continues to use cloning.

V0 primary partitions in an HA group cannot synchronize with other members on a pre-7.7.0-firmware HSM.

A V0 partition on an appliance with HSM firmware 7.7.0 (or newer) can be added to an existing HA group that already has HA members made up of partitions from an HSM with pre-version-7.7.0 firmware.

V1 Partition

With V1 partitions, HA must function with SKS as the method of object / key replication among members, rather than cloning. Because this type of HA is client-mediated, you need Luna Client 10.3.0 or newer.

V1 partition can be added to an existing HA group that already has HA members made up of partitions from a pre-7.7.0-firmware HSM. However, when V1 partition becomes the primary member of the HA group, synchronization with remaining member of the HA group will no longer function.

An HA group with V1 partitions must have all members at V1 and all members sharing the same SMK.

A V1 partition cannot be a member of more than one HA group unless both groups have the same SMK. If a member of an existing HA group is added to a different HA group with a different SMK, the new member takes on the SMK of the new HA group and ceases to function properly in its original group (and should be removed).

High Availability Indirect Login

This type of HA is set up and managed by means of the HA Indirect Login API (a.k.a. "roll your own HA"), and does not rely on the Client.

Pre-firmware 7.7.0 Partition

HA behaves as it always has, for pre-7.7.0 HSMs (see High Availability Indirect Login Functions Prior to HSM Firmware 7.7.0).

V0 Partition and V1 Partition

For adjustments to API and behavior, see High Availability Indirect Login For HSM Firmware 7.7.0 and Newer

Functionality Modules

Pre-firmware 7.7.0 Partition

FM behavior is as previously, for pre-7.7.0 HSMs.

V0 Partition and V1 Partition

Backup HSM (G5) at firmware 6.28 - FM-vs-non-FM support

	to HSM FW <= 7.4 FM	to HSM FW <= 7.4 non-FM	to HSM FW 7.7 V0 FM	to HSM FW 7.7 V0 non-FM	to HSM FW 7.7 V1 FM	to HSM FW 7.7 V1 non-FM
From HSM FW 7.4 FM	**yes**	no	**yes**	**yes**	**yes**	**yes**
From HSM FW 7.4 non-FM	no	**yes**	no	**yes**	no	**yes**

"**yes**" indicates a supported backup/restore path

Partition Roles

Pre-firmware 7.7.0 Partition

Roles and their behavior remain as-is for pre-7.7.0 HSMs.

V0 Partition

As in pre-7.7.0

V1 Partition

V1 partitions add the Limited Crypto Officer role for Per-Key Authorization operations see "Partition Roles" on page 200.

Backup/Restore

Pre-firmware 7.7.0 Partition

Backup and restore remain as-is for pre-7.7.0 HSMs.

V0 Partition and V1 Partition

Use of Luna Backup HSM G5 with V0 or V1 partitions implies Backup HSM firmware 6.28 and Luna Client 10.3 (or newer). Both the Client and the RBS server version must be aligned -- that is, the RBS server must be installed from the 10.3 Client or newer, replacing any previous RBS server.

A Luna Backup HSM G5 with firmware earlier than 6.28.0 can restore onto a partition in a firmware-7.7.0 (or newer) HSM, but the Luna Backup HSM G5 must be at firmware 6.28.0 in order to properly backup from a version 7.7.0 (or newer) application partition. In other words, if your Luna Backup HSM G5 is not updated, then its contents can be considered a backup for key-migration, but not a production backup for firmware 7.7.0 (and newer) HSM partitions.

If there is a need to maintain an older version of client library for your main application and to use Luna Backup HSM G5 firmware 6.28.0 for backup/restore purposes, then you must have a separate workstation dedicated for running the RBS server from Luna Client 10.3.

Even if RBS service is not required, you would still need the separate workstation to run lunacm to take advantage of Luna Backup HSM G5 firmware 6.28.0.

Luna Backup HSM (G5) at firmware 6.28.0 used locally with Luna Network HSM appliance with software <=7.4

	to HSM FW <= 7.4	to HSM FW 7.7 V0	to HSM FW 7.7 V1
From HSM FW <= 7.4	not recommended	supported	supported

See also the functionality module-related Luna Backup HSM G5 concerns, above on this page.

> **NOTE** To perform backup operations on Luna HSM Firmware 7.7.0 or newer (V0 or V1 partitions) you require at minimum:
>
> > Luna Backup HSM 7 Firmware 7.7.1
> >
> > Luna Backup HSM G5 Firmware 6.28.0
>
> You can use a Luna Backup HSM with older firmware to restore objects to a V0 or V1 partition, but this is supported for purposes of getting your objects from the older partitions onto the newer V0 or V1 partitions only. V0 and V1 partitions are considered more secure than partitions at earlier firmware versions - any attempt to restore from a higher-security status to lower-security status fails gracefully.

The Limited Crypto Officer role does not do cloning, and therefore cannot transfer the current partition's SMK to a Backup HSM for SKS backup.

(* If you had thousands of very small keys, you would notice a definite increase in the partition space taken by those keys after update.
If you had 100 big keys or fewer in the partition, you would barely notice a change in required space, as the overhead [new attributes] per key is proportionately much smaller against an individual large key.)

(** Luna Cloud HSM software has historically been named/numbered for the associated HSM version. The Client numbering has been restarted at 10.x to decouple from specific firmware and software versions.)

Converting Partitions from V0 to V1 or V1 to V0

> **CAUTION!** Back up any important keys and objects before proceeding.

This section describes how to convert partitions from V0 to V1 and from V1 to V0. It assumes that you have updated your Luna HSMs to Luna HSM Firmware 7.7.0 or newer, with all pre-existing partitions automatically converted to V0. For more information about V0 and V1 partitions, refer to "V0 and V1 Partitions" on page 17.

Converting a Partition From V0 to V1

To convert a partition from V0 to V1, the procedure differs, depending on whether the partition is a member partition of an HA group or a non-member partition.

Converting a non-member partition from V0 to V1

To convert your non-member partitions to V1 partitions with minimum application downtime, use the following procedure.

To convert a non-member partition from V0 to V1

1. Have the chosen partition visible in lunaCM.
2. Select that partition with the lunaCM command **slot set -slot** <slot number>
3. [Optional] Show the current partition policy values and verify that policy 41 is set to version 0, **partition showpolicies**
4. Log in to the partition as the Partition Security Officer with **role login -name po**
5. Change the value of **Partition Policy 41: Enable Partition Version** to version 1, with **partition changepolicy -policy 41 -value 1**

Converting an HA group member partition from V0 to V1

To convert your HA group member partitions to V1 partitions with minimum application downtime, use the following procedure. This procedure is performed by the HSM SO for each Luna PCIe HSM 7, the Partition SO and Crypto Officer for the HA group members.

Prerequisites

> You must be aware of the guidelines for upgrading an HA member partition to *any* firmware version and adhere to them carefully. For more information, read "Guidelines and Recommendations For Updating or Converting HA Member Partitions" on page 276.

> **NOTE** You must update/convert secondary partitions first and the primary partition last. If you do not adhere to this guideline, you may experience issues while updating/converting.

> You require **admin**-level access to the Luna PCIe HSM 7.

To convert an HA group member partition from V0 to V1

1. Migrate the HA group to V0 by completing the procedures described in Migrate High Availability Groups to Luna HSM Firmware 7.7.0 or Newer for every member partition.
2. On the client workstation that administers the HA group, stop all client applications.
3. Update the Luna HSM Client software to Luna HSM Client 10.3.0 or newer (see Updating the Luna HSM Client Software).
4. [Optional] You may now restart your client applications, or wait until the end of the procedure.
5. Launch LunaCM and use the following procedure to convert each HA member partition to V1. To prevent the HA group serial number from changing and disrupting your client applications, the member originally used to create the group must be the last member still remaining in the group:

> **NOTE** The member partition that has the same serial number as the HA group, minus the leading **1**, is the original member.

a. Remove a member partition from the HA group (see "Adding/Removing an HA Group Member" on page 261).

   lunacm:> **hagroup removemember -group** <label> {**-slot** <slotnum> | **-serial** <serialnum>}

b. Log in as Partition SO.

   lunacm:> **role login -name po**

c. Convert the partition to V1 by changing partition policy **41: Partition Version**.

   lunacm:> **partition changepolicy -policy 41 -value 1**

d. Repeat steps **a**-**c** until only the original member remains in the HA group.

e. When only the original member remains in the group, log in as Partition SO and convert it to V1. This member's SMK will be the one used for the entire HA group (see "Scalable Key Storage" on page 32 for more information).

   lunacm:> **role login -name po**

   lunacm:> **partition changepolicy -policy 41 -value 1**

f. Add each V1 partition back to the HA group (see "Adding/Removing an HA Group Member" on page 261). The primary member's SMK is automatically cloned to each new member added to the HA group.

   lunacm:> **hagroup addmember -group** <label> {**-slot** <slotnum> | **-serial** <serialnum>}

Converting a Partition From V1 to V0

1. Backup any valuable keys or objects.

   > **CAUTION!** This operation, going from V1 back to V0, is destructive. All objects on the partition are destroyed, as well as the SMK(s). If any valuable objects were created and archived from a version one (V1) partition, then they must have been SKS-stored off the HSM, and the SMK that encrypted those objects must be preserved on a Backup HSM or in another partition (that remains at V1), if those objects might ever be needed in future.
   >
   > If no valuable SKS blobs have been encrypted by the partition's current SMK, then there is no need for backup.

2. Have the chosen partition visible in lunaCM.
3. Select that partition with the lunaCM command **slot set -slot** <slot number>
4. [Optional] Show the current partition policy values and verify that policy 41 is set to version 1, **partition showpolicies**
5. Log into the partition as the Partition Security Officer with **role login -name po**
6. Change the value of policy 41 to version 0, with **partition changepolicy -policy 41 -value 0**

CHAPTER 2: Scalable Key Storage

This section describes the Scalable Key Storage (SKS) feature for Luna HSMs and assumes the following:

> You understand the differences between V0 and V1 partitions and how these partitions affect the operation of Luna HSM. For more information, refer to "V0 and V1 Partitions" on page 17.

> You plan on converting a partition from V0 to V1. For more information, refer to "Converting Partitions from V0 to V1 or V1 to V0" on page 29.

You do not need anything on the pages in this section *until* you convert an existing V0 partition to V1 or create new version one (V1) partitions, which will be using the new cloning protocol and SKS feature.

What is Scalable Key Storage?

SKS is virtually unlimited secure storage and handling of your sensitive keys.

By default, keys have resided in HSM hardware for Luna HSMs. This remains true, by default, with the introduction of Luna HSM Firmware 7.7.0. However, firmware 7.7.0 (and newer) adds key export flexibility to expand the Luna HSM's assurance boundary, to encompass much greater numbers of keys than the internal capacity of an HSM.

Keys secure anywhere, the SKS eIDAS model

Beginning with Luna HSM Firmware 7.7.0, you have the option to use the Scalable Key Storage (SKS) feature by converting or creating a partition as Version 1 (V1). When a partition is created, it is given a unique SKS Master Key (SMK) (See "V0 and V1 Partitions" on page 17).

SKS is based upon a model where keys generated on the HSM:

> are securely extracted as encrypted SKS objects and

> are inserted back into the HSM, to be temporarily decrypted, when cryptographic operations are to be performed with those keys.

Similarly, when a unique key encrypts data, the data and the key can be stored as an encrypted **b**inary **l**arge **o**bject (blob) up to 64KB in size, that can be decrypted only within the HSM.

If the HSM is upgraded from an earlier HSM firmware version to Luna HSM Firmware 7.7.0 or newer, then any existing partitions become version zero (V0). Similarly, if you create a new partition on a Luna HSM Firmware 7.7.0 (or newer) HSM, with the default "-version 0" option, it becomes a V0 partition. A V0 partition retains compatibility with older partitions and applications:

> that rely on cloning (secure copying/moving of objects between HSMs or HSM partitions or Backup HSMs, also known as Keys Always in Hardware)

> while benefiting from fixes and security updates that come with the new firmware, but with no access to the newer eIDAS-mandated features.

If you create a new partition in an HSM with Luna HSM Firmware 7.7.0 or newer, and select the V1 option (**-version 1**), then the new partition is version one (V1) and gets a unique SMK and uses SKS (rather than cloning) to replicate keys for HA or to Backup and Restore. The partition also engages Per Key Authorization and other eIDAS related features, but is incompatible with V0. You can also update a V0 partition to V1 while retaining existing objects (but de-converting, or converting back is not an option).

Here is what you will find in the pages of this section:

> "What is Scalable Key Storage?" on the previous page

> "When to use SKS" on the next page

> "SKS model" on page 35

- "How does SKS work?" on page 36
- "Limitation and scalability" on page 37

> "Characteristics of the SKS Implementation" on page 37

- "Characteristics and Implementation Notes" on page 37
- "Functional Notes" on page 38
- "SMK Locations in a Partition" on page 38

> "High Availability and SKS" on page 39

> "Preparing and Administering SKS Partitions " on page 40

- "Provisioning SKS" on page 40
- "Replicating the SMK to another SKS Partition" on page 40
- "Backing up the SMK" on page 41
- "Restoring the SMK from Backup" on page 41
- "Preparing to use SKS" on page 41

> "Using SKS" on page 42

- "Using SKS - options" on page 42
- "API" on page 43
- "ckdemo example" on page 43
- "Java Sample" on page 44
- "High Availability" on page 44
  - "Constraints on SKS HA" on page 44
  - "Replicating the SMK to all group members" on page 45
  - "When NOT to address the virtual slot" on page 46

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- "Cloning the SKS Master Key (SMK)" on page 53
- "SKS Blob Migration" on page 55

When to use SKS

When would it be appropriate to use SKS?

Use SKS when you need to handle greater numbers of keys and objects than can be stored within the HSM, and you want to employ methods more secure than wrap-off / wrap-on. You would also use it when needed to comply with a regulatory regime like eIDAS.

Any application where large numbers of very sensitive keys or records must be protected with the highest possible security, while remaining available and accessible to authorized users and applications, is a candidate for the Luna HSM with Scalable Key Storage. The SKS method - in contrast with merely wrapping-off/unwrapping-on - is needed when the HSM must be the assurance boundary for the keys. If it is permissible for the key material to originate outside the assurance boundary, or to reside outside the assurance boundary, then the extra security of SKS is not required.

A general use case for SKS is storing encrypted keys in external databases.

> Generate keys inside the cryptographic module.
> Using the SIMExtract API, extract the encrypted keys and store them in external databases and delete the original keys inside the cryptographic module.
> Insert individual encrypted keys back into the HSM when you need to use them for cryptographic operations inside the cryptographic module.

One example might be the creation and use of electronic signatures (for natural persons) or electronic seals (for organizations) for remote signing (RSS). The signatures or seal key materials are created within the HSM, extracted (not wrapped) in strongly encrypted form that preserves attributes, and stored in a repository. When they are needed, they are found in the repository by the managing system, inserted into the HSM for decryption by a master key that never resides outside an HSM, then used for signing or sealing respectively, and discarded from the HSM (the encrypted versions remain stored in the repository for the next time they are needed).

Another example might be a database of customers, with their contact and shipping information, credit-card information, history of purchases, current/recent browse interests on your commerce site, etc. All of that is likely to be sensitive information protected by regulations and by your own published privacy policies. In this case, the primary concern is privacy of data.

A third example might be a government database of land ownership, including detailed and official property descriptions, current ownership with identifying details, history of title transfers, subdivisions, legal rulings and encumbrances (such as rights of way and covenants), liens, and so on. In this case, the data is meant to be publicly viewable, but its integrity against unauthorized change is paramount.

Security consideration

Various models exist in the industry for handling of huge numbers of sensitive keys and objects. An important consideration is the manner in which the keys and objects are handled.

Method	Security
Wrap-off/wrap-on	Keys and objects can have unknown, uncontrolled origin, potentially outside the assurance boundary. Keys and objects can potentially be accessed outside the HSM, made available and used externally, in potentially unsafe environments. . Keys can have security attributes stripped.
SKS extract/insert	The history of keys and objects is known, controlled, auditable. Keys and objects remain within the security and access perimeter of the HSM. The master key never exists outside a Luna HSM, and all extracted keys and objects must be inserted back into the HSM at time of decryption and use. Keys retain their attributes.

SKS model

On this page:

- "How does SKS work?" on the next page
- "Limitation and scalability" on page 37

In an SKS model, in compliance with relevant standards, an application maintains thousands or millions of encrypted objects as records in a repository (such as a database, file system, cloud storage, etc.). SKS does not impose any restrictions on where or how you store encrypted blobs; although constraints like record-size might come into play depending on the type of storage in your implementation. The repository might have each record/object encrypted with a unique key. Examples of applications might include Remote Signing identities (Common Criteria PP 419221-5 use case). The salient points, for SKS, are that:

> Encryption and decryption of objects must take place in the cryptographic module.

> More individual object-encryption keys are needed by the application than can be accommodated by the internal capacity of any cryptographic module.

> Records or objects, and the keys that encrypt them, do not exist in-the-clear - both the record (data object, ID, etc.) and its encrypting key are stored in encrypted form.

> Keys that encrypt objects or signatures must have originated within the assurance boundary (a.k.a. security perimeter of the cryptographic module (HSM)) and are only ever decrypted within the assurance boundary.

> An object can be inserted into any cryptographic module (HSM) version that supports the same version of SKS and supports the same attributes that the original HSM supports for that object.

> **NOTE** Objects extracted from a current-version HSM can be inserted into older version HSMs with known vulnerabilities -- for security reasons, this should be avoided; as a best practice, keep your appliance software and crypto-module firmware up-to-date.

> Objects extracted from an HSM with Functionality Modules disabled cannot be inserted into an HSM with FMs enabled (including via backup/restore operations) - security rules prevent moving keys from a more-secure to a less-secure environment.

How does SKS work?

A key is created in an HSM partition at the direction of an application.

It might be intended as an ID for purposes of signing documents and verifying by private persons, or for sealing of documents and records by organizations.

It might be intended to encrypt records stored in an external database (perhaps customer-identifying records, perhaps medical records, perhaps supply-chain information, or other uses that require privacy and controlled access).

> Each record-encrypting key, or ID key, when not in immediate use inside a cryptographic module, is itself encrypted for extraction by an extraction/insertion key derived (in compliance with NIST SP800-108) from a master encryption key that never leaves the HSM; this is the SKS Master Key, or SMK.

> From the application's perspective, the data record, or the key/cert-as-ID, emerges from the HSM uniquely encrypted as a secure SKS blob (**b**inary **l**arge **ob**ject up to 64KB) that remains within the HSM's security and access perimeter, so it can be safely stored anywhere.

> The operations that an application might perform are:

- creating an identity or a record or data object
- acquiring a suitable key (SKS key) for encrypting that record or data object by either
  - requesting a new object-encryption key (new SKS key) to be generated by the HSM, or
  - providing an already existing object-encryption-key (SKS key) for the HSM to use
- encrypting that ID or object with the new SKS key, (or with the pre-existing, supplied SKS key, which must first be inserted and decrypted for use by the HSM)
- storing the encrypted record or key within the repository
- retrieving the encrypted record or key at a later time (when called by the application)
- inserting/decrypting the SKS blob into the HSM, using the SKS Master Key (SMK)
- using the decrypted key
  - to sign or seal documents or transactions in the case of RSS, or
  - to further decrypt a database record for reading or editing and then re-encrypting the record if it changed and sending the re-encrypted changed record back to storage
- deleting / destroying the material from the HSM (cryptographic module), once it is not needed (the encrypted SKS blob still exists in the external repository, for the next time it is required)

> The application is responsible for the storage and availability of the SKS object in the repository of choice (database, file system, directory, NAS, cloud, etc.).

It is possible to create data objects to store any kind of data in an HSM partition, SKS blobs included (which is essentially what is done if you choose to archive SKS objects in a Backup HSM). However, a practical workflow involving large numbers of keys or sensitive data objects, is assumed to include backing up SMKs, but not SKS blobs, since the latter are already securely encrypted and can be stored anywhere that is reasonably secure, and in numbers far greater than the capacity of any cryptographic module. However, we cannot anticipate all use-cases, and the onboard storage option exists.

To summarize, the options for SKS blobs (SMK-encrypted keys and objects) include:

> Storage of limited numbers of keys and objects encrypted within the cryptographic module;

> Storage of a larger, but still limited number of keys and objects encrypted within a backup HSM;
> Storage of a still larger number of encrypted keys and objects within the file system of the host;
> Storage of a virtually unlimited number of encrypted keys and objects across databases or networked file systems.

Optionally, such as in the case of Trust Service Providers, during the SKS object creation process, authentication can be added such that a password must be provided before the keys in an SKS object can be used.

SKS objects use 256-bit AES-GCM encryption for confidentiality and integrity protection.

Limitation and scalability

Because the SKS objects are stored external to the cryptographic module (but must be individually inserted back into the crypto module before use), there is *no capacity limitation* from an HSM perspective. The only scalability limitation would be based upon the number of SKS operations to be performed simultaneously (that is, SKS object creation/extract/insert, and resulting cryptographic operations).

In a Luna HSM at firmware 7.7.0 or newer, partitions are either V0 or V1.

> **In V0 partitions**, keys and objects are handled generally as in previous versions, depending on the type of crypto module configuration (cloning, key extraction, etc.); cloning of objects, such as for backup, HA, etc., is performed as you and your applications have always done, using Luna HSMs. All copying of keys and objects is done between application partitions or Backup partitions that share a security/cloning domain

> **In V1 partitions**, SKS is used. Other than for some SMK management operations, the copying and moving operations for partition objects/keys/etc., have been kept as similar to historic handling as practical. Thus, while the cloning commands are used, only the SMK is ever cloned in the Luna-traditional sense.

  Cloning operations (like Backup, and like HA-group synchronization) for V1 partitions use cloning for the SMK, but also seamlessly invoke SKS to transfer or extract/insert keys and objects as blobs encrypted by the SMK. Thus, encrypted keys/objects *can* be copied securely to another partition or a Backup HSM, if the quantity/storage usage is within the capacity of the receiving partition.

  Recall that partitions are created with default sizes, but you can specify to use up to all remaining space in the cryptographic module and you could store a number of keys/objects as SKS blobs within such a partition, but for large quantities, it is expected that you would store them encrypted in the HSM appliance's file system or external database, while maintaining them within the cryptographic module's security boundary.

Characteristics and Implementation Notes

On this page:

- "Characteristics and Implementation Notes" above
- "Functional Notes" on the next page
- "SMK Locations in a Partition" on the next page

Characteristics of the SKS Implementation

> The SKS feature is implemented at the application partition level; this differs from the older SKS protocol that was applied HSM-wide.

> The SKS mechanism complies with the per-key authorization requirements of Common Criteria PP 419221-5 ("Per-Key Authorization" on page 57).

> The cryptographic mechanisms employed by SKS comply with the FIPS 140-2 and PP 419221-5 standards (Secure External Scalable Key Storage Extensions).

> A migration path is available for customers using the Luna HSM firmware 6 SKS protocol, such that existing customer applications continue to work against the SKS implementation.

> For certification requirements and/or security best practices, the following are not allowed:

- The SKS implementation prevents objects that are extracted from an HSM with firmware 7.x being inserted into an older version of the HSM that might have known vulnerabilities.
- The SKS implementation prevents objects that are extracted from an HSM that has Functionality Modules (FMs) *disabled*, from being inserted into an HSM that has FMs *en*abled (or ever had FMs *en*abled) - doing so via a backup HSM is also prevented.

Functional Notes

SKS supports the following functionality:

> You can extract all key objects within a given partition by specifying an empty list on the input. Otherwise, specify only individual objects that you wish to extract at one time.

> You have the option to impose/require two possible authentication methods when extracting key objects:

- None (no extra authentication data)
- Password (MofN supported)

> The AES-GCM algorithm is used for encryption of objects during the creation of SKS blobs (extraction from the partition) or decryption upon insertion of an external SKS blob into the partition.

> You can see, and practice, examples of such usage in the ckdemo utility :

- OFFBOARD KEY STORAGE Menu Functions

SMK Locations in a Partition

Each SKS-capable partition supports several types of SMK, each with its own location and limitations within the partition.

The **Primary SMK**, generated at partition initialization time, or replaced via **partition smkclone** command from another partition, resides in the Primary SMK location in the partition, and is used for extraction and insertion operations. Only the firmware 7.x primary SMK can be used for extraction. No path is allowed for extraction to older-version HSMs and partitions.

The **Rollover SMK** location holds the replaced primary, when **partition smkrollover start** command creates a new primary SMK. The rollover SMK is retained while SMK rollover is taking place, to allow all SKS blobs that were encrypted/extracted with the old SMK to be brought back into the HSM partition so that they can be re-extracted with the new primary SMK. When **partition smkrollover end** signals the completion of the rollover operation, the rollover SMK is deleted and the new Primary SMK remains.

The **FM SMK** location is specifically for transfer from an FM-enabled partition to an FM-never-enabled partition. That is, a **partition smkclone** command from an FM-enabled HSM partition places the source Primary SMK into the FM SMK location of the target partition. This ensures that key material can be transferred from FM-enabled

partitions to FM-never-enabled partitions. It is not permitted to move key material from FM-never-enabled partition to FM-enabled partition, because a Functionality Module could extract in plain text. Similarly, there is no FM SMK rollover location.

The **Firmware 6 SMK** location can contain an SMK from a firmware 6.x HSM (if one has been cloned in) for the purpose of inserting SKS blobs that were extracted from a firmware 6.x partition. After insertion of such older blobs, the key material is extracted as a new firmware 7 SKS blob, encrypted via the partition's primary SMK. Whenever a partition is on the receiving end of a **partition smkclone** operation, any contents of the primary and non-primary locations from the source partition overwrite their equivalent locations in the target partition.

High Availability and SKS

To address performance and availability requirements SKS supports high availability configurations similar to Luna HSM Cloning models, with some minor differences. High availability and load balancing is implemented in the Luna Cloud HSM software and is completely transparent to the application, in that the application is configured to use a virtual slot and not a physical slot on the HSM.

One difference, from cloning HSMs in HA configuration is that, for SKS HA, the **hagroup addmember** command clones the SMK from the initial SKS application partition to all other group member partitions as they are added. Thereafter, your application deals with the HA virtual slot, and HA operation is automatic.

> **NOTE** **V1 partitions:** If you add an application partition with an existing SMK to an HA group, the primary member's SMK overwrites the existing SMK of the joining partition.
>
> If a partition's SMK has ever been used to encrypt important SKS objects, save a backup of the SMK before adding that partition to any HA group.

> **NOTE** If a remote partition is involved (Network HSM) on either side of the SMK cloning operation, the HSM that contains the remote partition must have Network Replication enabled. See HSM Capabilities and Policies "Policy 16 - Allow network replication".

When the application needs to perform a cryptographic operation, it employs the SKS API call, which imports an SKS object into the HSM. In an HA configuration, the Luna HSM Client also replicates the SKS blob to all HSMs that have been included in the defined HA group (by performing sksExtract from the source partition and sksInsert into the target partition as a single, combined operation, repeated for each), unless HA synchronization is turned off. When the application requests the "HSM" to perform a cryptographic operation (sign, encrypt, decrypt, etc.) the Luna HSM Client load balances the request to the application partition that is available, in essence making the SKS operation stateless. The SKS operation succeeds because all partitions in the HA group have a copy of the imported SKS object.

Replication of objects in HA is accomplished by SKS feature's SIM`extract` and SIM`insert` in one call, transparently.

> **TIP** If your primary use-case is to insert a key and use it for one signing operation, then consider using the multisign API for better performance with SKS under HA, since invoking multisign would use the key on just the one physical partition, and would avoid the overhead of having the inserted key replicated unnecessarily to other HA group members.

> **NOTE** HA failover is not supported in the case of member failure during a SIMInsert, SIMExtract, or SIMMultisign operation.

Preparing and Administering SKS Partitions

On this page:

"Provisioning SKS" below

- "Replicating the SMK to another SKS Partition" below
- "Backing up the SMK" on the next page
- "Restoring the SMK from Backup" on the next page
- "Preparing to use SKS" on the next page

Checklist

The following subsections describe briefly what you need

> to set up one or more SKS partitions ready for use,

> to backup and restore SKS Master Keys (SMK) from-and-to the SKS partition, and

> to directly replicate the SMK from one SKS partition to another for High Availability operation.

Cross-reference links are provided to each topic or section, containing explicit instructions for each task.

Provisioning SKS

> You need at least one Luna Network HSM 7 at and Luna HSM Firmware 7.7.0 or newer, or Luna PCIe HSM 7 at Luna HSM Firmware 7.7.0 or newer.

> If you already have an older 7.x HSM, download and install the updates from the Support Portal.

> Install Luna HSM Client 10.3.0 or newer, which includes a version of the lunacm tool that supports the "partition smkrollover" commands - this ensures that the associated library has the updated SKS capabilities and is also able to handle migration from legacy SKS instances

> Follow the instructions at the beginning of "Preparing to use SKS" on the next page to get the appliance installed and network connected

> If you plan to use an HA group, then repeat the above process with the second HSM, and again with any additional active or standby members.

Replicating the SMK to another SKS Partition

Stand-alone - If you are using a *single HSM* with your application, you should have at least one backup copy of the SMK (for each partition) so that any SKS blobs encrypted by that SMK are recoverable in case of loss or damage to the original HSM or partition.

> proceed to "Backup the SKS Master Key (SMK)" on page 47.

HA group - If you are using an *HA group* with your application, then initially, each member has a unique SMK created when its SKS partition is created. For HA operation, the **hagroup addmember** command replicates the desired SMK from the initial member to all additional members of the group. This means that, in order for a partition to take part in HA operation as the second or later member, its original SMK is overwritten by the SMK of the first member of the group.

> Safeguard the desired SMK by backing it up to a Backup HSM before going further. See "SKS Backup and Restore" on page 46.

> **NOTE** If an SMK, already existing on a partition, has ever been used to encrypt an SKS key or objects, then you must backup the existing SMK before replacing/overwriting it, if you wish to ever retrieve the previously encrypted SKS key and objects.

> Follow the instructions for using the **partition smkclone** command in "High Availability and SKS" on page 39.

Backing up the SMK

Always ensure that you have safeguarded any important SMK (one that has been used to encrypt key material for export from the HSM) by backing it up to a Backup HSM partition before you perform any action that might destroy that SMK (such as cloning a different SMK to the current HSM, or restoring a different SMK from a Backup HSM partition).

> To backup, see "Backup the SKS Master Key (SMK)" on page 47.

Restoring the SMK from Backup

When you wish to use the SKS partition to encrypt objects or decrypt objects with an SMK other than the SMK that resides in the current partition, you must restore from a Backup of the desired SMK to overwrite the current SMK in the current partition. If the current SMK (before restoring from archive) is valuable, then back it up first before restoring a different SMK to overwrite the current one.

> To restore, see "Restore an SKS Master Key (SMK)" on page 49.

Preparing to use SKS

Perform all the steps to install and configure a Luna HSM, as described at Installing and Configuring Your New Luna PCIe HSM 7.

1. If your HSM is not already at Luna HSM Firmware 7.7.0, perform the firmware update.

   > **NOTE** To update an HA group to Luna HSM Firmware 7.7.0 or newer, all the *non-primary partitions* must be updated *first*, to ensure that the key objects from the firmware 7.7-or-newer primary can still move to the non-primaries through key cloning. *Then* the primary member can be updated.

2. When you reach the steps to create an application partition, ensure that it is created as the default version one (V1), which is necessary for SKS operation.

> **NOTE** The SKS Master Key (or SMK) is created when the partition Crypto Officer logs in. For security reasons the SMK is not made visible in output of the usual commands that show objects on an HSM partition (lunacm:>**partition contents** and lunash:>**partition showcontents**).

3. Go to "Using SKS" below to continue with SKS.

Using SKS

On this page:

"Using SKS - options" below

- "API" on the next page
- "ckdemo example" on the next page
- "Java Sample" on page 44
- "High Availability" on page 44
  - "Constraints on SKS HA" on page 44
  - "Replicating the SMK to all group members" on page 45
  - "When NOT to address the virtual slot" on page 46

Logistical considerations for SKS operation include:

> you must create a V1 partition before you can use the SKS functionality;

> initializing and logging into an SKS partition (as CO) creates a unique SMK in that partition, at the same time;

> you have the option to use the SMK that is created with the partition, or you can overwrite that SMK with
  - an SMK that is restored from an SKS partition on a Backup HSM (with **partition archive restore**), or
  - an SMK that is cloned (with **partition smkclone**) from another partition (usually for purposes of HA operation);

> **NOTE** **V1 partitions:** If you add an application partition with an existing SMK to an HA group, the primary member's SMK overwrites the existing SMK of the joining partition.
>
> If a partition's SMK has ever been used to encrypt important SKS objects, save a backup of the SMK before adding that partition to any HA group.

Using SKS - options

Two approaches are available, to use SKS :

> Use the API, where you have the ability to write or modify your applications:
  - Directly access the PKCS#11 C-language extensions that interact with the HSM.

    or
  - Use the provided Java toolkit.

> Use a commercial, off-the-shelf Windows CNG application, mediated by the provided SKS Client Extension for Luna HSM KSP.

API

Authorization forms currently supported are none, and password.

Export a key from a partition as an SMK-encrypted blob, using SIMExtract function

```
SIM_AUTH_FORMS = (CKA_SIM_NO_AUTHORIZATION,
                  CKA_SIM_PASSWORD)
CK_RV CA_SIMExtract(CK_ULONG handleCount, CK_ULONG *handleList,

   CK_ULONG authForm, CK_ULONG authDataCount, CK_ULONG subsetRequired,

   CK_BYTE **authDataList,

   CK_BOOL deleteAfterExtract,

   CK_ULONG *pBlobSize, CK_BYTE *pBlob );
```

Import a previously extracted blob, using the SIMInsert function

```
CK_RV SIMInsert( CK_ULONG blobSize, CK_BYTE *pBlob,

   CK_ULONG authForm, CK_ULONG authDataCount, CK_BYTE **authDataList,

   CK_ULONG *pHandleListSize, CK_ULONG *pHandleList );
```

For further information, refer to the SDK Guide (Secure External Scalable Key Storage Extensions).

ckdemo example

1. Start by running ckdemo and executing **Open Session (1)** to the slot and **Login (3)** as **Crypto Officer**, giving the partition password.
2. Generate an AES key using **Simple Generate Key (45)** and keep track of the object handle for the generated key.
3. Execute **SIMExtract (105)**.

   Enter the object handle for **Enter handle of object to add to blob** and then

   Enter **0** to **end the list**.

   Enter **1** for **Enter authentication form**.

   Enter **1** for **number of authorization secrets (N value)**.

   Enter **1** for **Enter subset size required for key use (M value)**.

   Enter a password.

   Enter **1** for **Delete after extract.**

   The masked key is saved to **blobfile.sim**.
4. List all of the objects in the partition by running **Find object (26)** with option **All Standard Objects (6)**.
5. Execute **SIMInsert (106)**.

   Enter **blobfile.sim** for **Enter filename with object to insert**.

Enter **1** for **Enter authentication form**.

Enter **1** for **Enter number of authorization secrets to be provided**.

Enter the password that was entered in the previous step.

6. List all of the objects in the partition by running **Find object (26)** with option **All Standard Objects (6)**. The key that was extracted should now be present in the partition.

> **NOTE** The example above uses the password authentication form. Other authentication forms can be used.

Java Sample

As a prerequisite, ensure that the **LunaProvider.jar** and **libLunaAPI.so** has been installed to your JDK.

1. Navigate to the directory that contains the java sample:

   cd JavaSample

2. In the **SIMExtractInsert.java,** modify the **slot** and **hsmPass** variables appropriately.
3. Compile the sample using **javac**:

   javac SIMExtractInsert.java

4. Run the sample using java.

High Availability

Replication of objects in HA is accomplished by SIMExtract and SIMInsert in one call, transparently.

> **TIP** Turn off HA synchronization for better performance if the inserted keys are to be used for single operations. An inserted key would be replicated to all HA group members even if it were to be used only by one member for (say) one signing operation.
>
> If inserted keys are likely to be used for multiple load-balanced operations, then the overhead of replicating to all members is unavoidable and would be minimal in that context.

OPTIONS for HA Operation are:

> Use with V0 partitions. The assumption is that you have existing partitions and application(s) that use those partitions in HA. Continue as you already do. Your pre-existing upgraded partitions, as well as any new partitions that you create with the V0 option will work as before.

> Use with V1 partitions - all HA group members must be at V1, and your application must be SKS-aware, because only SMKs are cloned between V1 partitions; all other objects are extracted/inserted as SKS blobs.

Constraints on SKS HA

HA for SKS requires that each member of the HA group must have the same SMK.

> **NOTE** For HA environments, if you perform SMK rollover on a member, then the new SMK must be cloned to all members. However, database / repository update for rollover should be done by directly addressing the primary physical member, and *not* using the virtual slot (to avoid the performance penalty when keys inserted to the virtual slot during rollover would be propagated to all members before the re-extraction).

Replicating the SMK to all group members

> **CAUTION!** Each SKS partition contains a single SMK, and this operation overwrites the SMK in the target partition. Therefore, always ensure that the SMK in the target partition is **not** of any use, or that it has been backed up, before you perform **partition smkclone**.

These steps are performed from the lunacm utility in the client computer.

1. Use **slot set** to select one of the HSM partitions, with the desired SMK, as the current slot.

```
lunacm:> slot set -slot 0

Command Result : No Error
```

2. Log into the current slot as Crypto Officer.

```
lunacm:> role login -name Crypto Officer

        Please attend to the PED.

Command Result : No Error
```

3. Use the **partition smkclone** operation to clone the desired SMK from the current slot SKS partition to another SKS partition in a named slot. The SMK from the source slot overwrites the SMK in the target slot. You are logged into the source partition, where you are launching this command, but not to the target partition; specify the password for the target partition.

```
partition smkclone -slot 1 -password myuserpin

  Logging in to target slot 1

  Cloning the SMK.

    The SMK was cloned successfully.

Command Result : No Error
```

   To verify that the SMKclone operation was successful, see below.

4. Repeat the previous step for any other HA group members, to ensure that all members share the same SMK.
5. Set HA-only mode for the group, so that your application sees only the HA virtual slot, and not any of the physical slots.

```
lunacm:> haGroup HAOnly -enable

Command Result : No Error
```

6. Note the number of the HA virtual slot. Your application will direct all operations to that slot.

Verify SMKclone

If necessary, verify the success of the SMKclone operation as follows.

1. Create an object on the original HSM partition (for example, a keypair).
2. SIMExport the object from that original HSM and SIMInsert it into the second (target) HSM, using any of the methods (API, CKDemo, or Java, earlier on this page). If the importation is successful, then the SMK on the second HSM is the same as the SMK on the first, or source HSM.

When NOT to address the virtual slot

As indicated above, blob insertion results in the inserted key being propagated to the other HA members.

However, key external storage database rollover *should **not*** be done over the virtual slot as this would cause the inserted keys to be propagated *before* the re-extraction, affecting performance. Ideally, the database update should be done by direct communication with the primary HA member.

SKS Backup and Restore

On this page:

- "Constraints on SKS Backup and Restore" on the next page
- "Backup the SKS Master Key (SMK)" on the next page
- "Restore an SKS Master Key (SMK)" on page 49
- "Troubleshooting SKS Backup and Restore" on page 50

As described, the partition permanently stores the SKS Master Key (SMK) from the time of its creation when the partition is created. The application partition is intended :

> to create encryption keys as session objects

> to encrypt those keys with the SMK, for SKS extraction from the HSM

> to extract those encrypted keys, as encrypted SKS blobs, for storage by your application, external to the cryptographic module

> to temporarily SKS insert (decrypt) blobs to make individual keys available for crypto operations within the partition

> to use the decrypted key

- to sign or seal documents and other digital objects, using the inserted key as a personal or organization identity, or
- to encrypt data (records) for your external database, archive, cloud, or other repository, or
- decrypt and modify such records before re-encrypting them to go back into your repository.

Therefore, it is not intended that objects other than the SMK be stored in the SKS partitions; however, you can do so if you wish, up to the limits of the partition capacity.

Using Luna HSM Firmware 7.7.0 and newer, SMKs are replicated (for HA) or are backed up and restored using cloning. All other objects are treated as SKS objects and are encrypted/decrypted by the SMK for extraction and [re-]insertion as needed.

Constraints on SKS Backup and Restore

SKS Backup and Restore are intended to redundantly safeguard the SMK, only. The following conditions and constraints apply :

> The SMK is not visible as a partition object, and does not appear in list output.

> Backing up and restoring the SMK uses the same commands as backing up and restoring ordinary cryptographic objects.

> SKS Backup and Restore require a Backup HSM with Luna Backup HSM G5 Firmware 6.28.0 or Luna Backup HSM 7 Firmware 7.7.1 (or newer).

> SKS Backup and Restore is supported only when the currently selected slot is an SKS partition (V1).

> Individual SKS blobs are limited to 64KB in size. Large groups of keys, or larger data objects might need to be split across multiple blobs for extraction or insertion.

> The **partition archive backup** and **partition archive restore** commands test the currently selected slot to ensure it is an SKS-capable (V1) partition.

> If the current slot is an SKS partition, then the **partition archive** commands perform backup or restore of the SMK, and ignore any other objects.

> **TIP** The assumption is that since any extracted SKS blobs are solidly encrypted and remain within the assurance boundary, they can be safely stored in any repository. There is no need to store such blobs in another crypto-capable HSM partition, nor in a Backup HSM partition (though you could do the latter by storing as data objects, if desired) - they can be decrypted and used only by SKS insertion into an HSM partition that contains the relevant SMK.

If you invoked scalable key storage (SKS) for your applications to create and store large numbers of keys, then the partition is V1. If you perform cloning operations (including HA) or Backup and Restore, see "Cloning or Backup / Restore with SKS" on page 81.

Backup the SKS Master Key (SMK)

The SMK backup operation creates a new partition on the backup HSM, using a partition name that is automatically created at the time of the backup operation. The system ensures that the archive partition name does not already exist on the Backup HSM by creating the target partition with a unique name that combines

- the serial number of the source partition (from your Network HSM)
  with
- a time stamp.

To back up the SMK, do the following:

1. Have a Backup HSM connected to the client workstation from which you are running the command, or have a Backup HSM connected through a Remote Backup Server (see "Configuring a Remote Backup Server" on page 338). The Backup HSM must be visible as a slot.
2. Launch the lunacm utility.
3. Use **slot list** to determine the slot numbers of the SKS partition and of the Backup HSM.
4. Set the SKS partition as the current slot.

```
lunacm:> slot set -slot 4

Command Result : No Error
```

5. Log into the current slot as Crypto Officer.

```
lunacm:> role login -name Crypto Officer

        Please attend to the PED.

Command Result : No Error
```

6. Use **partition archive backup** to backup the SMK from the current slot to the indicated Backup HSM.

> **NOTE** Do not name the target partition to be created on the Backup HSM, because SKS backup creates the name from the serial number of the source partition, combined with a time-stamp.

```
lunacm:>partition archive backup -slot 5

You are backing up a SKS partition.
 Only the SKS master key (SMK) will be backed up.
 No other objects will be cloned.

Are you sure you wish to continue?

Type 'proceed' to continue, or 'quit' to quit now ->proceed

Logging in as the SO on slot 5.

Please attend to the PED.

Creating partition 358628973182_2017:03:09-16:52:47 on slot 5.

Please attend to the PED.

Logging into the container 358628973182_2017:03:09-16:52:47 on slot 5 as the user.

Please attend to the PED.

Creating Domain for the partition 358628973182_2017:03:09-16:52:47 on slot 5.

Please attend to the PED.

The SMK was cloned successfully.

Command Result : No Error
```

7. You can test the success by
   a. creating and initializing a V1 test partition on any HSM with Luna HSM Firmware 7.7.0 or newer,
   b. restoring the backed-up SMK onto that test partition, and
   c. successfully importing an SKS blob (that was previously extracted using the specific SMK) into that partition.

Restore an SKS Master Key (SMK)

To restore the SMK from backup, follow these steps.

> **CAUTION!** When you restore an SMK from a Backup HSM, that restored SMK overwrites (destroys) any SMK that was already present on the partition. If the current SMK has been used to encrypt any important keys, ensure that you have backed it up safely before restoring a different SMK over it.
>
> Also be sure to record the particulars of that backup, including the backup partition name and some notes to identify which keys have been encrypted by the SMK archived in that partition, for future reference.

1. Have a Backup HSM connected to the client workstation from which you are running the command, or have a Backup HSM connected through a Remote Backup Server (see "Configuring a Remote Backup Server" on page 338). The Backup HSM must be visible as a slot.
2. Launch the lunacm utility.
3. Use **slot list** to determine the slot numbers of the SKS partition and of the Backup HSM.
4. Set the SKS partition as the current slot.

```
lunacm:> slot set -slot 4

Command Result : No Error
```

5. Log into the current slot as Crypto Officer.

```
lunacm:> role login -name Crypto Officer

        Please attend to the PED.

Command Result : No Error
```

6. Use **partition archive restore** to restore the SMK from the current slot to the indicated Backup HSM, naming the partition with the desired SMK,on the Backup HSM.

```
lunacm:>partition archive restore -slot 5 -partition 358628973182_2017:03:09-16:52:47

You are restoring a SKS partition.
 Only the SKS master key (SMK) will be restored.
 No other objects will be cloned.

Are you sure you wish to continue?

Type 'proceed' to continue, or 'quit' to quit now ->proceed

Logging in to partition 358628973182_2017:03:09-16:52:47 on slot 5 as the user.

Please attend to the PED.

The SMK was cloned successfuly.

Command Result : No Error
```

7. You could test the success by restoring the SMK to a test partition, and successfully importing an SKS object that was previously exported, encrypted with that SMK.

Backup objects

In most cases, only the SMK needs preserving, and any crypto objects on the SKS partition are just passing through (as temporary session objects), so there is no provision to backup crypto objects from an SKS partition. It is possible to store SKS blobs, but only as data objects, not as crypto objects. Therefore, to use them in any way, they must be inserted back into a V1 partition that has the correct SMK in either the Primary SMK location or the Rollover SMK location.

The Backup HSM can support a mix of

> SKS-only archive partitions that each can contain a single SMK, and

> ordinary cloning-backup partitions that each can contain multiple crytographic objects for traditional cloning-based (non-SKS) HSM backup and restore operations.

In other words,

> you can use an SKS client to backup crypto objects
  - from a non-SKS partition
  - into a non-SKS archive partition on the Backup HSM)

> you can restore crypto objects
  - from a non-SKS archive partition on the Backup HSM
  - to a regular cloning-based (non-SKS) HSM partition.

> you cannot restore ordinary objects onto an SKS partition; they must be SKS inserted (siminsert API call.)

Troubleshooting SKS Backup and Restore

The following are some examples that highlight incorrect usage, along with the communication from the system.

Not logged into partition at current slot

Here is an example of the output if you attempt to use the partition archive command without logging in as "Crypto Officer" on the SKS partition slot, which must be the current slot.

> **NOTE** "-slot 5" in the example points to the Backup HSM slot, not the current SKS partition slot.

```
lunacm:>partition archive backup -slot 5

You are backing up a SKS partition.
 Only the SKS master key (SMK) will be backed up.
 No other objects will be cloned.

Are you sure you wish to continue?

Type 'proceed' to continue, or 'quit' to quit now ->proceed
```

```
Error: Failed to open session.

Command Result : 0xb0 (CKR_SESSION_CLOSED)
```

An incorrect option is specified for backup

In this example, the command fails because the "-partition" option is not applicable for SKS backup:

```
lunacm:>partition archive backup -slot 5 -partition test

You are backing up a SKS partition.
Only the SKS master key (SMK) will be backed up.
No other objects will be cloned.

Are you sure you wish to continue?
Type 'proceed' to continue, or 'quit' to quit now ->proceed

Syntax Error: Option -partition cannot be used for SKS operation.

Command Result : No Error
```

Archive contains crypto objects

If the backup partition to be restored contains crypto objects and SKS backup is being performed, restore of the SMK proceeds with a warning.

```
lunacm:> par ar r -s 5 -par pre-7-7

You are restoring an SKS partition.
Only the SKS master key (SMK) will be restored.
CAUTION: The existing SMK will be overwritten.


Are you sure you wish to continue?
Type 'proceed' to continue, or 'quit' to quit now -> proceed
Logging in to partition mypar on slot 5 as the user.

Please attend to the PED.

WARNING: Crypto object(s) detected in the backup device container.
Dedicated backup container for SKS Master key is recommended.

The SMK was cloned successfully.

Command Result : No Error
```

SMK Rollover

Mandated rollover schedules might place limits on the allowable lifetimes of important keys, like the SMK. Toward this end, the **partition smkrollover** command generates a new SMK and allows you to re-encrypt your SKS blobs with a new SMK.

However, if a new SMK is created - such as in the SMK rollover operation - then every blob that has been encrypted with the old SMK must be inserted, its contained keys/objects re-encrypted with the new SMK and

extracted as a new blob, and this must be accomplished for all such externally stored blobs, *during* the **smkrollover -start** to **smkrollover -end** interval. Any blobs for which the encrypting SMK no longer exists can no longer be decrypted.

To rollover the current SMK

If you wish to perform SMK rollover, please realize that it is a disruptive process and a major one. Hence, plan it appropriately by scheduling a down-time and then follow this three-step procedure:

1. Dismantle the HA group.
2. Perform SMK Rollover.
   a. Begin with **partition smkrollover -start**
      – the original SMK is moved to the Rollover area, and
      – a new SMK is created and placed in the Primary SMK area of the current HSM.
   b. Retrieve every blob from your repository, one at a time, insert it into the HSM partition - the insert action is performed with *SIMInsert API* using the former-primary-now-rollover SMK.
   c. After each key or object is inserted, extract it again to external storage - the extract action is performed with *SIMExtract* using the new Primary SMK.
   d. When *all* blobs have been retrieved (from repository, database, backup HSM, etc), inserted and re-extracted, then perform **partition smkrollover -end** one time, to delete the previous SMK from the rollover slot, to conclude the rollover operation.
3. Re-create the HA group, cloning the *new* SMK to each HSM that will become a member of the recreated HA group, and resume operations.

You can generate a new SMK and immediately discard the old one with **partition smkrollover -start -end** command. Do this *only* if you know that no blobs exist that are encrypted with the old SMK, otherwise they will be orphaned.

> **NOTE** For HA environments, if you perform SMK rollover on a member, then the new SMK must be cloned to all members. However, database / repository update for rollover should be done by directly addressing the primary physical member, and *not* using the virtual slot (to avoid the performance penalty when keys inserted to the virtual slot during rollover would be propagated to all members before the re-extraction).

Migrating Scalable Key Storage (SKS)

On this page:

> "Cloning the SKS Master Key (SMK)" on the next page

> "SKS Blob Migration" on page 55

The SKS feature beginning with Luna HSM Firmware 7.7.0 (and newer) uses the same API as previous SKS versions, to retain backward compatibility; your applications that used older SKS should still work. However, the new structure for SKS was developed in conjunction with an updated cloning protocol and other features of Luna HSM Firmware 7.7.0 associated with V1 partitions, and you (or a regulatory regime under which your organization operates) might see benefit in migrating existing SKS secrets to the newer form.

For purposes of migration, the SKS Master Key (SMK) is cloned to a target partition - this is the only use for the cloning protocol in V1 partitions. *Objects **encrypted** by the SMK (that is, SKS blobs)* are generally expected to be stored external to the crypto module in a repository via SKS extract operation (SIMextract API call) from the partition and later SKS insert operation (SIMinsert API call) when needed. If blobs are small enough or few enough in number, such objects could be replicated to other members in an HA group, or to keyrings in a cluster, or stored on a Backup HSM if desired, but as data objects only.

Off-board storage is assumed to be the primary method of storing such blobs (and *not* storage inside a general purpose crypto module or a backup HSM).

Cloning the SKS Master Key (SMK)

No changes to the existing older SKS host API are necessary for the cloning of the earlier and the newer SMKs. The choice is based on the formatting of the incoming SMK Secret.

> **NOTE** If a remote partition is involved (Network HSM) on either side of the SMK cloning operation, the HSM that contains the remote partition must have Network Replication enabled. See HSM Capabilities and Policies "Policy 16 - Allow network replication".

The following table shows possible migration paths for existing SMKs -- the leftmost column is possible sources, while the heading row across the top lists possible destinations, and the intersecting table cells are the possible result for each source-to-destination scenario.

Destination Source	FM6 SKS appliance	FW6 SKS G5 Backup (6.25)	FW7.7 eIDAS G5 Backup (6.28)	FW<7.7 HSM	FW>=7.7	FM HSM FW>=7.7 Non-FM HSM
FW6 SKS appliance	FW6 SMKs	FW6 SMKs	FW6 SMKs	No SMK support on target	Target has FM cert only	FW6 SMKs
FW6 SKS G5 Backup (6.25)	FW6 SMKs	FW6 SMKs	FW6 SMKs	No SMK support on target	Target has FM cert only	FW6 SMKs
FW7.7 eIDAS G5 Backup (6.28)	FW6 SMKs	FW6 SMKs	All SMKs (cloning protocol used by V1 partitions)	No SMK support on source/target	All SMKs (cloning protocol used by V1 partitions)	All SMKs (cloning protocol used by V1 partitions)
FW<7.7 HSM	No SMK support on source	No SMK support on source	No SMK support on source	No SMK support on target	No SMK support on source	No SMK support on source

Destination Source	FM6 SKS appliance	FW6 SKS G5 Backup (6.25)	FW7.7 eIDAS G5 Backup (6.28)	FW<7.7 HSM	FW>=7.7	FM HSM FW>=7.7 Non-FM HSM
FW7.7 FM HSM	Source has FM cert only	Source has FM cert only	All SMKs (cloning protocol used by V1 partitions)	No SMK support on target	All SMKs (cloning protocol used by V1 partitions)	All SMKs (FW7.7-Primary -> FW7.7-FM, FW7.7-Rollover dropped) (V1 partition)
FW7.7 Non-FM SKS HSM	Required cloning protocol not on target	Required cloning protocol not on target	All SMKs (cloning protocol used by V1 partitions)	No SMK support on target	Blocked by V1 cloning protocol	All SMKs (cloning protocol used by V1 partitions)

(**FW>=7.7** means Luna HSM Firmware 7.7.0 or newer)

To migrate an older SMK

To move/copy an SMK from one of the supported source configurations to one of the supported targets

1. If the source and target are crypto partitions, clone the SMK secrets between partitions with the partition smkclone lunacm command.
2. If the target is a Luna Backup HSM clone to the Backup HSM with the partition archive backup lunacm command.
3. If the source is a Luna Backup HSM, clone from the Backup HSM with the partition archive restore lunacm command.

Only some combinations of source and target are supported. Reasons for a path to not be supported are summarized in the table.

SCENARIO 1:

0. You have a pre-existing 7.7.0 SMK, and a bunch of extracted blobs (encrypted with that SMK) in a repository, all of which you want to preserve, and to which you want to add 6.x SMK and SKS blobs after migrating them.

1. Backup the modern 7.7.0 SMK to a partition on a firmware 6.28.0 or 7.7.0 Backup HSM (partition archive backup).
2. Backup the 6.x or 4.x SMK (partition archive backup).
3. Restore the 6.x SMK onto a V1 partition (partition archive restore). This puts it in the Primary SMK slot of that partition, overwriting any SMK that was there.
4. Perform partition smkrollover **-start** on the V1 partition. This moves the 6.x SMK into the Rollover slot of the partition and generates a new Primary SMK.
5. Restore the production 7.7.0 SMK that you backed-up earlier (partition archive restore). This overwrites the newly-generated Primary, but the Rollover partition still has the 6.x SMK.

6. Insert one of your 6.x SKS blobs. The HSM tests it and knows to use the Rollover SMK to perform the SKS insert operation.
7. Extract the key/crypto-object as a new blob - the HSM allows only the Primary (the one you just got back from archive) to perform the extraction.
8. Repeat for all your old-style blobs to get them all encrypted with the new SMK for storage in your repository.
9. Perform partition smkrollover **-end** which deletes the old SMK from the Rollover slot of the V1 partition.

SCENARIO 2:

You have 6.x SMK and SKS blobs. You want to migrate the older blobs to use in a new V1 partition (7.7). So, no 7.7.0 SMK and blobs currently exist that need conserving.

1. 1. Backup the 6.x (to partition on 6.28.0 or 7.7.0 Backup HSM) with partition archive backup command.
2. Create a new V1 partition (partition create), initialize it (partition init), log in as CO (role login **-name co**) etc., but you don't care about the generated 7.7.0 SMK.
3. Restore the 6.x SMK onto the V1 partition (partition archive restore). This puts it in the Primary SMK slot of that partition, overwriting any SMK that was there.
4. Perform partition smkrollover **-start** on the V1 partition. This moves the 6.x SMK into the Rollover slot of the partition and generates a new Primary SMK.
5. Insert one of your 6.x SKS blobs. The HSM tests it and knows to use the Rollover SMK to perform the SIMinsert operation.
6. Extract the blob - the HSM allows only the Primary (recently generated) to do the extraction.
7. Repeat for all your old-style blobs to get them all encrypted with the new SMK for storage in your repository.
8. Perform partition smkrollover **-end** which deletes the old SMK from the Rollover slot of the V1 partition.

SKS Blob Migration

With no modifications to the pre-existing host API for offboard key storage (SKS), the version number for the mechanism used is prepended to the SKS blobs and employed to select the correct mechanism to insert the blob back into the HSM.

HSMs are allowed to extract key blobs using only the latest and greatest SMK secret and mechanism available to them. Incoming older blobs with older SMK secrets and mechanisms are accepted, provided that the HSM f/w supports them.

> **NOTE** Migration from older HSMs, that used possibly outdated encrypting keys/mechanisms should not present a problem, since older blobs would be inserted only. The same material would then be extracted using newer or unrestricted key types or sizes.

The following table shows options for SKS blob insertion into a partition, Protocol and Key Import/Export vs External Storage. The leftmost column is possible sources, while the heading row across the top lists possible destinations, and the intersecting table cells are the possible result for each source-to-destination scenario.

	FW6 SKS appliance	FW7.7.0 Non-FM HSM (V0 Partition)	FW7.7.0 FM HSM (V0 Partition)	FW7.7.0 Non-FM HSM (V1 Partition)	FW7.7.0 FM HSM (V1 Partition)
FW6 SKS appliance	Using FW6 SMK (V1 partition cloning protocol) Import/Export	No SKS Support on source/target	No SKS Support on source/target	Using FW6 SMK (V0 partition cloning protocol) Import/Export	No FW6 SMKs on Target
FW7.7.0 Non-FM HSM (V0 Partition)	No FW7.7.0-Primary SMK on Target	No SKS Support on source/target	No SKS Support on source/target	No SKS Support on source	No identical FW7.7.0-Primary SMK on Target
FW7.7.0 FM HSM (V0 Partition)	No FW7.7.0-FM SMK on Target	No SKS Support on source/target	No SKS Support on source/target	No SKS Support on source	No SKS Support on source
FW7.7.0 Non-FM HSM (V1 Partition)	No FW7.7.0-Primary SMK on Target	No SKS Support on source/target	No SKS Support on source/target	Using FW7.7.0-Primary SMK (V1 partition cloning protocol) External Storage	No identical FW7.7.0-Primary SMK on Target
FW7.7.0 FM HSM (V1 Partition)	No FW7.7.0-FM SMK on Target	No SKS Support on source/target	No SKS Support on source/target	Using FW7.7.0-FM SMK (V1 partition cloning protocol) External Storage	Using FW7.7.0-Primary SMK (V1 partition cloning protocol) External Storage

To migrate an older SKS blob:

To insert an SKS blob, for any of the supported scenarios (table above),

1. Insert with the SIMinsert operation as you always have.

   The CKDemo Utility, command 106, demonstrates the action - see OFFBOARD KEY STORAGE Menu Functions.

CHAPTER 3: Per-Key Authorization

Per-key authorization or authentication (PKA) is a feature introduced with Luna HSM Firmware 7.7.0 to support the eIDAS use case of Remote Signing and Sealing (RSS) and the relevant Protection Profile (PP 419-221.5). PKA introduces data structures to keys that are created and manipulated in the HSM such that keys can be handled in the ways that applications normally handle key material, but under the sole ownership and control of an end-user natural person or legal entity. The attributes are applied to keys that are created with Luna HSM Firmware 7.7.0 (or newer). In V0 partitions those attributes are simply ignored. In V1 partitions the attributes are actively used. See more at "V0 and V1 Partitions" on page 17.

Keys for use in eIDAS schemas:

> have authentication data structures that allow the possibility for an entity to have sole ownership and control

> can be unassigned, waiting for distribution to eventual owners/Users, or

> can be assigned to the control of a specific owner/User.

When a key has auth code data attached, then by definition anyone who holds the auth code is a/the key owner. But before it is assigned, the key does not have an owner/User, and might be part of a pool of unassigned keys, waiting for distribution to users. Keys do take some time to generate, so in times of high demand, it could be practical and convenient to have some ready-to-go.

Keys are intended to be used, but they must also be administered. That is, an individual natural person (or a non-natural legal entity) authorizes cryptographic usage of a key, perhaps to sign forms or documents. At the same time, the HSM has roles that perform actions within the HSM, either:

> *generally* - the eIDAS Administrator role represented by the Crypto Officer (CO) role in the HSM) or

> *specifically/individually* - the eIDAS User role represented by the Limited Crypto Officer (LCO) role in the HSM.

So, a citizen might log into a service and perform an action that directs the application to retrieve their existing personal key from a database/repository and insert/decrypt the key into an HSM partition, where the citizen authorizes a signing or other operation, and then the copy of the key is deleted from the HSM partition, but the archived, encrypted copy resides safely in the database for future retrieval and use. Alternatively, a citizen might request a single-use key, that is generated 'on-the-spot' in the HSM partition (by the LCO role) and is authorized by that citizen to perform one action (like signing) and then the key is permanently deleted, with no copy existing anywhere.

Generally, these and other operations related to keys are not performed by administrative commands (tools like lunacm); rather, they are performed via the PKA API or REST, while the performing application is logged in as one or the other of the partition roles.

Example Use Case

For example, an application might be instructed to retrieve a certain key and use it to sign a document on behalf of a citizen. The application acquires the key from a database (in the form of an encrypted blob) and inserts it into an HSM where it is decrypted to reveal the key that is to be used. But the application is able to actually use that key only when the owner/citizen presents her/his unique authentication data, which is part of the key attributes.

New Role and Handling

In order to manage this service, the individual application partition's Crypto Officer role and a new role called Limited Crypto User handle the actions of creating, modifying, and using keys containing auth data.

A key can be created in an assigned state, where it is immediately associated with an entity, or a key can be created in unassigned state and only later assigned to an owner, when convenient.

No New Administrative Commands

Because the operations around PKA and RSS are handled programmatically, no particular administrative commands are introduced - only a **-version** option for partition creation and a partition policy 40, which is off for V0 partitions, and which defaults to on for V1 partitions, but can be turned off if desired. Everything else about PKA is handled by the "PKA API" on page 1.

Dependencies and Interactions with Other Features

PKA generally requires Luna HSM Firmware 7.7.0 or newer and Luna HSM Client 10.3.0 or newer. The feature is ignored by older clients and applications that do not know how to make use of it. Active use of PKA requires a V1 partition, which means that cloning is used for:

> incoming keys and objects from older firmware, but not outgoing (that is, on V1 partitions, cloning of keys is inbound migration, only)

> copying (such as for HA), or backing-up/restoring, of the SMK

All other objects are stored, encrypted by the SMK, in external storage using the Scalable Key Storage (SKS) feature.

Stored Data Integrity (SDI) is also mandated by eIDAS and is therefore applied by Luna HSM Firmware 7.7.0 and newer.

HA Indirect Login support is constrained differently for V0 and V1 partitions - see section "V0 Partitions" in PKA API.

CHAPTER 4: Key Cloning

You can clone key material between partitions to back up the keys, or to migrate the keys from one HSM to another. The rules, prerequisites, and procedures for migrating your key material are described in the following topics:

> "Domain Planning" on the next page

> "Cloning Objects to Another Application Partition" on page 68

> "Cloning Keys Between Luna 6, Luna 7, and Luna Cloud HSM, Password or Multifactor Quorum" on page 76

> "Where is copying, sharing, migration of keys possible - from what source to what destination?" on page 83

> "Enabling and Disabling CPv4 Cipher Suites" on page 85

> "Considerations when Performing Cloning and Backup-Restore Operations, when SKS is Involved" on the next page

Overview and Key Concepts

A Crypto Officer can clone the cryptographic objects (keys) from one user partition to another user partition provided that:

> The user partitions share the same cloning/security domain. See "Domain Planning" on the next page. For firmware newer than 7.8.0 and client newer than Luna HSM Client 10.5.0 see "Where is copying, sharing, migration of keys possible - from what source to what destination?" on page 83 and "Universal Cloning" on page 65.

> The user partitions use the same authentication method (muiltifactor or password).

> The CO has the required credentials on both user partitions.

> The capabilities and policies set on the source and target HSM and user partitions allow cloning. See HSM Capabilities and Policies and "Partition Capabilities and Policies" on page 177.

Enhanced utility with Universal Cloning

Using Luna HSM Firmware 7.8.0 or newer, you can engage Extended Domain Management and Cloning Protocol Version 4 (CPv4) as described at "Universal Cloning" on page 65 to improve the versatility of key cloning.

Changes introduced with Luna HSM Firmware 7.7.0 and newer

You can update Luna HSM Client software and Luna HSM firmware at different times, according to your needs.

When the HSM is updated to Luna HSM Firmware 7.7.0 or newer, some changes take place in the partitions and their contents, such that updated Client software is needed to make full use of the updated partitions and their contents. See "V0 and V1 Partitions" on page 17 for more detail on behaviors and constraints of the partition types.

> In HA groups, update the secondary members first, and then the primary member last.
> Older clients will continue to work with V0 partition for Luna Network HSM 7.
> For Luna PCIe HSM 7, must use Luna HSM Client 10.3.0 or newer
> Need newer client for V1 partitions when you want to use SKS or PKA.
> Client software must be Luna HSM Client 10.3.0 or newer to work with V1 partitions to support SKS and/or PKA, and HA. See "V0 and V1 Partitions" on page 17 for more detail.

> **NOTE** For older Luna versions, or situations where only cloning protocol version one (CPv1) is available, the library attempts to perform the individual actions of a cloning operation in sequence on the respective partitions, opening and closing a separate session for each object to be copied. If the policies and partition types on the source and target partitions are incompatible, the **partition clone** command (or an attempted HA synchronization) can fail with a message like CKR_DATA_LEN_RANGE while trying to clone. This can occur if a key object from the source partition is a different size than an equivalent object expected by the target.
>
> **UPDATE**: Using Luna HSM Firmware 7.8.0 and newer, when a cloning negotiation agrees on the use of CPv4, a call to clone multiple keys/objects launches a *single session for all the requested objects*, rather than opening and closing individual sessions for each object. The above portion of this note about mismatched sizes remains valid.

Considerations when Performing Cloning and Backup-Restore Operations, when SKS is Involved

If you invoked scalable key storage (SKS) for your applications to create and store large numbers of keys, then the partition is V1. If you perform cloning operations (including HA) or Backup and Restore, see "Cloning or Backup / Restore with SKS" on page 81.

Domain Planning

The cloning or security domain is an element of Layered Encryption.

What is a security domain or cloning domain?

A security domain or cloning domain is a layer of encryption that is created, during initialization, on an HSM or HSM partition that you control. The domain determines whether a crypto object can leave the HSM, and where it can go if it is allowed to leave. That is, a security or cloning domain is a method for administrators to limit key migration such that your keys will only exist in specifically your Thales HSMs and not in simply any Thales HSM.

Cloning is a secure-copy operation by which sensitive HSM objects are copied, while strongly encrypted, from one HSM to another HSM. The security domain, or cloning domain, is a special-purpose secret that is attached to a partition on an HSM. It determines *to* which, and *from* which, other partitions (on the same HSM or on other HSMs) the current partition can clone objects. Partitions that send or receive partition objects by means of the cloning protocol must share identical cloning domain secrets. That is, the protocol verifies that the destination domain matches the source domain; otherwise an error is displayed and the attempted operation fails. This is important for:

> Cloning in backup and restore operations

> Synchronization in HA groups.

Domains per partition - (copying across domains)

Copying of keys and objects, which is controlled and constrained by domains assigned to a partition, has generally been consistent over many Luna releases. Luna HSM Firmware 7.8.0 expands the historic capability, while retaining integration with existing customer applications. That is, with respect to domains, Luna HSM Firmware 7.8.0 (and newer)

> **defaults to pre-existing domain-related behavior**,

- An application partition can have one cloning domain, which is either a password-like typed string, or a randomly generated PED key domain string.
- A cloning domain is not labeled, because there is no use for a label when only one is possible.
- It is not possible to clone objects from two or more different cloning domains to a single partition.
- By design, there is no provision to change the cloning domain of a partition without initializing it, which destroys any objects in that partition.

> **but expands the domain-related behavior, if desired**

- An application partition is initialized with a domain that can optionally have a label, or remain unlabeled.
- Up to two additional domains can be added to a partition
  - a label allows you to visually distinguish which domain is which
  - the original domain is designated "primary", but you have the option to declare a new domain to be the primary
- A new domain can be a text string (for password-authenticated domains) or a domain secret stored on a PED key
  - if you include a string, that is used
  - if you do not include a string, when adding a domain, the dialog prompts for PED input.

No common domains across password-authenticated and multifactor quorum-authenticated HSMs (superseded restriction)

> **NOTE** The information in this section concerns Luna HSM firmware versions older than Luna HSM Firmware 7.8.0.

Password-authenticated application partitions, with identical security domains, can clone partition contents one to the other, if the HSM type supports cloning. Multifactor Quorum-authenticated application partitions, with identical security domains, can clone partition contents one to the other, if the HSM type supports cloning.

Prior to firmware version 7.8.0, password-authenticated HSM partitions cannot perform cloning with multifactor quorum-authenticated HSM partitions.

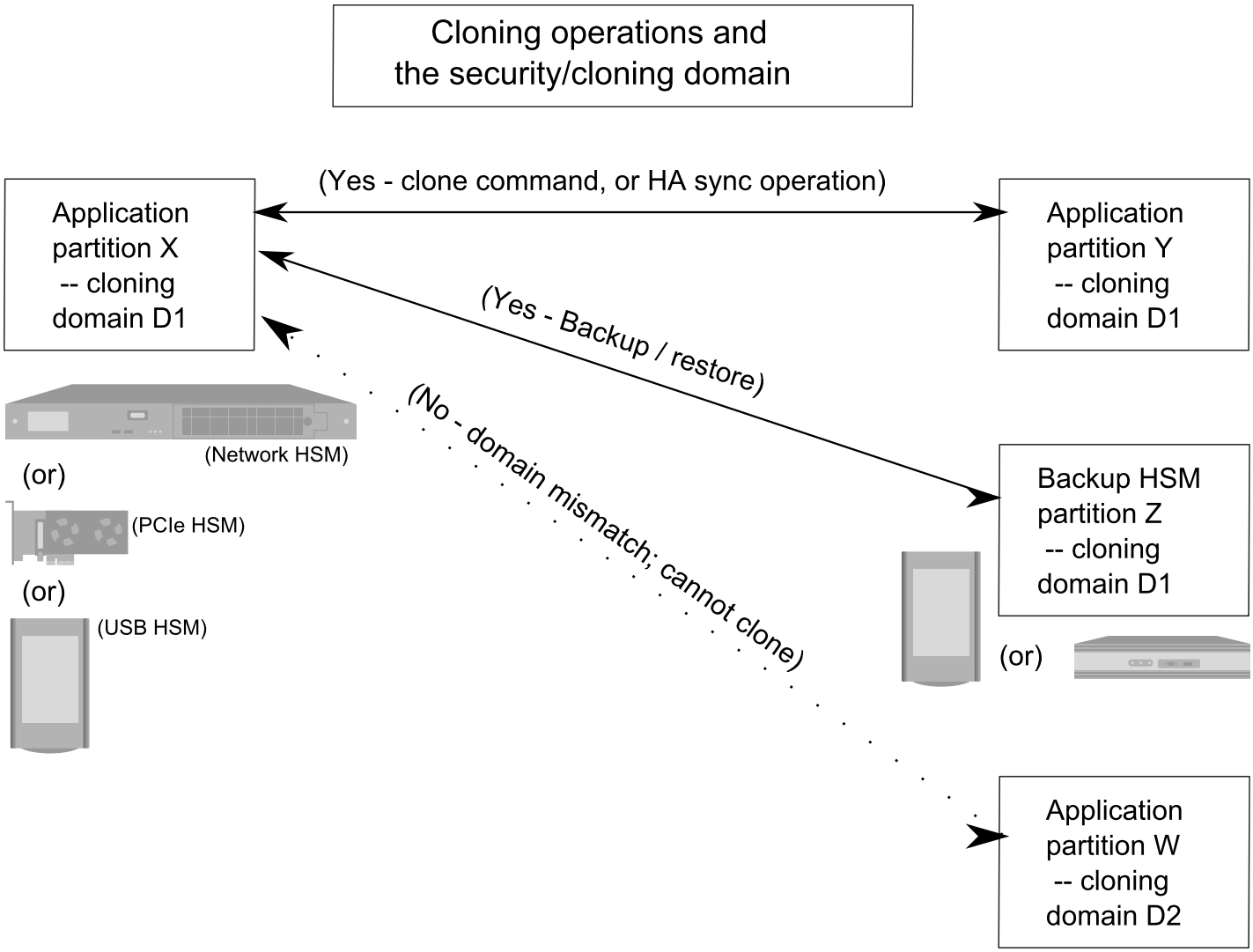
The security design consideration is that, if you have a key or object stored in a multifactor quorum-authenticated partition:

> It cannot be altered to a less-secure state and moved outside the protection of its original security/cloning domain.
> [The firmware 7.8.0 and newer Extended Domain Management allows you to clone keys and objects across

domains, as long as you have control of the domain(s) on the source partition and on the destination partition - nobody can transfer any partition content, or invoke any other domain, without your authorization]

> You are assured that the key or object has never been outside its original security/cloning domain, or in any less-secure state.
[Firmware 7.8.0 and newer Extended Domain Management modifies this proviso to "has never been outside a domain under your control".]

Using Luna HSM Firmware 7.7.0 or newer, any V1 (non-backward-compatible) partitions, backup and HA replication of crypto objects are accomplished with SKS encrypted blobs, and the cloning protocol is reserved for the SMK - the key that encrypts the SKS blobs.



Cloning Domains Using Luna HSM Firmware 7.8.0 and CPv4

Luna HSM Firmware 7.8.0 introduced Extended Domain Management, the ability for an application partition to support up to three KCVs (Key Cloning Vectors) or cloning/security domains. The original domain is retained as a PSK (pre-shared secret or pre-shared key) for CPv4 negotiation, so that existing workflows are not affected. Two additional domains can optionally be added, for greater operational flexibility, if needed. See partition domainadd.

Additional domains are optional, and can be typed (as for password-authenticated HSM partitions) or can be input from a PED, if the **-dped** option is used with the **partition domainadd** command.

Extended Domain Management permits:

> rotation of domain secrets (similar to password rotation)

> shifting of domains

> splitting of domains

> joining of domains.

As indicated elsewhere, it is possible to affect the availability of cloning protocols

> by turning CPv1 on with partition policy 42 "Allow CPv1" setting (which disables the use of CPv3 and CPv4, and must be decided in advance because it is destructive), or

> by using the partition cipherenable and partition cipherdisable commands to control the availability of cipher suites.

If the use of CPv1 or CPv3 is forced (by disabling all the CPv4 cipher-suite choices), then only the use of a single domain is supported. If more than one exists in a partition, the primary is used. By default, the primary domain is the one that was imprinted when the partition was initialized, but you can make a different domain the primary by specifying the **-primary** option when using the **partition domainadd** command.

> **NOTE** CPv1 UPDATE: In the upcoming FW 3.0 for Luna Cloud HSM, CPv1 will be removed from FIPS firmware support as it is no longer compliant with 140-3. As this only affects FIPS mode, all affected users should use CPv4 or transition service to non-FIPS mode. If Luna Network HSM users want to clone to Luna Cloud HSM they will have to use Luna 7.8 or higher. See Universal Cloning for more information.

Characteristics of Cloning Domains

Password-authenticated HSMs have text-string cloning domains for the HSM admin partition and for any partitions that are created on the HSM. HSM and Partition domains are typed at the command line of the host computer, when required. Password authentication cloning domains are created by you.

Multifactor Quorum-authenticated cloning domains are created by a Luna HSM, which could be the current HSM, or it could be a previously initialized HSM that you wish to include in a cloning group with the current HSM. Multifactor Quorum-authenticated HSMs have cloning domains in the form of encrypted secrets on red PED keys, for the admin partition and for any partitions that are created on the HSM.

The following characteristics are common to security (cloning) domains on all Luna HSMs.

> The unique *admin partition* security domain can be created in the HSM at initialization time, or it can be imported, meaning that it is shared with one-or-more other HSMs.

> The *application partition* security domain can be created by the current HSM when the partition is initialized, or it can be imported, meaning that it is shared with one-or-more other HSM partitions, and therefore direct cloning, backup/restore, and HA sync operations can be performed among the partitions that share a given domain.

> The application partition security domain is usually distinct from the HSM domain, as they are controlled by different people; on multipartition HSMs, the PSO is usually not the same person as the HSM SO, but on a single-partition HSM the two SOs might be the same person.

> The application partition security domain can be the same as the domain of another partition on the same HSM (for HSMs that support multiple partitions).

For multifactor quorum-authenticated HSMs, the domain secret for the admin partition or for an application partition can be a single red PED key, or it can be split (by the MofN quorum feature) over several red keys, which are then distributed among trusted personnel such that no single person is able to provide the cloning domain without oversight from other trusted personnel.

In scenarios where multiple HSM partitions are in use, it can be useful to segregate those partitions according to department or business unit, or according to function groups within your organization. This ensures that personnel in a given group are able to clone or backup/restore only the contents of partitions sharing the domain for which they are responsible. The segregation is maintained by physical and procedural control of the relevant PED keys that each group is allowed to handle.

For password-authenticated HSMs, that sort of segregation is maintained entirely by procedure and by trust, as you rely on personnel not to share the domain text strings, just as you rely on them not to share other passwords.

Have your naming conventions and allotments planned out ahead of HSM initialization and partition creation, including a well-thought-out map of who should control cloning domain access for admin partitions and for application partitions. These decisions must be made before you create the partitions.

Universal Cloning

At the highest level, Key Migration is a facility to move keys securely between our various forms of HSMs. The list of HSMs currently includes the Luna Network HSM 7 appliance, Luna PCIe HSM 7, Luna Backup HSM G5), and Luna USB HSM 7 form factors, as well as Luna Cloud HSM services.

The Luna HSM product has two main requirements on where and how keys can be shared:

> I want my keys to exist only in Thales Luna HSMs.

> I want my keys to exist only in Thales Luna HSMs/Partitions that I control.

What is universal cloning?

Universal cloning is the combination of two features added by Luna HSM Firmware 7.8.0 and client Luna HSM Client 10.5.0:

> **Cloning protocol version 4 (CPv4)**, which makes new cipher suites available to the cloning process and adds flexibility in handling and choosing among options

> **Extended Domain Management**, which adds the ability for a partition to have up to three cloning domains, any of which can be text-strings (Password Authentication) or can be multifactor quorum secrets, regardless of the nominal authentication mode of the current partition.

Prior to Luna HSM Firmware 7.8.0, Luna HSM partitions were generally limited to cloning objects between partitions that had the same single cloning security domain. As of firmware 7.8.0 and newer, application partitions can each optionally have as many as three cloning domains, and these can be added and deleted without risk to keys and other objects contained within the partition. With firmware 7.8.0 and client Luna HSM Client 10.5.0 the introduction of Extended Domain Management along with cloning protocol version 4 (CPv4) - increases your flexibility in choice of form factor:

> Originally chose on-premises HSM, but want to move to the cloud.

> Originally chose the cloud but have a need to repatriate back to on-premises HSM.

> Want to use both types seamlessly, such as in hybrid HA groups.

Extended Domain Management allows you to specify the source of a partition's domain, and provides the ability to have more than one domain in a partition, permitting:

> changing/rollover of cloning domains similar to what is done for passwords when your security regime mandates a refresh/rollover/password-change interval for all forms of authentication,

> migration of keys and objects between multifactor quorum authenticated partitions using authentication secrets on ikeys and

> migration of keys and objects between password authenticated partitions (on-premises HSMs) and services (Luna Cloud HSM) using text strings,

> migration of keys and objects between on-premises multifactor quorum authenticated HSM partitions and password authenticated partitions that share a common domain.

> migration of keys and objects between on-premises multifactor quorum authenticated HSM partitions and Luna Cloud HSM services that share a common domain.

In other words, if at least one of [as many as] three domain secrets on one partition is a match for at least one domain on the other partition, you can migrate objects between them. If more than one domain matches, then if one has been set as primary, that one is selected for the operation.

Enabling before using CPv4

To enable the use of CPv4, the HSM Security Officer MUST set the clock either before or immediately after the firmware has been updated. This is needed by the timing requirements inherent in the protocol.

No additional configuration steps are required as the Luna Cloud HSM service is compatible.

> **NOTE** There is no plan to update the older Luna Backup HSM G5 (nor any version of firmware 6) to support CPv4.

CPv4 is handled like the prior CPv1 cloning protocol.

> The default cloning configuration displays both CPv1 and CPv4. (However UC 10.4.x users and below can clone using only CPv1).

> Any scenario where CPv1 can be used, CPv4 can be used.

> Any scenario where CPv1 cannot be used, CPv4 cannot be used.

> CPv4 can be used to clone objects in V0 partitions, and clone the SMK in V1 partitions.

> The same set of roles that can use CPv1 can use CPv4. This includes the allowance for the Crypto-User to clone public objects.

> In Luna Cloud HSM service, CPv4 is the default protocol; however if only one side has CPv4 available the cloning process reverts to CPv1.

> Partition Policy 8 in Luna Cloud HSM displays both CPv1 and CPv4; however when paired with UC 10.4.x and lower only CPv1 is permitted.

> **NOTE** The Partition Policy difference between Luna Network HSM 7 and Luna Cloud HSM is as follows:
> - **Luna Network HSM 7 slot** Policy “42: Allow CPv1 : 1” means to force CPv1 and disable all other cloning protocols.
> - **Luna Cloud HSM slot** Policy “8: Allow CPv1 (Cryptovisor Only) : 1” means to allow CPv1 but you can *also* clone using CPv4.

Preconditions for Universal Cloning with Cloud or On-premises HSM Partitions

In order to use the Universal Cloning feature, the following must be true:

> you have Luna HSM Client 10.5.0 or newer

> you have either

- Luna Cloud HSM, and on-premises HSM at firmware version 7.8.0 or newer
  OR
- an on premises Luna HSM at firmware 7.8.0
  and
  another on-premises Luna HSM at any firmware version suitable for "Migrating Keys to Your New HSM" on page 216

  or

  another on-premises Luna HSM at any firmware 7.8.0 and onward for the widest range of domain management and key-cloning cipher options

> the source partition's security policy allows cloning of private and secret keys

> Partition policy **44**: "Allow Extended Domain Management" on page 190 is set to ON for at least one firmware 7.8.0 or newer partition.

> you have an uninitialized destination Luna Cloud HSM service (if cloning to Luna Cloud HSM rather than on-premises HSM)

> if your client host is a Windows device, you have installed pscp (PuTTY Secure Copy Protocol).

To clone cryptographic keys from one HSM to another, the HSMs must share the same cloning domain. As a result, you must initialize the destination partition with the source partition's cloning domain. The cloning domain was specified as a string when the source partition was initialized. However, with the advent of Extended Domain Management, you can add up to two additional security/cloning domains to any on-premises HSM partition (where the firmware is at version 7.8.0 or later).

The key migration process does not impose that both platforms use the same authentication mechanism. Key migrations are possible between HSMs that use Password or multifactor quorum authentication mechanisms. The only requirements on authorization, at either end, are that the user must be authenticated AND the user must be authorized to perform the migration.

To move objects between HSMs/Partitions that have different default security/cloning domain types (whether multifactor quorum/multifactor quorum,or password/password, or multifactor quorum/password) ensure that both source and target have at least one common domain among the three that each can have with Extended Domain Management (as of firmware 7.8.0).

> **CAUTION!** Domain secret strings for password-authenticated HSMs and Luna Cloud HSMs are used to generate the secret key for cloning, and are as cryptographically sensitive as a user password. The domain label associated with a domain string is not sensitive, and is used only to distinguish the domain from others assigned to the same partition. ***Never use the same string for the domain* label *and for the domain* secret.**

The commands to manage domains are:

- partition domainadd
- partition domainchangelabel
- partition domaindelete
- partition domainlist

For more information about CPv4, see "Where is copying, sharing, migration of keys possible - from what source to what destination?" on page 83.

Next steps

When you have arranged for two application partitions to have at least one domain in common, you are ready to perform direct partition-to-partition cloning, or to backup from one and restore to the other, or to join them to an HA group.

Cloning Objects to Another Application Partition

You can back up partition objects from an application partition to any other partition that shares its cloning domain. The Crypto Officer of both partitions can perform this operation using LunaCM.

> **TIP** ***The various ways you might use cloning***
>
> - **Basic cloning partition-to-partition** This page talks about generically performing cloning procedures with the explicit cloning commands **partition clone**.
> - **Key migration** In cases where you are looking to bring your important keys and objects from application partitions on older Luna HSMs to more modern HSMs or to HSMs with equivalent hardware, but with more recent firmware versions, then you might prefer to refer to the page: "Migrating Keys to Your New HSM" on page 216. The underlying cloning operations are the same, but the emphasis and discussion are more oriented to the migration task, and cover some activities and caveats not addressed here.
> - **Backup and Restore** Similarly, the backup and restore operations (to and from dedicated backup HSMs), for offline storage, employ dedicated commands that nevertheless invoke cloning operations and protocols. See "Partition Backup and Restore" on page 278.
> - **High Availability (HA)** Finally, the Luna High Availability (HA) feature permits you to dedicate two or more application partitions (usually on separate hosts) to processing your applications' cryptographic calls by sharing the workload across HA group-member partitions whose content is synchronized by means of cloning operations. Concepts and instructions are here "High-Availability Groups" on page 230.

Considerations when Performing Cloning and Backup-Restore Operations, when SKS is Involved

If you invoked scalable key storage (SKS) for your applications to create and store large numbers of keys, then the partition is V1. If you perform cloning operations (including HA) or Backup and Restore, see "Cloning or Backup / Restore with SKS" on page 81.

Prerequisites

> **Partition policy 0:** "Allow private key cloning" on page 178 must be set to **1** (ON) on both the source and target partitions.

> The target partition must be initialized with the same cloning domain as the source partition.

> You require the Crypto Officer credential for both the source and the target partition.

> Both partitions must be visible as slots in LunaCM.

> [Remote PED] This procedure is simpler when both partitions are activated (see "Activation on Multifactor Quorum-Authenticated Partitions" on page 207). If the partitions are not activated, you must connect the source partition to PEDserver before logging in, disconnect it, and then connect the target partition to PEDserver by specifying its slot.

lunacm:> **ped connect** [**-ip** <IP>] [**-port** <port>]

lunacm:> **ped disconnect**

lunacm:> **ped connect -slot** <target_slot> [**-ip** <IP>] [**-port** <port>]

> **NOTE** For older Luna versions, or situations where only cloning protocol version one (CPv1) is available, the library attempts to perform the individual actions of a cloning operation in sequence on the respective partitions, opening and closing a separate session for each object to be copied. If the policies and partition types on the source and target partitions are incompatible, the **partition clone** command (or an attempted HA synchronization) can fail with a message like CKR_DATA_LEN_RANGE while trying to clone. This can occur if a key object from the source partition is a different size than an equivalent object expected by the target.
>
> **UPDATE**: Using Luna HSM Firmware 7.8.0 and newer, when a cloning negotiation agrees on the use of CPv4, a call to clone multiple keys/objects launches a *single session for all the requested objects*, rather than opening and closing individual sessions for each object. The above portion of this note about mismatched sizes remains valid.

> **NOTE** CPv1 UPDATE: In FW 3.0 for Luna Cloud HSM, CPv1 will be removed from FIPS firmware support as it is no longer compliant with 140-3. As this only affects FIPS mode, all affected users should use CPv4 or transition service to non-FIPS mode. If Luna PCIe HSM 7 users want to clone to Luna Cloud HSM they will have to use Luna HSM Firmware 7.8.0 or newer. See Universal Cloning for more information.

To clone partition objects to another application partition

This is the simplest case, where source and target are similarly configured. For more detailed procedures, when cipher-suite availability and partition authorization method might differ, and additional choices are needed, see below.

1. In LunaCM, set the active slot to the source partition and log in as Crypto Officer.

lunacm:> **slot set -slot** <slotnum>

lunacm:> **role login -name co**

2. [Optional] View the partition objects and their object handles.

   lunacm:> **partition contents**

3. Clone objects on the partition to the target partition by specifying the target slot. You can choose which objects to clone by specifying a comma-separated list of object handles, or specify **all** to clone all objects on the partition. Present the target partition's Crypto Officer credential when prompted.

   lunacm:> **partition clone -slot** <slotnum> **-objects** <comma-separated_list/**all**>

   The specified objects are cloned to the target partition. Any objects that already exist on the target are not cloned.

> **NOTE** When a password-authenticated HSM partition is acquiring a domain from a multifactor quorum-authenticated partition, the password-authenticated HSM must have a Luna PED locally connected to it to facilitate the operation.
>
> A remote PED connection is not effective in this scenario, and any pedserver activity on the client should be halted for this cloning operation with "pedserver -mode stop" on page 160.
>
> This is not necessary if you instead choose to add a text domain to your multifactor quorum-authenticated HSM partition (requires Luna HSM Firmware 7.8.0 or newer and Luna HSM Client 10.5.0 or newer) with partition domainadd. However, you might choose to import an authentication secret (PED key) to a password-authenticated partition if there is no room for another domain on your multifactor quorum-authenticated partition, and you have strong reason to preserve all domains already there.

Copying Keys and Objects with Universal Cloning

Luna HSM Firmware 7.8.0 and Luna HSM Client 10.5.0 introduce universal cloning, which rounds out the ability to clone objects between differing HSM partitions and also with Cloud crypto services (now running Luna Cloud HSM firmware 2.0 or newer). Universal cloning makes use of cloning protocol version 4 (CPv4) along with Extended Domain Management features that allow each HSM partition to have, and select among, up to three different cloning/security domains. That is, a single partition can contain, and perform crypto, with keys and objects that are protected under as many as three different domains, whether password-authenticated or multifactor quorum-authenticated.

If your on-premises HSMs are at an earlier firmware version, you can still use the older protocol versions among on-premises partitions, and cloud crypto services can still negotiate back to CPv3 or CPv1 with the inherent abilities and limitations of those earlier versions.

> **NOTE** **Partition policy 44:** "Allow Extended Domain Management" on page 190 must be set to 1 or ON, in order for your partition to have more than one cloning/security domain, and to allow either adding new domain strings (password-authenticated), or adding-by-importing existing multifactor quorum domains (PED keys).

> **NOTE** CPv1 UPDATE: In FW 3.0 for Luna Cloud HSM, CPv1 will be removed from FIPS firmware support as it is no longer compliant with 140-3. As this only affects FIPS mode, all affected users should use CPv4 or transition service to non-FIPS mode. If Luna PCIe HSM 7 users want to clone to Luna Cloud HSM they will have to use Luna HSM Firmware 7.8.0 or newer. See Universal Cloning for more information.

To clone partition objects from on-premises password-authenticated partition to on-premises multifactor quorum-authenticated partition using Luna HSM Firmware 7.8.0 or newer

Requires Luna HSM Client 10.5.0 or newer.

This procedure is for:

> an on-premises password-authenticated Luna Network HSM 7 partition as the source, which could be for:

- a routine cloning between two HSM partitions that are at Luna HSM Firmware 7.8.0 or newer,
- *migration cloning of keys and objects* from a legacy HSM partition (firmware 5.x, 6.x), or from firmware older than Luna HSM Firmware 7.8.0.

> an on-premises multifactor quorum-authenticated Luna Network HSM 7 partition as the target (at Luna HSM Firmware 7.8.0 or newer).

1. Ensure that the two partitions can both use a common cloning protocol.
   a. for HSMs (both legacy and 7.x) before Luna HSM Firmware 7.7.0, only protocol CPv1 is available
   b. for Luna HSM Firmware 7.7.1 and newer, if partition policy 42 - Enable CPv1 is ON, then that protocol is chosen and others are disabled

      lunacm:> **slot set -slot** <slotnum>

      lunacm:> **partition showpolicies**
   c. if partition policy 42 - Enable CPv1 is OFF, then negotiation of common cipher suites is attempted between partitions; this is preferred when available.
   d. if CPv1 has not been forced, and all cipher suites for CPv4 have been disabled on one of the participating partitions, then only CPv3 remains and a common CPv4 cipher suite cannot be negotiated.
2. Ensure that the source and target partitions have a cloning domain in common.
   a. In LunaCM, set the active slot to the target multifactor quorum-authenticated partition and log in as Partition SO (po).

      lunacm:> **slot set -slot** <slotnum>

      lunacm:> **role login -name po**
   b. View the partition domains and note their labels.

      lunacm:> **partition domainlist**
   c. If the two partitions share a common domain, proceed to cloning.
   d. If the two partitions do not share a common domain, then make room, if necessary, by deleting one domain you can do without on the target partition.

      lunacm:> partition domaindelete
   e. Add a domain that matches one from the source partition

lunacm:> **partition domainadd -domain** <text domain secret> **-domainlabel** <label of the text domain being duplicated>

3. In LunaCM, set the active slot to the source partition and log in as Crypto Officer.

   lunacm:> **slot set -slot** <slotnum>

   lunacm:> **role login -name co**

4. [Optional] View the partition objects and their object handles.

   lunacm:> **partition contents**

5. Clone objects on the current partition to the target partition by specifying the target slot. You can choose which objects to clone by specifying a comma-separated list of object handles, or specify **all** to clone all objects on the partition. Present the target partition's Crypto Officer credential when prompted.

   lunacm:> **partition clone -slot** <slotnum> **-objects** <comma-separated_list/**all**>

   The specified objects are cloned to the target partition. Any objects that already exist on the target are not cloned.

6. [OPTIONAL] You can retain an added domain on a partition as long as it remains useful
   - as long as the partition contains objects encrypted under that particular domain, or
   - while you think the current partition might clone (as source or as target) objects with a partition or service using that domain.

   Or you can delete a domain using partition domaindelete if it is no longer needed.

To clone partition objects from on-premises multifactor quorum-authenticated partition to on-premises password-authenticated partition using Luna HSM Firmware 7.8.0 or newer

Requires Luna HSM Client 10.5.0 or newer.

This procedure is for :

> an on-premises multifactor quorum-authenticated Luna Network HSM 7 partition as the source, which could be for:
   - a routine cloning between two HSM partitions that are at Luna HSM Firmware 7.8.0 or newer,
   - *migration cloning of keys and objects* from a legacy HSM partition (firmware 5.x, 6.x), or from firmware older than Luna HSM Firmware 7.8.0.

> an on-premises password-authenticated Luna Network HSM 7 partition as the target (at Luna HSM Firmware 7.8.0 or newer).

1. Ensure that the two partitions can both use a common cloning protocol
   a. if the source has partition policy 42 - Enable CPv1 on , then that protocol is chosen and others are disabled (or if the source has firmware earlier than Luna HSM Firmware 7.7.0, meaning that CPv1 is the only protocol); this imposes restrictions on operations

      lunacm:> **slot set -slot** <slotnum>

      lunacm:> **partition showpolicies**

   b. if partition policy 42 - Enable CPv1 is OFF, then negotiation of common cipher suites is attempted between partitions; this is preferred when available.

c. if CPv1 has not been forced, and all cipher suites for CPv4 have been disabled on one of the participating partitions, then only CPv3 remains and a common CPv4 cipher suite cannot be negotiated.

2. Ensure that the source and target partitions have a cloning domain in common.

   a. If the source is a Luna HSM Firmware 7.8.0 or newer partition, then it can accept the target's domain string (password-authenticated) into the multifactor quorum-authenticated source partition, avoiding the need to connect a Luna PED to the target, in which case, skip to step **d.**; otherwise, go to step **b.**

   b. If the source multifactor quorum-authenticated partition is at any firmware version older than Luna HSM Firmware 7.8.0, it cannot have more than one domain, so its PED key secret must be brought to the target; connect a Luna PED locally to the password-authenticated target.

   c. In LunaCM, set the active slot to the target partition and log in as Partition SO.

      lunacm:> **slot set -slot** <slotnum>

      lunacm:> **role login -name po**

   d. View the partition domains and note their labels.

      lunacm:> **partition domainlist**

   e. If the two partitions share a common domain, proceed to cloning.

   f. If the two partitions do not share a common domain, then make room, if necessary, by deleting one domain you can do without.

      lunacm:>partition domaindelete

   g. Add a domain that matches one from the other partition.

      lunacm:> **partition domainadd -domain** <text domain secret> **-domainlabel** <label of the text domain being duplicated>

3. In LunaCM, set the active slot to the source partition and log in as Crypto Officer.

   lunacm:> **slot set -slot** <slotnum>

   lunacm:> **role login -name co**

4. [Optional] View the partition objects and their object handles.

   lunacm:> **partition contents**

5. Clone objects on the partition to the target partition by specifying the target slot. You can choose which objects to clone by specifying a comma-separated list of object handles, or specify **all** to clone all objects on the partition. Present the target partition's Crypto Officer credential when prompted.

   lunacm:> **partition clone -slot** <slotnum> **-objects** <comma-separated_list/**all**>

   The specified objects are cloned to the target partition. Any objects that already exist on the target are not cloned.

6. [OPTIONAL] You can retain an added domain on a partition as long as it remains useful

   - as long as the partition contains objects encrypted under that particular domain, or
   - while you think the current partition might clone (as source or as target) objects with a partition or service using that domain.

   Or you can delete a domain using partition domaindelete if it is no longer needed.

To clone keys and objects from a Luna Cloud HSM Service slot to an on-premises multifactor quorum-authenticated partition

1. Ensure that the two partitions can both use a common cloning protocol
   a. the source, as an Luna Cloud HSM service, is already at firmware 2.0 or a later level that supports CPv4
   b. if partition policy **42 - Allow CPv1** is ON, for the target partition, then that protocol is chosen and others are disabled

      lunacm:> **slot set -slot** <slotnum>

      lunacm:> **partition showpolicies**
   c. if partition policy **42 - Allow CPv1** is OFF, then the cloning protocols available will sort themselves and negotiate common cipher-suites between source and target; this is preferred.
   d. if all cipher suites for CPv4 have been disabled on the on-premises HSM partition, then only CPv3 remains and a common CPv4 cipher suite cannot be negotiated; this imposes restrictions on operation.
2. Ensure that the source and target partitions have a cloning domain in common.

   Just as you must know the password (text string) for a Luna Cloud HSM service, you must also know the domain secret (text string) to proceed with this cloning operation.

   > **NOTE Partition policy 44:** "Allow Extended Domain Management" on page 190 must be set to 1 or ON, in order for your partition to have more than one cloning/security domain, and to allow either adding new domain strings (password-authenticated), or adding-by-importing existing multifactor quorum domains (PED keys).

   a. In LunaCM, set the active slot to the on-premises target partition and log in as Partition SO.

      lunacm:> **slot set -slot** <slotnum>

      lunacm:> **role login -name po**
   b. View the partition domains and note their labels.

      lunacm:> **partition domainlist**
   c. If the Luna Cloud service and the target partition share a common domain, proceed to cloning.
   d. If the two do not share a common domain, then make room on the on-premises target, if necessary, by deleting one domain you can do without.

      lunacm:>partition domaindelete
   e. Add a domain that matches one from the source Luna Cloud HSM service

      lunacm:> **partition domainadd -domain** <text domain secret> **-domainlabel** <label of the text domain being duplicated>
3. In LunaCM, set the active slot to the source partition and log in as Crypto Officer.

   lunacm:> **slot set -slot** <slotnum>

   lunacm:> **role login -name co**
4. [Optional] View the partition objects and their object handles.

   lunacm:> **partition contents**

5. Clone objects on the cloud service to the target partition by specifying the target slot. You can choose which objects to clone by specifying a comma-separated list of object handles, or specify **all** to clone all objects on the partition. Present the target partition's Crypto Officer credential when prompted (in this case, the appropriate black PED key).

   lunacm:> **partition clone** **-slot** <slotnum> **-objects** <comma-separated_list/**all**>

   The specified objects are cloned to the target partition. Any objects that already exist on the target are not cloned.

6. [OPTIONAL] You can retain an added domain on a partition as long as it remains useful
   - as long as the partition contains objects encrypted under that particular domain, or
   - while you think the current partition might clone (as source or as target) objects with a partition or service using that domain.

   Or you can delete a domain using partition domaindelete if it is no longer needed.

To clone keys and objects from an on-premises multifactor quorum or password-authenticated partition to a Luna Cloud HSM service

This includes

> an on-premises Luna Network HSM 7 multifactor quorum-authenticated or password-authenticated partition as the source, and

> a Luna Cloud HSM service (password-auth) as the target.

1. Ensure that the two partitions can both use a common cloning protocol
   a. if the target partition is a Luna Cloud HSM service, then it is at a firmware level that supports CPv4
   b. if the source has partition policy 42 - Enable CPv1 on, then that protocol is chosen and others are disabled

      lunacm:> **slot set** **-slot** <slotnum>

      lunacm:> **partition showpolicies**

   c. if partition policy 42 - Enable CPv1 is off for the on-premises HSM partition, then the cloning protocols available will sort themselves and negotiate common cipher-suites between source and target; this is preferred.
   d. if all cipher suites for CPv4 have been disabled on the on-premises HSM partition, then only CPv3 remains and a common CPv4 cipher suite cannot be negotiated; this imposes restrictions on operation.
2. Ensure that the source and target partitions have a cloning domain in common.

   > **NOTE** **Partition policy 44:** "Allow Extended Domain Management" on page 190 must be set to 1 or ON, in order for your partition to have more than one cloning/security domain, and to allow either adding new domain strings (password-authenticated), or adding-by-importing existing multifactor quorum domains (PED keys).

   a. In LunaCM, set the active slot to the source partition and log in as Partition SO (po).

      lunacm:> **slot set** **-slot** <slotnum>

      lunacm:> **role login** **-name po**

   b. View the partition domains and note their labels.

lunacm:> **partition domainlist**

c. If the source partition and the target cloud service share a common domain, proceed to cloning.

d. If the source partition and the target cloud service do not share a common domain, then make room, if necessary, by deleting from the source partition one domain you can do without.

lunacm:>partition domaindelete

e. Add a domain to the source partition that matches the domain from the Luna Cloud HSM Service target.

lunacm:> **partition domainadd -domain** <text domain secret> **-domainlabel** <label of the text domain being duplicated>

3. In LunaCM, set the active slot to the source partition and log in as Crypto Officer.

lunacm:> **slot set -slot** <slotnum>

lunacm:> **role login -name co**

4. [Optional] View the partition objects and their object handles.

lunacm:> **partition contents**

5. Clone objects on the partition to the target Luna Cloud HSM Service by specifying the target slot. You can choose which objects to clone by specifying a comma-separated list of object handles, or specify **all** to clone all objects on the partition. Present the target partition's Crypto Officer credential when prompted.

lunacm:> **partition clone -slot** <slotnum> **-objects** <comma-separated_list/**all**>

The specified objects are cloned to the target Luna Cloud HSM Service. Any objects that already exist on the target are not cloned.

6. [OPTIONAL] You can retain an added domain on a partition as long as it remains useful

- as long as the partition contains objects encrypted under that particular domain, or
- while you think the current partition might clone (as source or as target) objects with a partition or service using that domain.

Or you can delete a domain using partition domaindelete if it is no longer needed.

> **NOTE** CPv1 UPDATE: In FW 3.0 for Luna Cloud HSM, CPv1 will be removed from FIPS firmware support as it is no longer compliant with 140-3. As this only affects FIPS mode, all affected users should use CPv4 or transition service to non-FIPS mode. If Luna PCIe HSM 7 users want to clone to Luna Cloud HSM they will have to use Luna HSM Firmware 7.8.0 or newer. See Universal Cloning for more information.

Cloning Keys Between Luna 6, Luna 7, and Luna Cloud HSM, Password or Multifactor Quorum

Luna HSM Client allows you to clone keys between Luna 6 partitions, Luna 7 partitions, and Thales Data Protection on Demand (DPoD) Luna Cloud HSM services. This includes creating HA groups made up of different HSM versions. This configuration is useful for:

> migrating your keys directly from Luna 6 to your new Luna 7 HSMs

> migrating your keys from Luna PCIe HSM 7 to the cloud, or vice-versa

> gradually upgrading your on-premises production environment from Luna 6 to Luna 7 HSMs
> maintaining a real-time, cloud-based backup of your cryptographic objects

This page contains guidelines and general considerations for cloning keys between the different HSMs, or using mixed-version HA groups. Mixed-version HA groups have all the same requirements of standard HA groups (see "Planning Your HA Group Deployment" on page 242), in addition to the considerations listed below.

> "Luna On-Premises/Luna Cloud HSM Cloning" below
> "Supported Software/Firmware Versions" on the next page
> "Mismatched Partition Policies and FIPS Mode" on the next page
> "Mismatched Key Types/Cryptographic Mechanisms" on page 79
> "Minimum Key Sizes" on page 79
> "SafeXcel 1746 Co-Processor" on page 80
> "RSA-186 Mechanism Remapping for FIPS Compliance" on page 80
> "HA Performance Optimization" on page 80
> "Cloning between multifactor quorum and password-authenticated HSM partitions" on page 81

Luna On-Premises/Luna Cloud HSM Cloning

Cloning between Luna partitions and Luna Cloud HSM services require the following special considerations, in addition to the general considerations below.

> **NOTE** This feature requires minimum Luna HSM Client 10.2.0 for password-authenticated partitions, and minimum Luna HSM Client 10.4.1 for multifactor quorum-authenticated partitions. The scope is expanded with Universal Cloning in Luna HSM Firmware 7.8.0 and Luna HSM Client 10.5.1.

Authentication

Luna Cloud HSM services use password authentication, but you can use them with multifactor quorum-authenticated Luna HSM partitions by importing a domain PED key secret during initialization. This feature requires minimum Luna HSM Client 10.4.1. Refer to Initializing a Luna Cloud HSM Service for the procedure.

> **NOTE** All PED FW versions are currently compatible with Luna Cloud HSM.

Network Latency and Luna Cloud HSM as Active HA Member

Requests performed by cloud services like Luna Cloud HSM may experience greater network latency than those sent to on-premise HSMs. Thales recommends using a Luna Cloud HSM service as a standby HA member to achieve the best performance. By default, you can add a Luna Cloud HSM service as a standby HA member only. If all other HA members fail and the Luna Cloud HSM service becomes active, it will revert to standby when another member recovers.

If you prefer to use the Luna Cloud HSM service as an active HA member, you must first edit the following toggle in the **Chrystoki.conf/crystoki.ini** configuration file (see Configuration File Summary):

```
[Toggles]
lunacm_cv_ha_ui = 0
```

> **CAUTION!** HA failover from multifactor quorum-authenticated Luna partitions to Luna Cloud HSM requires minimum Luna HSM Client 10.5.0. Refer to known issue LUNA-23945.

Cloning Capacity Limitations

The following limitations apply to clients accessing a Luna Cloud HSM service:

> 100 token objects (or 50 RSA-2048 key pairs) per service.

> 100 session objects (or 50 RSA-2048 key pairs) per application.

> 100 simultaneous sessions per application.

Clients that exceed the token object and session object limits can experience slow or failed request responses. The session limit is enforced, and the client receives the error CKR_MAX_SESSION_COUNT when the application reaches the limit.

If you exceed the recommended maximum number of objects cloned to/from a Luna Cloud HSM service in a single cloning operation, the operation sometimes fails with CKR_DEVICE_ERROR. In the case of HA groups, this could include key creation operations, since objects are then cloned to the Luna Cloud HSM service.

Supported Software/Firmware Versions

Thales supports cloning between Luna 6/7 partitions and Luna Cloud HSM services using combinations of appliance software/firmware as outlined in the table below.

> **NOTE** Luna HSM Firmware 7.7.0 is not compatible with older Luna versions or Luna Cloud HSM.

Client Software	Luna Appliance Software	Luna HSM Firmware
Luna only: 10.3.0 or higher	7.7.0 or higher	7.7.0 or higher
Luna Cloud HSM with password-authenticated Luna 6/7: 10.2 or higher **Luna Cloud HSM with multifactor quorum-authenticated Luna 6/7:** 10.4.1 or higher **Luna 6/7:** 7.2 or higher	6.2.1 or higher	6.10.9 or higher

Mismatched Partition Policies and FIPS Mode

Partitions in an HA group, and the HSMs on which they reside, must be configured with the same policy settings (see "HSM and Partition Prerequisites" on page 242). For example, Luna 6 HSMs have certain policies that have been removed from Luna 7 and Luna Cloud HSM, and new policies have been introduced.

Ensure that policies common to Luna 6/7/Luna Cloud HSM members have the same settings, according to your deployment requirements.

lunacm:> **partition showpolicies**

When setting up HA groups, note the following:

> If you are using Luna HSM Client 10.4.0 or newer, you *can* set up an HA group with a mix of FIPS and non-FIPS partitions as members. However, some limitations must be considered. For more information, refer to "Key Replication" on page 235.

> If you are using Luna HSM Client 10.3.0 or older, you *cannot* set up an HA group with a mix of FIPS and non-FIPS partitions as members.

Mismatched Key Types/Cryptographic Mechanisms

Cloning is limited to key types that are recognized by the firmware on both HSMs. If an HSM does not recognize the type of key being cloned to it, the cloning operation may fail. Ensure that the firmware on the destination HSM is capable of recognizing all cryptographic objects that are to be cloned to the source HSM.

> **NOTE** Luna HSMs comply closely with the relevant FIPS standards and their generally accepted interpretations. These are moving targets, as the crypto and security climate continues to evolve. It is possible for a validated HSM version (firmware) to be fully compliant when its NIST certificate is issued, and for same-model HSMs with newer firmware and more stringent restrictions to refuse to accept "less secure" objects.
>
> Alternatively, the more up-to-date HSM might accept an object from an earlier-firmware HSM, but permit only limited uses of such an object. This can affect the operation of HA groups, and other situations, where applications attempt operations against old keys, or with the use of antiquated mechanisms.
>
> If you are cloning between HSMs operating in FIPS mode, please consult Supported Mechanisms, for the destination HSM's version, to determine if all key types can be cloned.

Mixed-version HA groups are limited to functions that are common to all member partitions. Mechanisms are added to/removed from new firmware releases, to provide new functionality and fix vulnerabilities. Operations assigned by load-balancing to a member lacking the correct mechanism will fail. Keys created on one member may fail to replicate to the other group members.

Ensure that your applications use only mechanisms that are available on all HA group members. Use LunaCM to see a list of mechanisms available on each partition/service.

lunacm:> **partition showmechanism**

Minimum Key Sizes

Minimum key sizes are enforced when using certain cryptographic algorithms. These minimums may differ between versions. If a Luna 6 partition creates a key that is smaller than the minimum size required by Luna 7 or Luna Cloud HSM, the key will not be replicated to the other partitions in the HA group.

> **NOTE** Minimum key sizes for many mechanisms are larger in FIPS mode, and FIPS minimums may vary among firmware releases.

To avoid this, use LunaCM to check a mechanism's minimum key size. Check the same mechanism on each HA member slot, and always use the highest minimum reported in the HA group.

lunacm:> **partition showmechanism -m** <mechanism_ID>

SafeXcel 1746 Co-Processor

Luna 6 HSMs include the SafeXcel 1746 security co-processor, which is used to offload packet processing and cryptographic computations from the host processor. Applications using this co-processor are not compatible with mixed-version HA groups.

The co-processor is not enabled by default. If you have previously enabled it on your Luna 6 HSMs, you can disable it by editing the **Chrystoki.conf/crystoki.ini** configuration file as follows:

```
[Misc]
PE1746Enabled=0
```

RSA-186 Mechanism Remapping for FIPS Compliance

Under FIPS 186-3/4, the only RSA methods permitted for generating keys are 186-3 with primes and 186-3 with aux primes. RSA PKCS and X9.31 key generation is not approved in a FIPS-compliant HSM. While Luna 6.10.9 firmware allows these older mechanisms, later firmware does not (and keys created using these mechanisms cannot be replicated to Luna 7 HSMs or Luna Cloud HSM services).

If you have older applications that use RSA PKCS and X9.31 key generation, you can remap these calls to use the newer, secure mechanisms. Add a line to the **Chrystoki.conf/crystoki.ini** configuration file as follows:

```
[Misc]
RSAKeyGenMechRemap=1
```

> **NOTE** This setting is intended for older applications that call outdated mechanisms, to redirect calls to FIPS-approved mechanisms. The ideal solution is to update your applications to call the approved mechanisms.
>
> Mechanism remapping is automatic, and ignores the configuration file entry if:
>
> > you are using Luna HSM Client 10.1.0 or newer, and
> >
> > HSM firmware is older than Luna HSM Firmware 7.7.1 (which introduced FIPS mode on individual partitions; clients up to and including Luna HSM Client 10.3.0 are unaware of the independent partition setting and do not remap mechanisms).
>
> Luna HSM Client 10.4.0 and newer are aware of the change in Luna HSM Firmware 7.7.1 and perform the mechanism remapping as expected when the current partition is in FIPS mode.

HA Performance Optimization

Luna PCIe HSM 7 provides significant (10x) performance improvements over Luna 6 HSMs. In a mixed-version HA group, operations assigned to Luna 6 member partitions will take longer than those assigned to Luna 7 members. The HA logic does not compensate for these performance differences, and schedules operations on the partition with the shortest queue. Since Luna 7 partitions complete operations more quickly, they will naturally be assigned more operations, but a mixed-version HA group generally does not perform as well as an HA group made up entirely of Luna 7 partitions.

The performance of Luna Cloud HSM services may be limited by network latency, compared to on-premises Luna HSMs. See "Luna On-Premises/Luna Cloud HSM Cloning" on page 77.

Thales recommends that you set a Luna 7 partition as the primary HA member (the first member specified when creating the HA group). All key generation takes place on the primary HA member, so this allows you to take advantage of the Luna PCIe HSM 7's vastly improved performance for:

> key generation

> random number generation

The load-balancing logic is determined by the Luna HSM Client software, so the Luna 7 behavior applies to mixed-version HA (see "Load Balancing" on page 234).

> **NOTE** The primary HA member may not remain the same over time. If the primary member fails, another member takes over all key generation operations. If you notice a significant drop in performance for key generation operations, it could mean that a Luna 6 partition or Luna Cloud HSM service has become the primary member. By default, a Luna Cloud HSM service will revert to standby once another HA member recovers.

Cloning between multifactor quorum and password-authenticated HSM partitions

Beginning with Luna HSM Firmware 7.8.0 and Luna HSM Client 10.5.0, Extended Domain Management allows you to clone keys and objects between multifactor quorum-authenticated and password-authenticated HSM partitions, including Luna Cloud HSM services, in either direction.

> Luna HSM Firmware 7.8.0 introduced the ability for any partition to have up to three cloning/security domains,
  - the original domain, created when the partition is first initialized and,
  - one or two more that can, optionally, be added later by command.

> Luna HSM Client 10.5.0 introduced the client-side commands to manage the additional domains.

Prior to Luna HSM Firmware 7.8.0, each application partition had a single domain that was created at partition initialization and remained until the partition was reinitialized or deleted. Cloning operations (including HA and backup) could take place between a partition with a given domain and any other partition (or service) with the same domain.

See "Universal Cloning" on page 65.

Cloning or Backup / Restore with SKS

Primary use-case

Huge numbers of keys can be safely off-boarded from the crypto module by scalable key storage (SKS) and stored, securely encrypted, in databases or file systems (which normally have their own backup regimes), or in keyrings within the Luna Network HSM 7 file system.

Only the SKS Master Key (SMK) needs to be

> backed-up to a Backup HSM with **partition archive backup**, for storage only (not used for any encryption/decryption while it is archived), or

> cloned to another HSM partition with **partition smkclone** (such as in an HA group), where it can insert/decrypt externally-stored keys and objects as needed when they are retrieved from your database by your application.

However, for smaller numbers of keys that fit inside a partition...

If an application creates smaller quantities of keys that can all fit inside a partition of a crypto module, then it can be convenient to keep the SMK *and* those keys together within the crypto module.

Backup/Restore

If a V1 partition containing some number of keys is backed-up (**partition archive backup**. command) to a Backup HSM, then that target Backup HSM sees

> one SMK cloned in from the source V1 partition,

> along with several SMK-encrypted opaque blobs having only their OUIDs and labels visible.

The blobs are not decrypted in the Backup HSM, but they can be identified for retrieval.

Cloning from General Purpose HSM source to General Purpose HSM target

Where you are cloning such a mixed partition (SMK plus multiple keys) from a V1 source partition to a V1 target (non-Backup),

> the SMK must be cloned over first, (with **partition smkclone**),

> then the **partition clone** command is invoked against the keys,

- where it actually launches SKS* to extract the keys (encrypted by the original SMK) from the source partition and,
- inserts the keys in the target partition, using the SMK copy that was just cloned over.

(*In this case, you use the **partition clone** command that quietly invokes SKS, so that your action to launch the process has the same "look and feel" as key cloning operations in V0 and pre-firmware-version 7.7.0 application partitions.)

For non-V1 partitions, the partition clone command behaves as previously, with no SKS involvement..

Enabling and Using CPv4

The ability to employ cloning protocol version 4 (CPv4) becomes available when using Luna HSM Client 10.5.0 and newer, with HSMs at Luna HSM Firmware 7.8.0 or newer. (See "Universal Cloning" on page 65)

In order to enable the use of CPv4, the HSM Security Officer *must* set the clock either before or immediately after the firmware has been updated.

No additional configuration steps are required; the Luna Cloud HSM service is compatible.

> **NOTE** There is no plan to update the Luna Backup HSM G5 (nor any version of firmware 6) to support CPv4.

CPv4 is handled like the prior CPv1 cloning protocol.

> The default cloning configuration displays both CPv1 and CPv4. (However, Luna HSM Client 10.4.1 and older can clone using only CPv1).

> Any scenario where CPv1 can be used, CPv4 can be used.

> Any scenario where CPv1 cannot be used, CPv4 cannot be used.

> CPv4 can be used to clone objects in V0 partitions, and clone the SMK in V1 partitions.

> The same set of roles that can use CPv1 can use CPv4. This includes the allowance for the Crypto-User to clone public objects.

> Prior rules about Functionality Modules are preserved where the current partition has FMs allowed:

- can clone out to non-FM partitions (allowed to clone from lesser-security to greater-security environment)
- non-FM partitions cannot clone in (not allowed to clone from greater-security to lesser-security environment)

> In Cloud HSM service, CPv4 is the default protocol; however if only one side has CPv4 available, it reverts to CPv1.

> Partition Policy 8 in Luna Cloud HSM fdisplays both CPv1 and CPv4, however when paired with Luna HSM Client 10.4.1 and earlier clients, only CPv1 is permitted.

> **NOTE** The Partition Policy difference between Luna PCIe HSM 7 and Luna Cloud HSM is as follows:
>
> > Luna HSM slot “42: Allow CPv1 : 1” means to force CPv1 and disable all other cloning protocols
> >
> > Luna Cloud HSM slot “8: Allow CPv1 (Cryptovisor Only) : 1” means to allow CPv1 but you can *also* clone using CPv4

Where is copying, sharing, migration of keys possible - from what source to what destination?

This section summarizes paths and limitations for getting keys and objects from one HSM to another, starting with the most general case and proceeding through more particular and sheltered use cases.

Moving or copying objects from any HSM to any Luna HSM or any Luna HSM to any HSM

Only objects whose properties allow them to be wrapped-off of an HSM and wrapped-onto another HSM can be transferred or migrated(*) in this fashion between Luna HSMs and non-Luna HSMs.

> **NOTE** SKS blobs (objects encrypted by the Scalable Key Storage Master Key [SMK]) can be considered wrapped-off/wrapped-on, but the SMK that can decrypt them is shared only among ThalesLuna HSMs with a security/cloning domain in common.

By manipulating HSM or partition policies, it is possible to modify the handling options for keys/objects having secret and private attributes. This requires pre-planning (before creating and using such objects) for these reasons:

> because the changes to such policies tend to be destructive of partition contents;

> because, while in many cases it is possible to override policy-change destructiveness defaults by using a Partition Policy Template that was adjusted for the purpose, when creating a partition, this same action is refused by the HSM if the HSM detects an attempted modification that would compromise security.

Moving or copying objects from any Luna HSM to any other Luna HSM

Luna HSMs have more options for sharing/migrating keys and objects with other Luna HSMs, although specific cooperation and prearrangement are needed.
That is, you can share keys with virtually any Luna HSM, but only if you want to allow it. Your HSM and its application partitions and their contents are not open to other Luna HSMs without your permission and action.
When testing requests for copying/migrating keys and objects, a Luna HSM needs to recognize the other HSM by its Hardware Origin Certificate, derived from its Hardware Origin Key.

Moving or copying objects from any Luna HSM that you control to another Luna HSM that you control

This is the situation where you own/control both HSMs that are to be exchanging key material ("control", in addition to outright ownership of on-premises HSMs, could refer to a Luna Cloud HSM service subscription). The parameters of such a situation might be either:

> before firmware 7.8.0, any other HSM of the same authentication type, Password-auth vs Multifactor Quorum, can clone objects with each other of the same authentication type (as pre-configured before being populated), but not with the other type.

or

> starting with firmware 7.8.0,
- source can be either Password-authenticated or Multifactor Quorum authenticated, and
- destination can be either Password-authenticated or Multifactor Quorum authenticated
- as long as
  - at least one of the HSMs is at firmware version 7.8.0 or newer and
  - the affected partition has Partition Policy 44 Allow Extended Domain Management set to ON, and
- as long as the intended source and destination partitions have at least one security/cloning domain in common between them and
- as long as both have matching cloning cipher suites available (in other words, not disabled).

Two arrangements

That is, both parties to the transaction can have firmware 7.8.0 or newer and have Policy 44 set to ON, which offers maximum flexibility, as either participant could import a domain from the other (depending on which selection was more convenient).

Or just one party could have the newer firmware and policy setting, while the other (perhaps with older firmware) could have only its original default domain, and in that case, the partition with up to three domains must import the domain from the partition with only the single domain it acquired at initialization.

Across authentication types

In general, if cloning is desired between a password-authenticated partition and a multifactor quorum-authenticated partition, it is more convenient to share the password-auth domain string to become one of the domains on the multifactor quorum-auth partition, since the latter would already have a PED connection, whereas to share an iKey secret from a multifactor quorum partition to a password-auth partition requires that a Remote PED connection be established to the password-auth partition's HSM for just that purpose. However, both options are open, if your situation imposes constraints.

Restriction to any Luna HSM that you control that has certain configurations

Configuration settings that differ between participating source-vs-target HSM partitions (or at the level of the containing HSM) might imply constraints that could affect whether an object is acceptable to clone, or if cloned-in or wrapped-in, whether it can be used in the same ways as on the source partition. Some such configuration differences might include:

> If the source is set to allow use of non-FIPS algorithms and key sizes and curve types, etc., while the destination is restricted to FIPS-only crypto mechanisms, or perhaps the same mechanisms are available on both, but with restricted operations on the target, and so on;

> Similarly, if the firmware versions of source and destination differ, then so might available mechanisms, key sizes, etc.;

> **Functionality Modules**

An HSM might have the option to invoke Functionality Modules, meaning it has firmware version 7.4.0 or newer and was manufactured with both the regular HOK / HOC that all Luna HSMs have, and also the FM-HOK and FM-HOC included, on standby, and might never have FMs activated (by never having HSM Policy 50 Allow Functionality Modules set to ON

- cloning is permitted from an HSM that has FMs allowed to another HSM that has had FMs allowed (FM license is installed and HSM Policy 50 is ON)
- cloning is permitted from an FM-allowed HSM to a never-FM-allowed HSM
- cloning is not permitted from an HSM where FMs have never been allowed (the HSM retains its HOK/HOC) to an FM-allowed HSM (has only FM-HOK/FM-HOC) - this is considered an attempt to clone from a higher-security environment to a lower-security environment.

Enabling and Disabling CPv4 Cipher Suites

Cipher suites for CPv4 are used for cloning to-and-from partitions, if the individual suites are enabled for a partition, and the use of CPv4 is *not* prevented by CPv1 being active (see "Allow CPv1" on page 188).

By default, eight CPv4 cipher suites are available and active, and the system negotiates the best/most secure suite for the current cloning operation, based on which suites are available to both the source and target partitions. If you have reason to do so, you can disable some cipher suites, which reduces negotiation time among those that remain enabled. You can also enable desired cloning cipher suites that have been disabled.

To show the current status of enabled and disabled cipher suites

1. Run **partition ciphershow** command.

```
lunacm:>partition ciphershow

 Cipher ID    Cipher Suite                                          Enabled
_____________________________________________________________________________

 0            CPv3 RSA-4096-PKCS-SHA-384 AES-256-GCM                Yes

 1            CPv4 ECDSA-P521-SHA-512 ECDH-P521-SHA512 AES-256-GCM  No

 2            CPv4 ECDSA-P521-SHA-512 ECDH-P521-SHA512              No
              AES-256-CTR-SHA256-HMAC

 3            CPv4 ECDSA-BP521-SHA-512 ECDH-BP521-SHA512 AES-256-GCM  No

 4            CPv4 ECDSA-BP521-SHA-512 ECDH-BP521-SHA512            No
              AES-256-CTR-SHA256-HMAC

 5            CPv4 ECDSA-P521-SHA3-512 ECDH-P521-SHA3-512 AES-256-GCM No

 6            CPv4 ECDSA-P521-SHA3-512 ECDH-P521-SHA3-512           No
              AES-256-CTR-SHA256-HMAC

 7            CPv4 ECDSA-BP521-SHA3-512 ECDH-BP521-SHA3-512         No
              AES-256-GCM
```

```
 8            CPv4 ECDSA-BP521-SHA3-512 ECDH-BP521-SHA3-512           No
              AES-256-CTR-SHA256-HMAC
```

To enable a cipher suite

1. Run the **partition cipherenable** command with the ID of the cloning cipher suite you want to enable.

```
lunacm:>partition cipherenable -id 1
CPv4 ECDSA-P521-SHA-512 ECDH-P521-SHA512 AES-256-GCM is now enabled

Command Result : No Error
```

2. Run **partition ciphershow** command to verify the result.

```
lunacm:>partition ciphershow

 Cipher ID    Cipher Suite                                            Enabled
_____________________________________________________________________________

 0            CPv3 RSA-4096-PKCS-SHA-384 AES-256-GCM                  Yes

 1            CPv4 ECDSA-P521-SHA-512 ECDH-P521-SHA512 AES-256-GCM    Yes

 2            CPv4 ECDSA-P521-SHA-512 ECDH-P521-SHA512                No
              AES-256-CTR-SHA256-HMAC

 3            CPv4 ECDSA-BP521-SHA-512 ECDH-BP521-SHA512 AES-256-GCM  No

 4            CPv4 ECDSA-BP521-SHA-512 ECDH-BP521-SHA512              No
              AES-256-CTR-SHA256-HMAC

 5            CPv4 ECDSA-P521-SHA3-512 ECDH-P521-SHA3-512 AES-256-GCM No

 6            CPv4 ECDSA-P521-SHA3-512 ECDH-P521-SHA3-512             No
              AES-256-CTR-SHA256-HMAC

 7            CPv4 ECDSA-BP521-SHA3-512 ECDH-BP521-SHA3-512           No
              AES-256-GCM

 8            CPv4 ECDSA-BP521-SHA3-512 ECDH-BP521-SHA3-512           No
              AES-256-CTR-SHA256-HMAC
```

To disable a cipher suite

1. Run the **partition cipherdisable** command with the ID of the cloning cipher suite you want to disable.

```
lunacm:>partition cipherdisable -id 0
CPv3 RSA-4096-PKCS-SHA-384 AES-256-GCM is now disabled

Command Result : No Error
```

2. Run the **partition ciphershow** command to verify the result.

```
lunacm:>partition ciphershow

 Cipher ID    Cipher Suite                                            Enabled
_____________________________________________________________________________
```

```
0            CPv3 RSA-4096-PKCS-SHA-384 AES-256-GCM                 No

1            CPv4 ECDSA-P521-SHA-512 ECDH-P521-SHA512 AES-256-GCM    Yes

2            CPv4 ECDSA-P521-SHA-512 ECDH-P521-SHA512                Yes
             AES-256-CTR-SHA256-HMAC

3            CPv4 ECDSA-BP521-SHA-512 ECDH-BP521-SHA512 AES-256-GCM  Yes

4            CPv4 ECDSA-BP521-SHA-512 ECDH-BP521-SHA512              Yes
             AES-256-CTR-SHA256-HMAC

5            CPv4 ECDSA-P521-SHA3-512 ECDH-P521-SHA3-512 AES-256-GCM Yes

6            CPv4 ECDSA-P521-SHA3-512 ECDH-P521-SHA3-512             Yes
             AES-256-CTR-SHA256-HMAC

7            CPv4 ECDSA-BP521-SHA3-512 ECDH-BP521-SHA3-512           Yes
             AES-256-GCM

8            CPv4 ECDSA-BP521-SHA3-512 ECDH-BP521-SHA3-512           Yes
             AES-256-CTR-SHA256-HMAC


Command Result : No Error
```

Updating or rotating cloning domain secrets

From time to time, it might be necessary to change the secret associated with a role on an HSM or a partition of an HSM, or a cloning domain secret. Reasons for changing credentials include:

> Regular credential rotation as part of your organization's security policy

> Compromise of a role or secret due to loss or theft of a PED key

> Personnel changes in your organization or changes to individual security clearances

> Changes to your security scheme (implementing/revoking M of N, PINs, or shared secrets)

Changing/rotating domains was not possible when each partition was allowed only one cloning domain (prior to HSM firmware 7.8.0), as changing the domain required initializing the partition, which destroyed all data. It also meant that once a partition had a new domain, it could not receive objects restored from backup HSM/partition that had only the old cloning domain.

This changed with the introduction of Extended Domain Management in Luna HSM Client 10.5.0 and Luna HSM Firmware 7.8.0 or newer, where each partition can have up to three different cloning domains, and those domains can be added or deleted as needed.

How to change or rotate the cloning domain

Prerequisites

> The partition must belong to an HSM at firmware 7.8.0 or newer.

> Partition Policy 44: Allow Extended Domain Management must be set to ON (partition showpolicies and partition changepolicy if necessary).

> The partition must have an available space for the new domain

- either it currently has just one or two domains (partition domainlist),
- or it has three domains (the maximum) but one can be deleted to make room for a new domain (with partition domaindelete) if necessary.

To rotate the cloning domain of an application partition,

1. Create the new domain, assigning it primary status and a label that will be used for that domain in any other partition or backup HSM with which it will need to clone objects.

   partition domainadd -domain <string for PW-auth> **-domainlabel** <unique label for new domain> **-primary**

   (provide a suitable text string as the domain secret

   or

   partition domainadd -domainped -domainlabel<unique label for new domain> **-primary**

   (attend to the PED with an appropriate iKey [blank if creating a new domain, or else containing an existing domain to be reused here], since you have elected to add a PED-mediated domain secret)

2. If the next partition you are rotating already has three domains (partition domainlist) delete one of them that is no longer needed, to make room for the new domain secret.

   partition domaindelete **-domainlabel**<label of domain to delete>

   Otherwise, skip to the next step.

3. Continue to create the same domain, as in step 1, on each other partition/HSM that is expected to participate in cloning with the first partition

   (includes any of another partition that needs to contain the same key material, such as

   - a backup HSM that already contains relevant backed-up material ,
   - other members of any HA group where the current partition is a member,
   - etc.)

   partition domainadd -domain <string for PW-auth> **-domainlabel** <same new label as used in step 1, above> **-primary**

   or

   partition domainadd -domainped -domainlabel<same new label as used in step 1, above> **-primary**

4. Delete the old, rotated-out domain from all affected partitions/HSMs, after all other intended cloning partners possess the new domain that is being rotated in

   partition domaindelete **-domainlabel**<label of domain to delete>

5. All the affected partitions should now have the new domain, properly labeled and identified as "primary" and should no longer have the old, superseded domain secret. You have satisfied the rotation requirement (with respect to domain secrets) for the current cycle. Carry on with normal operation.

6. [Optional] If you wish to verify before deleting all copies of the old pre-rotation domain secret, that the new, post-rotation domain is functional, and is now the domain being used for cloning,

   a. Delete the old domain secret from all but one of the affected partitions.

b. Leave the old domain on just that one (source) partition (that also has the new domain) for now, so you still have a copy of it.

c. Perform a cloning operation between the partition that has both the old and new domain secrets, and any of the other partitions that have the new domain, but no longer have the old domain. Successful cloning indicates that the new domain secret is being used, as it should be the only domain in common among all the affected partitions/HSMs.

d. Delete the last remaining copy of the old domain.

> **NOTE** For multi-factor quorum-authenticated partitions when all partitions have been imprinted with new role credentials and new domain secrets, then it no longer matters if any iKeys retain the old secrets, as they can no longer be used to access or clone respectively, and can be re-used/overwritten if desired.

CHAPTER 5: Multifactor Quorum Authentication

The Luna PIN Entry Device (Luna PED) provides PIN entry and secret authentication to a Luna HSM that requires trusted-path multifactor quorum authentication. The requirement for multifactor quorum or password authentication is configured at the factory, according to the HSM model you selected at time of purchase.

The Luna PED and PED keys are the only means of accessing the multifactor quorum-authenticated HSM's administrative functions. They prevent key-logging exploits on workstations connected to the host HSM, because authentication is delivered directly from the hand-held Luna PED to the HSM via the independent, trusted-path interface. No password is entered via computer keyboard.

> **NOTE** If you are updating or have already updated to Luna HSM Firmware 7.7.0 or newer, refer to Special Considerations for Luna HSM Firmware 7.7.0 and Newer for more information about multifactor quorum authentication.
>
> Luna PCIe HSM 7 7.x requires Luna PED Firmware 2.7.1 or newer. This firmware is backward-compatible with Luna PCIe HSM 7 6.x.

This chapter contains the following sections about multifactor quorum authentication:

> "Multifactor Quorum Authentication Architecture" on the next page
- "Comparing Password and Multifactor Quorum Authentication" on the next page

> "PED keys" on page 92
- "PED key Types and Roles" on page 92
- "Shared PED key Secrets" on page 94
- "Domain PED keys" on page 95
- "PINs" on page 95
- "Quorum Split Secrets (M of N)" on page 95

> "Luna PED Received Items" on page 98

> "Luna PED Hardware Functions" on page 100

> "Updating External Supply-Powered Luna PED Firmware" on page 123

> "Local PED Setup" on page 104

> "About Remote PED" on page 106

> "Multifactor Quorum PED key Management" on page 129

> "PEDserver and PEDclient" on page 144

Multifactor Quorum Authentication Architecture

The multifactor quorum authentication architecture consists of the following components:

> **Luna PED:** a PIN Entry Device with a local or remote connection to the HSM. The PED reads authentication secrets from PED keys on behalf of an HSM or partition (see "Luna PED Hardware Functions" on page 100).

> **Authentication secrets:** Cryptographic secrets generated by the HSM and stored on PED keys. These secrets serve as login credentials for the various roles on the HSM. They can be shared among roles, HSMs, and partitions according to your security scheme.

> **PED keys:** physical USB-connected devices that contain authentication secrets, created by the HSM (see "PED keys" on the next page). PED keys have the following custom authentication features:

- **Shared Secrets:** PED keys of the same type can be reused or shared among HSMs or partitions, allowing domain sharing (necessary for HA and backup configurations), legacy-style Security Officer authentication, and other custom configurations. See "Shared PED key Secrets" on page 94.
- **PINs:** optional PINs associated with specific PED keys, set by the owner of the PED key at the time of creation. PINs offer an extra layer of security for PED keys which could be lost or stolen. See "PINs" on page 95.
- **M of N Split Key Scheme:** optional configuration which allows a role to split its authentication secret across multiple PED keys, and require a minimum number of those keys for authentication. This scheme can be customized to be as simple or complex as your organization's security policy dictates. See "Quorum Split Secrets (M of N)" on page 95.

Comparing Password and Multifactor Quorum Authentication

The following table describes key differences between password- and multifactor quorum-authenticated HSMs.

	Password authentication	Multifactor Quorum authentication
Ability to restrict access to cryptographic keys	> Knowledge of role password is sufficient > For backup/restore, knowledge of partition domain password is sufficient	> Ownership of the black Crypto Officer PED key is mandatory > For backup/restore, ownership of both black CO and red domain PED keys is mandatory > The Crypto User role is available to restrict access to read-only, with no key management authority > Option to associate a PIN with any PED key, imposing a two-factor authentication requirement on any role
Dual Control	> Not available	> Quorum (also called MofN split-knowledge secret sharing) requires "M" different holders of portions of the role secret (a quorum) in order to authenticate to an HSM role - can be applied to any, all, or none of the administrative and management operations required on the HSM

	Password authentication	Multifactor Quorum authentication
Key-custodian responsibility	> Password knowledge only	> Linked to partition password knowledge > Linked to black PED key(s) ownership and optional PIN knowledge
Two-factor authentication for remote access	> Not available	> Remote PED and orange (Remote PED Vector) PED key deliver highly secure remote management of HSM, including remote backup

PED keys

PED keys are USB authentication devices, embedded in a molded plastic body. Each contains a secret, generated by the HSM, that authenticates a role, cloning domain, or remote PED server. This secret is retained until deliberately changed by an authorized user.

The Luna PED does not hold the authentication secrets. They reside only on the portable PED keys.

PED keys are created when an HSM, partition, role, or Remote PED vector is initialized. Each PED key can contain only one authentication secret at a time, but it can be overwritten with a new authentication secret. See "Multifactor Quorum PED key Management" on page 129.

> **CAUTION!** Do not subject PED keys to extremes of temperature, humidity, dust, or vibration. Use the included key cap to protect the USB connector.

PED key Types and Roles

The Luna PED uses PED keys for all credentials. You can apply the appropriate labels included with your PED keys, according to the table below, as you create them.

The PED key colors correspond with the HSM roles described in HSM Roles. The following table describes the keys associated with the various roles:

Lifecycle	PED key	Authentication Secret	Function
HSM Administration	**Blue**	HSM Security Officer (HSM SO) secret	Authenticates the HSM SO role. The HSM SO manages provisioning functions and security policies for the HSM. **Mandatory**
	Red Luna HSM Domain	HSM Domain or Key Cloning Vector	Cryptographically defines the set of HSMs that can participate in cloning for backup. See "Domain PED keys" on page 95. **Mandatory**
	Orange Luna HSM Remote PED	Remote PED Vector	Establishes a connection to a Remote PED server. See * below table. **Optional**
HSM Auditing	**White** Luna HSM Audit	Auditor (AU) secret	Authenticates the Auditor role, responsible for audit log management. This role has no access to other HSM services. **Optional**
Partition Administration	**Blue**	Partition Security Officer (PO) secret	Authenticates the Partition SO role. The PO manages provisioning activities and security policies for the partition. **NOTE:** If you want the HSM SO to also perform Partition SO duties, you can use the same blue key to initialize both roles. **Mandatory**
	Red Luna HSM Domain	Partition Domain or Key Cloning Vector	Cryptographically defines the set of partitions that can participate in cloning for backup or high-availability. See "Domain PED keys" on page 95. **Mandatory**

Lifecycle	PED key	Authentication Secret	Function
Partition Operation	**Black** Luna HSM Crypto Officer	Crypto Officer (CO) secret	Authenticates the Crypto Officer role. The CO can perform both cryptographic services and key management functions on keys within the partition. **Mandatory**
	Gray Luna HSM Crypto User	Limited Crypto Officer (LCO) secret **	Authenticates the Limited Crypto Officer role. The LCO can perform a subset of the actions available to the Crypto Officer. **Optional (used in eIDAS-compliant schemes)**
	Gray Luna HSM Crypto User	Crypto User (CU) secret	Authenticates the Crypto User role. The CU can perform cryptographic services using keys already existing within the partition. It can create and back up public objects only. **NOTE:** If administrative separation is not important, you can use a single black key to initialize the Crypto Officer and Crypto User roles and still have two separate challenge secrets to distinguish read-write and read-only role privileges. **Optional**

* Orange PED keys (RPK) for use with Luna HSM Firmware 7.7.0 or newer, with enhanced security to address modern threat environments and to comply with updated standards, have increased infrastructure onboard the key. If such an initialized RPK is overwritten to become a different role PED key (example SO), this process that formerly would take about six seconds now takes about 36 seconds.

** No use-case is anticipated that requires both the LCO and the CU roles at the same time (Crypto User for Luna use-cases and Limited Crypto Officer for eIDAS use-cases), so the gray Crypto User stickers should be adequate to identify either role as you manage and distribute PED keys.

Shared PED key Secrets

The Luna PED identifies the type of authentication secret on an inserted PED key, and secrets of the same type (color designation) can be used interchangeably. During the key creation process, you have the option of reusing an authentication secret from an existing key rather than have the HSM create a new one. This means that you can use the same PED key(s) to authenticate multiple HSMs or partitions. This is useful for:

> legacy-style authentication schemes, where the HSM SO also functions as the owner of application partitions. This is achieved by using the same blue PED key to initialize the HSM and some or all of the partitions on the HSM.

> allowing a single HSM SO to manage multiple HSMs, or a single Partition SO to manage multiple partitions

> ensuring that HSMs/partitions share a cloning domain (see "Domain PED keys" on the next page)

> allowing a read-write Crypto Officer role and a read-only Crypto User role to be managed by the same user

It is not necessary for partitions in an HA group to share the same blue Partition SO key. Only the red cloning domain key must be identical between HA group members.

> **NOTE** Using a single PED key secret to authenticate multiple roles, HSMs, or partitions is less secure than giving each its own PED key. Refer to your organization's security policy for guidance.

Domain PED keys

A red domain PED key holds the key-cloning vector (the domain identifier) that allows key cloning between HSMs and partitions, and is therefore the PED key most commonly shared between HSMs or partitions. Cloning is a secure method of copying cryptographic objects between HSMs and partitions, required for backup/restore and within HA groups. It ensures that keys copied between HSMs or partitions are:

- strongly encrypted
- copied only between HSMs and partitions that share a cloning domain.

> **NOTE** An HSM or partition can be a member of only one domain, decided at initialization. A domain can only be changed by re-initializing the HSM. Partition domains may not be changed after initialization.

PINs

The Luna PED allows the holder of a PED key to set a numeric PIN, 4-48 characters long, to be associated with that PED key. This PIN must then be entered on the Luna PED keypad for all future authentication. The PIN provides two-factor authentication and ensures security in case a key is lost or stolen.

PINs can be set only at the time of key creation, and can be changed only by changing the secret on the PED key. Duplicate keys made at the time of creation can have different PINs, allowing multiple people access to the role (see "Creating PED keys" on page 129). Copies made later are true copies with the same PIN, intended as backups for one person (see "Duplicating Existing PED keys" on page 140). Duplicates of the PED key all have the same PIN.

If you are using an M of N configuration, each member of the M of N keyset may set a different PIN.

> **CAUTION!** Forgetting a PIN is equivalent to losing the key entirely; you can no longer authenticate the role, domain, or RPV. See "Consequences of Losing PED keys" on page 137.

Quorum Split Secrets (M of N)

The Luna PED can split an authentication secret among multiple PED key iKeys (up to 16), and require a minimum number of the split keys (a quorum of key-holders) to authenticate the role. This provides a customizable layer of security by requiring multiple trusted people (sometimes called the quorum) to be present for authentication to the role. The key splits are presented to the Luna PED and combined inside the Luna HSM firmware to authenticate the role.

This can be likened to a club, or a board of directors, or a legislature, with some arbitrary number of members. You don't need all members present, to make a decision or perform an action, but you do not want a single person to be able to arbitrarily make decisions or take action affecting everyone. So your security rules set out a number of participants - a quorum - who must be assembled in order to perform certain actions

For example, you could decide (or your security policy could dictate) that at least three trusted people must be present for changes to the HSM policies or for client partition assignments. To accommodate illness, vacations, business travel, or any other reasons that a key-holder might not be present at the HSM site, it is advisable to split the authentication secret among more than three people. If you decide on a five-key split, you would specify M of N for the HSM SO role, or for the cloning domain, or any other role/function, to be 3 of 5. That is, the pool of individual holders of splits of that role secret is five persons, and from among them, a quorum of three must be available to achieve authentication (any three in this 3 of 5 scenario, but cannot be the same key presented more than once during an authentication attempt).

In this example scenario, the HSM SO authentication secret is split among five blue PED key iKeys, and at least three of those keys must be presented to the Luna PED to log in as HSM SO. The PED enforces your quorum rule.

This feature can be used to customize the level of security and oversight for all actions requiring multifactor quorum authentication. You can elect to apply a quorum (M of N split-secret) scheme to all roles and secrets, to some of them, or to none of them. If you do choose to use M of N, you can set different M and N values for each role or secret. Please note the following recommendations:

> M = N is not recommended; if one of the key holders is unavailable, you cannot authenticate the role.

> M = 1 is not recommended; it is no more secure than if there were no splits of the secret - a single person can unlock the role without oversight. If you want multiple people to have access to the role, it is simpler to create multiple copies of the PED key.

> **NOTE** Using an M of N split secret can greatly increase the number of PED keys you require. Ensure that you have enough blank or rewritable PED keys on hand before you begin backing up your M of N scheme.
>
> More keys means that some actions:
>
> > initialization
>
> > organization-mandated "password" change or roll-over
>
> can require longer to complete and might risk Luna PED timeout. In that case, the options are to increase the PED timeout value in the config file, or become very organized and adept at getting all participants to quickly perform their pin-change tasks.

Activated Partitions and Quorum (M of N)

For security reasons, the HSM and its servers are often kept in a locked facility, and accessed under specific circumstances, directly or by secure remote channel. To accommodate these security requirements, the Crypto Officer and Crypto User roles can be Activated (to use a secondary, alpha-numeric login credential to authenticate - Partition Policy 22), allowing applications to perform cryptographic functions without having to present a black or gray PED key (see "Activation on Multifactor Quorum-Authenticated Partitions" on page 207). In this case, if the HSM is rebooted for maintenance or loses power due to an outage, the cached authentication secret is erased and the role must be reactivated (by logging in the role via LunaCM and presenting the requisite

M number, or quorum, of PED keys) before normal operations can resume. A further measure called Auto-Activation (Partition Policy 23) can cache the authenticated state as long as two hours, allowing automatic, hands-off resumption of operation.

If Auto-Activation is not allowed, or if it is common for your devices to experience outages greater than two hours in duration, you can invoke Remote PED operation and perform PED operations from a location that is distant from the HSM, and possibly more convenient for your authentication secret key holders to convene. See "About Remote PED" on page 106.

Updated Luna PED Behavior Notes

USB-powered and DC-powered Luna PEDs can be updated to Luna PED Firmware 2.9.0 and Luna PED Firmware 2.7.4 respectively.

> Updated Luna PEDs support new communications security protocols for compliance with evolving standards. For more information about these changes, refer to the following sections:
  - "Secure Communication Between the Local PED and Luna PCIe HSM 7s With Firmware 7.7.0 and Newer" on page 106
  - "Secure Communication Between the Remote PED and Luna PCIe HSM 7s With Firmware 7.7.0 and Newer" on page 110

> A Luna HSM at Luna HSM Firmware 7.7.0 or newer requires connection with an updated Luna PED.
  - If you are updating to Luna HSM Firmware 7.7.0 or newer, refer to Special Considerations for Luna HSM Firmware 7.7.0 and Newer, Luna PED Firmware 2.9.0, and Luna PED Firmware 2.7.4 *before* proceeding with the update.
  - For more information about PED behavior on Luna HSMs that contain V0 or V1 partitions, refer to "Multifactor Quorum Authentication" on page 25.

> PEDs with Luna PED Firmware 2.7.4 or Luna PED Firmware 2.9.0 or newer can also function with the following HSMs:
  - HSMs with firmware 5.x and 6.x that will not be updated with the new PED communication protocols.
  - HSMs with firmware 7.x that have yet to be updated for compliance with current eIDAS/Common Criteria and NIST standards.

New-series Luna PED Behavior Notes

All of the following points apply to the newer-series PED (firmware versions 2.8.0, 2.8.1, or 2.9.0).

> If a PED is connected via USB to a version 7.x HSM (whether that HSM is installed in a host computer or is embedded in a Luna Network HSM 7 appliance), if the server housing the HSM is booted from a power-off condition, the PED display might come up blank. The PED must be reset.

> If a new-series PED is powered via USB from a 7.x HSM, and the HSM is reset, the PED will become unresponsive. The PED must be reset.

> If a PED is connected via USB to a PED server (for Remote PED), if the server is booted from a power-off condition, the PED display might come up blank OR the PED might be unresponsive to the PED server. The PED must be reset.

> A new-series PED will be unresponsive after a 7.x HMS firmware update or rollback, and/or the display might come up blank. The PED must be reset.

> In environments where the user is switching RPED connections to the same PED between a Luna PCIe HSM 7 with Luna HSM Firmware 7.7.0 and one with firmware older than 7.7.0, the following error may occur after receiving a prompt to present the orange PED key:
  - PED_ERROR when running Luna HSM Client 10.3.0 or newer.
  - DEVICE_ERROR when running Luna HSM Client 10.2.0 or older.

  The user may need to clear the RPK from the PED's cache before attempting to switch connection to the non-7.7.0 HSM by pressing the **<** key, or repeat the command after encountering the error.

References to resetting the PED mean cycling the power. This can be done by disconnecting and reconnecting the USB cable.

A new-series PED, powered by a 7.x HSM over USB retains the AC power socket of the older-series model. If an AC power block is plugged into the power socket of the PED, this will reset the PED.

Updating or Rolling Back Multifactor Quorum-Authenticated HSM Firmware

After a version 7.x HSM is updated to Luna HSM Firmware 7.7.0 (or newer), or rolled back to an earlier firmware version, a USB-connected PED should be power cycled. Also restart the PED after any appliance reboot. Without this action, attempted operations against the HSM can result in "device error".

Luna PED Received Items

This chapter describes the items you received with your Luna PED device. For instructions on setting up the PED, see "Multifactor Quorum Authentication" on page 90.

Basic Luna PED Order Items

The following items are included with your Luna PED. All are required for a successful installation.

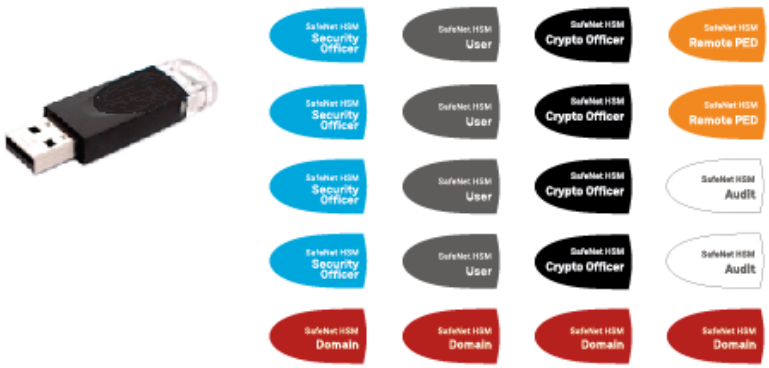
Qty	Item
1	**Luna PED** (with Luna PED Firmware 2.7.1 or newer)

Qty	Item
1	**Power Supply** kit with replaceable mains plug modules for international use (employed when the PED is operated in Remote PED mode) **NOTE** If your PED has Luna PED Firmware 2.8.0 or newer, it contains refreshed internal hardware and is powered by USB connection. Refreshed PEDs are not shipped with the external power supply, as they do not need it.
1	**Cable, USB 2.0, Type A to Mini B connectors** (for Remote PED operation).

Qty	Item
1	**Cable, Data, 9-pin, Micro-D to Micro-D connectors** (for local PED operation prior to HSM firmware versions 7.x.).

Other Required Multifactor Quorum-Authentication Items

The following required items may be shipped with your Luna PED, or ordered separately.

Qty	Item
1	**Set of PED keys and Labels**  Your order may include a set of PED keys and peel-and-stick labels.

Luna PED Hardware Functions

The Luna PED reads authentication secrets from PED keys on behalf of an HSM or partition. This section contains the following information about the Luna PED device:

> "Physical Features" on the next page

> "Keypad Functions" on page 102

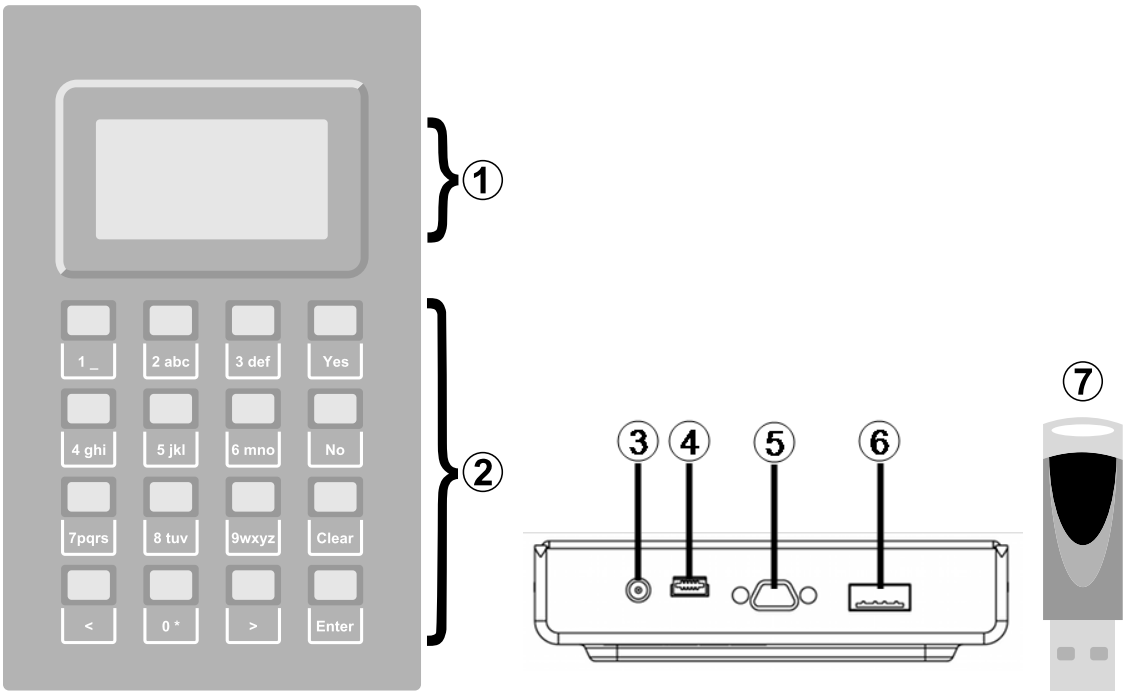
> "Modes of Operation" on page 102

> "Admin Mode Functions" on page 103

> "Luna PED with Newer CPU (External Power Supply Now Optional)" on page 103

Physical Features

The Luna PED is illustrated below, with important features labeled.



1	Liquid Crystal Display (LCD), 8 lines.
2	Keypad for command and data entry. See "Keypad Functions" on the next page.
3	DC power connector. Not used for PED version 2.8 and above. *
4	USB mini-B connector. Used for connecting to the HSM and for file transfer to or from the PED. Luna PED Firmware 2.8.0 and above is powered by this USB connection.
5	Micro-D subminiature (MDSM) connector. Not used for Luna release 7.x.
6	USB A-type connector for PED keys.
7	PED key. Keys are inserted in the PED key connector (item 6).

* Luna PEDs with Luna PED Firmware 2.8.0 and newer are powered by any USB 2.x or 3.x connection, and do not have an external DC power supply. The PED driver must be installed on the connected computer. If the Luna PED is connected to a hub or to a computer without the driver, then the PED display backlight illuminates, but no PED menu is presented.)

Keypad Functions

The Luna PED keypad functions are as follows:

Key	Function
Clear	> Clear the current entry, such as when entering a PIN > Hold the key down for five seconds to reset the PED during an operation. This applies only if the PED is engaged in an operation or is prompting for action. There is no effect when no command has been issued or when a menu is open
<	> **Backspace:** clear the most recent digit you typed on the PED > **Exit:** return to the previous PED menu
>	> **Log:** displays the most recent PED actions (since entering Local or Remote Mode)
Numeric keys	> Select numbered menu items > Input PINs
Yes and No	> Respond to Yes or No questions from the PED
Enter	> Confirm an action or entry

Modes of Operation

The Luna PED can operate in four different modes, depending on the type of HSM connection you want to use:

> **Local PED-SCP:** This mode is reserved for legacy Luna 6.x HSMs that use an MDSM connector between the PED and the HSM. It does not apply to Luna 7.x. Initial HSM configuration must be done in Local PED mode. See "Local PED Setup" on page 104 for instructions.

> **Admin:** This mode is for upgrading the Luna PED device firmware, diagnostic tests, and PED key duplication. See "Admin Mode Functions" on the next page for the functions available in this mode.

> **Remote PED:** In this mode, the PED is connected to a remote workstation and authenticated to the HSM with an orange PED key containing a Remote PED Vector (RPV) secret. This mode allows the Luna PCIe HSM 7 to be located in a data center or other location restricting physical access. See "About Remote PED" on page 106 for more information.

> **Local PED-USB:** In this mode, the PED is connected directly to the HSM card with a USB mini-B to USB-A connector cable. Initial HSM configuration must be done in Local PED mode.

If the Luna PED is connected to an interface when it is powered up, it automatically detects the type of connection being used and switches to the appropriate mode upon receiving the first command from the HSM.

Changing Modes

If you change your PED configuration without disconnecting the PED from power, you must select the correct mode from the main menu.

To change the Luna PED's active mode

1. Press the **<** key to navigate to the main menu.

```
Select Mode
1 Local PED-SCP
4 Admin
7 Remote PED
0 Local PED-USB

      PED V.2.7.1-5
```

   The main menu displays all the available modes, as well as the PED's current firmware version.

2. Press the corresponding number on the keypad for the desired mode.

> **NOTE** The Luna PED must be in **Local PED-USB** mode when connected to a Luna PCIe HSM 7 7 card, or LunaCM will return an error (CKR_DEVICE_ERROR) when you attempt authentication.

Admin Mode Functions

In this mode, you can upgrade the Luna PED device software, run diagnostic tests, and duplicate PED keys without having the Luna PED connected to an HSM. Press the corresponding number key to select the desired function.

```
Admin mode...
1 PED Key
5 Backup Devices
7 Software Update
9 Self Test

< EXIT
```

- **PED Key:** allows you to identify the secret on an inserted PED key, or duplicate the key, without having the Luna PED connected to an HSM.
- **Backup Devices:** Not applicable to Luna 7.x.
- **Software Update:** requires a PED software file and instructions sent from Thales.
- **Self Test:** test the PED's functionality. Follow the on-screen instructions to test button functions, display, cable connections, and the ability to read PED keys. The PED returns a PASS/FAIL report once it concludes the test.

Luna PED with Newer CPU (External Power Supply Now Optional)

A refresh of PED hardware (December 2017) was made necessary by suppliers discontinuing some original components. One of the replaced parts was the CPU, which necessitated a new line of PED firmware, incompatible with the previous versions.

The older PED was shipped with an AC adapter.

The newer PED has the same socket, for connection to an AC adapter, but an adapter/power-block is not shipped with the PED. You can purchase one locally if desired, but the new-CPU PED is reliably powered via USB.

The following points apply to the new-CPU PED - versions 2.8, 2.8.1, 2.9.0 - (that is, any released new CPU PED firmware version)

> when connected over USB to a Luna PCIe HSM 7 or Luna Network HSM 7, if the server housing the HSM card is booted from power off - the PED display might come up blank. The PED must be reset. Reset = power cycle

> when connected via USB to a server (but not directly to the HSM card), if the server is booted from power off - the PED display may come up blank OR unresponsive to PED server; the PED must be reset.

> when powered by the HSM over USB, if an AC power block is then connected, the PED resets.

> when powered by an AC power block, and also plugged into the HSM's USB port ,then if the AC power block is disconnected, the PED will power off.

> the new-CPU PED will be unresponsive after HSM firmware update or rollback, and the display might come up blank; the PED must be reset.

> if the new-CPU PED is powered via the USB connection on the HSM, and the HSM is reset, the PED becomes unresponsive; the PED must be reset.

> if the new-CPU PED is connected to AC and to the HSM's USB connector, if the server housing the HSM is power cycled (not the PED), the PED will not be unresponsive when the server and the HSM are back online; nevertheless, the PED must be reset.

"The PED must be reset" means that the PED must be power cycled by unplugging/replugging the USB cable, or by removing/reinserting the cord from the AC power block (if it is in use).

Local PED Setup

A Local PED connection is the simplest way to set up the Luna PED. In this configuration, the PED is connected directly to the HSM card. It is best suited for situations where all parties who need to authenticate credentials have convenient physical access to the HSM. When the HSM is stored in a secure data center and accessed remotely, you must use a Remote PED setup.

Setting Up a Local PED Connection

The Luna PCIe HSM 7 administrator can use these directions to set up a Local PED connection. You require:

> Luna PED with Luna PED Firmware 2.7.1 or newer

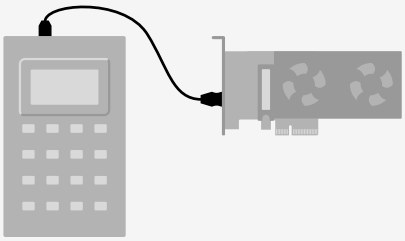
> USB mini-B to USB-A connector cable

> Luna PED DC power supply (if included with your Luna PED)

To set up a Local PED connection

1. Connect the Luna PED to the HSM using the supplied USB mini-B to USB-A connector cable.

NOTE To operate in Local PED-USB mode, the Luna PED must be connected directly to the HSM card's USB port, and not one of the other USB connection ports on the host system.



2. Luna PED Firmware 2.8.0 and newer is powered via the USB connection. If you are using Luna PED Firmware 2.7.1, connect it to power using the Luna PED DC power supply.

   As soon as the PED receives power, it performs start-up and self-test routines. It verifies the connection type and automatically switches to the appropriate operation mode when it receives the first command from the HSM.

3. If you prefer to set the operation mode to **Local PED-USB** manually, see "Changing Modes" on page 102.

The Luna PED is now ready to perform authentication for the HSM. You may proceed with setting up or deploying your Luna PCIe HSM 7. All commands requiring authentication (HSM/partition initialization, login, etc.) will now prompt the user for action on the locally-connected Luna PED.

PED Actions

There are several things that you can do with the Luna PED at this point:

> Wait for a PED authentication prompt in response to a LunaCM command (see "Performing Multifactor Quorum Authentication" on page 135)

> Create copies of your PED keys (see "Duplicating Existing PED keys" on page 140)

> Change to the Admin Mode to run tests or update PED software (see "Changing Modes" on page 102)

> Prepare to set up a Remote PED server (see "About Remote PED" on the next page)

Local PED Troubleshooting

If you encounter problems with Local PED, refer to this section.

CKR_PED_UNPLUGGED error after hsm restart

After running **hsm restart**, LunaCM returns a CKR_PED_UNPLUGGED error when authentication is attempted.

```
lunacm:>role login -n so

        Please attend to the PED.

Caution: You have only 3 so login attempts left. If you fail 3
         more consecutive login attempts (i.e. with no successful
         logins in between) the HSM will be ZEROIZED!!!

Error in execution: CKR_PED_UNPLUGGED.

Command Result : 0x8000002e (CKR_PED_UNPLUGGED)
```

If you receive this error, disconnect the Luna PED from the HSM's USB port and reconnect it before issuing the login command again.

Secure Local PED

PED firmware can be updated to Luna PED Firmware 2.7.4 or newer on a PED with older CPU, and to Luna PED Firmware 2.9.0 or newer on a PED with new CPU.

> The firmware update is optional for multifactor quorum-authenticated HSMs with firmware versions older than Luna HSM Firmware 7.7.0, and *required* to work with HSMs at Luna HSM Firmware 7.7.0 and newer. This combination complies with an eIDAS-related requirement for an updated secure channel.

> The updated secure channel for Remote PED operation is now also replicated in the local channel, but because it is local it does not need to be mediated via an orange PED key. The Luna PED, however, sees both local and remote connections as equivalent.

> **NOTE** Pressing the "**<**" key on the Luna PED, to change menus, now warns that the RPV will be invalidated, even though the local connection does not use an orange PED Key. Simply ignore the message.

Secure Communication Between the Local PED and Luna PCIe HSM 7s With Firmware 7.7.0 and Newer

Luna HSM Firmware 7.7.0 introduces a level of protection for data that is exchanged between the Local PED (running Luna PED Firmware 2.7.4 or Luna PED Firmware 2.9.0) and Luna PCIe HSM 7. All exchanged data is protected in the following way:

> All CSPs exchanged between the Local PED and the Luna PCIe HSM 7 are protected using an AES-256-KWP CSP wrapping key (CWK).

> The CWK is established using the One-pass Diffie-Hellman key agreement scheme C(1e, 1s ECDH CDH) with unilateral key confirmation, as defined in *NIST Special Publication 800-56A Revision 3*.The key agreement scheme requires the following:

- The Luna PCIe HSM 7 uses a static ECDH key pair. In this case, the HSM generates its own static P-521 ECDH key on startup and the key is assigned a certificate which chains back to the HSM’s ECC HOC.
- The Local PED uses an ephemeral ECDH key pair. In this case, the Local PED generates its ephemeral P-521 ECDH key pair during the key agreement.

> The SHA-512 based Single-step key derivation function defined in *NIST Special Publication 800-56C Revision 1* is used to derive the CWKs from the shared secret. The derivation function derives separate CWKs for HSM-to-Local PED and Local PED-to-HSM communication.

About Remote PED

A Remote PED connection allows you to access multifactor quorum-authenticated HSMs that are kept in a secure data center or other remote location where physical access is restricted or inconvenient. This section provides descriptions of the following aspects of Remote PED connections:

> "Remote PED Architecture" on the next page

> "Remote PED Connections" on page 108

> "Secure Communication Between the Remote PED and Luna PCIe HSM 7s With Firmware 7.7.0 and Newer" on page 110

> "Initializing the Remote PED Vector and Creating an Orange Remote PED key" on page 112

> "Installing PEDserver and Setting Up the Remote Luna PED" on page 115

> "Opening a Remote PED Connection" on page 116

> "Ending or Switching the Remote PED Connection" on page 119

> Configuring PED Timeout Settings

> "Remote PED Troubleshooting" on page 119

Remote PED Architecture

The Remote PED architecture consists of the following components:

> **Remote PED:** a Luna PED with Luna PED Firmware 2.7.1, connected to a network-connected workstation, powered on, and set to Remote PED mode.

> **NOTE** For the enhanced connection security and NIST SP 800-131A Rev.1 compliance implemented with Luna HSM Firmware 7.7.0 and newer, the following Luna PED firmware versions are required:
>
> > Luna PED Firmware 2.7.4 for PEDs that require the external power block
>
> > Luna PED Firmware 2.9.0 for USB-powered PEDs

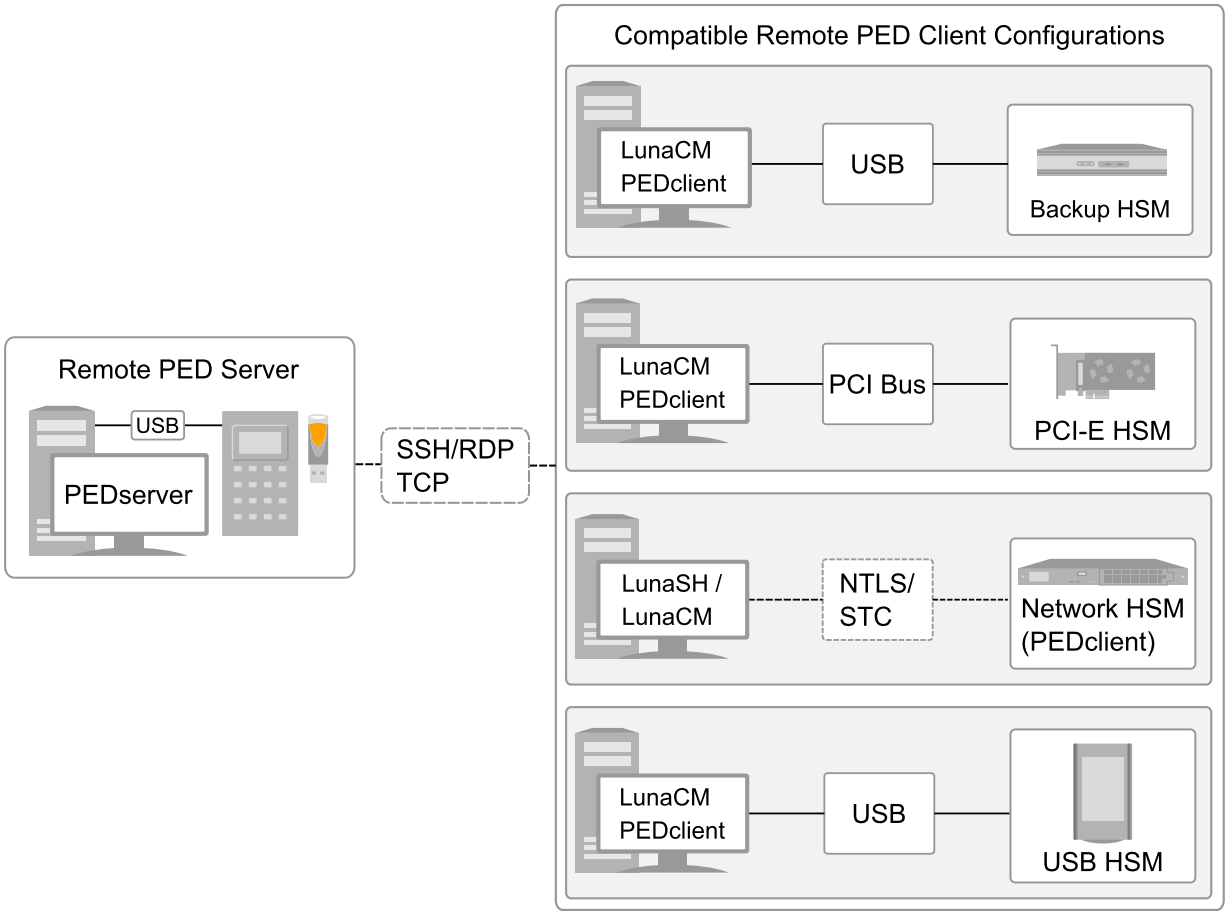
> **Remote PED Vector (RPV):** a randomly generated, encrypted value used to authenticate between a Remote PED (via PEDserver) and a Luna HSM (via PEDclient).

> **Remote PED Key (RPK):** an orange PED key containing an RPV (or multiple PED keys with a split RPV in an M of N quorum implementation).

> **PEDserver:** software that runs on the remote workstation with a USB-connected Luna PED. PEDserver accepts requests from and serves PED actions and data to PEDclient.

> **PEDclient:** software that requests remote PED services from PEDserver. PEDclient runs on the network-connected system hosting the HSM, which can be one of the following:

- Host computer with USB-connected Luna Backup HSM, configured for remote backup
- Host computer with Luna PCIe HSM 7 installed
- Luna Network HSM 7
- Host computer with Luna USB HSM 7 connected



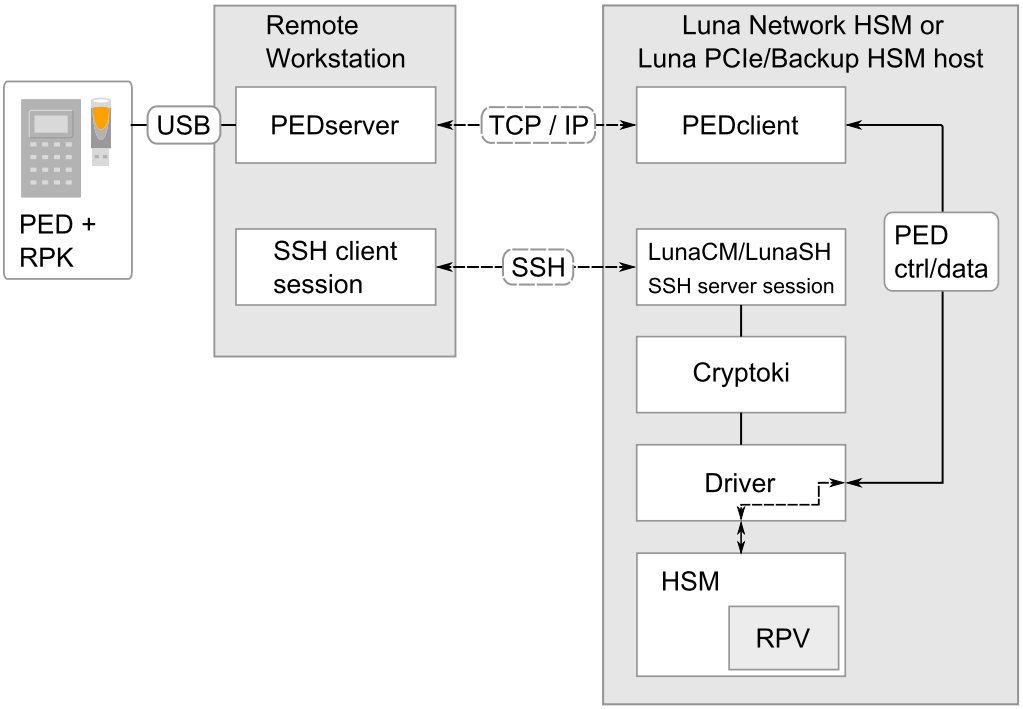
Remote PED Connections

A Luna PCIe HSM 7 on a host computer running PEDclient can establish a Remote PED connection with any workstation that meets the following criteria:

> PEDServer is running

> a Luna PED with Luna PED Firmware 2.7.1 or newer is connected

> The orange PED key containing the Remote PED Vector (RPV) for that HSM is available



Priority and Lockout

If a Local PED connection is active and an operation is in progress, a Remote PED connection cannot be initiated until the active Local PED operation is completed. If the Local PED operation takes too long, the Remote PED command may time out.

When a Remote PED connection is active, the Local PED connection is ignored, and all authentication requests are routed to the Remote PED. Attempts to connect to a different Remote PED server are refused until the current connection times out or is deliberately ended. See "Ending or Switching the Remote PED Connection" on page 119.

One Connection at a Time

Remote PED can provide PED services to only one HSM at a time. To provide PED service to another HSM, you must first end the original Remote PED connection. See "Ending or Switching the Remote PED Connection" on page 119.

Timeout

Remote PED connections have configurable timeout settings. For more information, refer to Configuring PED Timeout Settings.

Once a partition has been activated and cached the primary authentication (PED key) credential, the Crypto Officer or Crypto User can log in using only the secondary (alphanumeric) credentials and the Remote PED connection can be safely ended until the Partition SO needs to log in again.

Broken Connections

A Remote PED connection is broken if any of the following events occur:

> The connection is deliberately ended by the user

> The connection times out (default: 1800 seconds)

- Luna PED is physically disconnected from its host
- VPN or network connection is disrupted
- You exit Remote PED mode on the Luna PED. If you attempt to change menus, the PED warns:

```
   ** WARNING **
Exiting now will
invalidate the RPK.
Confirm? YES/NO
```

If the link is broken, as long as the network connection is intact (or is resumed), you can restart PEDserver on the Remote PED host and run **ped connect** in LunaCM to re-establish the Remote PED link. In a stable network situation, the link will remain available until timeout.

Secure Communication Between the Remote PED and Luna PCIe HSM 7s With Firmware 7.7.0 and Newer

Communication between the Remote PED and Luna PCIe HSM 7 is kept secure before and after RPV initialization.

Secure Communication Before RPV Initialization

Before the RPV is initialized, data exchanged between the Remote PED and Luna PCIe HSM 7 is protected using the same method that is used to secure communication between a Local PED and Luna PCIe HSM 7 (see "Secure Communication Between the Local PED and Luna PCIe HSM 7s With Firmware 7.7.0 and Newer" on page 106). However, the SHA-512 based single-step key derivation function defined in *NIST Special Publication 800-56C Revision 1* is used to derive the CWKs from the shared secret, with a password used instead of an RPV.

After the RPV is initialized, the Luna PCIe HSM 7 and Remote PED re-establish a full secure channel. For more information, see the section below.

Secure Communication After RPV Initialization

After the RPV is initialized, all communication between the Remote PED and the Luna PCIe HSM 7 is transmitted within a secure channel that is protected using an AES-256-CTR data encryption key (DEK) and a SHA-512-HMAC data MAC key (DMK). CSPs transmitted within the secure channel are additionally encrypted using an AES-256-KWP CSP wrapping key (CWK). The secure channel is established using the Full Unified C (2e, 2s ECDH CDH) key agreement scheme with bilateral key confirmation, as defined in *NIST Special Publication 800-56A Revision 3*. The key agreement scheme requires each party to use a static ECDH key pair and an ephemeral ECDH key pair. The key pairs are generated in the following ways:

- The HSM generates its own static P-521 ECDH key on startup. During RPV initialization, the HSM generates a static P-521 ECDH key and loads it onto the RPK along with the RPV (or RPV split is MofN is used). Both static keys are assigned certificates which chains back to the HSM's ECC HOC.
- During the key agreement, the Luna PCIe HSM 7 and Remote PED both generate their ephemeral P-521 ECDH key pair.

As part of the key agreement, the SHA-512 based single-step key derivation function defined in *NIST Special Publication 800-56C Revision 1* is used to combine the shared secret, the RPV, and the derived the secure channel protection keys; that is, the DEK, DMK, and CWK. The derivation function derives separate keys (DEK, DMK, and CWK) for HSM-to-Remote PED and Remote PED-to-HSM communication.

The RPV ensures mutual authentication of both end points and the HSM's static ECDH key ensures additional authentication of the HSM.

Secure Communication Between the Remote PED and Luna PCIe HSM 7s With Firmware 7.4.2 and Older

All communication between the Remote PED and the HSM is transmitted within an AES-256 encrypted channel, using session keys based on secrets shared out-of-band. This is considered a very secure query/response mechanism. The authentication conversation is between the HSM and the PED. Authentication data retrieved from the PED keys never exists unencrypted outside of the PED or the HSM. PEDclient and PEDserver provide the communication pathway between the PED and the HSM, and the data remains encrypted along that path.

Once the PED and HSM are communicating, they establish a common Data Encryption Key (DEK). DEK establishment is based on the Diffie-Hellman key establishment algorithm and a Remote PED Vector (RPV), shared between the HSM and the PED via the orange Remote PED Key (RPK). Once a common Diffie-Hellman value is established between the parties via the Diffie-Hellman handshake, the RPV is mixed into the value to create a 256-bit AES DEK on each side. If the PED and the HSM do not hold the same RPV, the resulting DEKs are different and communication is blocked.

Mutual authentication is achieved by exchanging random nonces, encrypted using the derived data encryption key. The authentication scheme operates as follows:

HSM	_	Remote PED
Send 8 bytes random nonce, R1, encrypted using the derived encryption key.	$\{R1 \mid\mid padding\}_{Ke}$ ->	
	<- $\{R2 \mid\mid R1\}_{Ke}$	Decrypt R1. Generate an 8 byte random nonce, R2. Concatenate R2 || R1 and encrypt the result using the derived encryption key.
Decrypt R2 || R1. Verify that received R1 value is the same as the originally generated value. Re-encrypt R2 and return it to Remote PED.	$\{padding \mid\mid R2\}_{Ke}$ ->	Verify that received R2 value is the same as the originally generated value.

Following successful authentication, the random nonce values are used to initialize the feedback buffers needed to support AES-OFB mode encryption of the two communications streams (one in each direction).

Sensitive data in transition between a Luna PED and an HSM is end-to-end encrypted: plaintext security-relevant data is never exposed beyond the HSM and the PED boundaries at any time. The sensitive data is also hashed, using a SHA-256 digest, to protect its integrity during transmission.

Initializing the Remote PED Vector and Creating an Orange Remote PED key

The Remote PED (via PEDserver) authenticates itself to the Luna PCIe HSM 7 with a randomly-generated encrypted value stored on an orange PED key. That secret originates in an HSM, and can be carried to other HSMs via the orange key. An newly-configured HSM either:

> generates its own RPV secret to imprint on an orange PED key,

> accepts a pre-existing RPV from a previously imprinted orange PED key, at your discretion.

The orange key proves to the HSM that the Remote PED is authorized to provide authentication for HSM roles. A Luna PCIe HSM 7 administrator can create this key using one of the following two methods:

> "Local RPV Initialization" below**:** The RPV is initialized using a Luna PED connected to the USB port on the HSM card. This is the standard method of initializing the RPV.

> "Remote RPV Initialization" on the next page**:** The RPV is initialized using a Luna PED connected to a remote workstation running PEDserver. A one-time numeric password is used to authenticate the Remote PED to the HSM before initializing the RPV. It is available only if the HSM is in a zeroized state (uninitialized) and your firewall settings allow an HSM-initiated Remote PED connection. If you choose this method, you will set up Remote PED before initializing the RPV.

> **NOTE** Generally, the HSM SO creates an orange PED key (and backups), makes a copy for each valid Remote PED server, and distributes them to the Remote PED administrators.

See also "Rotating or Re-Initializing the Orange Remote PED key" on page 114.

Local RPV Initialization

If the HSM is already initialized, the HSM SO must log in to complete this procedure. You require:

> Luna PED with Luna PED Firmware 2.7.1 or newer

> USB mini-B to USB-A connector cable

> Luna PED DC power supply (if included with your Luna PED)

> Blank or reusable orange PED key (or multiple keys, if you plan to make extra copies or use an M of N security scheme). See "Creating PED keys" on page 129 for more information.

> **NOTE** Orange PED keys (RPK) for use with Luna HSM Firmware 7.7.0 or newer, with enhanced security to address modern threat environments and to comply with updated standards, have increased infrastructure onboard the key. If such an initialized RPK is overwritten to become a different role PED key (example SO), this process that formerly would take about six seconds now takes about 36 seconds.

To initialize the RPV and create the orange PED key locally

1. If you have not already done so, set up a Local PED connection (see "Local PED Setup" on page 104).
2. Launch LunaCM on the Luna PCIe HSM 7 host workstation.

3. If the HSM is initialized, log in as HSM SO (see Logging In as HSM Security Officer). If not, skip to the next step.

   lunacm:> **role login -name so**

4. Ensure that you have the orange PED key(s) ready. Initialize the RPV.

   lunacm:> **ped vector init**

5. Attend to the Luna PED and respond to the on-screen prompts. See "Creating PED keys" on page 129 for a full description of the key-creation process.

```
SLOT
SETTING RPV...
Would you like to
reuse an existing
keyset?(Y/N)
```

   - If you have an orange PED key with an existing RPV that you wish to use for this HSM, press **Yes**.
   - If you are creating a new RPV, press **No**.

```
SLOT
SETTING RPV...
Insert a
RPK / Remote
PED Key (ORANGE)
Press ENTER.
```

   Continue following the prompts for PIN, M of N, and duplication options.

To continue setting up a Remote PED server, see "Installing PEDserver and Setting Up the Remote Luna PED" on page 115.

Remote RPV Initialization

When you initialize an RPV with the PED connected locally, you have direct physical control of the operation and its security.

When you initialize an RPV remotely, you must secure the link and the operation with a one-time password. The HSM must be *uninitialized* for this operation.

> **NOTE** This feature requires minimum Luna HSM Firmware 7.7.0 and Luna HSM Client 10.3.0.

Use the following procedure to initialize the RPV. You require:

> A blank or reusable orange PED key (or multiple keys, if you plan to make extra copies or use an M of N security scheme). See "Creating PED keys" on page 129 for more information.

> The HSM must be in a zeroized state and the RPV uninitialized.

To initialize the RPV and create the orange key remotely

1. Open an HSM-initiated Remote PED connection.

lunacm:> **ped connect -ip** <PEDserver_IP>

The Remote PED connection command prepares to secure the connection and LunaCM presents a randomly-generated 8-digit numeric one-time password that the HSM will use to identify the Remote PED server.

```
        Please attend to the PED and enter following password: 18246843

Command Result : No Error
```

The remote Luna PED prompts you for the one-time password:

```
SLOT
COMPUTE SESSION KEY.

Enter PED Password.

********
```

2. Enter the numeric password on the PIN pad, exactly as displayed in LunaCM, and press **Enter**.
3. Set the active slot to the Luna PCIe HSM 7 admin partition.
4. Ensure that you have the orange PED key(s) ready. Initialize the RPV.

   lunacm:> **ped vector init**
5. Attend to the Luna PED and respond to the on-screen prompts. See "Creating PED keys" on page 129 for a full description of the key-creation process.

   When the initialization is complete, the HSM establishes a Remote PED connection using the newly-created RPV.

   You may now initialize the HSM. See Initializing the HSM for more information.

> **NOTE** After creating the orange (Remote PED Vector) key for an HSM using the single-session, one-time password-authenticated PED connection that is used to create the key, the Luna PED prompts for the one-time password when you end the session using **ped disconnect**.
>
> This prompt can be safely ignored. The PED session is disconnected properly by pressing the Enter key on the Luna PED, without entering the password.

Rotating or Re-Initializing the Orange Remote PED key

You can rotate the RPV at any time, using either a local or remote Luna PED. This might be necessary if an orange PED key is lost, or as part of scheduled security measures. If the original orange PED key is lost, or you do not have enough M of N splits to reach a quorum, you must use a local PED. You require:

> [Remote PED only] The original orange PED key or enough M of N splits for a quorum.

> A blank or reusable orange PED key (or multiple keys, if you plan to make extra copies or use an M of N security scheme). See "Creating PED keys" on page 129 for more information.

To rotate or re-initialize the orange remote PED key

1. If you have not already done so, set up a Local or Remote PED connection (see "Local PED Setup" on page 104 or "Opening a Remote PED Connection" on the next page).
2. Launch LunaCM on the Luna PCIe HSM 7 host workstation.
3. [Remote PED only] Open a Remote PED connection using the original orange PED key(s).

   lunacm:> **ped connect -ip** <PEDserver_IP>
4. Log in as HSM SO (see Logging In as HSM Security Officer).

   lunacm:> **role login-name so**
5. Ensure that you have the blank orange PED key(s) ready. Initialize the RPV.

   > **CAUTION!** Do not overwrite your original orange PED key(s) unless you have a backup copy. The RPV is not rotated until the entire operation is complete. If you encounter network connectivity or PED timeout issues, particularly when presenting multiple M of N splits, you might not have enough splits of the original RPV left for quorum. In this case, you must re-initialize the orange RPK using a Local PED connection.

   lunacm:> **ped vector**
6. Attend to the Luna PED and respond to the on-screen prompts. See "Creating PED keys" on page 129 for a full description of the key-creation process.

Installing PEDserver and Setting Up the Remote Luna PED

The PEDserver software, installed on the Remote PED host workstation, allows the USB-connected Luna PED to communicate with remotely-located HSMs. The Remote PED administrator can install PEDserver using the Luna HSM Client installer. You require:

> Network-connected workstation with compatible operating system (refer to the release notes)

> Luna HSM Client installer

> Luna PED with Luna PED Firmware 2.7.1 or newer

> USB mini-B to USB-A connector cable

> Luna PED DC power supply if required by your Luna PED hardware

> **NOTE** To set up a Remote PED Server on Linux, you require Luna HSM Client 10.1.0 or newer.

To install PEDserver and the PED driver, and set up the Luna PED

1. Run the Luna HSM Client installer and follow the on-screen instructions, as detailed in Luna HSM Client Software Installation, and select the **Luna Remote PED** option. Any additional installation choices are optional, for the purpose of this procedure.
2. On Windows, if you are prompted to install the driver, accept the installation.

3. On Windows, reboot the computer to ensure that the Luna PED driver is accepted by Windows. This step is not required for Linux or Windows Server operating systems.
4. Connect the Luna PED to a USB port on the host system using the supplied USB mini-B to USB-A connector cable.

   Luna PED with Luna PED Firmware 2.8.0 and above is powered via the USB connection. If you are using a Luna PED with Luna PED Firmware 2.7.1, connect it to power using the Luna PED DC power supply.

   As soon as the PED receives power, it performs start-up and self-test routines (for PED v2.8 and later, the PED driver must be installed on the connected computer, or the display remains blank). It verifies the connection type and automatically switches to the appropriate operation mode when it receives the first command from the HSM.

   To manually set the operation mode to **Remote PED**, see "Changing Modes" on page 102.
5. On Windows, open the Windows **Device Manager** to confirm that the Luna PED is recognized as **PED2**. If it appears as an unrecognized USB device:
   a. Disconnect the Luna PED from the host USB port.
   b. Reboot the computer to ensure that the Luna PED driver is accepted by Windows.
   c. Reconnect the Luna PED.

To continue setting up a Remote PED connection, see "Opening a Remote PED Connection" below.

Opening a Remote PED Connection

The HSM/client administrator can use this procedure to establish an HSM-initiated Remote PED connection. You require:

> Administrative access to a network-connected workstation with PEDserver installed and Luna PED connected (see "Installing PEDserver and Setting Up the Remote Luna PED" on the previous page)

> Administrative access to the Luna PCIe HSM 7 host via SSH

> Orange PED key with the HSM's RPV (see "Initializing the Remote PED Vector and Creating an Orange Remote PED key" on page 112)

If you encounter issues, see "Remote PED Troubleshooting" on page 119.

To open a Remote PED connection

1. On Windows, open an Administrator command prompt by right-clicking the Command Prompt icon and selecting **Run as administrator**. This step is not necessary if you are running Windows Server 20xx, as the Administrator prompt is launched by default.
2. Navigate to the Luna HSM Client install directory.

   Windows default: **cd C:\Program Files\SafeNet\LunaClient**

   Linux/UNIX default: **cd /usr/safenet/lunaclient**
3. Launch PEDserver. If you are launching PEDserver on an IPv6 network, you must include the **-ip** option.

   > **"pedserver -mode start" on page 158** [**-ip** <PEDserver_IP>]

```
C:\Program Files\SafeNet\LunaClient>pedserver mode start
Ped Server Version 1.0.6 (10006)
Ped Server launched in startup mode.
```

```
Starting background process
Background process started
Ped Server Process created, exiting this process.
```

4. Verify that the service has launched successfully.

   > **"pedserver -mode show" on page 156**

   Note the **Ped2 Connection Status**. If it says **Connected**, PEDserver is able to communicate with the Luna PED.

   Note also the server port number (default: **1503**). You must specify this port along with the PEDserver host IP when you open a connection.

```
c:\Program Files\SafeNet\LunaClient>pedserver mode show
Ped Server Version 1.0.6 (10006)
Ped Server launched in status mode.


   Server Information:
      Hostname:                          DWG9999
      IP:                                0.0.0.0
      Firmware Version:                  2.7.1-5
      PedII Protocol Version:            1.0.1-0
      Software Version:                  1.0.6 (10006)

      Ped2 Connection Status:            Connected
      Ped2 RPK Count                     0
      Ped2 RPK Serial Numbers            (none)

   Client Information:                   Not Available

   Operating Information:
      Server Port:                       1503
      External Server Interface:         Yes
      Admin Port:                        1502
      External Admin Interface:          No

      Server Up Time:                    190 (secs)
      Server Idle Time:                  0 (secs) (0%)
      Idle Timeout Value:                1800 (secs)

      Current Connection Time:           0 (secs)
      Current Connection Idle Time:      0 (secs)
      Current Connection Total Idle Time: 0 (secs) (100%)
      Total Connection Time:             0 (secs)
      Total Connection Idle Time:        0 (secs) (100%)

Show command passed.
```

5. Use **ipconfig** (Windows) or **ifconfig** (Linux) to determine the PEDserver host IP. A static IP is recommended, but if you are connecting over a VPN, you may need to determine the current IP each time you connect to the VPN server.

6. Via SSH, launch LunaCM on the Luna PCIe HSM 7 host.

7. Initiate the Remote PED connection.

   lunacm:> **ped connect -ip** <PEDserver_IP> **-port** <PEDserver_port> **-slot** <slot>

> **NOTE** The **-slot** option may be required if you have multiple Luna PCIe HSM 7s installed in one server. If you do not include this option, the currently-active slot is used.

```
lunacm:>ped connect -ip 192.124.106.100 -port 1503

Command Result : No Error
```

8. Issue the first command that requires authentication.
   - If the HSM is already initialized and you have the blue HSM SO key, log in.

     lunacm:> **role login -name so**
   - If the HSM is uninitialized, you can initialize it now (see Initializing the HSM). Have blank or reusable blue and red PED keys ready (or multiple blue and red keys in case of M of N or if making multiple copies). See "Creating PED keys" on page 129 for more information.

     lunacm:> **hsm init -label** <label>
9. The Luna PED prompts for an orange PED key. Present the orange PED key with the correct RPK.

```
SLOT
COMPUTE SESSION KEY.
Insert a
RPK / Remote
PED Key (ORANGE)
Press ENTER.
```

10. TheLuna PED prompts for the key associated with the command you issued. Follow the on-screen directions to complete the authentication process.

```
SLOT
SO LOGIN...
Insert a
SO / HSM Admin
PED Key (BLUE)
Press ENTER.
```

> **NOTE** The Remote PED connection eventually times out (default: 1800 seconds), and must be re-initiated each time authentication is required. To simplify this process, you can set a default IP address and/or port for LunaCM to use each time you connect. To drop the Remote PED connection manually, see "Ending or Switching the Remote PED Connection" on the next page.

11. [OPTIONAL] Set a default IP address and/or port for the Luna PCIe HSM 7 to look for a Remote PED host with PEDserver running.

    lunacm:> **ped set -ip** <PEDserver_IP> **-port** <PEDserver_port>

```
lunacm:>ped set -ip 192.124.106.100 -port 1503

Command Result : 0 (Success)
```

    With this default address set, the HSM administrator can use lunacm:> **ped connect** to initiate the Remote PED connection. The orange PED key may be required if the RPK has been invalidated since you last used it.

Ending or Switching the Remote PED Connection

PEDserver runs on the Remote PED host until explicitly stopped. PEDclient (running on the Luna PCIe HSM 7 host) has a default timeout period of 1800 seconds. If you want to connect to a different Remote PED server, or allow another HSM to use the current server, you must manually break the Remote PED connection.

To end or switch an HSM-initiated connection

1. End the Remote PED connection.

   lunacm:> **ped disconnect**

2. You are now able to initiate a connection to a different Remote PED host running PEDserver. You will need to present the orange PED key.

   lunacm:> **ped connect -ip** <PEDserver_IP> **-port** <port>

> **NOTE** Running this command does not change the default Remote PED IP/port you may have previously set. If you want this new Remote PED server to be the default, set it using lunacm:> **ped set -ip** <PEDserver_IP> **-port** <port>.

Remote PED Troubleshooting

If you encounter problems at any stage of the Remote PED connection process, the following troubleshooting tips may help resolve the problem:

> "Intermittent CKR_CALLBACK_ERROR: PED Cannot Service its USB Data Channel Fast Enough to Communicate with PEDserver" below

> "No Menu Appears on Luna PED Display: Ensure Driver is Properly Installed" on the next page

> "RC_SOCKET_ERROR: PEDserver Requires Administrator Privileges" on the next page

> "CKR_PED_UNPLUGGED: Reconnect Remote PED Before Issuing Commands" on the next page

> "Remote PED Firewall Blocking" on page 121

> "Remote PED Blocked Port Access" on page 122

> "ped connect Fails if IP is Not Accessible" on page 123

> "PEDserver on VPN fails" on page 123

Intermittent CKR_CALLBACK_ERROR: PED Cannot Service its USB Data Channel Fast Enough to Communicate with PEDserver

> **NOTE** This issue might occur during Remote PED connections between
>
> > A Luna PCIe HSM 7 with Luna HSM Firmware 7.7.0 or newer and a remote workstation with Luna HSM Client 10.3.0 or newer.
>
> > A Luna Backup HSM 7 with firmware 7.7.1 or newer and a remote workstation with Luna HSM Client 10.3.0 or newer.

The PED might not be able service its USB data channel fast enough to communicate with PEDserver and you will intermittently receive CKR_CALLBACK_ERROR.

The following error appears in the PEDserver log file:

```
* ERROR ** 32725 : pedsock_rmtped_write_1_waitack_write_n_waitack failed: 0xffffffff (-1)*
```

If driver log messages are available on your system, the following message may appear where driver logs are reported:

```
kernel: lunaped: read: usb_bulk_msg: rc = -110
```

To avoid this error, throttle communication between the PED and PEDserver by running the following command from a command prompt:

pedserver -mode config -set -pedwritedelay <int>

> **NOTE** To resolve this error in most cases, Thales recommends setting the value of **-pedwritedelay** to **50**. If you still experience this issue, set **-pedwritedelay** to a value higher than **50**. For more information about this option, refer to "pedserver -mode config" on page 152.

No Menu Appears on Luna PED Display: Ensure Driver is Properly Installed

If the PED driver is not properly installed before connecting the PED to the workstation's USB port, the PED screen does not display the menu. If you encounter this problem, ensure that you have followed the entire procedure at "Installing PEDserver and Setting Up the Remote Luna PED" on page 115.

RC_SOCKET_ERROR: PEDserver Requires Administrator Privileges

If PEDserver is installed in the default Windows directory, it requires Administrator privileges to make changes. if you run PEDserver as an ordinary user, you may receive an error like the following:

```
c:\Program Files\SafeNet\LunaClient>pedserver mode start
Ped Server Version 1.0.6 (10006)
Ped Server launched in startup mode.
Starting background process
Failed to recv query response command: RC_SOCKET_ERROR c0000500
Background process failed to start : 0xc0000500 RC_SOCKET_ERROR
Startup failed. : 0xc0000500 RC_SOCKET_ERROR
```

To avoid this error, when opening a command line for PEDserver operations, right-click the Command Prompt icon and select **Run as Administrator**. Windows Server 20xx opens the Command Prompt as Administrator by default.

> **NOTE** If you do not have Administrator permissions on the Remote PED host, contact your IT department or install Luna HSM Client in a non-default directory (outside the **Program Files** directory) that is not subject to permission restrictions.

CKR_PED_UNPLUGGED: Reconnect Remote PED Before Issuing Commands

As described in the connection procedures, Remote PED connections time out after a default period of 1800 seconds (30 minutes). If you attempt authentication via PED after timeout or after the connection has been broken for another reason, the Luna PED will not respond and you will receive an error like this:

```
lunacm:> role login -n so

        Please attend to the PED.

Error in execution: CKR_PED_UNPLUGGED.

Command Result : 0x8000002e (CKR_PED_UNPLUGGED)
```

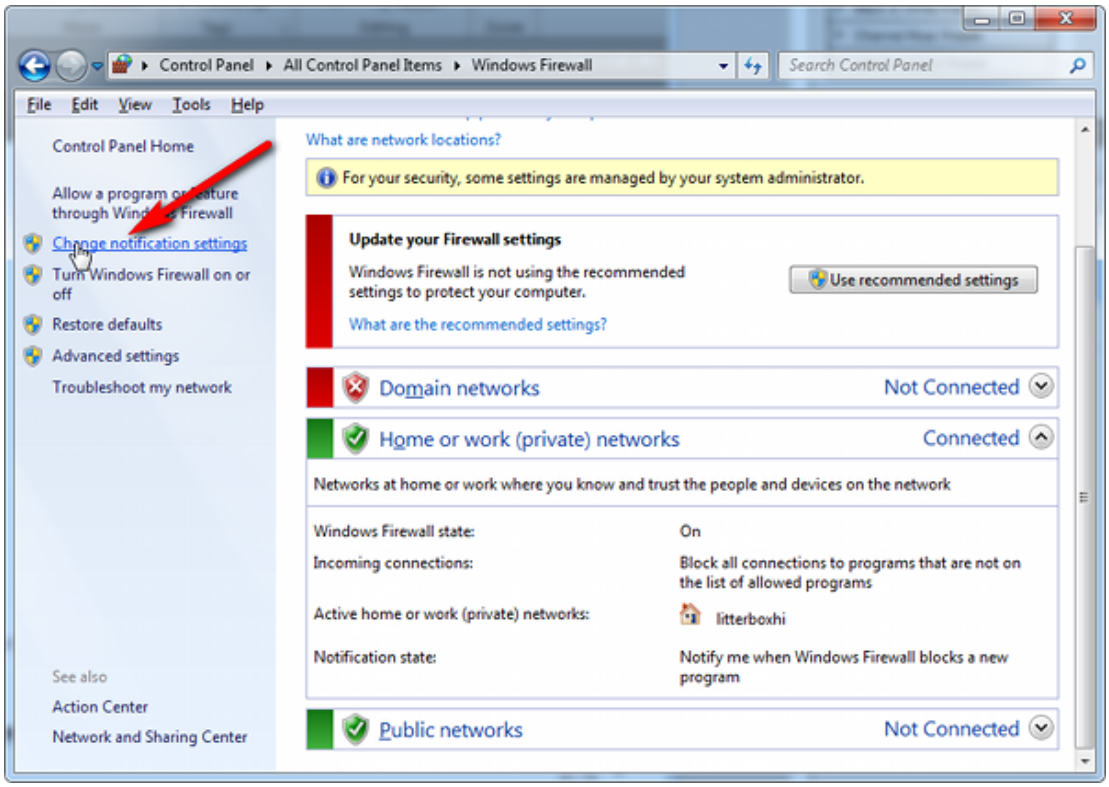
To avoid this error, re-initiate the connection before issuing any commands requiring authentication via PED:

lunacm:> **ped connect -ip** <PEDserver_IP> **-port** <PEDserver_port>

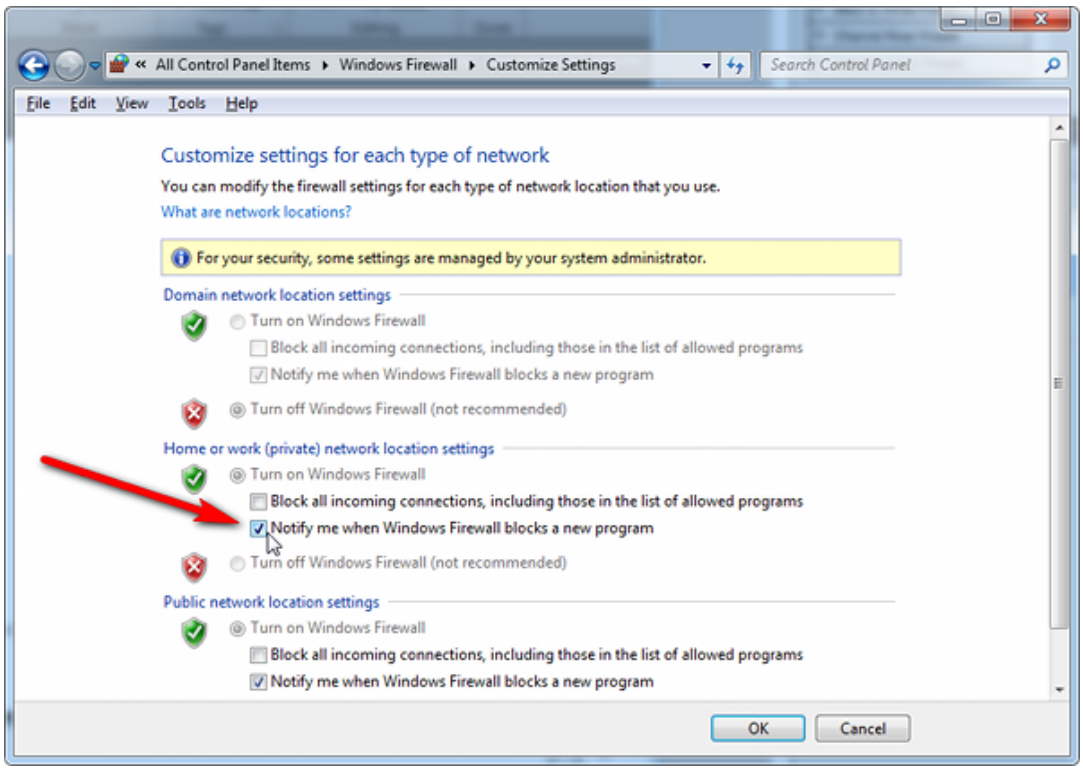
Remote PED Firewall Blocking

If you experience problems while attempting to configure a Luna Remote PED session over VPN, you might need to adjust Windows Firewall settings.

1. From the Windows Start Menu, select **Control Panel**.
2. Select **Windows Firewall**.
3. Select **Change notification settings**.



4. In the dialog **Customize settings for each type of network**, go to the appropriate section and activate **Notify me when Windows Firewall blocks a new program**.



With notifications turned on, a dialog box appears whenever Windows Firewall blocks a program, allowing you to override the block as Administrator. This allows PEDserver to successfully listen for PEDclient connections.

Remote PED Blocked Port Access

The network might be configured to block access to certain ports. If ports 1503 (the default PEDserver listening port) and 1502 (the administrative port) are blocked on your network, choose a different port when starting PEDserver, and when using lunacm:> **ped connect** to initiate the Remote PED connection. Contact your network administrator for help.

You might choose to use a port-forwarding jump server, co-located with the Luna PCIe HSM 7(s) on the datacenter side of the firewall. This can be a low-cost solution for port-blocking issues. It can also be used to implement a PKI authentication layer for Remote PED or other SSH access, by setting up smart-card access control to the jump server.

For example, you can use a standard Ubuntu Server distribution with OpenSSH installed and no other changes made to the standard installation with the following procedure:

1. Connect the Luna PED to a Windows host with Luna HSM Client installed and PEDserver running.
2. Open an Administrator command prompt on the Remote PED host and start the port-forwarding service.

   >**plink -ssh -N -T -R 1600:localhost:1503 <user>@<Ubuntu_server_IP>**.
3. Launch LunaCM on the Luna PCIe HSM 7 host, and open the HSM-initiated connection.

   lunacm:> **ped connect -ip <Ubuntu_server_IP> -port 1600**

The Remote PED host initiates the SSH session, via the Ubuntu jump server, which returns to the Remote PED host running PEDserver.

A variant of this arrangement also routes port 22 through the jump server, which allows administrative access to the Luna PCIe HSM 7 under the PKI access-control scheme.

ped connect Fails if IP is Not Accessible

On a system with two network connections, if PEDserver attempts to use an IP address that is not externally accessible, lunacm:>**ped connect** can fail. To resolve this:

1. Ensure that PEDserver is listening on the IP address that is accessible from outside.
2. If not, disable the network connection on which PEDserver is listening.
3. Restart PEDserver and confirm that it is listening on the IP address that is accessible from outside.

PEDserver on VPN fails

If PEDserver is running on a laptop that changes location, the active network address changes even though the laptop is not shutdown. If you unplugged from working at home, over the corporate VPN, commuted to the office, and reconnected the laptop there, PEDserver is still configured with the address you had while using the VPN. Running **pedserver -mode stop** does not completely clear all settings, so running **pedserver -mode start** again fails with a message like "Startup failed. : 0x0000303 RC_OPERATION_TIMED_OUT". To resolve this problem:

1. Close the current command prompt window.
2. Open a new Administrator command prompt.
3. Verify the current IP address.

   >**ipconfig**
4. Start PEDserver, specifying the new IP and port number ().

   > **"pedserver -mode start" on page 158** **-ip** <new_IP> **-port** <port>

Updating External Supply-Powered Luna PED Firmware

This section describes how to update the firmware on your Luna PED that is powered by a power-block. Refer to Customer Release Notes for valid update paths.

> **NOTE** If your Luna PED is the newer model that is powered by a USB connection (and is not shipped with a power-block), see "Updating USB-Powered Luna PED Firmware" on page 127.

Files Included in the Upgrade Package

The update package includes the following files. Both files are required to successfully perform the update:

> Firmware update file for the desired version (<PED_firmware_file_name>**.bin**, where the version is in the range 2.7.x)

> if the package contains **LunaPED_Update.exe** use that; otherwise, download KB0015846 from the Support Portal for a copy of LunaPED_Update.exe that works with PEDs powered by power block.

Preparing for the Update

Before you can install the new firmware, you must download the update package to the Windows Luna HSM Client workstation you will use to perform the update, and configure the Luna PED to accept the update.

> **CAUTION!** It is strongly recommended that you protect both your computer and Luna PED with an uninterruptible power supply during the upgrade operation. A power failure while any of the file images are being applied to the PED can result in loss of function that might require RMA.

To prepare your computer for the update

1. Ensure that Luna HSM Client software, including the Remote PED option, is installed on the Windows PC you will use to update the PED. To verify, ensure that the following files/directories are installed:
   - **C:\Program Files\SafeNet\LunaClient\RemotePEDDriver**
   - **C:\Program Files\SafeNet\LunaClient\pedserver.exe**
2. The update files are provided in an archive file named for the PED upgrade part number. Extract the files to the Windows Luna HSM Client workstation connected to the Luna PED you are updating.
3. On your Luna HSM Client workstation, where the PED is physically connected, stop the pedserver and pedclient services before starting the PED update.

> **NOTE** If you are updating the PED firmware from version 2.4.x to 2.5.0 or to 2.6.0 on a Windows 10 workstation (recall that the upgrade path is 2.4.0=>2.4.1=>2.5.0=>2.6.0=>2.7.0=>2.7.1=>2.7.4), then use the PEDupdate.exe that is included with the 2.7.x or 2.9.0 PED firmware update and *not* the firmware update package that was included with the Luna Client 6.2.2 package.

4. On your Luna HSM Client workstation, open a command prompt window and move to the directory where you copied the files in the update package.

To prepare the Luna PED for the firmware update

1. Connect the Luna PED to power (if you have an older PED that is not powered by the USB connection) and connect the USB cable between the Luna PED and your Luna HSM Client workstation.
2. Allow the PED to boot normally until it reaches the default **Local PED mode Awaiting command…**.
3. Press the **<** key to display the **Mode** menu.
4. Verify the currently-installed PED firmware version.

> **CAUTION!** If you are updating an older PED (not powered by the USB connection), this procedure requires starting from version **2.6.0-6** or newer. If your PED displays an earlier version, the update will fail and the PED will require RMA. If you have an older version, update the PED to 2.6.0-6 before continuing with this procedure.

5. Select **4** to display the **Admin** menu.
6. Select **7** for **Software Update**.

7. Select **0** to reset the PED and immediately press and hold the **<** key while the PED is resetting. Continue to hold the **<** key until the **Select Mode** menu is displayed.
8. Select **USB Mode** (4) when prompted to **Select Mode**. The PED displays **USB Mode**.

Updating the Luna PED Firmware

During this procedure, each of the **.bin** files is individually uploaded from your computer to the Luna PED, and then saved into permanent memory as the new version of that component. Individual responses are required at the PED to accept and load each file.

> **CAUTION!** Complete the following instructions in the order provided, or the PED could be left in an unusable state.

Once you start transferring / uploading a file to the PED, pay attention and promptly respond to the PED messages to acknowledge the upload and then to confirm installation of that new file. The individual PED operations do impose a timeout. However, you can pause before the next file transfer step, as there is no time restriction from one file upload to the next.

To update the Luna PED firmware

1. In the command prompt window on the Windows Luna HSM Client workstation you prepared to perform the update, execute the following command:

   > **LunaPED_Update.exe** <PED_firmware_file_name>**.bin**

   > **NOTE** If you have both older Luna PEDs (that are powered by a power block), and the newer Luna PEDs (powered by USB connection and addressed in "Updating USB-Powered Luna PED Firmware" on page 127), then the LunaPED_Update.exe files for each are different and not interchangeable.

2. On the Luna PED, select **Yes** in response to the prompt: **Software update. Upload Image? YES/NO**.

   Wait approximately six minutes. While transfer is in progress, the command line shows a progress indicator (remaining bytes to transfer), and the PED displays the following message:

   ```
   USB Mode
   Software update
   Uploading image
   ```

3. The output of the update command in the Windows command prompt should be similar to the following:

   ```
   LunaPED_Update v2.1.0-1 Nov 25 2013 12:44:48
   PED operation is required (to upload image)...
   (Sent 3199130 bytes in 327977000 microsecs).
   PED operation is required (to save image)...
   ```

4. If the image has been sent correctly, the PED displays the following message:

   ```
   USB Mode
   Software update
   ** WARNING **
   A power failure during save is unsupported!
   Save Image? YES/NO
   ```

   Select **Yes** to save the new image.

5. Wait for 20-30 seconds. When the PED displays the following message, press the **Enter** key on the PED keypad to return to USB mode:

```
Software update
Success
Press ENTER
```

6. Unplug all cables from the PED and then reconnect to restart the PED. As the PED starts booting, it should display the following messages:

```
BOOT  V.1.0.6-2,
loading PED…
Local PED Mode   Awaiting command…
```

7. Press **<** to exit to the **Select Mode** menu. If the update was successful, the new PED version is displayed at the bottom of the PED screen.
8. Your Luna PED is now updated and ready to use. Repeat the procedure for each Luna PEDLuna PED that you own.

Troubleshooting

This section provides guidance for resolving problems you may encounter when updating the PED firmware.

If your update attempt fails with a Receive error (rx error), check if you have Remote PED services running on the computer to which the PED is connected. Issue the command **PedServer –m stop** and restart the update to resolve the problem.

No Luna PED Prompts

You must attend to the PED when image files are being applied. If no prompts appear on the PED shortly after you issue the **LunaPED_Update.exe** command, re-check your connections, as follows:

> The PED power block must be connected to AC power and to the power socket on the PED.

> A USB connection must exist between a USB port on the sending computer and the USB-mini port on the PED (immediately beside the power socket).

> The PED must be powered on, and in USB mode.

Files Uploaded in the Wrong Order

If you attempt to upload the files in the wrong order, the PED performs some verification at the end of a file upload. If the PED displays a message similar to the following, it is a good indication that you uploaded the wrong file first:

```
Failure (VERIFY) (7)
Press Enter
```

You are not given an opportunity to attempt to install/confirm the file if the upload does not verify.

To resolve the issue, restart the process from the beginning of these instructions, ensuring that you follow the sequence in these instructions, taking the upgrade files in the order specified. If that does not correct the problem, contact Technical Support.

Upgrade Failed Message (or Similar)

If the Luna PED displays an **Upgrade Failed** message, or any message that does not say **Upgrade in Progress** followed by **Upgrade Complete**, before the **Admin** menu appears, stop the upgrade process immediately.

To resolve the issue, you can take the following actions:

> Reboot the PED by disconnecting and then re-connecting the PED cables. This might clear the problem. If the problem clears, the PED displays a **Nothing to Upgrade** message. In this case, try the update again.

> If the PED shows **Upgrade in Progress** followed by **Upgrade Failed!** every time you reboot it, contact Customer Support.

> You can re-upload the file and try again if the upload action failed to complete, or if you failed to acknowledge it on the PED.

Updating USB-Powered Luna PED Firmware

This section describes how to update the firmware on your Luna PED that is powered by USB connection. Refer to Customer Release Notes for valid update paths.

To update the Luna PED from Luna PED Firmware 2.8.0 a newer version, follow the steps below.

If your Luna PED is the older type, that was shipped with a power-block, then do not use these instructions; see "Updating External Supply-Powered Luna PED Firmware" on page 123 instead.

Preparing for the Upgrade

> **CAUTION!** It is strongly recommended that both your computer and Luna PED be protected by an uninterruptible power supply during the upgrade operation. A power failure while any of the file images is being applied to the PED can result in loss of function that might require repair at a Thales facility.

Prepare your computer for the upgrade

The needed upgrade files are provided in an archive file named for the PED upgrade part number. At time of writing this instruction, KB0023048 from the Support Portal contained the appropriate firmware and updater files.

1. Extract the files like *ped-2.9.1-0-x-production-itb-real.bin* (or newer if available) and *LunaPED_Update.exe* contained in the zip file, to the Windows PC that is connected to the Luna PED that you are upgrading.

> **NOTE** If you have both older Luna PEDs (that are powered by a power block and addressed on "Updating External Supply-Powered Luna PED Firmware" on page 123), and the newer Luna PEDs (powered by USB connection and addressed on this page), then the LunaPED_Update.exe files for each are different and *not interchangeable*.

2. On your Windows PC, open a command prompt window and move to the directory where you copied the files in the upgrade package.

Prepare the Luna PED for the firmware upgrade

1. Ensure that the Luna HSM Client, including the Remote PED option, is installed on your Windows PC. To verify, ensure that the following files / directories are installed:
   - C:\Program Files\SafeNet\LunaClient\RemotePEDDriver
   - C:\Program Files\SafeNet\LunaClient\pedserver.exe

2. Connect *the USB data cable between the USB-mini port* on top of the Luna PED and a USB port on your computer.

> **NOTE** Luna PED Firmware 2.8.0 and newer is powered by the USB port; a separate power supply to the Luna PED is not provided nor required.

3. Allow the PED to boot normally until it reaches the default “Local PED mode Awaiting command…”
4. Press the **<** key to display the **Mode** menu.
5. Verify the PED version – the bottom line of the PED display should say “PED V.2.8.0”

> **CAUTION!** If any other version is shown, stop, acquire a factory shipped Luna PED with Luna PED Firmware 2.8.0, and then return and resume these instructions. If your Luna PED firmware version is older than 2.8.0 (such as 2.6.x) it can only ever be updated to version 2.7.x - see "Updating External Supply-Powered Luna PED Firmware" on page 123 for the relevant update instructions.

6. Select **4** to display the **Admin** menu.
7. Select **7** for **Software Update**.

Upgrading the Luna PED Firmware to Version 2.9.0 (or newer)

During this procedure, the .bin file is individually uploaded from your computer to the Luna PED, and then saved into permanent memory as the new version. Individual responses are required at the PED to accept and load the file.

> **CAUTION!** Complete the instructions in the order provided, otherwise the Luna PED could be left in an unusable state.

Once you start transferring / uploading a file to the PED, pay attention and promptly respond to the PED messages to acknowledge the upload and then to confirm installation of that new file. *The individual PED operations **do** impose a timeout*. However, you can pause before the next file transfer step, as there is no time restriction from one file upload to the next.

Transfer and confirm the Luna PED firmware update

1. In a command prompt window, on your Windows PC, from the directory where you copied the files in the upgrade package, execute the following command:

   Prompt > **LunaPED_Update.exe ped-2.9.x-y-z-production-itb-real.bin** (where x-y-z are numbers specific to the released build of the firmware)

2. At the Luna PED keypad, select **Yes** in response to the prompt.
3. The output of the update command in the Windows command prompt should be similar to the following:

```
LunaPED_Update v3.0.0-1 May 10 2017 22:52:25
PED operation is required (to upload image)...
(Sent xxxxxxx bytes in xxxxxxxxx microsecs).
PED operation is required (to save image)...
```

4. If the image has transferred correctly, Luna PED displays the following message:

```
USB Mode Software update
** WARNING **
A power failure during save is unsupported!
Save Image? YES/NO"
```

5. Select **Yes** to save the new image.
6. Wait approximately 20 seconds. The PED displays the following message:

   ```
   USB Mode Software update Success Press ENTER
   ```

   Press the **Enter** key on the PED to continue.
7. Unplug all cables from the PED and then reconnect to restart the PED.
8. As the PED starts booting, it should show “BOOT V.1.1.0-1”, then “loading PED…,” and then should finish in “Local PED Mode awaiting command…”

   If you press “<” to exit to “Select Mode” menu, the bottom of the PED screen should now show "PED V.2.8.1-0" (or "PED V.2.9.0" or a newer version, as one becomes available).

Done
Luna PED is now updated and ready to use. Repeat the above sequence for each USB-powered Luna PED that you want to upgrade.

Multifactor Quorum PED key Management

Once you have established a Local or Remote PED connection, you can proceed with initializing roles on the HSM that require multifactor quorum authentication. The procedures in this section will guide you through the Luna PED prompts at each stage of PED key creation, multifactor quorum authentication, and other operations with the Luna PED.

> "Creating PED keys" below
- "Stage 1: Reusing Existing PED keys" on page 131
- "Stage 2: Defining M of N" on page 132
- "Stage 3: Setting a PIN" on page 133
- "Stage 4: Duplicating New PED keys" on page 134

> "Performing Multifactor Quorum Authentication" on page 135

> "Consequences of Losing PED keys" on page 137

> "Identifying the PED key Secret" on page 139

> "Duplicating Existing PED keys" on page 140

> "Changing the PED key Secret" on page 141

Creating PED keys

When you initialize an HSM, partition, or role, the Luna PED issues a series of prompts for you to follow to create your PED keys. PED key actions have a timeout setting (default: 200 seconds); ensure that you have everything you need before issuing an initialization command. The requirements for the operation depend on the PED key

scheme you have chosen in advance, based on your organization's security policy. Consider these guidelines before you begin:

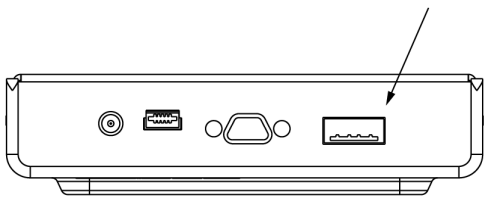
> If you are reusing an existing PED key or keyset, the owners of those keys must be present with their keys and PINs ready.

> If you plan to use an M of N authentication scheme (quorum, or split-secret), all the parties involved must be present and ready to create their authentication split (the initial setup of the quorum and spares). It is advisable for each key holder to create backup duplicates, so you must have a sufficient number of blank or rewritable PED keys ready before you begin.

> If you plan to make backup duplicates of PED keys, you must have a sufficient number of blank or rewritable PED keys ready.

> If you plan to use PINs, ensure that they can be privately entered on the Luna PED and memorized, or written down and securely stored.

Whenever the Luna PED prompts you to insert a PED key, use the USB port on the top of the PED:



To initiate PED key creation

1. Issue one of the following LunaCM commands to initialize the applicable role, domain, or vector.
   - **Blue HSM SO and Red HSM Domain PED key**:

     lunacm:> **hsm init**
   - **Orange Remote PED Vector PED key**:

     lunacm:> **ped vector init**
   - **Blue Partition SO and Red Partition Domain PED keys**:

     lunacm:> **partition init**
   - **Black Crypto Officer PED key**:

     lunacm:> **role init -name co**
   - **Gray Crypto User PED key**:

     lunacm:> **role init -name cu**
   - **White Audit User PED key**:

     lunacm:> **role init -name au**

   The Luna PED responds, displaying:

```
Remote PED mode
Token found
```

> **NOTE** The Luna PED screen prompts for a black PED key for any of
> > "User",
> > "Crypto Officer",
> > "Limited Crypto Officer",
> > "Crypto User".
>
> The Luna PED is not aware that the key you present has a black or a gray sticker on it. The colored stickers are visual identifiers for your convenience in keeping track of your PED keys. You differentiate by how you label, and how you use, a given physical key that the Luna PED sees as "black" (once it has been imprinted with a secret).

2. Follow the PED prompts in the following four stages.

Stage 1: Reusing Existing PED keys

If you want to use a PED key with an existing authentication secret, have the key ready to present to the Luna PED. Reasons for reusing keys may include:

> You want to use the same blue SO key to authenticate multiple HSMs/partitions

> You want to initialize a partition in an already-existing cloning domain (to be part of an HA group)

> **CAUTION!** The initialization procedure is the only opportunity to set the HSM/partition's cloning domain. It cannot be changed later without reinitializing the HSM, or deleting and recreating the partition. Ensure that you have the correct red key(s) ready.

See "Shared PED key Secrets" on page 94 and "Domain PED keys" on page 95 for more information.

1. The first Luna PED prompt asks if you want to reuse an existing PED key. Press **Yes** or **No** on the keypad to continue.

```
SLOT
SETTING SO PIN...
Would you like to
reuse an existing
keyset?(Y/N)
```

- If you select **No**, skip to "Stage 2: Defining M of N" on the next page.
- If you select **Yes**, the PED prompts you for a key. Insert the key you want to reuse and press **Enter**.

```
SLOT
SETTING SO PIN...
Insert a
SO / HSM Admin
PED Key (BLUE)
Press ENTER.
```

2. If the key has a PIN, the PED prompts you to enter it now. Enter the PIN on the keypad and press **Enter**.

```
SLOT
READING SO PIN...
Enter PED PIN:
*********
```

3. If the key is part of an M of N scheme, the PED prompts you for the next key. You must present enough key splits (M, a.k.a. the quorum) to reconstitute the entire authentication secret.

```
SLOT
READING SO PIN...
Keys read: 01 of 03
Insert another
SO / HSM Admin
PED Key (BLUE)
Press ENTER.
```

4. The PED asks if you want to create a duplicate set of keys. If you are duplicating an M of N keyset, you need a number of blank or rewritable keys equal to N.

```
SLOT
READING SO PIN...
Are you duplicating
this keyset?(Y/N)
Warning: You will
need all N keys!
```

- If you select **No**, the process is complete.
- If you select **Yes**, complete "Stage 3: Setting a PIN" on the next page for all the duplicate keys you want.

Stage 2: Defining M of N

If you chose to create a new keyset, the Luna PED prompts you to define the M of N scheme (quorum and pool of splits) for the role, domain, or vector. See "Quorum Split Secrets (M of N)" on page 95 for more information. If you do not want to use M of N (authentication by one PED key), enter a value of **1** for both M and N. Effectively, you have set a "quorum" of one key-holder.

1. The PED prompts you to enter a value for M (the minimum number of split-secret keys required to authenticate the role, domain, or vector - the quorum). Set a value for M by entering it on the keypad and pressing **Enter**. If you are not using an M of N scheme, enter "**1**".

```
SLOT
SETTING SO PIN...
M value? (1-16)

>03
```

2. The PED prompts you to enter a value for N -- the total number of split-secret keys you want to create (the pool of splits from which a quorum will be drawn). Set a value for N by entering it on the keypad and pressing **Enter**. If you are not using an M of N scheme, enter "**1**".

```
SLOT
SETTING SO PIN...
N value? (M-16)

>05
```

3. Continue to "Stage 3: Setting a PIN" below. You must complete stage 3 for each key in the M of N scheme.

Stage 3: Setting a PIN

If you are creating a new key or M of N split, you have the option of setting a PIN that must be entered by the key owner during authentication. PINs must be 4-48 digits long. Do not use 0 for the first digit. See "PINs" on page 95 for more information.

> **CAUTION!** If you forget your PIN, it is the same as losing the PED key entirely; you cannot authenticate the role. See "Consequences of Losing PED keys" on page 137.

1. The PED prompts you to insert a blank or reusable PED key. If you are creating an M of N split, the number of already-created splits is displayed.

```
SLOT
SETTING SO PIN...
Insert a
SO / HSM Admin
PED Key (BLUE)
Press ENTER.
```

```
SLOT
SETTING SO PIN...
Keys write: 03 of 05
Insert another
SO / HSM Admin
PED Key (BLUE)
Press ENTER.
```

2. Insert the PED key and press **Enter**. The PED prompts for confirmation.

```
SLOT
SETTING SO PIN...
   ** WARNING **
This PED Key is
blank.
Overwrite? YES/NO
```

If the PED key you inserted is not blank, you must confirm twice that you want to overwrite it.

```
SLOT
SETTING SO PIN...
   ** WARNING **
This PED Key is for
Domain.
Overwrite? YES/NO
```

```
SLOT
SETTING SO PIN...
   ** WARNING **
Are you sure you
want to overwrite
this PED key? YES/NO
```

3. The PED prompts you for a PIN.
   - If you want to set a PIN, enter it on the keypad and press **Enter**. Enter the PIN again to confirm it.

```
SLOT
SETTING SO PIN...
Enter new PED PIN:
*********
Confirm new PED PIN:
*********
```

   - If you do not want to set a PIN, press **Enter** twice without entering anything on the keypad. You will not be asked to enter a PIN for this key in the future.

```
SLOT
SETTING SO PIN...
Enter new PED PIN:

Confirm new PED PIN:
```

4. If there are more keys in the M of N scheme, repeat this stage. Otherwise, continue to "Stage 4: Duplicating New PED keys" below.

Stage 4: Duplicating New PED keys

You now have the option to create duplicates of your newly-created PED key(s). There are two reasons to do this now:

> If you want more than one person to be able to authenticate a role, you can create multiple keys for that role now, with each person being able to set their own PIN. Duplicates you create later are intended as backups, and will have the same PIN (or none) as the key they are copied from.

> In case of key loss or theft.

You can make backups now or later. See also "Duplicating Existing PED keys" on page 140.

1. The next PED prompt asks if you want to create a duplicate keyset (or another duplicate). Press **Yes** or **No** on the keypad to continue.

```
SLOT
SETTING SO PIN...
Are you duplicating
this keyset?(Y/N)
```

```
SLOT
SETTING SO PIN...
Would you like to
make another
duplicate set?(Y/N)
```

   - If you select **No**, the key creation process is complete.

- If you select **Yes**, complete "Stage 3: Setting a PIN" on page 133 for the duplicate keyset. You can set the same PIN to create a true copy, or set a different PIN for each duplicate.

2. If you specified an M of N scheme, you are prompted to repeat "Stage 3: Setting a PIN" on page 133 for each M of N split. Otherwise, the key creation process is complete.

Performing Multifactor Quorum Authentication

When connected, the Luna PED responds to authentication commands in LunaCM. Commands that require PED actions include:

> Role login commands (blue, black, gray, or white PED keys)

> Backup/restore commands (red PED keys)

> Remote PED connection commands (orange PED key)

> **NOTE** The Luna PED screen prompts for a black PED key for any of
>
> > "User",
> >
> > "Crypto Officer",
> >
> > "Limited Crypto Officer",
> >
> > "Crypto User".
>
> The Luna PED is not aware that the key you present has a black or a gray sticker on it. The colored stickers are visual identifiers for your convenience in keeping track of your PED keys. You differentiate by how you label, and how you use, a given physical key that the Luna PED sees as "black" (once it has been imprinted with a secret).

When you issue a command that requires Luna PED interaction, the interface returns a message like the following:

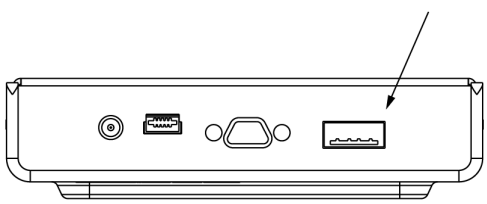
```
lunacm:>role login -name po

        Please attend to the PED.
```

The PED briefly displays the following message before prompting you for the appropriate PED key:

```
Remote PED mode
Token found
```

Whenever the Luna PED prompts you to insert a PED key, use the USB port on the top of the PED:



> **CAUTION!** Multiple failed authentication attempts result in zeroization of the HSM or partition, or role lockout, depending on the role. This is a security measure designed to thwart repeated, unauthorized attempts to access cryptographic material. For details, see Logging In as HSM Security Officer or "Logging In to the Application Partition" on page 203.

To perform multifactor quorum authentication with the Luna PED

1. The PED prompts for the corresponding PED key. Insert the PED key (or the first M of N split-secret key) and press **Enter**.

```
lunacm:>role login -name po

        Please attend to the PED.
```

```
SLOT
SO LOGIN...
Insert a
SO / HSM Admin
PED Key (BLUE)
Press ENTER.
```

   - If the key you inserted has an associated PIN, continue to step 2.
   - If the key you inserted has no PIN, but it is an M of N split, skip to step 3.
   - Otherwise, authentication is complete and the Luna PED returns control to the command interface.

```
Command Result : No Error
```

2. The PED prompts for the PIN. Enter the PIN on the keypad and press **Enter**.

```
SLOT
SO LOGIN...
Enter PED PIN:
*********
```

   - If the key you inserted is an M of N split, continue to step 3.
   - Otherwise, authentication is complete and the PED returns control to the command interface.

```
Command Result : No Error
```

3. The PED prompts for the next M of N split-secret key. Insert the next PED key and press **Enter**.

```
SLOT
SO LOGIN...
Keys read: 01 of 02
Insert another
SO / HSM Admin
PED Key (BLUE)
Press ENTER.
```

   - If the key you inserted has an associated PIN, return to step 2.

- Repeat steps 2 and/or 3 until the requisite M number of keys have been presented to the Luna PED. At this point, authentication is complete and the PED returns control to the command interface.

  ```
  Command Result : No Error
  ```

> **NOTE** When authenticating an M of N split secret, the Luna USB HSM 7 cannot tell if an PED key PIN is entered incorrectly until the whole secret is reassembled. Therefore, PIN entry will appear to succeed and the authentication operation will only fail when all M PED keys have been presented.

Consequences of Losing PED keys

PED keys are the only means of authenticating roles, domains, and RPVs on the multifactor quorum-authenticated Luna PCIe HSM 7. Losing a keyset effectively locks the user out of that role. Always keep secure backups of your PED keys, including quorum (M of N) split secrets. Forgetting the PIN associated with a key is equivalent to losing the key entirely. Losing a split-secret key is less serious, unless enough splits are lost so that M cannot be satisfied.

If a PED key is lost or stolen, log in with one of your backup keys and change the existing PED key secret immediately, to prevent unauthorized HSM access.

The consequences of a lost PED key with no backup vary depending on the type of secret:

> "Blue HSM SO PED key" below

> "Red HSM Domain PED key" on the next page

> "Orange Remote PED key" on the next page

> "Blue Partition SO PED key" on the next page

> "Red Partition Domain PED key" on the next page

> "Black Crypto Officer PED key" on page 139

> "Gray Crypto User PED key" on page 139

> "White Audit User PED key" on page 139

Blue HSM SO PED key

If the HSM SO secret is lost, you can no longer perform administrative tasks on the HSM, including partition creation and client assignment. If you use the same blue SO key for your HSM backup partitions, the contents of the HSM Admin partition are unrecoverable. Take the following steps:

1. Contact all Crypto Officers and have them immediately make backups of their existing partitions at the client.
2. When all important partitions are backed up, execute a factory reset of the HSM.
3. Initialize the HSM and create a new HSM SO secret. Use the original red HSM cloning domain key.
4. Restore the HSM Admin partition contents from a recent backup, if you have one.
5. If you are using Remote PED, you must recreate the Remote PED Vector (RPV). Reuse the original orange key.
6. Recreate the partitions and reassign them to their respective clients.

7. Partition SOs must initialize the new partitions using their original blue and red key(s), and initialize the Crypto Officer role (and Activation secret, if applicable). Supply the new black CO keys to the Crypto Officers.
8. Crypto Officers must change the login credentials from the new black CO key to their original black keys (and reset the Activation secret password, if applicable).
9. Crypto Officers can now restore all partition contents from backup.

Red HSM Domain PED key

If the HSM Key Cloning Vector is lost, you can no longer perform backup/restore operations on the HSM Admin partition(s). If the HSM is factory-reset, the contents of the HSM Admin partition are unrecoverable. Follow the same procedure as you would if you lost the blue HSM SO key, but you cannot restore the HSM Admin partition from backup.

Orange Remote PED key

If the Remote PED Vector is lost, create a new one and distribute a copy to the administrator of each Remote PED server. See "Rotating or Re-Initializing the Orange Remote PED key" on page 114.

Blue Partition SO PED key

If the Partition SO secret is lost, you can no longer perform administrative tasks on the partition. Take the following steps:

1. Have the Crypto Officer immediately make a backup of the partition objects.
2. Have the HSM SO delete the partition, create a new one, and assign it to the same client.
3. Initialize the new partition with a new blue Partition SO key and the original red cloning domain key(s).
4. Initialize the Crypto Officer role (and Activation secret, if applicable). Supply the new black CO key to the Crypto Officer.
5. The Crypto Officer must change the login credentials from the new black CO key to their original black key (and reset the Activation secret password, if applicable).
6. The Crypto Officer can now restore all partition contents from backup.

Red Partition Domain PED key

If the Partition Key Cloning Vector is lost, you can no longer perform backup/restore operations on the partition (s), or make changes to HA groups in that cloning domain. You can still perform all other operations on the partition. Take the following steps:

1. Have the HSM SO create a new partition (or multiple partitions, to replace the entire HA group) and assign it to the same client(s).
2. Initialize the partition(s)with a new cloning domain.
3. Initialize the Crypto Officer role with the original black Crypto Officer key (and Activation password, if applicable).
4. Create objects on the new partition to replace those on the original partition.
5. As soon as possible, change all applications to use the objects on the new partition.

6. When objects on the original partition are no longer in production use, the HSM SO can delete the original partition.

Black Crypto Officer PED key

If the Crypto Officer secret is lost, you can no longer create objects on the partition, or perform backup/restore operations. You might still be able to use the partition, depending on the following criteria:

> **PIN reset by Partition SO:**

- If HSM policy **15: Enable SO reset of partition PIN** is set to **1**, the Partition SO can reset the Crypto Officer secret and create a new black CO key.

  lunacm:>**role resetpw -name co**

- If this policy is set to **0** (default), the CO is locked out unless other criteria in this list apply.

> **Partition Activation:**

- If the partition is Activated, you can still access it for production using the CO challenge secret. Change your applications to use objects on a new partition as soon as possible.
- If the partition is not Activated, read-only access of essential objects might still be available via the Crypto User role.

> **Crypto User**

- If the Crypto User is initialized, you can use the CU role for read-only access to essential partition objects while you change your applications to use objects on a new partition.

If none of these criteria apply, the contents of the partition are unrecoverable.

Gray Crypto User PED key

If the Crypto User secret is lost, the Crypto Officer can reset the CU secret and create a new gray key:

lunacm:>**role resetpw -name cu**

White Audit User PED key

If the Audit User secret is lost, you can no longer cryptographically verify existing audit logs or make changes to the audit configuration. The existing logs can still be viewed. Re-initialize the Audit User role on the affected HSMs, using the same white key for HSMs that will verify each other's logs.

Identifying the PED key Secret

You can use this procedure to identify the type of secret (role, domain, or RPV) stored on an unidentified PED key. This procedure will not tell you:

> identifying information about the HSM the key is associated with

> whether the key is part of an M of N scheme, or how many keys are in the set

> whether the key has a PIN assigned

> who the key belongs to

You require:

> Luna PED in Admin Mode (see "Changing Modes" on page 102)

> the key you want to identify

To identify the type of secret stored on an existing PED key

1. Insert the PED key you want to identify.
2. From the Admin mode menu, press **1** on the keypad to select the **PED Key** option.

```
Admin mode...
1 PED Key
5 Backup Devices
7 Software Update
9 Self Test

< EXIT
```

3. From the PED Key mode menu, press **3** on the keypad to select the **List types** option.

```
PED Key mode
1 Login
3 List types



< EXIT
```

The secret type is identified on-screen.

```
PED Key mode
Found keys:
Domain



Press ENTER.
```

Duplicating Existing PED keys

During the key creation process, you have the option to create multiple copies of PED keys. If you want to make backups of your keys later, you can use this procedure to copy PED keys. You require:

> Luna PED in Admin Mode (see "Changing Modes" on page 102)

> Enough blank or rewritable keys to make your copies

The PED key is duplicated exactly by this process. If there is a PIN assigned, the same PIN is assigned to the duplicate key. If the key is part of a quorum (M of N) scheme, the duplicates may not be used in the same login process to satisfy the M of N requirements. You must also have copies of the other keys in the quorum (M of N) keyset. See "Quorum Split Secrets (M of N)" on page 95.

To duplicate an existing PED key

1. Insert the PED key you want to duplicate. Have a blank or rewritable PED key ready.
2. From the Admin mode menu, press **1** on the keypad to login to the PED key.

```
PED Key mode
1 Login
3 List types


< EXIT
```

3. Press **7** on the keypad and follow the on-screen instructions.

```
PED Key mode
          2 Logout
3 List types

7 Duplicate

< EXIT
```

Changing the PED key Secret

Use the instructions on this page to change/rotate the secrets on any of the indicated PED iKeys.

From time to time, it might be necessary to change the secret associated with a role on an HSM or a partition of an HSM, or a cloning domain secret. Reasons for changing credentials include:

> Regular credential rotation as part of your organization's security policy

> Compromise of a role or secret due to loss or theft of a PED key

> Personnel changes in your organization or changes to individual security clearances

> Changes to your security scheme (implementing/revoking M of N, PINs, or shared secrets)

The procedure for changing a PED key credential depends on the type of key. Procedures for each type are provided below.

> **CAUTION!** If you are changing a multifactor quorum credential that is shared among multiple HSMs/partitions/roles, always keep at least one copy of the old keyset until the affected HSMs/partitions/roles are all changed to the new credential. When changing multifactor quorum credentials, you must always present the old keyset first; do not overwrite your old PED keys until you have no further need for them.

> "Blue HSM SO PED key" on the next page

> "Red HSM Domain PED key" on the next page

> "Orange Remote PED Vector PED key" on the next page

> "Blue Partition SO PED key" on the next page

> "Red Partition Domain PED key" on page 143

> "Black Crypto Officer PED key" on page 143

> "Gray Crypto User PED key" on page 143

> "White Audit User PED key" on page 144

Blue HSM SO PED key

The HSM SO can use this procedure to change the HSM SO credential.

To change the blue HSM SO PED key credential

1. In LunaCM, set the active slot to the Admin partition and login as HSM SO.

   lunacm:> **role login -name so**

2. Initiate the PED key change.

   lunacm:> **role changepw -name so**

3. You are prompted to present the original blue PED key(s) and then to create a new HSM SO keyset. See "Creating PED keys" on page 129.

Red HSM Domain PED key

It is not possible to change an **HSM's cloning domain** without factory-resetting the HSM and setting the new cloning domain as part of the standard initialization procedure.

> **CAUTION!** If you set a different cloning domain for the HSM, you cannot restore the HSM Admin partition from backup.

Orange Remote PED Vector PED key

The HSM SO can use this procedure to change the Remote PED Vector (RPV) for the HSM.

To change the RPV/orange key credential

1. In LunaCM, set the active slot to the Admin partition and login as HSM SO.

   lunacm:> **role login -name so**

2. Initialize the RPV.

   lunacm:> **ped vector init**

   You are prompted to create a new Remote PED key. See "Creating PED keys" on page 129.

3. Distribute a copy of the new orange key to the administrator of each Remote PED server.

Blue Partition SO PED key

The Partition SO can use this procedure to change the Partition SO credential.

To change a blue Partition SO PED key credential

1. In LunaCM, log in as Partition SO.

   lunacm:> **role login -name po**

2. Initiate the PED key change.

   lunacm:> **role changepw -name po**

3. You are prompted to present the original blue key(s) and then to create a new Partition SO keyset. See "Creating PED keys" on page 129.

Red Partition Domain PED key

If you are using Luna HSM Firmware 7.7.2 and older, it is not possible to change a partition's cloning domain. A new partition must be created and initialized with the desired domain. The new partition will not have access to any of the original partition's backups. It cannot be made a member of the same HA group as the original.

Using Luna HSM Firmware 7.8.0 and newer, each partition can support up to three different cloning domains, allowing your sensitive keys and objects to remain within the cryptographic perimeter of the HSM while:

> migrating objects from one domain to another

> splitting domains

> rotating or rolling-over or refreshing your partition domain secrets as part of mandated periodic changes of credential/authentication, just as you would with passwords for

- appliance administration (including network, logging, ntp. tamper response, etc.)
- HSM or partition roles
  - container/partition administrative access
  - client access for crypto operations on keys and objects
- etc.

To change the domain secret

See "Updating or rotating cloning domain secrets" on page 87.

Black Crypto Officer PED key

The Crypto Officer can use this procedure to change the Crypto Officer credential.

To change a black Crypto Officer PED key credential

1. In LunaCM, log in as Crypto Officer.

   lunacm:> **role login -name co**

2. Initiate the PED key change.

   lunacm:> **role changepw -name co**

3. You are prompted to present the original black key(s) and then to create a new Crypto Officer keyset. See "Creating PED keys" on page 129.

Gray Crypto User PED key

The Crypto User can use this procedure to change the Crypto User credential.

To change a gray Crypto User PED key credential

1. In LunaCM, log in as Crypto User.

   lunacm:> **role login-name cu**

2. Initiate the PED key change.

   lunacm:> **role changepw -name cu**

3. You are prompted to present the original gray key(s) and then to create a new Crypto User keyset. See "Creating PED keys" on page 129.

> **NOTE** The Luna PED screen prompts for a black PED key for any of
> > "User",
> > "Crypto Officer",
> > "Limited Crypto Officer",
> > "Crypto User".
>
> The Luna PED is not aware that the key you present has a black or a gray sticker on it. The colored stickers are visual identifiers for your convenience in keeping track of your PED keys. You differentiate by how you label, and how you use, a given physical key that the Luna PED sees as "black" (once it has been imprinted with a secret).

White Audit User PED key

The Audit User can use this procedure to change the Audit User credential.

To change the white Audit User PED key credential

1. In LunaCM, set the active slot to the Admin partition and login as Auditor.

   lunacm:> **role login -name au**

2. Initiate the PED key change.

   lunacm:> **role changepw -name au**

3. You are prompted to present the original white key(s) and then to create a new Audit User keyset. See "Creating PED keys" on page 129.

PEDserver and PEDclient

You can use the **PEDserver** and **PEDclient** utilities to manage your remote PED devices.

The PEDserver Utility

PEDserver is required to run on any computer that has a Luna Remote PED attached, and is providing PED services.

The PEDserver utility has one function. It resides on a computer with an attached Luna PED (in Remote Mode), and it serves PED operations to an instance of PEDclient that operates on behalf of an HSM. The HSM could be local to the computer that has PEDserver running, or it could be on another HSM host computer at some distant location.

See "pedserver" on page 146.

The PEDclient Utility

PEDclient is required to run on any host of an HSM that needs to be served by a Remote Luna PED. PEDclient must also run on any host of a Remote Backup HSM that will be serving remote primary HSMs.

The PEDclient utility performs the following functions:

> It mediates between the HSM where it is installed and the Luna PED where PEDserver is installed, to provide PED services to the requesting HSM(s).

> It resides on a computer with RBS and an attached Luna Backup HSM, and it connects with another instance of PEDclient on a distant host of an HSM, to provide the link component for Remote Backup Service. See "Configuring a Remote Backup Server" on page 338 for more information.

> It acts as the logging daemon for HSM audit logs.

Thus, for example, in the case where an administrative workstation or laptop has both a Remote PED and a Remote Backup HSM attached, PEDclient would perform double duty. It would link with a locally-running instance of PEDserver, to convey HSM requests from the locally-connected Backup HSM to the locally-connected PED, and return the PED responses. As well, it would link a locally-running instance of RBS and a distant PEDclient instance to mediate Remote Backup function for that distant HSM's partitions.

See "pedclient" on page 161.

pedserver

Use the **pedserver** commands to manage certificates in PEDserver and the appliance, initiate connections between the Luna PEDand HSM, and select the PED for HSM operation.

To run PEDserver from the command line, you must specify one of the following three options.

Syntax

pedserver

-appliance
-mode
-regen

Option	Description
-appliance	Registers or deregisters an appliance, or lists the registered appliances. Applies to server-initiated (peer-to-peer) mode only. See "pedserver -appliance" on the next page.
-mode	Specifies the mode that the PED Server will be executed in. See "pedserver mode" on page 151.
-regen	Regenerates the client certificate. Applies to server-initiated (peer-to-peer) mode only. See "pedserver -regen" on page 161.

pedserver -appliance

Registers or deregisters an appliance, or lists the registered appliances. These commands apply to PED-initiated mode only.

Syntax

pedserver -appliance

delete
list
register

Option	Description
delete	Deregisters an appliance. See "pedserver -appliance delete" on the next page.
list	Lists the registered appliances. See "pedserver -appliance list" on page 149.
register	Registers an appliance. See "pedserver -appliance register" on page 150

pedserver -appliance delete

Deregister an appliance certificate from PEDserver.

Syntax

pedserver -appliance delete -name <unique name> [**-force**]

Option	Description
-name <unique name>	Specifies the name of the appliance to be deregistered from PEDserver.
-force	Optional parameter. Suppresses any prompts.

Example

```
C:\Program Files\Safenet\LunaClient>pedServer –appliance delete –name hello -force
```

pedserver -appliance list

Displays a list of appliances registered with PEDserver.

Syntax

pedserver -appliance list

Example

```
C:\Program Files\Safenet\LunaClient>pedServer -appliance list
>
Server Name          IP Address        Port Number     Certificate Common
                                                                Name
_____________________________________________________________________________
abox               192.20.1.23       9697               test2
bbox               192.20.12.34      9696               test1
hello              192.20.1.34       9876               hellocert
```

pedserver -appliance register

Register an appliance certificate with PEDserver.

Syntax

pedserver -appliance register -name <unique name> **-certificate** <appliance certificate file> **-ip** <appliance server IP address> [**-port** <port number>]

Option	Description
-name <unique name>	Specifies the name of the appliance to be registered to PEDserver.
-certificate <appliance certificate file>	Specifies the full path and filename of the certificate that was retrieved from the appliance.
-ip <appliance server IP address>	Specifies the IP address of the appliance server.
-port <port number>	Optional field. Specifies the port number used to connect to the appliance (directly or indirectly according to network configuration). **Range:** 0-65525

Example

```
C:\Program Files\Safenet\LunaClient>pedServer –appliance register –name hello -certificate the-best-appliance.pem -ip 123.321.123.321 –port 9697
```

pedserver mode

Specifies the mode that PEDserver will be executed in.

Syntax

pedserver -mode

config
connect
disconnect
show
start
stop

Option	Description
config	Modifies or shows existing configuration file settings. See "pedserver -mode config" on the next page.
connect	Connects to the appliance. See "pedserver -mode connect" on page 154.
disconnect	Disconnects from the appliance. See "pedserver -mode disconnect" on page 155.
show	Queries if PEDserver is currently running, and gets details about PEDserver. See "pedserver -mode show" on page 156.
start	Starts PEDserver. See "pedserver -mode start" on page 158.
stop	Shuts down PEDserver. See "pedserver -mode stop" on page 160

pedserver -mode config

Shows and modifies internal PEDserver configuration file settings.

Syntax

pedserver -mode config -name <registered appliance name> **-show -set** [**-port** <server port>] [**-set**][**-configfile** <filename>] [**-admin** <admin port number>] [**-eserverport** <0 or 1>] [**-eadmin** <0 or 1>] [**-idletimeout** <int>] [**-socketreadtimeout** <int>] [**-socketwritetimeout** <int>] [**-internalshutdowntimeout** <int>] [**-bgprocessstartuptimeout** <int>] [**-bgprocessshutdowntimeout** <int>] [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logerror** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>] [**-pedwritedelay** <int>] [**-pinginterval** <int>] [**-pingtimeout** <int>]

Option	Description
-name <registered appliance name>	Specifies the name of the registered appliance to be configured.
-show	Displays the contents of the PEDserver configuration file.
-set	Updates the PEDserver configuration file to be up to date with other supplied options.
-port <server port>	Optional. Specifies the server port number.
-configfile <filename>	Optional. Specifies which PEDserver configuration file to use.
-admin <admin port number>	Optional. Specifies the administration port number.
-eserverport <0 or 1>	Optional. Specifies if the server port is on "localhost" or listening on the external host name.
-eadmin <0 or 1>	Optional. Specifies if the administration is on "localhost" or listening on the external host name.
-idletimeout <int>	Optional. Specifies the idle connection timeout, in seconds.
-socketreadtimeout <int>	Optional. Specifies the socket read timeout, in seconds.
-socketwritetimeout <int>	Optional. Specifies socket write timeout, in seconds.
-internalshutdowntimeout <int>	Optional. Specifies the shutdown timeout for internal services, in seconds.
-bgprocessstartuptimeout <int>	Optional. Specifies the startup timeout for the detached process, in seconds.
-bgprocessshutdowntimeout <int>	Optional. Specifes the shutdown timeout for the detached process, in seconds.

Option	Description
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.
-pedwritedelay <int>	Optional. Specifies the communications delay over USB between the Luna PED and PEDserver, in microseconds. Default value is 0 and maximum value is 10000. This option is available only if you are using a multifactor quorum-authenticated Luna HSM with Luna HSM Firmware 7.7.0 or newer.
-pinginterval <int>	Optional. Specifies the time interval between pink commands, in seconds.
-pingtimeout <int>	Optional. Specifies timeout of the ping response, in seconds.

Example

```
C:\Program Files\Safenet\LunaClient>pedServer -mode config -name hellohi -show
```

pedserver -mode connect

Connects to the appliance by retrieving information (IP address, port, PEDserver certificate) from the PEDserver configuration file.

If the running mode is legacy, an error is returned. **pedserver -mode connect** is not a valid command for legacy connections.

The **connect** command will try connecting to PEDclient 20 times before giving up.

Syntax

pedserver -mode connect -name <registered appliance name> [**-configfile** <filename>] [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logerror** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>]

Option	Description
-name <registered appliance name>	Specifies the name of the registered appliance to be connected to PEDserver.
-configfile <filename>	Optional. Specifies which PEDserver configuration file to use.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.

Example

```
C:\Program Files\Safenet\LunaClient>pedServer -mode connect -name hellohi
>Connecting to Luna SA. Please wait....
>Successfully connected to Luna SA.
```

pedserver -mode disconnect

Disconnects PEDserver from the appliance.

If the running mode is legacy, an error is returned. **pedserver -mode disconnect** is not a valid command for legacy connections.

Termination of the connection may take a few minutes.

Syntax

pedserver -mode disconnect -name <registered appliance name> [**-configfile** <filename>] [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logerror** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>]

Option	Description
-name <registered appliance name>	Specifies the name of the registered appliance to be disconnected from PEDserver.
-configfile <filename>	Optional. Specifies which PEDserver configuration file to use.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.

Example

```
C:\Program Files\Safenet\LunaClient>pedServer -mode disconnect -name hellohi
>Connection to Luna SA terminated.
```

pedserver -mode show

Queries if PEDserver is currently running, and gets details about PEDserver.

Syntax

pedserver -mode show [**-name** <registered appliance name>] [**-configfile** <filename>] [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logerror** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>]

Option	Description
-name <registered appliance name>	Specifies the name of the registered appliance to be queried. Applies to server-initiated (peer-to-peer) mode only.
-configfile <filename>	Optional. Specifies which PEDserver configuration file to use.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.

Example

```
C:\Program Files\Safenet\LunaClient>pedServer -mode show -name hellohi
>Ped Server launched in status mode.
   Server Information:
      Hostname:                          ABC1-123123
      IP:                                192.10.10.123
      Firmware Version:                  2.5.0-1
      PedII Protocol Version:            1.0.1-0
      Software Version:                  1.0.5 (10005)
      Ped2 Connection Status:            Connected
      Ped2 RPK Count                     1
      Ped2 RPK Serial Numbers            (1a123456789a1234)
   Client Information:                   Not Available
   Operating Information:
      Server Port:                       1234
      External Server Interface:         Yes
      Admin Port:                        1235
```

```
      External Admin Interface:           No
      Server Up Time:                     8 (secs)
      Server Idle Time:                   8 (secs) (100%)
      Idle Timeout Value:                 1800 (secs)
      Current Connection Time:            0 (secs)
      Current Connection Idle Time:       0 (secs)
      Current Connection Total Idle Time: 0 (secs) (100%)
      Total Connection Time:              0 (secs)
      Total Connection Idle Time:         0 (secs) (100%)
>Show command passed.
```

pedserver -mode start

Starts up PEDserver.

Syntax

pedserver -mode start [**-name** <registered appliance name>] [**-ip** <server_IP>] [**-port** <server port>] [**-configfile** <filename>] [**-admin** <admin port number>] [**-eserverport** <0 or 1>] [**-eadmin** <0 or 1>] [**-idletimeout** <int>] [**-socketreadtimeout** <int>] [**-socketwritetimeout** <int>] [**-internalshutdowntimeout** <int>] [**-bgprocessstartuptimeout** <int>] [**-bgprocessshutdowntimeout** <int>] [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logerror** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>] [**-pinginterval** <int>] [**-pingtimeout** <int>] [**-force**]

Option	Description
-admin <admin port number>	Optional. Specifies the administration port number.
-bgprocessshutdowntimeout <int>	Optional. Specifes the shutdown timeout for the detached process, in seconds.
-bgprocessstartuptimeout <int>	Optional. Specifies the startup timeout for the detached process, in seconds.
-configfile <filename>	Optional. Specifies which PED Server configuration file to use.
-eadmin <0 or 1>	Optional. Specifies if the administration is on "localhost" or listening on the external host name.
-eserverport <0 or 1>	Optional. Specifies if the server port is on "localhost" or listening on the external host name.
-force	Optional parameter. Suppresses any prompts.
-idletimeout <int>	Optional. Specifies the idle connection timeout, in seconds.
-internalshutdowntimeout <int>	Optional. Specifies the shutdown timeout for internal services, in seconds.
-ip <server_IP>	Optional. Specifies the server listening IP address. When **running pedserver -mode start** on an IPv6 network, you must include this option.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.

Option	Description
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.
-name <registered appliance name>	
-pinginterval <int>	Optional. Specifies the time interval between pink commands, in seconds.
-pingtimeout <int>	Optional. Specifies timeout of the ping response, in seconds.
-port <server port>	Optional. Specifies the server port number.
-socketreadtimeout <int>	Optional. Specifies the socket read timeout, in seconds.
-socketwritetimeout <int>	Optional. Specifies socket write timeout, in seconds.

Example

```
C:\Program Files\Safenet\LunaClient>pedServer –mode start -name hellohi -force
>Ped Server launched in startup mode.
>Starting background process
>Background process started
>Ped Server Process created, exiting this process.
```

pedserver -mode stop

Stops PEDserver.

Syntax

pedserver -mode stop [**-name** <registered appliance name>] [**-configfile** <filename>] [**-socketwritetimeout** <int>] [**-internalshutdowntimeout** <int>] [**-bgprocessstartuptimeout** <int>] [**-bgprocessshutdowntimeout** <int>] [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logerror** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>]

Option	Description
-name <registered appliance name>	Specifies the name of the registered appliance on which PEDserver will be stopped. Applies to server-initiated (peer-to-peer) mode only.
-configfile <filename>	Optional. Specifies which PEDserver configuration file to use.
-socketreadtimeout <int>	Optional. Specifies the socket read timeout, in seconds.
-socketwritetimeout <int>	Optional. Specifies socket write timeout, in seconds.
-internalshutdowntimeout <int>	Optional. Specifies the shutdown timeout for internal services, in seconds.
-bgprocessstartuptimeout <int>	Optional. Specifies the startup timeout for the detached process, in seconds.
-bgprocessshutdowntimeout <int>	Optional. Specifes the shutdown timeout for the detached process, in seconds.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.

Example

```
C:\Program Files\Safenet\LunaClient>pedServer -mode stop -name hellohi
```

pedserver -regen

Regenerates the client certificate. This command is available in server-initiated (peer-to-peer) mode only.

Existing links (PEDserver, NTLS or STC) will not be affected until they are terminated. Afterward, the user is required to re-register the client certificate to NTLS and PEDserver.

> **NOTE** The **pedserver -regen** command should be used only when there is no Luna HSM Client installed. When Luna HSM Client is installed on the host computer, use the LunaCM command **clientconfig deploy** with the **-regen** option .

Syntax

pedserver -regen -commonname <commonname> [**-force**]

Option	Description
-commonname <commonname>	The client's common name (CN).
-force	Optional parameter. Suppresses any prompts.

Example

```
C:\Program Files\SafeNet\LunaClient>pedServer -regen -commonname win2016_server -force
Ped Server Version 1.0.6 (10006)

Private Key created and written to: C:\Program Files\SafeNet\LunaClient\cert\client\win2016_
serverKey.pem
Certificate created and written to: C:\Program Files\SafeNet\LunaClient\cert\client\win2016_
server.pem

Successfully regenerated the client certificate.
```

pedclient

Use the **pedclient** commands to start, stop, and configure the PEDclient service.

Syntax

pedclient -mode

assignid
config
deleteid
releaseid
setid
show

start
stop
testid

Option	Description
assignid	Assigns a PED ID mapping to an HSM. See "pedclient -mode assignid" on the next page.
config	Modifies or shows existing configuration file settings. See "pedclient -mode config" on page 164.
deleteid	Deletes a PED ID mapping. See "pedclient -mode deleteid" on page 166.
releaseid	Releases a PED ID mapping from an HSM. See "pedclient -mode releaseid" on page 167.
setid	Creates a PED ID mapping. See "pedclient -mode setid" on page 168.
show	Queries if PEDclient is currently running and gets details about PEDclient. See "pedclient -mode show" on page 169.
start	Starts up PEDclient. See "pedclient -mode start" on page 170.
stop	Shuts down PEDclient. See "pedclient -mode stop" on page 172.
testid	Tests a PED ID mapping. See "pedclient -mode testid" on page 173.

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pedclient -mode assignid

Assigns a PED ID mapping to a specified HSM.

Syntax

pedclient -mode assignid -id <pedid> **-id_serialnumber** <serial> [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logerror** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>] [**-locallogger**]

Option	Description
-id <pedid>	Specifies the ID of the PED to be assigned.
-id_serialnumber <serial>	Specifies the serial number of the HSM to be linked to the specified PED ID.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.
-locallogger	Optional. Specifies that the Remote PED logger should be used, not the IS logging system.

Example

```
C:\Program Files\Safenet\LunaClient>pedClient –mode assignid -id 1234 -id_serialnumber
123456789
```

pedclient -mode config

Modifies or shows existing configuration file settings.

Syntax

pedclient -mode config -show -set [**-eadmin** <0 or 1>] [**-idletimeout** <int>] **[-ignoreideltimeout]** [**-socketreadtimeout** <int>] [**-socketwritetimeout** <int>] [**-shutdowntimeout** <int>] [**-pstartuptimeout** <int>][**-pshutdowntimeout** <int>] [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>] [**-locallogger**]

Option	Description
-show	Displays the contents of the configuration file.
-set	Updates the configuration file to be up to date with other supplied options.
-eadmin <0 or 1>	Optional. Specifies if the administration port is on "localhost" or on the external host name.
-idletimeout <int>	Optional. Specifies the idle connection timeout, in seconds.
-ignoreidletimeout	Optional. Specifies that the idle connection timeout should not apply to the connection established between the PED and HSM during their assignment.
-socketreadtimeout <int>	Optional. Specifies the socket read timeout, in seconds.
-socketwritetimeout <int>	Optional. Specifies the socket write timeout, in seconds.
-shutdowntimeout <int>	Optional. Specifies the shutdown timeout for internal services, in seconds.
-pstartuptimeout <int>	Optional. Specifies the startup timeout for the detached process, in seconds.
-pshutdowntimeout <int>	Optional. Specifies the shutdown timeout for the detached process, in seconds.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.

Option	Description
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.
-locallogger	Optional. Specifies that the Remote PED logger should be used, not the IS logging system.

Example

```
C:\Program Files\Safenet\LunaClient>pedClient –mode config -show
```

pedclient -mode deleteid

Deletes a PED ID mapping between a specified Luna PED and PEDserver.

Syntax

pedclient -mode deleteid -id <PED_ID> [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logerror** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>] [**-locallogger**]

Option	Description
-id <PED_ID>	Specifies the ID of the PED to be deleted from the map.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.
-locallogger	Optional. Specifies that the Remote PED logger should be used, not the IS logging system.

Example

```
C:\Program Files\Safenet\LunaClient>pedClient –mode deleteid -id 1234
```

pedclient -mode releaseid

Releases a PED ID mapping from the HSM it was assigned to.

Syntax

pedclient -mode releaseid -id <PED_ID> [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logerror** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>] [**-locallogger**]

Option	Description
-id <PED_ID>	Specifies the ID of the PED to be released.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.
-locallogger	Optional. Specifies that the Remote PED logger should be used, not the IS logging system.

Example

```
C:\Program Files\Safenet\LunaClient>pedClient –mode releaseid -id 1234
```

pedclient -mode setid

Creates a PED ID mapping between a specified Luna PED and PEDserver.

Syntax

pedclient -mode setid -id <PED_ID> **-id_ip** <hostname> **-id_port** <port> [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logerror** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>] [**-locallogger**]

Option	Description
-id <PED_ID>	Specifies the ID of the PED to be mapped.
-id_ip <hostname>	Specifies the IP address or hostname of the PEDserver to be linked with the PED ID.
-id_port <port>	Specifies the PED Server port to be linked with the PED ID.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.
-locallogger	Optional. Specifies that the Remote PED logger should be used, not the IS logging system.

Example

```
C:\Program Files\Safenet\LunaClient>pedClient –mode setid -id 1234 -id_ip myhostname -id_port
3456
```

pedclient -mode show

Queries if PEDclient is currently running and gets details about PEDclient.

Syntax

pedclient -mode show [**-admin** <admin port number>] [**-eadmin** <0 or 1>] [**-socketreadtimeout** <int>] [**-socketwritetimeout** <int>] [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>] [**-locallogger**]

Option	Description
-admin <admin port number>	Optional. Specifies the administration port number to use.
-eadmin <0 or 1>	Optional. Specifies if the administration port is on "localhost" or on the external host name.
-socketreadtimeout <int>	Optional. Specifies the socket read timeout, in seconds.
-socketwritetimeout <int>	Optional. Specifies the socket write timeout, in seconds.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.
-locallogger	Optional. Specifies that the Remote PED logger should be used, not the IS logging system.

Example

```
C:\Program Files\Safenet\LunaClient>pedClient -mode show
```

pedclient -mode start

Starts up the PEDclient.

Syntax

pedclient -mode start [**-winservice**] [**-eadmin** <0 or 1>] [**-idletimeout** <int>] [**-socketreadtimeout** <int>] [**-socketwritetimeout** <int>] [**-shutdowntimeout** <int>] [**-pstartuptimeout** <int>][**-pshutdowntimeout** <int>] [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>] [**-locallogger**]

Option	Description
-winservice	Starts PEDclient for Windows service. The standard parameters used for **pedclient mode start** can be used for **pedclient mode start -winservice** as well.
-eadmin <0 or 1>	Optional. Specifies if the administration port is on "localhost" or on the external host name.
-idletimeout <int>	Optional. Specifies the idle connection timeout, in seconds.
-socketreadtimeout <int>	Optional. Specifies the socket read timeout, in seconds.
-socketwritetimeout <int>	Optional. Specifies the socket write timeout, in seconds.
-shutdowntimeout <int>	Optional. Specifies the shutdown timeout for internal services, in seconds.
-pstartuptimeout <int>	Optional. Specifies the startup timeout for the detached process, in seconds.
-pshutdowntimeout <int>	Optional. Specifies the shutdown timeout for the detached process, in seconds.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.

Option	Description
-locallogger	Optional. Specifies that the Remote PED logger should be used, not the IS logging system.

Example

```
C:\Program Files\Safenet\LunaClient>pedClient -mode start
```

pedclient -mode stop

Shuts down PEDclient.

Syntax

pedclient -mode stop [**-eadmin** <0 or 1>] [**-socketreadtimeout** <int>] [**-socketwritetimeout** <int>] [**-shutdowntimeout** <int>] [**-pstartuptimeout** <int>][**-pshutdowntimeout** <int>] [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>] [**-locallogger**]

Option	Description
-eadmin <0 or 1>	Optional. Specifies if the administration port is on "localhost" or on the external host name.
-socketreadtimeout <int>	Optional. Specifies the socket read timeout, in seconds.
-socketwritetimeout <int>	Optional. Specifies the socket write timeout, in seconds.
-shutdowntimeout <int>	Optional. Specifies the shutdown timeout for internal services, in seconds.
-pstartuptimeout <int>	Optional. Specifies the startup timeout for the detached process, in seconds.
-pshutdowntimeout <int>	Optional. Specifies the shutdown timeout for the detached process, in seconds.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.
-locallogger	Optional. Specifies that the Remote PED logger should be used, not the IS logging system.

Example

```
C:\Program Files\Safenet\LunaClient>pedClient -mode stop
```

pedclient -mode testid

Tests a PED ID mapping between a specified Luna PED and PEDserver.

Syntax

pedclient -mode testid -id <PED_ID> [**-logfilename** <filename>] [**-loginfo** <0 or 1>] [**-logwarning** <0 or 1>] [**-logerror** <0 or 1>] [**-logtrace** <0 or 1>] [**-maxlogfilesize** <size>] [**-locallogger**]

Option	Description
-id <PED_ID>	Specifies the ID of the PED to be tested.
-logfilename <filename>	Optional. Specifies the log file name to which the logger should log messages.
-loginfo <0 or 1>	Optional. Specifies if the logger should log "info" messages. Set to 0 for no, 1 for yes.
-logwarning <0 or 1>	Optional. Specifies if the logger should log "warning" messages. Set to 0 for no, 1 for yes.
-logerror <0 or 1>	Optional. Specifies if the logger should log "error" messages. Set to 0 for no, 1 for yes.
-logtrace <0 or 1>	Optional. Specifies if the logger should log "trace" messages. Set to 0 for no, 1 for yes.
-maxlogfilesize <size>	Optional. Specifies the maximum log file size in KB.
-locallogger	Optional. Specifies that the Remote PED logger should be used, not the IS logging system.

Example

```
C:\Program Files\Safenet\LunaClient>pedClient –mode testid -id 1234
```

CHAPTER 6: Initializing an Application Partition

Before it can be used to store cryptographic objects or perform operations, an application partition must be initialized. Initialization is performed by the Partition Security Officer and sets the authentication credential. There are two scenarios where the Partition SO would initialize the partition:

> **Preparing a new partition:** On a new partition, initialization sets the Partition SO authentication credential, an identifying label for the partition, and the partition's cloning domain (see "Initializing a New Partition" below).

> **Erasing an existing partition:** The Partition SO can re-initialize a partition to erase all cryptographic objects and the Crypto Officer/Crypto User roles, and select a new partition label. The Partition SO credential and the cloning domain remain the same (see "Re-initializing an Existing Partition" on the next page).

Initializing a New Partition

Initializing an application partition for the first time establishes you as the Partition SO and sets a cloning domain for the partition. This procedure can be performed

> from an administrative connection to the network HSM appliance (via SSH) using Luna Shell (lunash) commands

- and then use the new PSO credential on that partition to initialize the Crypto Officer role), or

> from a registered client, with an NTLS or STC connection, using LunaCM commands.

The Crypto User role is created from the client side, via lunacm.

Any subsequent *re*-initialization of an application partition is performed from the client.

Prerequisites

> The new partition must be created on the HSM and visible in LunaCM (see Creating or Deleting an Application Partition).

> If you want to configure the partition's policies with a policy template using lunacm, the template file must be available on the client (see "Setting Partition Policies Using a Template" on page 192).

> If you want to configure the partition's policies with a policy template using lunash on the appliance, the pre-edited template file must be uploaded to the appliance.

> Multifactor Quorum authentication: A local or remote Luna PED connection must be established (see "Local PED Setup" on page 104 or "About Remote PED" on page 106). Ensure that you have enough blue (Partition SO) and red (Domain) PED keys for your planned authentication scheme (see "Creating PED keys" on page 129).

To initialize a new application partition

1. Launch LunaCM on the client workstation.

2. Set the active slot to the partition you want to initialize.

   lunacm:> **slot set -slot** <slot_number>

3. Initialize the partition by specifying an identifying label. To initialize the partition using a policy template, specify the path to the template file.

   In LunaCM, the partition label created during initialization must be 1-32 characters in length. If you specify a longer label, it will automatically be truncated to 32 characters. The following characters are allowed:
   `abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^&*()-_=+[]{}\|/;:',.<>`~`
   Spaces are allowed; enclose the label in double quotation marks if it includes spaces.

   - **Password authentication:** You can specify a Partition SO password and/or a domain string with the initialization command, or enter them when prompted.

     In LunaCM, passwords and activation challenge secrets must be 8-255 characters in length (**NOTE:** If you are using firmware version 7.0.x, 7.3.3, or 7.4.2, activation challenge secrets must be 7-16 characters in length). The following characters are allowed:
     `abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^&*()-_=+[]{}\|/;:',.<>?`~`
     Double quotation marks (`"`) are problematic and should not be used within passwords.
     Spaces are allowed; to specify a password with spaces using the **-password** or **-newpw** option of a command, enclose the password in double quotation marks.

     The domain string must be 1-128 characters in length. The following characters are allowed:
     `abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^*-_=+[]{}/:',.~`
     The following characters are problematic or invalid and must not be used in a domain string: `"&;<>\`|()`
     Spaces are allowed, as long as the leading character is not a space; to specify a domain string with spaces using the **-domain** option, enclose the string in double quotation marks. For password-authenticated HSMs, the domain string should match the complexity of the partition password.

     lunacm:> **partition init -label** <label> [**-applytemplate** <template_file>] [**-password** <password>] [**-domain** <domain_string>]

   - **Multifactor Quorum authentication:**

     lunacm:> **partition init -label** <label> [**-applytemplate** <template_file>]

     Respond to the Luna PED prompts to create the blue Partition SO key and the red domain key (see "Creating PED keys" on page 129).

Re-initializing an Existing Partition

The Partition SO can re-initialize an existing partition at any time. Re-initialization erases all cryptographic objects on the partition, and the login credentials for the Crypto Officer and Limited Crypto Officer and Crypto User roles. The Partition SO login credential and cloning domain are retained.

Prerequisites

> The partition must be already initialized.

> Back up any important cryptographic objects stored on the partition.

> [Multifactor Quorum authentication] A local or remote PED connection must be established (see "Local PED Setup" on page 104 or "About Remote PED" on page 106).

To re-initialize an existing application partition

1. Launch LunaCM on the client workstation.
2. Set the active slot to the partition you want to re-initialize.

   lunacm:> **slot set -slot** <slot_number>
3. Initialize the partition by specifying an identifying label. You must specify a label for the partition (the same label or a new one). You are prompted for the current Partition SO credential.

   lunacm:> **partition init -label** <label>

CHAPTER 7: Partition Capabilities and Policies

An application partition can be configured to provide a range of different functions. The Partition Security Officer can customize this functionality using partition policies. This configuration is governed by the following settings:

> **Partition Capabilities** are features of partition functionality that are inherited from the parent HSM policies (see HSM Capabilities and Policies). The HSM SO can configure HSM policies to allow or disallow partition capabilities. Some capabilities have corresponding modifiable partition policies.

> **Partition Policies** are configurable settings that allow the Partition Security Officer to modify the function of their corresponding capabilities.

The table below describes all partition capabilities, their corresponding policies, and the results of changing their settings. This section contains the following procedures:

> "Setting Partition Policies Manually" on page 191

> "Setting Partition Policies Using a Template" on page 192

Destructive Policies

As a security measure, changing some partition policies forces deletion of all cryptographic objects on the partition. These policies are listed as **destructive** in the table below. Some policy changes are destructive in either direction (**OFF-to-ON** and **ON-to-OFF**), while others are destructive only in the direction resulting in lowered partition security.

Some destructiveness settings can be customized using a partition policy template to initialize the partition. Refer to "Editing a Partition Policy Template" on page 193 for details. All destructiveness information on this page reflects the default settings for each policy.

Use lunacm:> **partition showpolicies -verbose** to check whether the policy you want to enable/disable is destructive.

Policy descriptions and settings

#	Partition Capability	Partition Policy
0	**Enable private key cloning** Always **1**. This capability allows private keys to be cloned to another Luna HSM partition (required for backup and HA). **NOTE** The HSM SO can disable cloning for all partitions on the HSM by turning off **HSM policy 7:** Allow cloning. In this case, cloning is not possible on the partition, regardless of this capability/policy's setting. See also "Cloning vs Key Management" on page 191.	**Allow private key cloning** *Destructive OFF-to-ON* > **1** (default): The partition is capable of cloning private keys to another partition. This policy must be enabled to back up partitions or create HA groups. Public keys and objects can always be cloned, regardless of this policy's setting. > **0**: Private keys can never be cloned to another application partition. Partition policies **0** and **1** may not be set to **1** (ON) at the same time. **NOTE** Enabling or disabling this policy requires Luna HSM Firmware 7.1.0 or newer. Key attributes can be set modifiable, and a key can then be set with (for example) attribute -extractable (see cmu generatekeypair), but Partition Policies overrule object attributes; Cloning ON and Private Key Wrapping OFF would prevent export despite the attribute settings.

#	Partition Capability	Partition Policy
1	**Enable private key wrapping** Always **1**. This capability allows private keys to be encrypted (wrapped) and exported off the partition.	**Allow private key wrapping** *Destructive OFF-to-ON* > **1**: Private keys may be wrapped and saved to an encrypted file off the partition. Public keys and objects can always be wrapped and exported, regardless of this policy's setting. This applies to V0 partitions only; V1 partitions cannot enable this policy. > **0** (default): Private keys can never be wrapped and exported off the partition. Partition policies **0** and **1** may not be set to **1** (ON) at the same time. **NOTE** Enabling or disabling this policy requires Luna HSM Firmware 7.1.0 or newer. Key attributes can be set modifiable, and a key can then be set with (for example) attribute -extractable (see cmu generatekeypair), but Partition Policies overrule object attributes; Cloning ON and Private Key Wrapping OFF would prevent export despite the attribute settings.
2	**Enable private key unwrapping** Always **1**. This capability allows wrapped private keys to be imported to the partition.	**Allow private key unwrapping** *Not destructive* > **1** (default): Private keys can be unwrapped and stored on the partition. > **0**: Private keys cannot be unwrapped onto the partition.
3	**Enable private key masking** Private keys can be masked off the partition.	**Allow private key masking** *Not destructive* > **1** (default for V1 partitions): Private keys can be masked off the partition. > **0** (default for V0 partitions): Private keys cannot be masked off the partition.

#	Partition Capability	Partition Policy
4	**Enable secret key cloning** Always **1**. This capability allows secret keys to be cloned to another Luna HSM partition (required for backup and HA). **NOTE** The HSM SO can disable cloning for all partitions on the HSM by turning off **HSM policy 7:** Allow cloning. In this case, cloning is not possible on the partition, regardless of this capability/policy's setting. See also "Cloning vs Key Management" on page 191.	**Allow secret key cloning** *Destructive OFF-to-ON* > **1** (default): Secret keys on the partition can be cloned to another partition. This is required for partition backup and HA groups. > **0**: Secret keys cannot be backed up, and will not be cloned to other HA group members.
5	**Enable secret key wrapping** Always **1**. This capability allows secret keys to be encrypted (wrapped) and exported off the partition.	**Allow secret key wrapping** *Destructive OFF-to-ON* > **1** (default): Secret keys can be wrapped and saved to an encrypted file off the partition. > **0**: Secret keys can never be wrapped and exported off the partition.
6	**Enable secret key unwrapping** Always **1**. This capability allows wrapped secret keys to be imported to the partition.	**Allow secret key unwrapping** *Not destructive* > **1** (default): Secret keys can be unwrapped and stored on the partition. > **0**: Secret keys cannot be unwrapped onto the partition.
7	**Enable secret key masking** Enable masking secret keys off the partition.	**Allow secret key masking** *Not destructive* > **1** (default for V1 partitions): Secret keys can be masked and stored off the partition. > **0** (default for V0 partitions): Secret keys cannot be masked off the partition.

#	Partition Capability	Partition Policy
9	**Enable DigestKey** Always **1**. Enable the C_DigestKey function to hash a symmetric key and return the hash to the calling application. The hashing is a subset of steps performed in many HASH/HMAC-based KDFs. The HSM firmware checks the policy every time LUNA_DIGEST_KEY is called, and returns LUNA_RET_OPERATION_RESTRICTED if the policy is off. Only FIPS-compliant hashes are allowed, so the state of the policy does not affect overall FIPS compliance. **NOTE** DigestKey can allow replication of Key Derive Functions externally, permitting some keys to be derived outside the HSM. Requires Luna HSM Firmware 7.8.0 or newer.	**Allow DigestKey** *Destructive OFF-to-ON* > **1** : Key Derive Functions can be performed using DigestKey > **0** (default): Key Derive Functions cannot use DigestKey.
10	**Enable multipurpose keys** Always **1**. This capability allows keys that are created or unwrapped on the partition to have more than one of the following attributes enabled (set to **1**), and can therefore be used fro multiple types of operation: > Encrypt/Decrypt > Sign/Verify > Wrap/Unwrap > Derive	**Allow multipurpose keys** *Destructive OFF-to-ON* > **1** (default): Keys that are created or unwrapped on the partition may be used for multiple operations. > **0**: Keys that are created or unwrapped on the partition may have only one of the affected attributes enabled. Thales recommends that you create keys with only the attributes required for their intended purpose. Disabling this policy enforces this rule on the partition. **NOTE** This policy does not affect Diffie-Hellman keys, which are always created with only Derive set to **1**.

#	Partition Capability	Partition Policy
11	**Enable changing key attributes** Always **1**. This capability allows the Crypto Officer to modify the following non-sensitive attributes of keys on the partition, changing key functions: > CKA_ENCRYPT > CKA_DECRYPT > CKA_WRAP > CKA_UNWRAP > CKA_SIGN > CKA_SIGN_RECOVER > CKA_VERIFY > CKA_VERIFY_RECOVER > CKA_DERIVE > CKA_EXTRACTABLE	**Allow changing key attributes** *Destructive OFF-to-ON* > **1** (default): The Crypto Officer can modify the non-sensitive attributes of keys on the partition. > **0**: Keys created on the partition cannot be modified.
15	**Allow failed challenge responses** Always **1**. This capability/policy applies to multifactor quorum-authenticated Luna PCIe HSM 7 only. It determines whether failed login attempts using a challenge secret count towards a partition lockout.	**Ignore failed challenge responses** *Destructive OFF-to-ON* > **1** (default): Failed challenge secret login attempts are not counted towards a partition lockout. Only failed PED key authentication attempts increment the counter. > **0**: Failed login attempts using either a PED key or a challenge secret will count towards a partition lockout. See "Activation on Multifactor Quorum-Authenticated Partitions" on page 207 and "Logging In to the Application Partition" on page 203 for more information.
16	**Enable operation without RSA blinding** Always **1**. RSA blinding is a technique that introduces random elements into the signature process to prevent timing attacks on the RSA private key. Some security policies may require this technique, but it does affect performance.	**Operate without RSA blinding** *Destructive OFF-to-ON* > **1** (default): The partition does not use RSA blinding. > **0**: The partition uses RSA blinding. Performance will be affected.

#	Partition Capability	Partition Policy
17	**Enable signing with non-local keys** Always **1**. Keys generated on the HSM have the attribute CKA_LOCAL=1. Keys that are imported (unwrapped) to the HSM have CKA_LOCAL=0. These attributes are maintained if keys are backed up or cloned to another HSM partition.	**Allow signing with non-local keys** *Not destructive* > **1** (default): Keys with attribute CKA_LOCAL=0 can be used for signing and their trust history is not assured. > **0**: Only keys with attribute CKA_LOCAL=1 can be used to sign data on the partition.
18	**Enable raw RSA operations** Always **1**. This capability enables the RSA mechanism CKM_RSA_X_509 on the partition, which allows weak encryption.	**Allow raw RSA operations** *Destructive OFF-to-ON* > **1** (default): The partition allows operations using the RSA mechanism CKM_RSA_X_509. > **0**: Operations using CKM_RSA_X_509 are blocked on the partition.
20	**Max failed user logins allowed** Displays the maximum number of failed partition login attempts (**10**) before the partition is locked out (see "Logging In to the Application Partition" on page 203).	**Max failed user logins allowed** *Not destructive* The Partition SO can lower the effective number of failed logins below the maximum if desired. Default: **10**
21	**Enable high availability recovery** Always **1**. This capability enables the RecoveryLogin feature on the partition. This feature allows other HA group members to restore the login state of the partition in the event of a power outage or other such deactivation.	**Allow high availability recovery** *Not destructive* > **1** (default): RecoveryLogin is enabled on the partition. This feature must be configured in advance (see role recoveryinit and role recoverylogin). > **0**: RecoveryLogin is disabled on the partition.
22	**Enable activation** This capability allows the partition to be activated. See "Activation on Multifactor Quorum-Authenticated Partitions" on page 207. > **1**: Always enabled on PED-authenticated HSMs. > **0**: Always disabled on password-authenticated HSMs.	**Allow activation** *Not destructive* > **1**: The black and/or gray PED keysecrets can be encrypted and cached, so that only a keyboard-entered challenge secret is required to log in. > **0** (default): PED keys must be presented at each login, whether via LunaCM or a client application. This policy is overridden and activation is disabled if a tamper event occurs, or if an uncleared tamper event is detected on reboot. See Tamper Events for more information.

#	Partition Capability	Partition Policy
23	**Enable auto-activation** This capability allows the partition to remain activated for up to two hours if the Luna PCIe HSM 7 loses power. See "Activation on Multifactor Quorum-Authenticated Partitions" on page 207. > **1**: Always enabled on multifactor quorum-authenticated HSMs. > **0**: Always disabled on password-authenticated HSMs.	**Allow auto-activation** *Not destructive* > **1**: Partition activation (see policy 22 above) is maintained after an HSM power loss of up to two hours. > **0** (default): The partition is deactivated in the event of a power loss. When power is restored, the black and/or gray PED keys must be presented to re-activate the partition.
25	**Minimum PIN length** > Luna HSM Firmware 7.7.2 and newer: Always **247** (**8** characters). > Luna HSM Firmware 7.7.1 and older: Always **248** (**7** characters). The absolute minimum length for a role password/challenge secret. This is displayed as a value subtracted from 255. The reason for this inversion is that a policy can only be set to a value equal to or lower than the value set by its capability. If the absolute minimum length was set to 8, the Partition SO would be able to set the preferred minimum to 2, a less-secure policy. The Partition SO may only change the minimum length to increase security by forcing stronger passwords.	**Minimum PIN length** *Not destructive* The Partition SO can choose to increase the effective minimum length of a role password/challenge secret by setting this policy. The policy value is determined as follows: Subtract the desired minimum length from 255 (the absolute maximum length), and set policy 25 to that value. **255 - (desired length) = (policy value)** For example, to set the minimum length to 10 characters, set the value of this policy to 245: **255 - 10 = 245** Default: > Luna HSM Firmware 7.7.2 and newer: **247** (**8** characters). > Luna HSM Firmware 7.7.1 and older: **248** (**7** characters).
26	**Maximum PIN length** Always **255**. The absolute maximum length for a role password/challenge secret is 255 characters.	**Maximum PIN length** *Not destructive* The effective maximum role password/challenge secret length may be changed by the Partition SO. It must always be greater than or equal to the effective minimum length, determined by the formula described in policy 25 (above). Default: **255**

#	Partition Capability	Partition Policy
28	**Enable Key Management Functions** Always **1**. This capability allows cryptographic objects to be created, deleted, generated, derived, modified on the partition. See also "Cloning vs Key Management" on page 191.	**Allow Key Management Functions** *Destructive OFF-to-ON* > **1** (default): The Crypto Officer can manage (create/delete, etc.) objects on the partition. The Crypto User is restricted to read-only operations. > **0**: Partition objects are read-only for both the CO and CU roles.
29	**Enable RSA signing without confirmation** Always **1**. This capability governs the HSM's internal signing verification.	**Perform RSA signing without confirmation** *Destructive OFF-to-ON* > **1** (default): No internal signing verification is performed. > **0**: The HSM performs an internal verification of signing operations to validate the signature. This has a performance impact on signature operations.
31	**Enable private key unmasking** Always **1**. Private keys can be unmasked onto the partition.	**Allow private key unmasking** *Not destructive* > **1** (default for V1 partitions): Private keys can be unmasked onto the partition (meaning they also can be migrated from legacy Luna HSMs that used SIM). > **0** (default for V0 partitions): Private keys cannot be unmasked onto the partition (meaning that migration of private keys from legacy HSMs using SIM is also not possible).
32	**Enable secret key unmasking** Enable unmasking of a secret key onto the partition.	**Allow secret key unmasking** *Not destructive* > **1** (default for V1 partitions): Secret keys can be masked and stored onto the partition. > **0** (default for V0 partitions): Secret keys cannot be masked onto the partition.
33	**Enable RSA PKCS mechanism** Always **1**. The mechanism CKM_RSA_PKCS has known weaknesses, which you can address in your applications. If you are not prepared to address these issues, you can choose to disable the mechanism entirely.	**Allow RSA PKCS mechanism** *Destructive OFF-to-ON* > **1** (default): CKM_RSA_PKCS is enabled on the partition. > **0**: CKM_RSA_PKCS is disabled on the partition.

#	Partition Capability	Partition Policy
34	**Enable CBC-PAD (un)wrap keys of any size** Always **1**. There are known vulnerabilities using small keys wrapped/unwrapped with CBC_PAD mechanisms (and with small keys in general). You can choose to enforce a size restriction so that small weak keys cannot be unwrapped onto the partition. The following mechanisms are affected: > CKM_AES_CBC_PAD > CKM_AES_CBC_PAD_IPSEC > CKM_ARIA_CBC_PAD > CKM_ARIA_L_CBC_PAD > CKM_CAST3_CBC_PAD > CKM_CAST5_CBC_PAD > CKM_DES_CBC_PAD > CKM_DES3_CBC_PAD > CKM_DES3_CBC_PAD_IPSEC > CKM_RC2_CBC_PAD > CKM_RC5_CBC_PAD > CKM_SEED_CBC_PAD > CKM_SM4_CBC_PAD	**Allow CBC-PAD (un)wrap keys of any size** *Not destructive* > **1** (default): All keys can be wrapped or unwrapped using CBC_PAD mechanisms. > **0**: Small keys cannot be wrapped or unwrapped using CBC_PAD mechanisms.
37	**Enable Secure Trusted Channel** Always **1**. This capability allows the partition to use STC for client access. **NOTE** If you are using Luna HSM Firmware 7.4.2 or older, the HSM SO must first enable STC by turning on **HSM policy 39:** Allow Secure Trusted Channel. This is not required using Luna HSM Firmware 7.7.0 or newer; STC is always enabled.	**Force Secure Trusted Channel** *Destructive ON-to-OFF* Secure Trusted Channel is a Luna Network HSM 7 feature, and has no function on Luna PCIe HSM 7. Thales does not recommend turning this policy on at any time.
39	**Enable Start/End Date Attributes** Always **1**. This capability allows you to enforce the CKA_START_DATE and CKA_END_DATE attributes of partition objects.	**Allow Start/End Date Attributes** *Destructive ON-to-OFF* > **1**: CKA_START_DATE and CKA_END_DATE attributes are enforced for all partition objects. > **0** (default): These attributes can be set for partition objects, but their values are ignored.

#	Partition Capability	Partition Policy
40	**Enable Per-Key Authorization Data** Both assigned and unassigned secret keys (symmetric or private) are given per-key authorization attributes in the form of CKA_AUTH_DATA, in any newly created or upgraded Luna HSM Firmware 7.7.0 or newer partition. For V0 partitions PKA is ignored and applications can use the pre-existing APIs as before. For V1 partitions it is actively used, for eIDAS compliance with newer API.	**Require Per-Key Authorization Data** *Not destructive* > **1** (default for V1 partitions): Per-Key-Authorization is on by default, but can be turned off for performance. > **0** (default for V0 partitions): Per-Key-Authorization is off by default, and cannot be turned on - V0 partitions do not allow policy changes that would require new clients.
41	**Enable Partition Version** Always **1**. This capability is visible for any partition at Luna HSM Firmware 7.7.0 or newer, and allows you to switch a partition between version V0 and V1.	**Partition Version** *Destructive ON-to-OFF* > **1**: Version 1 (V1) partition supports all features of Luna HSM Firmware 7.7.0 or newer. • cloning is used/permitted only for SMKs • key objects are transferred using SKS • only HA Login version 2 is supported. > **0** (default): Version 0 (V0) supports older API and your pre-existing applications (used with Luna HSM Firmware 7.7.0), enhanced by fixes and security updates of Luna HSM Firmware 7.7.0 (or newer), but Per Key Authorization, SKS, and other V1-dependent features are not available. Pre-7.7.0 version of HA Login can be used (full use of v1.1 or version 2.0, while v1.0 HA Login for use as primary only)

#	Partition Capability	Partition Policy
42	**Enable CPv1** This capability is visible for any partition at Luna HSM Firmware 7.7.1 or newer, and allows the partition to use the cloning protocol needed for HA with older partitions.	**Allow CPv1** *Destructive OFF-to-ON* For V0 partitions created while the HSM is at Luna HSM Firmware 7.7.1 or newer. This policy was added in order to reintroduce CPv1 ability for cloning keys from Luna on-premises HSM to Luna Cloud HSM, or to other on-premises HSMs with lower firmware versions. When the HSM is in non-FIPS mode (where HSM policy 12 is set to ON) > **1**: Cloning (CPv1) can be used by the partition for key objects. > **0** (default): Cloning (CPv1) is not allowed by the partition for key objects. When the HSM is in FIPS mode (where HSM policy 12 is set to OFF), this policy setting cannot be changed. Cloning (CPv1) is not allowed, by the partition, for key objects. Therefore, cloning can use only CPv3 if it is available on both source and target. For Luna HSM Firmware 7.7.0 V0 partitions, "Allow CPv1" is OFF after firmware update from version 7.7.0 to Luna HSM Firmware 7.7.1 or newer. For Luna HSM Firmware 7.7.0 V1 partitions, "Allow CPv1" is always OFF. For pre-7.7.0 firmware partitions, CPv1 is turned ON after update (to firmware version 7.7.1 or newer), if the HSM is not in FIPS mode, OFF if the HSM is in FIPS mode. Enabling CPv1 disables CPv3 and CPv4.

#	Partition Capability	Partition Policy
43	**Enable non-FIPS algorithms** This capability is visible for any partition at Luna HSM Firmware 7.7.1 or newer, and allows the use of algorithms that are FIPS non-compliant, within the current partition. Requires that HSM policy 12 be set to ON (that is, with policy 12 ON for the HSM, the overall HSM allows non-FIPS algorithms, so you can then choose to allow or disallow non-FIPS mode per individual partition on that HSM by using this partition policy 43).	**Allow non-FIPS algorithms** *Destructive OFF-to-ON* For V0 partitions created while the HSM is at Luna HSM Firmware 7.7.1 or newer When the HSM is in non-FIPS mode (where HSM policy 12 is set to ON) > **1** (default): Non-FIPS-compliant algorithms can be used by the partition. > **0**: Non-FIPS-compliant algorithms are not permitted. When the HSM is in FIPS mode (where HSM policy 12 is set to OFF), this policy setting cannot be changed; non-FIPS-compliant algorithms are not permitted on any partition on the HSM. For Luna HSM Firmware 7.7.0 V0 partitions, "Allow non-FIPS" is OFF after firmware update from version 7.7.0 to Luna HSM Firmware 7.7.1 or newer. For Luna HSM Firmware 7.7.0 V1 partitions, "Allow non-FIPS" follows the HSM policy (on if on, off if off). For pre-7.7.1 firmware partitions, this partition policy follows the HSM policy.

#	Partition Capability	Partition Policy
44	**Enable Extended Domain Management** This capability is visible for any partition at Luna HSM Firmware 7.8.0 or newer, and allows multifactor quorum-authenticated HSMs to inter-operate with password-authenticated HSMs -- which also allows multifactor quorum-authenticated HSMs to inter-operate with Luna Cloud HSM services. This capability is ON by default, so that the associated policy can always be modified.	**Allow Extended Domain Management** *Not destructive* This policy controls the ability of a partition to support more than one cloning/security domain, which further allows multifactor quorum-authenticated and password-authenticated partitions to interoperate. > **1** : Partition cloning/security domains, in addition to the original, can be specified and accessed by the partition. > **0** (default): For newly created partitions, the policy is off, and only the primary/native domain is available. For partitions that existed prior to upgrading to Luna HSM Firmware 7.8.0 or newer, the policy is off. This ensures that continuity of existing applications and processes requires no change due to firmware update. Changes come into play only when you set this policy to ON. This policy is non-destructive of partition contents when switched from OFF-to-ON or from ON-to-OFF. The destructiveness for either transition can be adjusted by the use of Partition Policy Template at partition initialization time. When enabled, this policy provides the ability to specify the source of a partition's domain and the ability to have more than one domain. See the lunacm commands partition domainlist, partition domainadd, partition domaindelete, and partition domainchangelabel. When the policy is turned OFF, all domains except the primary domain are deleted.

A number of partition capabilities are linked to the corresponding HSM capabilities and policies including:

> Partition Policy (0) Enable private key cloning is dependent on HSM Policy (7) Allow cloning;

> Partition Policy (3) Enable private key masking is dependent on HSM Policy (6) Allow Masking;

> Partition Policy (4) Enable secret key cloning is dependent on HSM Policy (7) Allow cloning;

> Partition Policy (7) Enable secret key masking is dependent on HSM Policy (6) Allow Masking;

> Partition Policy (22) Enable Activation and Partition Policy (23) Enable Auto-Activation are dependent on HSM Policy (1) Allow PED-based authentication;

> Partition Policy (31) Enable private key unmasking is dependent on HSM Policy (6) Allow Masking; and

> Partition Policy (32) Enable secret key unmasking is dependent on HSM Policy (6) Allow Masking.

In addition – the following dependencies within the partition level policies are observed:

- Partition Policy (7) Allow cloning cannot be enabled at the same time as Partition Policy (1) Allow private key wrapping;
- Partition Policy (1) Allow private key wrapping cannot be enabled at the same time as either one of the policies, Partition Policy (0) Enable private key cloning, Partition Policy (3) Allow private key masking, Partition Policy (31) Enable private key unmasking;
- Partition Policy (23) Allow Auto-Activation is dependent on Partition Policy (22) Allow Activation being enabled;
- Partition Policies related to 'Masking' (3, 7, 31 and 32) can only be enabled when Partition Policy (41) Partition Version is '0'; and
- Partition Policy (41) Partition Version cannot be set to '1' at the same time as either Partition Policy (40) Enable Per-Key Authorisation Data or any of the Partition Policies covering key masking (3, 7, 31 and 32).
- Partition Policy (40) Enable Per-Key Authorisation Data is enabled by default but is disabled if Partition Policy (41) Partition Version is set to '0'.
- Partition Policy (42) Allow CPv1 requires that HSM Policy (12) Allow non-FIPS algorithms is ON, and Partition Policy (43) Allow non-FIPS algorithms is on, setting the partition to FIPS non-approved mode.

Cloning vs Key Management

> **TIP Security Note -***Cloning policies (**0** and **4**)* permit or deny the ability to securely copy keys and objects into and out of a partition.
> The *Key Management Functions policy (**28**)* controls the ability to create, delete, generate, derive, or modify cryptographic objects in the current partition.
>
> These controls are independent of each other. With Key Management functions denied, you can still clone objects in and out of partitions where Cloning policy is allowed. Thus HA (high availability) operation can clone keys into a partition that disallows Key Management functions (creation, deletion, etc.). **Cloning a key or object into a partition is not considered creation** - the key or object already existed within the security / cloning domain that encompasses the partition.
>
> Ultimately the security administrators define where keys can exist by controlling distribution of the security / cloning domain, and by defining policies around those keys.
>
> Additionally, key owners can choose to make their keys non-modifiable and non-extractable, if those options are indicated by your use-case.

Setting Partition Policies Manually

The Partition Security Officer can change available policies to customize partition functionality. Policy settings apply to all roles/objects on the partition. Refer to "Partition Capabilities and Policies" on page 177 for a complete list of partition policies and their effects. In most cases, partition policies are either enabled (**1**) or disabled (**0**), but some allow a range of values.

To change multiple policy settings during partition initialization, see "Setting Partition Policies Using a Template" on the next page.

See also "Configuring the Partition for Cloning or Export of Private/Secret Keys" on page 196.

Prerequisites

> The partition must be initialized (see "Initializing an Application Partition" on page 174).

> If you are changing a destructive policy, back up any important cryptographic objects (see "Partition Backup and Restore" on page 278).

To manually set or change a partition policy

1. Launch LunaCM and set the active slot to the partition.

   lunacm:> **slot set -slot** <slotnum>

2. [Optional] Display the existing partition policy settings.

   lunacm:> **partition showpolicies**

3. Log in as Partition SO (see "Logging In to the Application Partition" on page 203).

   lunacm:> **role login -name po**

4. Change the policy setting by specifying the policy number and the desired value (**0**, **1**, or a number in the accepted range for that policy). You can specify multiple policy changes in the same command by using comma-separated lists (for example, **-policy 33,37,40 -value 0,1,1**).

   lunacm:> **partition changepolicy -policy** <policy_ID> **-value** <value>

   If you are changing a destructive policy, you are prompted to enter **proceed** to continue the operation.

   > **NOTE** If you are running more than one LunaCM session against the same partition, and change a partition policy in one LunaCM session, the new policy setting is visible in that session only (although it is in effect). You must exit and restart the other LunaCM sessions to display the new policy setting.

Setting Partition Policies Using a Template

A partition policy template is a file containing a set of preferred partition policy settings, used to initialize partitions with those settings. You can use the same file to initialize multiple partitions, rather than changing policies manually after initialization. This can save time and effort when initializing partitions that are to function as an HA group, or must comply with your company's overall security strategy. Templates enable scalable policy management and simplify future audit and compliance requirements.

> **NOTE** This feature is for partitions in on-premises, physical Luna HSMs, and is not supported for Luna Cloud HSM (DPoD) services.

See also Setting HSM Policies Using a Policy Template.

> **NOTE** This feature requires minimum Luna HSM Firmware 7.1.0 and Luna HSM Client 7.1.0.

You can create a partition policy template file from an initialized or uninitialized partition, and edit it using a standard text editor. Partition policy templates have additional customization options.

Policy templates cannot be used to alter settings for an initialized partition. Once a partition has been initialized, the Partition SO must change individual policies manually (see "Setting Partition Policies Manually" on page 191).

This section provides instructions for the following procedures, and some general guidelines and restrictions:

> "Creating a Partition Policy Template" below

> "Editing a Partition Policy Template" below

> "Applying a Partition Policy Template" on page 195

Creating a Partition Policy Template

The following procedure describes how to create a policy template for a partition. This can be done optionally at two points in the partition setup process:

> before the partition is initialized: this produces a template file containing the default policy settings, which can then be edited

> after initializing and setting the partition policies manually: this produces a template file with the current policy settings, which can then be used to initialize other partitions to take on the same settings.

To create a partition policy template

1. Launch LunaCM and set the active slot to the partition.

   lunacm:> **slot set -slot** <slotnum>

   > **NOTE** The command to create and export a partition policy template (ppt) file is a sub-command of **partition showpolicies**, which does not require login by the partition SO.

2. Create the partition policy template file. Specify an existing save directory and original filename. No file extension is required. If a template file with the same name exists in the specified directory, it is overwritten.

   lunacm:> **partition showpolicies -exporttemplate** <filepath/filename>

```
lunacm:> partition showpolicies -exporttemplate /usr/safenet/lunaclient/templates/ParPT

Partition policies for Partition: myPartition1 written to
/usr/safenet/lunaclient/templates/ParPT

Command Result : No Error
```

Editing a Partition Policy Template

Use a standard text editor to manually edit policy templates for custom configurations. This section provides template examples and customization guidelines.

Partition Policy Template Example

This example shows the contents of a partition policy template created using the factory default policy settings. Use a standard text editor to change the policy and/or destructiveness values (0=OFF, 1=ON, or the desired value 0-255).

Partition policy template entries have two additional fields: **Off to on destructive** and **On to off destructive** (see example below). Change these values to **0** or **1** to determine whether cryptographic objects on the partition should be deleted when this policy is changed in the future. Policies that lower the security level of the objects stored on the partition are normally destructive, but it may be useful to customize this behavior for your own security strategy. See "Partition Capabilities and Policies" on page 177 for more information.

> **CAUTION!** Setting policy destructiveness to **0** (OFF) makes partitions less secure. Use this feature only if your security strategy demands it.

If you export a policy template from an uninitialized partition, the **Sourced from partition** header field remains blank. This field is informational and you can still apply the template.

The **Policy Description** field is included in the template for user readability only. Policies are verified by the number in the **Policy ID** field.

```
# Policy template FW Version 7.8.3
# Field format - Policy ID:Policy Description:Policy Value:Off to on destructive:On to off
destructive
# Sourced from partition: myPartition1, SN: 154438865290


0:"Allow private key cloning":1:1:0
1:"Allow private key wrapping":0:1:0
2:"Allow private key unwrapping":1:0:0
3:"Allow private key masking":0:1:0
4:"Allow secret key cloning":1:1:0
5:"Allow secret key wrapping":1:1:0
6:"Allow secret key unwrapping":1:0:0
7:"Allow secret key masking":0:1:0
9:"Allow DigestKey":0:1:0
10:"Allow multipurpose keys":1:1:0
11:"Allow changing key attributes":1:1:0
15:"Ignore failed challenge responses":1:1:0
16:"Operate without RSA blinding":1:1:0
17:"Allow signing with non-local keys":1:0:0
18:"Allow raw RSA operations":1:1:0
20:"Max failed user logins allowed":10:0:0
21:"Allow high availability recovery":1:0:0
22:"Allow activation":0:0:0
23:"Allow auto-activation":0:0:0
25:"Minimum pin length (inverted  255 - min)":248:0:0
26:"Maximum pin length":255:0:0
28:"Allow Key Management Functions":1:1:0
29:"Perform RSA signing without confirmation":1:1:0
31:"Allow private key unmasking":1:0:0
32:"Allow secret key unmasking":1:0:0
33:"Allow RSA PKCS mechanism":1:1:0
34:"Allow CBC-PAD (un)wrap keys of any size":1:1:0
39:"Allow Start/End Date Attributes":0:1:0
40:"Require Per-Key Authorization Data":0:1:0
41:"Partition Version":0:0:1
42:"Allow CPv1":0:1:0
43:"Allow non-FIPS Algorithms":1:1:0]
44:"Allow Extended Domain Management":0:0:0
```

Editing Guidelines and Restrictions

When creating or editing partition policy templates:

> You can remove a policy from the template by adding **#** at the beginning of the line or deleting the line entirely. When you apply the template, the partition will use the default values for that policy.

> Partition policy templates from older Luna versions (6.x or earlier) cannot be applied to Luna 7.x partitions.

> This version of the partition policy template feature is available on Luna 7.x application partitions only. When the active slot is set to a Luna 6.x partition or the Admin partition, the **-exporttemplate** option is not available. To create an HSM policy template from the Admin partition, see Setting HSM Policies Using a Template.

> The following restrictions apply when configuring partitions for Cloning or Key Export (see "Configuring the Partition for Cloning or Export of Private/Secret Keys" on the next page for more information):

- **Partition policy 0: Allow private key cloning** and **partition policy 1: Allow private key wrapping** can never be set to **1** (ON) at the same time. Initialization fails if the template contains a value of **1** for both policies.
- **Partition policy 1: Allow private key wrapping** must always have **Off-to-on** destructiveness set to **1** (ON). Initialization fails if the template contains a value of **0** in this field.

> You may not use invalid policy values (outside the acceptable range), or values that conflict with your HSM or partition's capabilities. For example, **Partition capability 3: Enable private key masking** is always **0**, so you cannot set the corresponding partition policy to **1**. If you attempt to initialize a partition with a template containing invalid policy values, an error is returned and initialization fails.

If there is a mismatch between template policies and the default values of newer or dependent policies, then the attempt to apply the old policy would fail with CKR_FAILED_DEPENDENCIES.

You have the option to edit a policy file before applying it, to add newer policies.

Applying a Partition Policy Template

The following procedure describes how to initialize a partition using a policy template.

To apply a policy template to a new partition

1. Ensure that the template file is saved on the client workstation.
2. Launch LunaCM and set the active slot to the new partition.

   lunacm:> **slot set -slot** <slotnum>

3. Initialize the partition, specifying a label and the policy template file. If the template file is not in the same directory as LunaCM, include the correct filepath.

   lunacm:> **partition init -label** <label> **-applytemplate** <filepath/filename>

4. [Optional] Verify that the template has been applied correctly by checking the partition's policy settings. Include the **-verbose** option to view the destructiveness settings.

   lunacm:> **partition showpolicies** [**-verbose**]

Configuring the Partition for Cloning or Export of Private/Secret Keys

By default, the Luna PCIe HSM 7 stores all keys in hardware, allowing private asymmetric and secret keys to be copied only to another Luna HSM (cloning). Cloning allows you to move or copy key material from a partition to a backup HSM or to another partition in the same HA group. You might, however, want to export private or secret keys to an encrypted file for off-board storage or use. Individual partitions can be configured in one of three modes for handling private keys.

> **NOTE** This feature requires Luna HSM Firmware 7.1.0 or newer.

The Partition SO can set the mode by changing the following policies (see "Partition Capabilities and Policies" on page 177 for more information):

> **Partition policy 0: Allow private key cloning** (default: **1**)

> **Partition policy 1: Allow private key wrapping** (default: **0**)

> **NOTE** These partition policies can never be set both to **1** (ON) at the same time. An error will result (CKR_CONFIG_FAILS_DEPENDENCIES) if it is attempted.

The policies can be set at the time of initialization, using a policy template (see "Setting Partition Policies Using a Template" on page 192) or by following the procedures described below:

> "Cloning Mode" on the next page

> "Key Export Mode" on page 198

> "No Backup Mode" on page 199

> **NOTE** Partition configurations are listed in LunaCM as "Key Export With Cloning Mode". This indicates that the partition is *capable* of being configured for either Key Export or Cloning, with the mode of operation defined by the policies listed above. You can never configure a partition to allow both export and cloning of private keys at once.

> **TIP** **Security Note -***Cloning policies (**0** and **4**)* permit or deny the ability to securely copy keys and objects into and out of a partition.
> The *Key Management Functions policy (**28**)* controls the ability to create, delete, generate, derive, or modify cryptographic objects in the current partition.
>
> These controls are independent of each other. With Key Management functions denied, you can still clone objects in and out of partitions where Cloning policy is allowed. Thus HA (high availability) operation can clone keys into a partition that disallows Key Management functions (creation, deletion, etc.). **Cloning a key or object into a partition is not considered creation** - the key or object already existed within the security / cloning domain that encompasses the partition.
>
> Ultimately the security administrators define where keys can exist by controlling distribution of the security / cloning domain, and by defining policies around those keys.
>
> Additionally, key owners can choose to make their keys non-modifiable and non-extractable, if those options are indicated by your use-case.

Cloning Mode

A partition in Cloning mode has the following capabilities and restrictions:

- All keys/objects can be cloned to another partition or Luna Backup HSM in the same cloning domain.
- All keys/objects are replicated within the partition's HA group.
- Private asymmetric keys cannot be wrapped off the HSM (cannot be exported to a file encrypted with a wrapping key).

In this mode, private keys are never allowed to exist outside of a trusted Luna HSM in the designated cloning domain. Cloning mode is the default setting for new partitions.

Setting Cloning Mode on a Partition

Cloning mode is the default setting on new partitions. If another mode was set previously, the Partition SO can use the following procedure to set Cloning mode. Use lunacm:> **partition showpolicies** to see the current policy settings.

> **CAUTION!** **Partition policy 0: Allow private key cloning** is Off-to-On destructive by default. Back up any important cryptographic material on the partition before continuing. This destructiveness setting can be customized by initializing the partition with a policy template (see "Editing a Partition Policy Template" on page 193).

To manually set Cloning mode on a partition

1. Log in to the partition as Partition SO.

   lunacm:> **slot set -slot** <slotnum>

   lunacm:> **role login -name po**

2. Set **partition policy 1: Allow private key wrapping** to **0** (OFF).

   lunacm:> **partition changepolicy -policy 1 -value 0**

3. Set **partition policy 0: Allow private key cloning** to **1** (ON).

lunacm:> **partition changepolicy -policy 0 -value 1**

To initialize a partition in Cloning mode using a policy template

Use a standard text editor to include the following lines in the policy template file (see "Editing a Partition Policy Template" on page 193):

```
0:"Allow private key cloning":1:1:0
1:"Allow private key wrapping":0:1:0
```

Key Export Mode

A partition in Key Export mode has the following capabilities and restrictions:

> Private asymmetric keys cannot be cloned to other partitions nor to a Luna Backup HSM.

> The partition cannot be part of an HA group (private keys will not be replicated).

> All keys/objects, including private keys, can be wrapped off the HSM (can be exported to a file encrypted with a wrapping key).

This mode is useful when generating key pairs for identity issuance, where transient key-pairs are generated, wrapped off, and embedded on a device. They are not used on the HSM, but generated and issued securely, and then deleted from the HSM. This applies to V0 partitions only; V1 partitions cannot enable this mode.

Setting Key Export Mode on a Partition

The Partition SO can use the following procedure to set Key Export mode. Use lunacm:> **partition showpolicies** to see the current policy settings.

> **CAUTION!** **Partition policy 1: Allow private key wrapping** is always Off-to-On destructive. Back up any important cryptographic material on the partition before continuing. This destructiveness setting cannot be changed with a policy template (see "Editing Guidelines and Restrictions" on page 195).

To manually set Key Export mode on a partition

1. Launch LunaCM and log in to the partition as Partition SO.

   lunacm:> **slot set -slot** <slotnum>

   lunacm:> **role login-name po**

2. Set **partition policy 0: Allow private key cloning** to **0** (OFF).

   lunacm:> **partition changepolicy -policy 0 -value 0**

3. Set **partition policy 1: Allow private key wrapping** to **1** (ON).

   lunacm:> **partition changepolicy -policy 1 -value 1**

To initialize a partition in Key Export mode using a policy template

Use a standard text editor to include the following lines in the policy template file (see "Editing a Partition Policy Template" on page 193):

```
0:"Allow private key cloning":0:1:0
1:"Allow private key wrapping":1:1:0
```

No Backup Mode

A partition in No Backup mode has the following restrictions:

> Private asymmetric keys cannot be cloned to other partitions or to a Luna Backup HSM. All other objects can still be cloned.

> Private asymmetric keys cannot be wrapped off the HSM (exported to a file encrypted with a wrapping key). All other objects can still be wrapped off.

Without backup capability, private keys can never leave the HSM. This mode is useful when keys are intended to have short lifespans, and are easily replaced.

Setting No Backup Mode on a Partition

The Partition SO can use the following procedure to set No Backup mode. Use lunacm:> **partition showpolicies** to see the current policy settings.

To manually set No Backup mode on a partition

1. Launch LunaCM and log in to the partition as Partition SO.

   lunacm:> **slot set -slot** <slotnum>

   lunacm:> **role login -name po**

2. If **partition policy 0: Allow private key cloning** is set to **1** (ON), set it to **0** (OFF).

   lunacm:> **partition changepolicy -policy 0 -value 0**

3. If **partition policy 1: Allow private key wrapping** is set to **1** (ON), set it to **0** (OFF).

   lunacm:> **partition changepolicy -policy 1 -value 0**

To initialize a partition in No Backup mode using a policy template

Use a standard text editor to include the following lines in the policy template file (see "Editing a Partition Policy Template" on page 193):

```
0:"Allow private key cloning":0:1:0
1:"Allow private key wrapping":0:1:0
```

CHAPTER 8: Partition Roles

The security of an HSM and its cryptographic contents depends on well-controlled access to that HSM. A controlled access policy is defined by:

> the set of users with valid login credentials for the host system, the HSM and the application partition

> the actions each user is allowed to perform when logged in (the user's role)

For example, an access policy that adheres to the PKCS#11 standard requires two roles: the security officer (SO), who administers the user account(s), and the standard user, who performs cryptographic operations. When a user logs in to the HSM, they can perform only those functions that are permitted for their role.

All cryptographic operations take place on an application partition. This partition is created on the Luna PCIe HSM 7 by the HSM SO and is designed to function independently of the Admin partition, with its own Security Officer and users. This provides more flexibility in meeting the security needs of your organization. Personnel holding the roles described below must have administrative access to the Luna PCIe HSM 7 host workstation.

The partition-level roles are as follows:

Partition Security Officer (PO)

The Partition SO handles all administrative and configuration tasks on the application partition, including:

> Initializing the partition, setting the PO credential, and setting a cloning domain for the partition (see "Initializing an Application Partition" on page 174)

> Configuring partition policies (see "Partition Capabilities and Policies" on page 177)

> Initializing the Crypto Officer role (see "Initializing the Crypto Officer Role" on page 205)

> Activating the partition (see "Activation on Multifactor Quorum-Authenticated Partitions" on page 207)

Managing the Partition SO Role

Refer also to the following procedures to manage the PO role:

> "Logging In to the Application Partition" on page 203

> Changing a Partition Role Credential

Crypto Officer (CO)

The Crypto Officer is the primary user of the application partition and the cryptographic objects stored on it. The Crypto Officer has the following responsibilities:

> Creating, deleting, and modifying cryptographic objects via user applications

> Performing cryptographic operations via user applications

> Managing backup and restore operations for partition objects (see "Partition Backup and Restore" on page 278)

> Initializing the Crypto User role (see "Initializing the Crypto User Role" on page 205)

> The CO can modify keys - must provide per-key authorisation (PKA) data for unassigned keys
> The CO can unblock blocked (due to per-key auth failures) PKA keys
> The CO can increment usage counters and change/set the limit
> The CO can perform SMK rollover

Managing the Crypto Officer Role
Refer also to the following procedures to manage the CO role:

> "Logging In to the Application Partition" on page 203
> Changing a Partition Role Credential

Limited Crypto Officer (LCO)

The Limited Crypto Officer is a role needed for eIDAS compliance and the performance of Per Key Authorization functions, with a subset of the abilities and responsibilities of the Crypto Officer, but wider authority and ability than the Crypto User. The LCO is created by the partition CO. The LCO role is visible and accessible in V1 partitions if the Client software version is 10.3 or newer. The Limited Crypto Officer has the following abilities and responsibilities:

> Creating, deleting, and modifying cryptographic objects via user applications
> Performing cryptographic operations via user applications
  - The LCO can copy and modify keys and private objects- must provide per-key authorisation (PKA) data for unassigned keys
  - The LCO can increment usage counters, but cannot change/set the limit
  - The LCO cannot unblock blocked (due to per-key auth failures) PKA keys
  - The LCO can wrap/unwrap keys - must specify the per-key auth data for both the wrapping/unwrapping keys and the wrapped/unwrapped keys
  - The LCO can derive keys - must provide the per-key auth data for the key used for derivation and specify the per-key auth data for the key being derived in the template
  - The LCO can derive-and-wrap - must provide per-key auth data as above
  - The LCO can perform SKS operations (SIMExtract / SIMInsert)
  - The LCO cannot perform SMK rollover
> Creating and configuring HA groups (see "Setting Up an HA Group" on page 243)
> Initializing the Crypto User role (see "Initializing the Crypto User Role" on page 205)

Managing the Limited Crypto Officer Role
Refer also to the following procedures to manage the LCO role:

> "Logging In to the Application Partition" on page 203
> Changing a Partition Role Credential
> The LCO role does not support cloning
> The LCO role is not visible for V0 partitions.

> The LCO role is subject to role-affecting partition policies like
  - Minimum PIN length [25]
  - Maximum PIN length [26]
  - Maximum failed challenge responses [15]
  - Maximum failed user logins allowed [20]
    - Upon reaching the limit, the LCO is locked out; CO and CU remain operational
    - Partition CO can unlock a locked LCO by resetting its credentials
> The LCO can create and destroy private objects
> The LCO can generate keys assigned or unassigned, but cannot assign a key after it is generated.
> The LCO can delete keys
  - Unlike CO role, LCO must provide per-key authorization (PKA) data
  - LCO supports the “single-use signing keys” scenario where a user generates a key, signs with that key, and deletes the key
> The LCO can modify keys - must provide per-key authorisation (PKA) data for unassigned keys
> The LCO can increment usage counters but, unlike CO, cannot change/set the limit
> The LCO can wrap/unwrap
  - PKA behaviour for wrap: must provide the per-key auth data for both the wrapping and the wrapped keys
  - PKA behaviour for unwrap: must provide the per-key auth data for unwrapping key and specify the per-key auth data for the unwrapped key in the template
> For PKA operation
  - The LCO can derive keys
  - The LCO can derive-and-wrap
> The LCO can extract/insert in all scenarios
  - Including SKS key migration (old SKS: Insert; no Extract)
  - Including new SKS (Extract and Insert)
> The LCO cannot clone/replicate in any scenario - this means that LCO is not self-sufficient for HA; the CO is needed to clone SMK(s)
> Unlike the CO, the LCO cannot perform SMK rollover

Crypto User (CU)

The Crypto User is an optional role that can perform cryptographic operations using partition objects in a read-only capacity, but can create only public objects. This role is useful in that it provides limited access; the Crypto Officer is the only role that can make significant changes to the contents of the partition. The Crypto User has the following capabilities:

> Performing operations like encrypt/decrypt and sign/verify using objects on the partition
> Creating and backing up public objects (see "Partition Backup and Restore" on page 278)
> The CU can increment usage counters but, unlike CO, cannot change/set the limit

Managing the Crypto User Role

Refer also to the following procedures to manage the CU role:

> "Logging In to the Application Partition" below

> Changing a Partition Role Credential

Logging In to the Application Partition

Before you can perform administrative tasks on the partition or its stored cryptographic objects, you must log in with the appropriate role:

> Partition Security Officer (specify **po** for <role>)

> Crypto Officer (specify **co** for <role>)

> Crypto User (specify **cu** for <role>)

To log in to the application partition

1. Launch LunaCM on the Luna PCIe HSM 7 host workstation.
2. Set the active slot to the desired partition.

   lunacm:> **slot set -slot** <slotnum>
3. Log in by specifying your role on the partition.

   lunacm:> **role login -name** <role>

   You are prompted for the role's credential.

Failed Partition Login Attempts

The consequences of multiple failed login attempts vary by role, depending on the severity of the security risk posed by that role being compromised. This is a security feature meant to thwart repeated, unauthorized attempts to access your cryptographic material.

> **NOTE** The system must actually receive some erroneous/false information before it logs a failed attempt; if you merely forget to insert the PED key, or insert the wrong color key, that is not counted as a failed attempt. You must insert an incorrect PED key of the correct type, or enter an incorrect PIN or challenge secret, to fail a login attempt.

Partition Security Officer

If you fail ten consecutive Partition SO login attempts, the partition is zeroized and all cryptographic objects are destroyed. The Partition SO must re-initialize the partition and Crypto Officer role, who can restore key material from a backup device.

Crypto Officer

If you fail ten consecutive Crypto Officer login attempts, the CO and CU roles are locked out. But see below for the exception. The default lockout threshold of 10 is governed by partition policy 20: Max failed user logins allowed, and the Partition SO can set this threshold lower if desired (see "Partition Capabilities and Policies" on page 177).

Is recovery possible from lockout or loss of the partition role credential?
Yes, and no, depending on configuration options you might choose.

Separation of roles ensures that,

> while the Partition Crypto Officer (and subsidiary roles) can see and manage the *content* of an application partition,

> the partition SO cannot access or manage the content of a partition; SO manages at the provisioning and security level for the partition.

If you lose the use of your CO credential, the contents of the partition are no longer accessible. The Partition SO might not be able to help in that situation, for the following reason.

The partition SO cannot just reset the password of the partition CO if you have disallowed it

Recovery from partition role lockout depends on the setting of **HSM policy 15: Enable SO reset of partition PIN**:

> If HSM policy 15 is set to **1** (enabled), the CO and CU and LCO roles are temporarily locked out by too many bad authentication attempts. The Partition SO must unlock the CO role and reset the credential (see "Resetting the Crypto Officer, Limited Crypto Officer, or Crypto User Credential" on page 206).

> If HSM policy 15 is set to **0** (disabled), the CO and CU and LCO roles are permanently locked out and the partition contents are no longer accessible. The Partition SO must re-initialize the partition (destroying all contents) and the Crypto Officer role, who can restore key material from a backup. This is the default setting.

NOTE If you have a backup and know its password, you can recover material. If you do not have a backup, or the backup that you have is not secured by a known password, then the material is lost.

CAUTION! If loss of partition contents is not the desired outcome, ensure that the HSM SO *en*ables this destructive policy *before* creating partitions and assigning to clients.

Crypto User
If you fail ten consecutive Crypto User login attempts, the CU role is locked out. The default lockout threshold of 10 is governed by partition policy **20: Max failed user logins allowed**, and the Partition SO can set this threshold lower if desired (see "Partition Capabilities and Policies" on page 177). The CO must unlock the CU role and reset the credential (see "Resetting the Crypto Officer, Limited Crypto Officer, or Crypto User Credential" on page 206).

Initializing Crypto Officer and Crypto User Roles for an Application Partition

The following procedures will allow you to initialize the Crypto Officer (CO) and Crypto User (CU) roles and set an initial credential.

Initializing the Crypto Officer Role

The Crypto Officer (CO) is the primary user of the application partition and the cryptographic objects stored on it. The Partition Security Officer (PO) must initialize the CO role and assign an initial credential.

To initialize the Crypto Officer role

1. In LunaCM, log in to the partition as Partition SO (see "Logging In to the Application Partition" on page 203).

   lunacm:> **role login -name po**

2. Initialize the Crypto Officer role. If you are using a password-authenticated partition, specify a CO password. If you are using a multifactor quorum-authenticated partition, ensure that you have a blank or rewritable black PED key available. Refer to "Creating PED keys" on page 129 for details on creating PED keys.

   In LunaCM, passwords and activation challenge secrets must be 8-255 characters in length (**NOTE:** If you are using firmware version 7.0.x, 7.3.3, or 7.4.2, activation challenge secrets must be 7-16 characters in length). The following characters are allowed:
   `abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^&*()-_=+[]{}\|/;:',.<>?`~`
   Double quotation marks (`"`) are problematic and should not be used within passwords.
   Spaces are allowed; to specify a password with spaces using the **-password** or **-newpw** option of a command, enclose the password in double quotation marks.

   lunacm:> **role init -name co**

3. Provide the CO credential to your designated Crypto Officer.

> **NOTE** If **HSM policy 21: Force user PIN change after set/reset** is enabled (this is the default setting), the CO must change the credential before any other actions are permitted. See Changing a Partition Role Credential.

Initializing the Crypto User Role

The Crypto User (CU) is an optional role that can perform cryptographic operations using partition objects in a read-only capacity, but can only create public objects. The Crypto Officer must initialize the CU role and assign an initial credential.

To initialize the Crypto User role

1. In LunaCM, log in to the partition as Crypto Officer (see "Logging In to the Application Partition" on page 203).

   lunacm:> **role login -name co**

2. Initialize the Crypto User role. If you are using a password-authenticated partition, specify a CU password. If you are using a multifactor quorum-authenticated partition, ensure that you have a blank or rewritable gray PED keys available. Follow the instructions on the Luna PED screen. Refer to "Creating PED keys" on page 129 for details on creating PED keys.

   In LunaCM, passwords and activation challenge secrets must be 8-255 characters in length (**NOTE:** If you are using firmware version 7.0.x, 7.3.3, or 7.4.2, activation challenge secrets must be 7-16 characters in length). The following characters are allowed:
   `abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^&*()-_=+[]{}\|/;:',.<>?`~`

Double quotation marks (") are problematic and should not be used within passwords.
Spaces are allowed; to specify a password with spaces using the **-password** or **-newpw** option of a command, enclose the password in double quotation marks.

lunacm:> **role init -name cu**

3. Provide the CU credential to your designated Crypto User.

> **NOTE** If **HSM policy 21: Force user PIN change after set/reset** is enabled (this is the default setting), the CU must change the credential before any other actions are permitted. See Changing a Partition Role Credential.

Resetting the Crypto Officer, Limited Crypto Officer, or Crypto User Credential

If necessary, the Crypto Officer can reset the Crypto User credential at any time, without providing the current credential. This is useful in cases where the Crypto User credential has been lost or otherwise compromised.

Prerequisites for Crypto Officer Reset

The Partition SO can also reset the Crypto Officer's credential, if **HSM policy 15: Enable SO reset of partition PIN** is enabled. By default, this policy is not enabled, and changing it is destructive. If you want the Partition SO to be able to reset the CO's credential, the HSM SO must enable this policy before creating the application partition (see "Partition Capabilities and Policies" on page 177).

> **CAUTION!** HSM policy 15 is destructive when turned on. All partitions on the HSM and their contents will be erased.

To reset the Crypto Officer, Limited Crypto Officer, or Crypto User credential

1. Log in with the appropriate role (see "Logging In to the Application Partition" on page 203).
2. Reset the desired role's credential.

   In LunaCM, passwords and activation challenge secrets must be 8-255 characters in length (**NOTE:** If you are using firmware version 7.0.x, 7.3.3, or 7.4.2, activation challenge secrets must be 7-16 characters in length). The following characters are allowed:
   `abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^&*()-_=+[]{}\|/;:',.<>?`~`
   Double quotation marks (") are problematic and should not be used within passwords.
   Spaces are allowed; to specify a password with spaces using the **-password** or **-newpw** option of a command, enclose the password in double quotation marks.

   lunacm:> **role resetpw -name** <role>

   You are prompted to set a new credential for the role.
3. Provide the new credential to the Crypto Officer, Limited Crypto Officer(*), or Crypto User.

> **NOTE** If **HSM policy 21: Force user PIN change after set/reset** is enabled, the user must change the credential before any other actions are permitted. See Changing a Partition Role Credential.
>
> The CO can reset the LCO's primary credentials (lunacm:> **role resetpw**) regardless of the status of "Enable SO reset of a partition PIN" policy 15.

(*LCO is applicable to Luna HSM Firmware 7.7.0 and newer.)

Activation on Multifactor Quorum-Authenticated Partitions

A multifactor quorum-authenticated partition requires a user's PED key each time a role (Partition SO, Crypto Officer, Limited Crypto Officer, Crypto User) logs in. For some use cases, such as key vaulting, this physical key requirement is desirable. For many applications, however, it is impractical to require the full Luna PED interaction every time.

For these use cases, the Partition SO can activate the partition and set a secondary password referred to as a challenge secret. When a partition is activated, the HSM caches the Crypto Officer and Limited Crypto Officer and Crypto User PED key secrets upon first login, and subsequent logins require the challenge secret only. The PED key secret remains cached until the role is explicitly deactivated or the HSM loses power due to a reboot or power outage.

Activation does not provide much advantage for clients that log in to the partition and remain logged in. It is an indispensable advantage in cases where the client application repeatedly logs in to perform a task, and then logs out or closes the cryptographic session after the task is completed.

Auto-activation
Auto-activation allows PED key credentials to remain cached even in the event of a reboot or a brief power outage (up to 2 hours).

Tamper events and activation/auto-activation
When a tamper event occurs, or if an uncleared tamper event is detected on reboot, the cached PED key data is zeroized, and activation/auto-activation is disabled. See Tamper Events and "Partition Capabilities and Policies" on page 177 for more information.

This section contains instructions for the following procedures:

> "Enabling Activation on a Partition" below

> "Activating a Role" on the next page

> "Enabling Auto-activation" on page 209

> "Deactivating a Role" on page 210

Enabling Activation on a Partition

The Partition SO can enable activation on a partition by setting **partition policy 22: Allow activation** to **1** (on). This setting enables activation for the Crypto Officer and Limited Crypto Officer and Crypto User roles. When partition policy 22 is enabled, the Partition SO can set an initial challenge secret for the Crypto Officer.

Prerequisites

> The partition must be initialized (see "Initializing an Application Partition" on page 174).

To enable activation on a partition using LunaSM on Luna HSM Client

1. Log in to the partition as Partition SO (see "Logging In to the Application Partition" on page 203).

   lunacm:> **role login -name po**

2. Enable partition policy 22.

   lunacm:> **partition changepolicy -policy 22 -value 1**

Activating a Role

After enabling partition policy 22, activate the CO or LCO or CU roles on the partition. You must set a challenge secret password for each role you want to activate. The Partition SO must set the initial challenge secret for the Crypto Officer, who must set it for the Limited Crypto Officer or Crypto User. The role becomes activated the first time the user logs in to the partition.

Prerequisites

> **Partition policy 22: Allow activation** must be enabled on the partition (see "Enabling Activation on a Partition" on the previous page).

> The role you wish to activate must be initialized on the partition (see "Initializing Crypto Officer and Crypto User Roles for an Application Partition" on page 204).

> The partition must be assigned to the client and visible as a slot in LunaCM (see Client-Partition Connections).

To activate a role via lunacm on a client

1. Log in to the partition using the appropriate role (see "Logging In to the Application Partition" on page 203):

   - If you are activating the Crypto Officer role, log in as Partition SO.
   - If you are activating the Crypto User or Limited Crypto Officer role, log in as Crypto Officer.

   lunacm:> **role login -name** <role>

2. Set an initial challenge secret for the role you wish to activate. The length of the challenge secret is configurable by the Partition SO (see "Partition Capabilities and Policies" on page 177).

   In LunaCM, passwords and activation challenge secrets must be 8-255 characters in length (**NOTE:** If you are using firmware version 7.0.x, 7.3.3, or 7.4.2, activation challenge secrets must be 7-16 characters in length). The following characters are allowed:
   `abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^&*()-_=+[]{}\|/;:',.<>?`~`
   Double quotation marks (") are problematic and should not be used within passwords.
   Spaces are allowed; to specify a password with spaces using the **-password** or **-newpw** option of a command, enclose the password in double quotation marks.

   lunacm:> **role createchallenge -name** <role>

> **NOTE** Activation requires that a challenge secret is set for the specified role. If the role does not have a challenge secret, you are prompted for the PED key, regardless of the policy setting.

3. Log out of the partition.

   lunacm:> **role logout**

4. Provide the initial challenge secret to the designated CO or CU by secure means. The PED key secret is cached when they log in for the first time. The CO or CU can store the black or gray PED key in a safe place. The cached PED key secret allows their application(s) to open and close sessions and perform operations within those sessions.

> **NOTE** If **HSM policy 21:** Force user PIN change after set/reset is enabled (this is the default setting), the CO or CU must change the challenge secret before any other actions are permitted. See Changing a Partition Role Credential.

> **NOTE** The Luna PED screen prompts for a black PED key for any of
>
> > "User",
> > "Crypto Officer",
> > "Limited Crypto Officer",
> > "Crypto User".
>
> The Luna PED is not aware that the key you present has a black or a gray sticker on it. The colored stickers are visual identifiers for your convenience in keeping track of your PED keys. You differentiate by how you label, and how you use, a given physical key that the Luna PED sees as "black" (once it has been imprinted with a secret).

Enabling Auto-activation

Auto-activation allows PED key credentials to be cached even in the event of a reboot or a brief power outage (up to 2 hours). Clients can re-connect and continue using the application partition without needing to re-authenticate using a PED key.

The Partition SO can enable auto-activation on a partition by setting **partition policy 23:** "Allow auto-activation" on page 184.

Prerequisites

> **Partition policy 22: Allow activation** must be enabled on the partition (see "Enabling Activation on a Partition" on page 207).

To enable auto-activation on a partition

1. Log in to the partition as Partition SO (see "Logging In to the Application Partition" on page 203).

   lunacm:> **role login -name po**

2. Enable partition policy 23.

   lunacm:> **partition changepolicy -policy 23 -value 1**

   Auto-activation takes effect for each affected role (CO and/or CU) the next time the role is authenticated.

Deactivating a Role

An activated role on a partition remains activated until it is explicitly deactivated, or the HSM loses power due to a reboot or power outage (with auto-activation disabled). This deletes the cached PED key secret for the role.

Prerequisites

> You must be authorized to deactivate the role. The CO and CU can manually deactivate their own or each other's roles. The Partition SO can deactivate both the CO and CU roles.

To deactivate a role on a partition

1. Log in to the partition with the appropriate role (see "Logging In to the Application Partition" on page 203).

   lunacm:> **role login -name** <role>

2. Specify the role you wish to deactivate.

   lunacm:> **role deactivate -name** <role>

   This deletes the cached authentication credential for the role. The next time the role logs in, the credential is re-cached.

3. If you wish to disable activation entirely, so that credentials are not re-cached at the next login, the Partition SO can disable **partition policy 22:** "Allow activation" on page 183.

   lunacm:> **partition changepolicy -policy 22 -value 0**

4. If partition policy 22 is disabled, auto-activation is also disabled (even though **partition policy 23:** "Allow auto-activation" on page 184 is set to **1**). When partition policy 22 is enabled again, auto-activation resumes. To turn off auto-activation, you must disable partition policy 23.

   lunacm:> **partition changepolicy -policy 23 -value 0**

Security of Your Partition Challenge

For Luna PCIe HSM 7s with Password Authentication, the partition password used for administrative access by the Crypto Officer is also the partition challenge secret or password used by client applications.

For Luna PCIe HSM 7s with multifactor quorum authentication, the partition authentication used for administrative access by the Crypto Officer is the secret on the black PED key(s) for that partition. The partition challenge secret or password used by client applications is a separate character string, set by the Partition SO and then changed by the Crypto Officer (mandatory) for the CO's use. This is one way in which we implement separation of roles in the Luna HSM security paradigm.

How Secure Is the Challenge Secret or Password?

The underlying concern is that a password-harvesting attack might eventually crack the secret that protects the partition. Layers of protection are in place, to minimize or eliminate such a risk.

First, such an attack must be run from a Luna HSM Client computer. For interaction with HSM partitions on a Luna Network HSM 7, a Luna HSM Client computer is one with Luna software installed, on which you have performed the exchange of certificates to create a Network Trust Link (NTL). That exchange requires the

knowledge and participation of the appliance administrator and the Partition SO (who might, or might not, be the same person). It is not possible to secretly turn a computer into a Client of a Luna HSM partition - an authorized person within your organization must participate.

Second, for Luna HSMs with password authentication, you set the partition password directly when you create the partition, so you can make it as secure as you wish (for an example of guidance on password strength, see http://howsecureismypassword.net/ or http://xkcd.com/936/)

For Luna HSMs with multifactor quorum authentication, an optional partition password (also called a challenge secret) may be added for the initialized Crypto Officer (CO) and/or Crypto User (CU) roles. See role createchallenge for the proper command syntax.

Using LunaCM or LunaSH, you can change the partition password (or challenge secret) if you suspect it has been compromised, or if you are complying with a security policy that dictates regular password changes.

As long as you replace any password/challenge secret with one that is equally secure, the possible vulnerability is extremely small.

Conversely, you can choose to replace a secure, random password/challenge-secret with one that is shorter or more memorable, but less secure - you assume the risks inherent in such a tradeoff.

Third, Luna HSM **partition policy 15: Ignore failed challenge responses** can be set to **0** (off). When that policy is off, the HSM stops ignoring bad challenge responses (that is, attempts to submit the partition secret) and begins treating them as failed login attempts. Each bad login attempt is counted. **Partition policy 20: Max failed user logins allowed** determines how high that count can go before the partition is locked out.

Once a partition is locked by bad login attempts, it cannot be accessed until the HSM Security Officer (SO) unlocks it. This defeats an automated harvesting attack that relies on millions of attempts occurring at computer-generated speeds. As well, after one or two lockout cycles, the HSM SO would realize that an attack was under way and would rescind the NTL registration of the attacking computer. That computer would no longer exist as far as the HSM partition was concerned. The SO or your security organization would then investigate how the client computer had been compromised, and would correct the problem before allowing any new NTL registration from that source. See "Logging In to the Application Partition" on page 203 for more information.

As the owner/administrator of the HSM, you determine any tradeoffs with respect to security, convenience, and other operational parameters.

Name, Label, and Password Requirements

This page describes length and character requirements for setting labels, domains, passwords, and challenge secrets on the Luna PCIe HSM 7. This information can also be found in relevant sections throughout the documentation. Refer to the applicable section below:

> "HSM Labels" below

> "Cloning Domains" on the next page

> "Partition Labels" on the next page

> "Role Passwords or Challenge Secrets" on the next page

HSM Labels

The HSM label created during initialization must be 1-32 characters in length. If you specify a longer label, it will automatically be truncated to 32 characters. The following characters are allowed:

```
abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^&*()-_=+[]{}\|/;:'",.<>?`~
```

Spaces are allowed; enclose the label in double quotes if it includes spaces. Including both spaces and quotation marks in a label may cause unexpected labeling behavior.

Cloning Domains

The domain string must be 1-128 characters in length. The following characters are allowed:

```
abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^*-_=+[]{}/:',.~
```

The following characters are problematic or invalid and must not be used in a domain string: `"&;<>\`|()`

Spaces are allowed, as long as the leading character is not a space; to specify a domain string with spaces using the **-domain** option, enclose the string in double quotation marks.

For password-authenticated HSMs, the domain string should match the complexity of the partition password.

Partition Labels

In LunaCM, the partition label created during initialization must be 1-32 characters in length. If you specify a longer label, it will automatically be truncated to 32 characters. The following characters are allowed:

```
abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^&*()-_=+[]{}\|/;:',.<>`~
```

Spaces are allowed; enclose the label in double quotation marks if it includes spaces.

Role Passwords or Challenge Secrets

In LunaCM, passwords and activation challenge secrets must be 8-255 characters in length (**NOTE:** If you are using firmware version 7.0.x, 7.3.3, or 7.4.2, activation challenge secrets must be 7-16 characters in length). The following characters are allowed:

```
abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^&*()-_=+[]{}\|/;:',.<>?`~
```

Double quotation marks (`"`) are problematic and should not be used within passwords.

Spaces are allowed; to specify a password with spaces using the **-password** or **-newpw** option of a command, enclose the password in double quotation marks.

CHAPTER 9: Verifying HSM Authenticity or Key Attestation

Hardware Security Modules have traditionally been deployed in the corporate data center's most secure zone. Establishing trust with the HSM is, in part, achieved by physical access control. In cases of remote client usage (such as cloud cryptography), the client needs a way to verify the authenticity of the device protecting their most valued cryptographic keys.

Thales also provides a tool for validating the attestation of keys created by the HSM, to verify that they were created by a Luna HSM.

> "Public Key Confirmations" below

> "Verifying the HSM's Authenticity" on the next page

> "Verifying Key Attestation" on page 215

Public Key Confirmations

Thales's Luna HSMs include factory-issued device identities certified by a Thales authority. The root of this authority is maintained by Thales in HSMs locked in a vault with layered physical and logical access controls. These certificates are used as the root of trust for the issuance of "public key confirmations" (PKCs), certificates issued by the HSM attesting to the life cycle of a specific private key. A Luna HSM will issue confirmations only for private keys that were created by a Luna cryptographic module and that can never exist outside the security perimeter of a Luna HSM. A valid confirmation is cryptographic proof that a specific key is inside the identified HSM. The confirmation is also proof that the identified HSM is real.

The key pair within the HSM that signs the confirmation is called a Hardware Origin Key (HOK). It is protected inside the cryptographic module's FIPS 140-2 Level 3 security boundary. Each HOK is unique and there is no way to extract or replace it. The HOK is created in the HSM at the time of manufacture and certified by Thales's secure manufacturing authority, which is certified by Thales's root authority.

Public key confirmations are automatically generated for RSA key pairs in the HSM. A user can get a confirmation through the PKCS #11 API or the Luna **cmu** utility, and use it to verify that any RSA key is protected and has always been protected by a Luna HSM. A PKC bundle contains the following certificates:

> **MIC:** Manufacturing Integrity Certificate; corresponds to the Manufacturing Integrity Private Key (MIK), signed by the Thales root.

> **HOC:** Hardware Origin Certificate; corresponds to the Hardware Origin Private Key (HOK). Unique to each HSM. Signed by MIK.

> **DAC:** Device Authentication Certificate; corresponds to the Device Authentication Private Key (DAK). Unique to each HSM. Signed by HOK.

> **PKC:** Public Key Confirmation Certificate; certificate for a private key on the HSM. Signed by DAK.

Public key confirmations are delivered as PKCS #7 files containing a certificate chain. The PKCS #7 files can be viewed using tools like OpenSSL and Microsoft's Certificates snap-in for MMC.

> **NOTE** While third-party tools are capable of cryptographically validating the certificate signature chain, they may display some certificate errors, since they do not recognize some Thales-specific key usage attributes included in the certificates.

Chains of Trust

The chain of trust available via the **cmu** utility included with the Luna HSM Client, **Chrysalis-ITS**, is built in by default, and originates from Thales's SafeNet root certificate authority. It uses the MIC, HOC, DAC, and the PKC.

> **NOTE** Since the introduction of Functionality Modules, HSMs are shipped from the factory with FM-ready hardware. This means that they contain, and use, the HOK and the HOC, but they also have the FM-HOK and FM-HOC on standby. If FMs are enabled on the HSM, the original HOK and HOC are deleted, and the chain-of-trust, thereafter, proceeds through the FM-HOC.

Verifying the HSM's Authenticity

The **cmu** utility also includes a command, **cmu verifyhsm**, that tests an HSM's authenticity by creating and verifying a confirmation on a temporary key created in the HSM. The test includes a proof of possession that asks the HSM to sign a user-entered string as proof the associated private key is present within the target HSM.

> **NOTE** This confirmation procedure is currently not supported on FM-enabled HSMs. Refer to FM Deployment Constraints for details.

The test requires the SafeNet root certificate, provided below:

safenet-root.pem

> **NOTE** The current certificate is valid until 2031-12-31, but it might change before this date at Thales's discretion. Ensure that you have the most recent version of this documentation.

To verify the HSM's authenticity

1. Right-click the link above and save the root certificate to the Luna HSM Client directory.
2. Open a command line and navigate to the Luna HSM Client directory.
3. Use the **cmu** utility to authenticate the HSM. You must specify a challenge string for the HSM to sign, and the root certificate file:

   # **cmu verifyhsm -challenge** <string> **-rootcert safenet-root.pem**

   When prompted, specify the partition you wish to use and the Crypto Officer credential for that partition.

```
>cmu verifyhsm -challenge "1234567890" -rootcert safenet-root.pem
Select token
 [0] Token Label: mypartition-1
 [1] Token Label: mypartition-2
 Enter choice: 0
Please enter password for token in slot 0 : ********
Reading rootcert from file "safenet-root.pem"... ok.
Generating temporary RSA keypair in HSM... ok.
Extracting PKC bundle from HSM... ok.
Verifying PKC certificate... ok.
Verifying DAC certificate... ok.
Verifying HOC certificate... ok.
Verifying MIC certificate... ok.
Verifying MIC against rootcert... ok.
Signing and verifying challenge... ok.
Verifying HSM serial number... ok.
Overall status: Success.
```

If this test fails, contact the HSM SO.

Verifying Key Attestation

Thales provides a Java utility, **Luna PKC Validator**, that allows you to verify that a key was created by a Luna HSM. This tool can be compiled from the repository below:

https://github.com/ThalesGroup/luna-pkc-validator

The utility requires one of the following root certificates for validation.

> To check the attestation of RSA keys, use the SafeNet root certificate, provided above.

> To check the attestation of ECC keys, use the Thales ECC Manufacturing Integrity Certificate:

CHAPTER 10: Migrating Keys to Your New HSM

This chapter describes how to migrate your keys and configuration from a Luna HSM 5.x or 6.x partition to a Luna HSM 7.x partition by using one of three methods; backup and restore, cloning, or cloning using a temporary HA group:

> "Luna PCIe HSM 5.x/6.x or Luna USB HSM 6.x to Luna PCIe HSM 7" on page 219

> "Moving from Pre-7.7.0 to Firmware 7.7.0 or Newer" on page 229

Refer also to the chapter on "Key Cloning" on page 60, particularly "Cloning Keys Between Luna 6, Luna 7, and Luna Cloud HSM, Password or Multifactor Quorum" on page 76.

This document guides you through several migration scenarios consisting of older and newer Luna HSMs, using each applicable migration method. Before migrating, preconditions are provided for each scenario that must be met. There are specific user roles that are identified for performing the migration. In addition, both authentication methods (password and PED-authenticated) are supported.

Supported Luna HSMs

This document describes key migration for these Luna HSMs:

> Luna Network HSM, version 5.x or 6.x to 7.x

> Luna USB HSM, version 5.x or 6.x to 7.x

> Luna PCIe HSM, version 5.x or 6.x to 7.x

> **TIP** When cloning objects:
>
> - by direct clone command, or
> - by backup/restore, or
> - by synchronization in an HA group)
>
> ...between 5.x or 6.x HSMs and 7.x HSMs, the common domain between the HSMs *must be* the designated *primary domain* on any HSM that is at firmware version 7.8.0 or newer.
>
> This is because the cloning protocol on HSMs prior to firmware 7.8.0 is unaware of the ability to have multiple domains and therefore the older HSM can interact with *only* the primary domain on the firmware 7.8.0+ HSM. So, if the domain of the old HSM exists on the firmware 7.8.0-and-newer HSM, set that domain to be Primary before cloning.

Order of operations

As indicated below, a variety of migration methods and paths are possible, and in your own situation, you might be performing different parts of an overall migration strategy at different times over some period. We advise to think carefully about the order in which actions are performed, and this section is a quick summary of considerations that might apply in your situation.

> If you have the older Luna HSMs and are using the older Luna Backup HSM G5, then maintain that Backup HSM at firmware older than Luna Backup HSM G5 Firmware 6.26.0. Firmware 6.26.0 and above will work only with Luna HSMs 7.x. By keeping the pre-6.26.0 Backup firmware, initially, you maintain the option to make new backups from your older HSMs if that need arises before your 5.x or 6.x HSMs are decommissioned.

> Until you are ready to advance further, maintain your new 7.x HSMs at firmware older than Luna HSM Firmware 7.7.0 (Luna HSM Firmware 7.4.0is recommended) - with Luna Backup HSM G5 Firmware 6.26.0, you can backup Luna 7.x HSMs up to Luna HSM Firmware 7.4.0 which benefits from many fixes and improvements / features compared to prior 7.x versions.

> In the case of multifactor quorum-authenticated HSMs, the Luna PED must be at minimum Luna PED Firmware 2.7.1.

> Assuming that everything goes well in your migration from HSMs version 5.x or 6.x to new version 7.x HSMs, you can then upgrade the Luna Backup HSM G5 and Luna PED to their latest firmware versions, and also upgrade the new Luna 7.x HSMs to the target Luna HSM Firmware 7.7.0 or newer.

> These are the eventual target versions for all components:

- Luna PED Firmware 2.9.0 or newer (for the USB-powered PED) or Luna PED Firmware 2.7.4 or newer (for the adapter-powered PED) are the minimum required to support Luna HSMs at firmware 7.7.x
- Luna Backup HSM G5 Firmware 6.28.0 or newer, which is needed to support backup of Luna HSMs at firmware 7.7.x, and is compatible with Luna HSM Client 10.3.0.
- Luna HSM Client 10.3.0 or newer is needed to support Luna HSMs at Luna HSM Firmware 7.7.0 or newer

Refer to Luna HSM Firmware Releases to find the latest FIPS and CC evaluated versions and to the NIST and Common Criteria sites for completed and in-progress applications).

Migration methods

The three migration methods used in this guide are:

> Backup and restore

The backup and restore method uses the LunaCM **partition archive backup** command to backup key material on an HSM (5.x or 6.x) partition and the Restore command to then restore this material to an HSM 7.x partition.

> Cloning

The cloning method uses the LunaCM **partition clone** command to clone from an HSM (5.x or 6.x) partition to an HSM 7.x partition. It is also referred to as slot-to slot cloning.

> Cloning using an HA group

The HA group method uses the LunaCM **ha synchronize** command on members of a temporary HA group consisting of a 5.x or 6.x HSM and a 7.x HSM, set up solely for the purpose of migration. After migration, this group should be removed since the members are not using the same software version.

All three methods invoke the cloning protocols, behind the commands that you specifically issue. This table is a quick summary of the options and cloning protocols that are available for migration from various source levels, up to, and including Luna HSM Firmware 7.8.0 (or newer) and client Luna HSM Client 10.5.0 (or newer), with the cloned objects going to targets that are at Luna HSM Firmware 7.8.0 (depending on settings at the target).

Source slot	Source cloning protocol	Destination cloning protocol (firmware 7.8.0)	Cloning protocol used
Firmware version < 7.7.0	CPv1	CPv1, CPv3, CPv4	CPv1
Firmware version = 7.7.0	CPv3	CPv1 (disabled here by partition policy 42), CPv3 , CPv4 (not matched at source)	CPv3
	CPv3	CPv1 (enabled here by partition policy 42), CPv3 (disabled because CPv1 enabled), CPv4 (not matched at source)	N/A
Firmware version > 7.7.0 < 7.8.0	CPv1-out, CPv3	CPv1 (enabled by partition policy 42), CPv3 (disabled because CPv1 enabled), CPv4 (not matched at source)	CPv1
	CPv1-out, CPv3	CPv1 (disabled by partition policy 42), CPv3 (enabled because CPv1 disabled), CPv4 (not matched at source)	CPv3
Firmware version = 7.8.0	CPv1-out, CPv3, CPv4	CPv1 (enabled by partition policy 42), CPv3, CPv4 (these are disabled if CPv1 ensabled)	CPv1
	CPv1-out, CPv3, CPv4	CPv1 (not enabled by partition policy 42), CPv3, CPv4 (these are enabled if CPv1 disabled)	CPv4 (if both slots have at least one CPv4 cipher-suite in common), otherwise CPv3, unless CPv3 cipher-suite is also disabled, then N/A

Preconditions

Each migration procedure in this document is prefaced by a "Preconditions" section that specifies the hardware and software requirements along with any assumptions the procedure is using to perform the migration steps. Examples are a 5.x or 6.x HSM, a 7.x HSM, 5.x, 6.x or 7.x client software, user roles and the slot #s used in the procedure.

Roles required for migration

The following partition roles are needed to migrate key material:

> Partition Security Officer. The partition security officer role is needed to perform LunaCM HA operations and to create the Crypto Officer role.

> Partition Crypto Officer. The partition Crypto Officer role is needed to perform LunaCM backup/restore and cloning operations.

> **NOTE** When logging in to a partition, be mindful of whether you're working with pre-PPSO or PPSO firmware. Use the **partition login** command if your HSM has pre-PPSO firmware (version 6.21.2 and earlier). Use the **role login** command if your HSM has PPSO firmware (version 6.22.0 and later). Also, with PPSO firmware 6.22.0 and later (up to but not including firmware 7.x), be careful with user names; that is, type **Crypto Officer** in full (is case sensitive) and not the abbreviation **co**.
>
> In firmware version release 7.x, partition login name requirements allow for abbreviations. That is, you can log in using **po** for Partition Security Officer or **co** for Crypto Officer.

Luna PCIe HSM 5.x/6.x or Luna USB HSM 6.x to Luna PCIe HSM 7

This chapter describes how to migrate your key material from release 5.x or 6.x of the Luna PCIe HSM 7 or Luna USB HSM partition to the Luna PCIe HSM 7 partition. You can migrate your key material using one of the following three methods:

> "Backup and Restore" below

> "Cloning" on page 222

> "Cloning Using an HA Group" on page 227

> **TIP** When cloning objects:
>
> - by direct clone command, or
> - by backup/restore, or
> - by synchronization in an HA group)
>
> ...between 5.x or 6.x HSMs and 7.x HSMs, the common domain between the HSMs *must be* the designated *primary domain* on any HSM that is at firmware version 7.8.0 or newer.
>
> This is because the cloning protocol on HSMs prior to firmware 7.8.0 is unaware of the ability to have multiple domains and therefore the older HSM can interact with *only* the primary domain on the firmware 7.8.0+ HSM. So, if the domain of the old HSM exists on the firmware 7.8.0-and-newer HSM, set that domain to be Primary before cloning.

Backup and Restore

Cryptographic key material can be backed up and then restored to a Luna PCIe HSM 7 partition using a Luna Backup HSM.

The new configuration's operating system must be compatible with both the new 7.x and the old 5.x/6.x hardware. Consult the 5.x/6.x CRN for a list of compatible operating systems.

To backup and restore cryptographic keys from one HSM to another, the HSMs must share the same cloning domain. For password-authenticated HSMs, this domain should have been specified when the partition was initialized. For multifactor quorum-authenticated HSMs, the red key determines the cloning domain. You will need the same red key that was imprinted during 5.x/6.x partition creation to initialize the 7.x partition (see "Initializing an Application Partition" on page 174).

> **NOTE** This process both became easier, and increased in scope, with Universal Cloning, part of which allows a partition with Luna HSM Firmware 7.8.0 (or newer), accessed by a client version Luna HSM Client 10.5.0 (or newer) to hold up to three cloning domains, which can be
> - a text string domain secret for password-authenticated partitions or Luna Cloud HSM services,
> - a red PED key domain secret for multifactor quorum-authenticated HSM partitions,
> - any combination of the two.

The 7.x client software should be installed, and the connection to both the source and destination partitions verified, before attempting this procedure (see Luna HSM Client Software Installation for details). The source and destination partitions must both be assigned to the client machine issuing the cloning commands. Use **slot list** to ensure both partitions are visible to the client.

Preconditions

The following instructions assume that:

- the 10.x client software has been installed
- an uninitialized partition has been created on the 7.x HSM
- the source and destination partitions are both registered with the client (visible)
- the source partition's security policy allows cloning of private and secret keys

In the following example:

- Slot 0: the source 5.x/6.x partition
- Slot 1: the destination 7.x partition
- Slot 2: the Backup HSM partition

> **NOTE** Partition login name requirements have changed with the hardware versions. With release 7.x , you can log in using the abbreviated **po** (Partition Security Officer) or **co** (Crypto Officer).

To migrate cryptographic keys from a 5.x/6.x partition to a 7.x partition using a Backup HSM

Follow these steps to back up all cryptographic material on a 5.x/6.x partition to a Backup HSM, and restore to a new 7.x partition.

1. Run LunaCM, set the current slot to the 7.x partition, and initialize the partition and the Partition SO role.

   slot set -slot 0

   partition init -label <7.x_partition_label>

a. If you are backing up a multifactor quorum-authenticated 5.x/6.x partition, use the 5.x/6.x partition's red key when prompted.

b. If you are backing up a password-authenticated 5.x/6.x partition, enter the same cloning domain when prompted.

2. Log in as the **po** (Partition Security Officer) and initialize the **co** (Crypto Officer) role.

   role login -name po

   role init -name co

   If you are backing up a multifactor quorum-authenticated 5.x/6.x partition, you can create an optional challenge secret for the Crypto Officer.

   role createchallenge -name co -challengeSecret <password>

3. Connect your backup HSM and make sure it is visible to the client, along with the 5.x/6.x and 7.x HSMs.

4. Set the current slot to the source 5.x/6.x slot.

   slot list

   slot set -slot 0

5. Log in as the Crypto Officer.

   > **NOTE** Be mindful of whether you're working with pre-PPSO or PPSO firmware and use the **partition login** or **role login** commands as specified below. Also, with PPSO firmware 6.22.0 and up, be careful with user names, i.e., type **Crypto Officer** in full (is case sensitive) and not **co**.

   a. If you are cloning a release 5.x or 6.x pre-PPSO partition (up to and including Firmware 6.21.2), use:

      partition login

   b. If you are cloning a release 6.x PPSO partition (Firmware 6.22.0 and up) , use:

      role login -name Crypto Officer

6. Optional: To verify the objects in the 5.x/6.x partition to be cloned, issue the "partition contents" command.

   partition contents

7. Back up the 5.x/6.x partition contents to the Backup HSM.

   partition archive backup -slot 2 -partition <backup_label>

   a. If you are backing up a multifactor quorum-authenticated 5.x/6.x partition, use the 5.x/6.x partition's red key when prompted.

   b. If you are backing up a password-authenticated 5.x/6.x partition, enter the same cloning domain when prompted.

   Optionally, verify that all objects were backed up successfully on the Backup HSM by checking the partition contents.

8. Set the current slot to the 7.x partition, log in as the Crypto Officer, and restore from backup.

   slot set -slot 1

   role login -name co

partition archive restore -slot 2 -partition <backup_label>

Afterwards, you can verify the partition contents on the 7.x partition:

partition contents

Cloning

The simplest method of migrating key material to a new 7.x partition is slot-to-slot cloning. This procedure copies all permitted cryptographic material from a 5.x/6.x Luna PCIe HSM 7 or USB HSM partition to a Luna PCIe HSM 7 partition.

> **NOTE** The Luna cloning protocol has been updated several times since the previous generation of Luna HSMs, for standards compliance and added security. If you are planning to migrate your key material from a Luna 5/6 in FIPS mode to a Luna 7 HSM in FIPS mode, you must use an intermediate firmware version before updating to Luna HSM Firmware 7.7.1 or newer. Thales recommends migrating to Luna Network HSM 7 7 with one of the following FIPS-validated firmware versions:
>
> > Luna HSM Firmware 7.3.3
> >
> > Luna HSM Firmware 7.0.3
>
> After the migration process is complete, you can update the Luna Network HSM 7 to Luna HSM Firmware 7.7.1 or newer (see Updating the Luna PCIe HSM 7 Firmware).

The new configuration's operating system must be compatible with both the new 7.x and the old 5.x/6.x hardware. Consult the 5.x/6.x CRN for a list of compatible operating systems.

To clone cryptographic keys from one HSM to another, the HSMs must share the same cloning domain. For password-authenticated HSMs, this domain should have been specified when the partition was initialized . For multifactor quorum-authenticated HSMs, the red key determines the cloning domain. You will need the same red key that was imprinted during 5.x/6.x partition creation to initialize the 7.x partition (see "Initializing an Application Partition" on page 174).

The Luna HSM Client 7/10 software should be installed, and the connection to both the source and destination partitions verified, before attempting this procedure (see Luna HSM Client Software Installation for details). The source and destination partitions must both be assigned to the client machine issuing the cloning commands. Use **slot list** to ensure both partitions are visible to the client.

If the source partition contains asymmetric keys, its security policy must allow cloning of private and secret keys. Use lunacm:> **partition showpolicies** to ensure that your source partition's security template allows this. If the 5.x/6.x HSM's security template does not allow cloning of private/secret keys, the HSM Admin may be able to turn this feature on using lunacm:> **partition changepolicy**.

> **CAUTION!** Check your source partition policies and adjust them to be sure you can clone private and symmetric keys. Depending on the configuration of your partition and HSM, these policies may be destructive.

Preconditions

The following instructions assume that:

> the 7.x client software has been installed

> an uninitialized partition has been created on the 7.x Luna Network HSM 7
> the destination 7.x partition must be registered with the client (visible)
> the source 5.x/6.x partition's security policy allows cloning of private and secret keys

In the following examples:

> Slot 0: the source 5.x/6.x partition
> Slot 1: the destination 7.x partition

> **NOTE** Partition login name requirements have changed with the hardware versions. With release 7.x, you can log in using the abbreviated **PO** (Partition Security Officer) or **CO** (Crypto Officer).

To clone cryptographic keys from a 5.x/6.x partition to a 7.x partition (pre-firmware 7.8.0)

Follow these steps to clone all cryptographic material on a 5.x/6.x partition to a 7.x partition.

1. Run LunaCM, set the current slot to the 7.x partition, and initialize the Partition SO role.

   slot list

   slot set -slot 1

   partition init -label <7.x_partition_label>

   a. If you are cloning a multifactor quorum-authenticated 5.x/6.x partition, use the 5.x/6.x partition's red key when prompted.

   b. If you are cloning a password-authenticated 5.x/6.x partition, enter the same cloning domain when prompted.

2. Log in as the **po** (Partition Security Officer) and initialize the **co** (Crypto Officer) role.

   role login -name po

   role init -name co

   If you are cloning a multifactor quorum-authenticated 5.x/6.x partition, you can create an optional challenge secret for the Crypto Officer.

   role createchallenge -name co -challengesecret <password>

3. Set the current slot to the source 5.x/6.x slot, log in as the Crypto Officer.

   slot set -slot 0

   > **NOTE** Be mindful of whether you're working with pre-PPSO or PPSO firmware and use the "partition login" or "role login" commands as specified below. Also, with PPSO firmware 6.22.0 and up, be careful with user names, i.e., type "Crypto Officer" in full (is case sensitive) and not "co".

   a. If you are cloning a release 5.x or 6.x pre-PPSO partition (up to and including Firmware 6.21.2), use:

      partition login

   b. If you are cloning a release 6.x PPSO partition (Firmware 6.22.0 and up) , use:

      role login -name Crypto Officer

4. Optional: To verify the objects in the 5.x/6.x partition to be cloned, issue the “partition contents” command.

   partition contents

5. Clone the objects to the 7.x partition slot (see partition clone for correct syntax).

   partition clone -objects 0 -slot 1

   Afterward, you can set the current slot to the 7.x partition and verify that all objects have cloned successfully.

   slot set -slot 1

   role login -name co -password <password>

   partition contents

   You should see the same number of objects that existed on the 5.x/6.x HSM. You can now decommission the old 5.x/6.x HSM.

To clone partition objects from on-premises multifactor quorum-authenticated partition to on-premises password-authenticated partition using Luna HSM Firmware 7.8.0 or newer

Requires Luna HSM Client 10.5.0 or newer.

This procedure is for :

> an on-premises multifactor quorum-authenticated Luna Network HSM 7 partition as the source, which could be for:

- a routine cloning between two HSM partitions that are at Luna HSM Firmware 7.8.0 or newer,
- *migration cloning of keys and objects* from a legacy HSM partition (firmware 5.x, 6.x), or from firmware older than Luna HSM Firmware 7.8.0.

> an on-premises password-authenticated Luna Network HSM 7 partition as the target (at Luna HSM Firmware 7.8.0 or newer).

1. Ensure that the two partitions can both use a common cloning protocol

   a. if the source has partition policy 42 - Enable CPv1 on , then that protocol is chosen and others are disabled (or if the source has firmware earlier than Luna HSM Firmware 7.7.0, meaning that CPv1 is the only protocol); this imposes restrictions on operations

      lunacm:> **slot set -slot** <slotnum>

      lunacm:> **partition showpolicies**

   b. if partition policy 42 - Enable CPv1 is OFF, then negotiation of common cipher suites is attempted between partitions; this is preferred when available.

   c. if CPv1 has not been forced, and all cipher suites for CPv4 have been disabled on one of the participating partitions, then only CPv3 remains and a common CPv4 cipher suite cannot be negotiated.

2. Ensure that the source and target partitions have a cloning domain in common.

   a. If the source is a Luna HSM Firmware 7.8.0 or newer partition, then it can accept the target's domain string (password-authenticated) into the multifactor quorum-authenticated source partition, avoiding the need to connect a Luna PED to the target, in which case, skip to step **d.**; otherwise, go to step **b.**

   b. If the source multifactor quorum-authenticated partition is at any firmware version older than Luna HSM Firmware 7.8.0, it cannot have more than one domain, so its PED key secret must be brought to the target; connect a Luna PED locally to the password-authenticated target.

c. In LunaCM, set the active slot to the target partition and log in as Partition SO.

   lunacm:> **slot set -slot** <slotnum>

   lunacm:> **role login -name po**

d. View the partition domains and note their labels.

   lunacm:> **partition domainlist**

e. If the two partitions share a common domain, proceed to cloning.

f. If the two partitions do not share a common domain, then make room, if necessary, by deleting one domain you can do without.

   lunacm:>partition domaindelete

g. Add a domain that matches one from the other partition.

   lunacm:> **partition domainadd -domain** <text domain secret> **-domainlabel** <label of the text domain being duplicated>

3. In LunaCM, set the active slot to the source partition and log in as Crypto Officer.

   lunacm:> **slot set -slot** <slotnum>

   lunacm:> **role login -name co**

4. [Optional] View the partition objects and their object handles.

   lunacm:> **partition contents**

5. Clone objects on the partition to the target partition by specifying the target slot. You can choose which objects to clone by specifying a comma-separated list of object handles, or specify **all** to clone all objects on the partition. Present the target partition's Crypto Officer credential when prompted.

   lunacm:> **partition clone -slot** <slotnum> **-objects** <comma-separated_list/**all**>

   The specified objects are cloned to the target partition. Any objects that already exist on the target are not cloned.

6. [OPTIONAL] You can retain an added domain on a partition as long as it remains useful

   - as long as the partition contains objects encrypted under that particular domain, or
   - while you think the current partition might clone (as source or as target) objects with a partition or service using that domain.

   Or you can delete a domain using partition domaindelete if it is no longer needed.

To clone partition objects from on-premises password-authenticated partition to on-premises multifactor quorum-authenticated partition using Luna HSM Firmware 7.8.0 or newer

Requires Luna HSM Client 10.5.0 or newer.

This procedure is for:

> an on-premises password-authenticated Luna Network HSM 7 partition as the source, which could be for:

- a routine cloning between two HSM partitions that are at Luna HSM Firmware 7.8.0 or newer,
- *migration cloning of keys and objects* from a legacy HSM partition (firmware 5.x, 6.x), or from firmware older than Luna HSM Firmware 7.8.0.

> an on-premises multifactor quorum-authenticated Luna Network HSM 7 partition as the target (at Luna HSM Firmware 7.8.0 or newer).

1. Ensure that the two partitions can both use a common cloning protocol.
   a. for HSMs (both legacy and 7.x) before Luna HSM Firmware 7.7.0, only protocol CPv1 is available
   b. for Luna HSM Firmware 7.7.1 and newer, if partition policy 42 - Enable CPv1 is ON, then that protocol is chosen and others are disabled

      lunacm:> **slot set** **-slot** <slotnum>

      lunacm:> **partition showpolicies**
   c. if partition policy 42 - Enable CPv1 is OFF, then negotiation of common cipher suites is attempted between partitions; this is preferred when available.
   d. if CPv1 has not been forced, and all cipher suites for CPv4 have been disabled on one of the participating partitions, then only CPv3 remains and a common CPv4 cipher suite cannot be negotiated.
2. Ensure that the source and target partitions have a cloning domain in common.
   a. In LunaCM, set the active slot to the target multifactor quorum-authenticated partition and log in as Partition SO (po).

      lunacm:> **slot set** **-slot** <slotnum>

      lunacm:> **role login** **-name po**
   b. View the partition domains and note their labels.

      lunacm:> **partition domainlist**
   c. If the two partitions share a common domain, proceed to cloning.
   d. If the two partitions do not share a common domain, then make room, if necessary, by deleting one domain you can do without on the target partition.

      lunacm:> partition domaindelete
   e. Add a domain that matches one from the source partition

      lunacm:> **partition domainadd** **-domain** <text domain secret> **-domainlabel** <label of the text domain being duplicated>
3. In LunaCM, set the active slot to the source partition and log in as Crypto Officer.

   lunacm:> **slot set** **-slot** <slotnum>

   lunacm:> **role login** **-name co**
4. [Optional] View the partition objects and their object handles.

   lunacm:> **partition contents**
5. Clone objects on the current partition to the target partition by specifying the target slot. You can choose which objects to clone by specifying a comma-separated list of object handles, or specify **all** to clone all objects on the partition. Present the target partition's Crypto Officer credential when prompted.

   lunacm:> **partition clone** **-slot** <slotnum> **-objects** <comma-separated_list/**all**>

   The specified objects are cloned to the target partition. Any objects that already exist on the target are not cloned.
6. [OPTIONAL] You can retain an added domain on a partition as long as it remains useful

- as long as the partition contains objects encrypted under that particular domain, or
- while you think the current partition might clone (as source or as target) objects with a partition or service using that domain.

Or you can delete a domain using partition domaindelete if it is no longer needed.

Cloning Using an HA Group

High Availability (HA) groups duplicate key material between the HSMs in the group. This function can be used to copy all cryptographic key material from a 5.x/6.x Luna PCIe HSM 7 or USB HSM partition to a new Luna PCIe HSM 7 partition.

The new configuration's operating system must be compatible with both the new 7.x and the old 5.x/6.x hardware. Consult the 5.x/6.x CRN for a list of compatible operating systems.

To clone cryptographic keys from one HSM to another, the HSMs must share the same cloning domain. For password-authenticated HSMs, this domain should have been specified when the partition was initialized. For multifactor quorum-authenticated HSMs, the red key determines the cloning domain. You will need the same red PED key that was imprinted during 5.x/6.x partition creation to initialize the 7.x partition (see "Initializing an Application Partition" on page 174).

The Luna HSM Client 7/10 software should be installed, and the connection to both the source and destination HSM partitions verified, before attempting this procedure (see Luna HSM Client Software Installation for details). The source and destination partitions must both be assigned to the client machine issuing the cloning commands. Use **slot list** to ensure both partitions are visible to the client.

> **NOTE** It is not recommended to maintain an HA group with different versions of the Luna Network HSM 7 hardware.

Preconditions

The following instructions assume that:

> the 7.x client software has been installed

> an uninitialized partition has been created on the 7.x Luna Network HSM 7

> the source and destination partitions are both registered with the client (visible)

In the following examples:

> Slot 0 = the source 5.x/6.x partition

> Slot 1 = the destination 7.x partition

> **NOTE** Partition login name requirements have changed between hardware versions. With release 7.x, you can log in using the abbreviated **po** (Partition Security Officer) or **co** (Crypto Officer).

To clone cryptographic keys from a 5.x/6.x partition to a 7.x partition using an HA group

Follow these steps to copy cryptographic material from an 5.x/6.x partition to a new 7.x partition by creating an HA group that includes both partitions.

1. Run LunaCM, set the current slot to the SA7 partition, and initialize the Partition SO role.

slot set -slot 1

partition init -label <7.x_partition_label>

a. If you are cloning a multifactor quorum-authenticated 5.x/6.x partition, use the 5.x/6.x partition's red key when prompted.

b. If you are cloning a password-authenticated 5.x/6.x partition, enter the same cloning domain when prompted.

2. Log in as the **po** (Partition Security Officer) and initialize the **co** (Crypto Officer) role.

   role login -name po

   role init -name co

   If you are cloning a multifactor quorum-authenticated 5.x/6.x partition, create a challenge secret for the Crypto Officer. This is required to set an HA activation policy.

   role createchallenge -name co -challengesecret <password>

3. Set the current slot to the source 5.x/6.x slot, log in as the Crypto Officer.

   slot set -slot 0

   > **NOTE** Be mindful of whether you're working with pre-PPSO or PPSO firmware and use the **partition login** or **role login** commands as specified below. Also, with PPSO firmware 6.22.0 and up, be careful with user names, i.e., type **Crypto Officer** in full (is case sensitive) and not **co**.

   a. If you are cloning a release 5.x or 6.x pre-PPSO partition (up to and including Firmware 6.21.2), use:

      partition login

   b. If you are cloning a release 6.x PPSO partition (Firmware 6.22.0 and up) , use:

      role login -name Crypto Officer

4. Optional: To verify the objects in the 5.x/6.x partition to be cloned, use:

   partition contents

5. Using LunaCM, create an HA group of the 5.x/6.x slot and the 7.x slot.

   > **NOTE** HA requires that all members have an activation policy set. See "Activation on Multifactor Quorum-Authenticated Partitions" on page 207 for details.

   a. Via LunaSH, log in as Security Officer and set policy 22 on the 5.x/6.x partition:

      partition changepolicy -partition <5.x_partition_label> **-policy 22 -value 1**

   b. In LunaCM, log in to the 7.x partition as Partition Security Officer, and set the activation policy from the client machine:

      slot set -slot 1

      role login -name po

      partition changepolicy -policy 22 -value 1

c. Create the HA group with the 5.x/6.x partition as the primary partition. Select the "copy" option to preserve objects.

   hagroup creategroup -label <group_label> **-slot 0 -password** <password>

d. Add the 7.x partition slot to the HA group. Repeat this step to add multiple 7.x partitions to the group.

   hagroup addmember -group <group_label> **-slot 1 -password** <password>

6. Synchronize the group to clone the objects to the 7.x member(s).

   hagroup synchronize -group <group_label> **-password** <password>

7. Check synchronization status of the group.

   hagroup listgroups

   Notice the entry "`Needs sync: no`". This means that the objects have been successfully cloned among all members of the HA group. You can also log in to the 7.x slot as the Crypto Officer and check the partition contents.

Moving from Pre-7.7.0 to Firmware 7.7.0 or Newer

Luna HSM Firmware 7.7.0 is a major release for the Luna PCIe HSM 7 that introduces significant changes to various product components. Some of these changes have been introduced to help customers attain eIDAS compliance, PP 419-221.5 compliance, or conformity with FIPS SP 800-131A (revised). If you are migrating keys from a Luna PCIe HSM 7 with Luna HSM Firmware 7.4.0 or older to Luna HSM Firmware 7.7.0 or newer, all information that is relevant to the migration process can be found in the following sections:

> Special Considerations for Luna HSM Firmware 7.7.0 and Newer for information you must be aware of and procedures you must complete before and after updating to Luna HSM Firmware 7.7.0 or newer.

> "V0 and V1 Partitions" on page 17 for information about the distinction between V0 and V1 partitions; one of the major changes introduced to Luna HSM partitions with Luna HSM Firmware 7.7.0.

> "Converting Partitions from V0 to V1 or V1 to V0" on page 29 for information about converting partitions from V0 to V1 after updating to Luna HSM Firmware 7.7.0 or newer.

> **NOTE** If you are operating an HA group and would like to migrate the pool of HA member partitions to Luna HSM Firmware 7.7.0 or newer, relevant information is contained or linked to within the topics above.

CHAPTER 11: High-Availability Groups

Luna HSMs can provide scalability and redundancy for cryptographic applications that are critical to your organization. For applications that require continuous, uninterruptible uptime, the Luna HSM Client allows you to combine application partitions on multiple HSMs into a single logical group, known as a High-Availability (HA) group.

High Availability Options for Luna HSMs

Luna HSMs support two, non-overlapping approaches to High Availability:

> client-mediated HA creation and management of HA groups, by means of the LunaCM hagroup commands, with preparation, management, and usage described at "High-Availability Groups" above ; the "participating" member HSMs are unaware that they are part of a group

> extensions to the PKCS#11 API to program your own complete HA environment, in full, or to tie into (integrate with) suitable COTS High Availability solutions that provide a suitable Application Interface, using HA Indirect Login calls to handle common authentication among HSM partitions in groups; refer to High Availability Indirect Login..

Network Latency and Luna Cloud HSM as Active HA Member

Requests performed by cloud services like Luna Cloud HSM may experience greater network latency than those sent to on-premise HSMs. Thales recommends using a Luna Cloud HSM service as a standby HA member to achieve the best performance. By default, you can add a Luna Cloud HSM service as a standby HA member only. If all other HA members fail and the Luna Cloud HSM service becomes active, it will revert to standby when another member recovers.

If you prefer to use the Luna Cloud HSM service as an active HA member, you must first edit the following toggle in the **Chrystoki.conf/crystoki.ini** configuration file (see Configuration File Summary):

```
[Toggles]
lunacm_cv_ha_ui = 0
```

> **CAUTION!** HA failover from multifactor quorum-authenticated Luna partitions to Luna Cloud HSM requires minimum Luna HSM Client 10.5.0. Refer to known issue LUNA-23945.

Key/object replication options for HA and other uses

HA ensures that your applications can continue to access a functioning partition as long as at least one partition is running, and reachable, in the HA group. Proper HA operation requires that all member partitions be populated with the same keys and objects, relying on replication and synchronization of keys among group-member partitions.

Luna HSMs have three ways to replicate partition objects (keys) among partitions, depending on partition type and settings. Each method can have limitations related to key type.

The replication of *symmetric* keys is enabled by default for each partition that belongs to the same HA group.

Different private-key replication options are offered for *asymmetric* keys, to adapt the level of security needed for customer use cases.

Each partition of an HSM can be configured in any of the following modes:

> Key Export

> Cloning

> the newer Scalable Key Storage (SKS)

Key Export and Cloning are set by partition policies, while availability of SKS is determined by selecting V1 as the partition type at partition creation time (requires Luna HSM Firmware 7.7.0 or newer). Cloning is the default mode, so Key Export needs to be explicitly selected if desired.

Cloning

To maintain the highest security level, enable the cloning mode (and thus turn off the export mode).

In cloning mode, the asymmetric private keys are cloned automatically between all the partitions of the HA group. In that mode, neither private keys nor secret keys are ever allowed to exist outside of a trusted Luna HSM that is a member of the designated cloning domain (sometimes also called "security domain"). As indicated above, symmetric keys are replicated. Cloning mode is the default setting for new partitions.

Key Export

For use cases that require asymmetric private keys, generated on the HSM, to be embedded or used on a device (for example identity issuance), cloning mode must be turned off and key export mode enabled. In that mode, your application is responsible:

> to ensure the availability of the generated asymmetric private keys (by storing the keys in a file or database), and

> to ensure the availability and security of the storage solution.

Cloning and Key Export are mutually exclusive

For a use case where applications require both modes, then it is possible to create separate partitions on an HSM, configured for cloning mode or export mode - an individual partition is set to be one or the other, but cannot be both at the same time. Changing the replication mode of a partition requires recreating the partition, which loses all content (and removes it from any HA group). Backup any important keys and objects before taking such action.

Where a partition belongs to an HA group, all member partitions must be configured for the same replication mode. Thus, if your use case needed to employ some partitions in cloning mode and some partitions in key export mode, you would need to have separate HA groups to accommodate the separate sets of keys.

Keys cannot pass between replication modes.

An HA group in Key Export mode replicates only the symmetric keys, and not the asymmetric keys.

SKS

For a use case that generates greater numbers of keys than can be stored within a cryptographic module (HSM), but also demands greater security of externally stored keys than is provided by Key Export mode, the Scalable Key Storage (SKS) mode is provided in Luna HSM Firmware 7.7.0 and newer.

> SKS ensures that the HSM remains the assurance boundary for your asymmetric private keys.

- In that mode SKS blobs, containing the key material and the associated objects, are encrypted with a symmetric key (SMK) that is cloned when managed within an HA group. Your application is responsible to ensure the availability of the SKS blobs (by storing the blobs into a file, or database and to ensure the availability of that storage solution). Because replication of the SMK is done by cloning, the SMK never exists outside a Luna HSM, thus the security of all keys and objects encrypted by that SMK is as high as security for the cloned key option, but without the storage limitation of the HSM.
- SKS requires that your partition be created as type V1. See "Scalable Key Storage" on page 32 and "V0 and V1 Partitions" on page 17.

Client-driven High Availability

(To develop your own HA solution or integrate with a commercial one, see High Availability Indirect Login For HSM Firmware 7.7.0 and Newer instead.)

This feature is best suited to provide redundancy to the Luna Network HSM 7 and Luna PCIe HSM 7 products. Luna Network HSM 7 partitions can be grouped with other Luna Network HSM 7 partitions or with a Luna Cloud HSM Service. Luna PCIe HSM 7 partitions can be grouped with other Luna PCIe HSM 7 partitions or with a Luna Network HSM 7 Service.

An HA group allows your client application to access cryptographic services as long as one member HSM is functional and network-connected. This allows you to perform maintenance on any individual member without ever pausing your application, and provides redundancy in the case of individual failures. Cryptographic requests are distributed across all active group members, enabling a performance gain for each member added. Cryptographic objects are replicated across the entire group, so HA can also be used to keep a current, automatic, remote backup of the group contents.

HA functionality is handled by the Luna HSM Client software. The individual partitions have no way to know they are configured in an HA group, so you can configure HA on a per-application basis. The way you group your HSMs depends on your circumstances and desired performance.

This chapter contains the following sections:

- "Planning Your HA Group Deployment" on page 242
- "Setting Up an HA Group" on page 243
- "Verifying an HA Group" on page 248
- "Setting an HA Group Member to Standby" on page 249
- "Configuring HA Auto-Recovery" on page 251
- "Enabling/Disabling HA Only Mode" on page 251
- "Example config file for a large HA group" on page 252
- "HA Logging" on page 256
- "Adding/Removing an HA Group Member" on page 261
- "Manually Recovering a Failed HA Group Member" on page 264
- "Replacing an HA Group Member" on page 265
- "Deleting an HA Group" on page 267
- "HA Troubleshooting" on page 274

> "Guidelines and Recommendations For Updating or Converting HA Member Partitions" on page 276

Performance

For repetitive operations (for example, many signings using the same key), an HA group provides linear performance gains as group members are added. The best approach is to maintain an HA group at a size that best balances application server capability and the expected loads, with an additional unit providing capacity for bursts of traffic.

For best overall performance, keep all group members running near their individual performance ideal, about 30 simultaneous threads per HSM. If you assemble an HA group that is significantly larger than your server(s) can manage, you might not achieve full performance from all members. Gigabit Ethernet connections are recommended to maximize performance.

Performance is also affected by the kind of cryptographic operations being requested. For some operations, an HA group can actually hinder performance by requiring extra operations to replicate new key objects. For example, if the operation involves importing and unwrapping keys:

Using an HA group	Using an individual partition
1. Encryption (to wrap the key) **2.** Decryption on the primary member partition (to unwrap the key) **3.** Object creation on the primary member partition (the unwrapped key is created and stored as a key object) **4.** Key replication across the HA group: **a.** RSA 4096-bit operation is used to derive a shared secret between HSMs **b.** Encryption of the key on the primary HA member using the shared secret **c.** Decryption of the key on each HA member using the shared secret **d.** Object creation on each HA member **5.** Encryption (using the unwrapped key object to encrypt the data)	**1.** Encryption (to wrap the key) **2.** Decryption (to unwrap the key) **3.** Object creation (the unwrapped key is created and stored as a key object) **4.** Encryption (using the unwrapped key object to encrypt the data)

In this case, the HA group must perform many more operations than an individual partition, most significantly the RSA-4096-bit operation and creating the additional objects. Those two operations are by far the most time-consuming on the list, and so this task would have much better performance on an individual partition.

The crucial HA performance consideration is whether the objects on the partitions are constant, or always being created and replaced. If tasks make use of already-existing objects, those objects exist on all HA group members; operations can be performed by different group members, boosting performance. If new objects are created, they must be replicated across the entire group, causing a performance loss while the replication occurs.

> **NOTE** The way your application uses the **C_FindObjects** function to search for objects in a virtual HA slot can have a significant impact on your application performance (see "Application Object Handles" on page 240).

Load Balancing

Cryptographic requests sent to the HA group's virtual slot are load-balanced across all active members of the HA group. The load-balancing algorithm sends requests for cryptographic operations to the least busy partition in the HA group. This scheme accounts for operations of variable length, ensuring that queues are balanced even when some partitions are assigned very long operations. When an application requests a repeated set of operations, this method works. When the pattern is interrupted, however, the request type becomes relevant, as follows:

- Single-part (stateless) cryptographic operations are load-balanced.
- Multi-part (stateful) cryptographic operations are load-balanced.
- Multi-part (stateful) information retrieval requests are not load-balanced. In this case, the cost of distributing the requests to different HA group members is generally greater than the benefit. For this reason, multi-part information retrieval requests are all targeted at one member.
- Key management requests are not load-balanced. Operations affecting the state of stored keys (creation, deletion) are performed on a single HA member, and the result is then replicated to the rest of the HA group.

For example, when a member partition is signing and an asymmetric key generation request is issued, additional operations on that member are queued while the partition generates the key. In this case, the algorithm schedules more operations on other partitions in the HA group.

The load-balancing algorithm operates independently in each application process. Multiple processes on the same client or on different clients do not share information when scheduling operations. Some mixed-use cases might cause applications to use some partitions more than others. If you increase key sizes, interleave other cryptographic operations, or if network latency increases, performance may drop for individual active members as they become busier.

> **NOTE** Partitions designated as standby members are not used to perform cryptographic operations, and are therefore not part of the load-balancing scheme (see "Standby Members" on page 239).

The Primary Partition

The primary partition is the first partition you specify as a member of the HA group. While cryptographic operations are load-balanced across all the partitions in the group, new keys are always created on the primary partition, and then replicated on the other partitions (see "Key Replication" on the next page). Depending on how many new keys you are creating on your HA group, this can mean that the primary partition has a heavier workload than the other partitions in the group. If your HSMs are in different remote locations, you could select one with the least latency as the primary partition.

Despite its name, the primary partition is not more critical than any other partition in the HA group. If the primary partition fails, its operations fail over to other partitions in the group, and the next member added to the group becomes the new primary partition.

> **NOTE** The mechanism list available to the current primary partition is the only mechanism list that is available to HA virtual slot.

Network Topography

The network topography of the HA group is generally not important to the functioning of the group. As long as the client has a network path to each member, the HA logic will function. Different latencies between the client and each HA member cause a command scheduling bias towards the low-latency members. Commands scheduled on the long-latency devices have a longer overall latency associated with each command.

In this case, the command latency is a characteristic of the network. To achieve uniform load distribution, ensure that partitions in the group have similar network latency.

Key Replication

Objects (session or token) are replicated immediately to all members in an HA group when they are generated in the virtual HA slot. Similarly, deletion of objects (session or token) from the virtual HA slot is immediately replicated across all group members. Therefore, when an application creates a key on the virtual HA slot, the HA library automatically replicates the key across all group members before reporting back to the application. Keys are created on one member partition and replicated to the other members. If a member fails during this process, the HA group reattempts key replication to that member until it recovers, or failover attempts time out. Once the key exists on all active members of the HA group, a success code is returned to the application.

> **NOTE** If you are using Luna HSM Client 10.4.0 or newer and are setting up an HA group with a mix of FIPS and non-FIPS partitions as members, objects will not replicate across all HSMs in the group in the following cases:
>
> > If you have set a non-FIPS primary, a FIPS secondary, and created a non-FIPS approved key on the group, the key will not replicate to the FIPS secondary. No error is returned when this occurs.
> >
> > If you synchronize group members with the **hagroup synchronize** LunaCM command, any non-FIPS keys will fail to replicate to the FIPS member(s). An error is returned when this occurs, but lunaCM synchronizes everything else.

> **NOTE** If your application bypasses the virtual slot and creates or deletes directly in a physical member slot, the action occurs only in that single physical slot, and can be overturned by the next synchronization operation. For this reason we generally advise to enable HA-only, unless you have specific reason to access individual physical slots, and are prepared (in your application) to perform the necessary housekeeping.

Key replication, for pre-firmware-7.7.0 HSM partitions and for V0 partitions, uses the Luna cloning protocol, which provides mutual authentication, confidentiality, and integrity for each object that is copied from one partition to another. Therefore, *prior to Luna HSM Firmware 7.8.0*, all HA group member partitions must be initialized with the same cloning domain.

Key replication, for Luna HSM Firmware 7.8.0 (and newer) HSM partitions and for V0 partitions, and Luna HSM Client 10.5.0 (and newer), becomes more versatile with Extended Domain Management, as each member partition can have as many as three cloning/security domains. It becomes possible to easily mix password-authenticated and multi-factor (PED) authenticated partitions in HA groups. Any member must have at

least one of its domains in common with the current primary member. [For reasons of redundancy and overlap, we recommend that you *not* create (say) a 4-member group where the primary has domains A, B, C, and the three secondary members include one member with domain A, one member with domain B, and one member with domain C, where no other domains belong to the group -- such a group could function only until the primary failed/went-offline, at which point the next primary would have no domain peers with which to synchronize. Therefore, consider redundancy overlap when using Extended Domain Management with HA group members.

Key replication for V1 partitions uses the Luna cloning protocol to ensure that all HA group members have the same SMK, and uses SKS to export a key originating at one member and to import and decrypt that key (using the common SMK) on each other member in the group. Again, all HA group member partitions must be initialized with the same cloning domain in order that the common SMK can be available on every member.

The cloning protocol (for pre-firmware-7.7.0 or V0 or mixed-version HA), or the SKS protocol (for blob transfers in a V1 partition HA) is invoked separately for each object to be replicated and the sequence of required calls must be issued by an authorized client library residing on a client platform that has been authenticated to each of the partitions in the HA group). That is, the client must have an authenticated NTLS or STC channel to the HSM appliance; only an authorized client can perform object synchronization across all HA members.

Failover

When any active HA group member fails, a failover event occurs – the affected partition is dropped from the list of available HA group members, and all operations that were pending on the failed partition are transparently rescheduled on the remaining member partitions. The Luna HSM Client continuously monitors the health of member partitions at two levels:

> network connectivity – disruption of the network connection causes a failover event after a 20-second timeout.

> command completion – any command that is not executed within 20 seconds causes a failover event.

> **NOTE** Most commands are completed within milliseconds. Some can take longer, either because the command itself is time-consuming (for example, key generation), or because the HSM is under extreme load. The HSM automatically sends a "heartbeat" signal every two seconds for commands that are pending or in progress. The client extends the 20-second timeout whenever it receives a heartbeat, preventing false failover events. When an HA group is active, the client sends another heartbeat signal every 10 seconds to check the status of HA member partitions.

When an HA group member fails, the HA group status (see hagroup listgroups) reports a device error for the failed member. The client tries to reconnect the failed member at a minimum retry rate of once every 60 seconds, for the specified number of times (see "Recovery" on the next page).

When a failover occurs, the application experiences a latency stall on the commands in process on the failing unit, but otherwise there is no impact on the transaction flow. The scheduling algorithm described in "Load Balancing" on page 234 automatically minimizes the number of commands that stall on a failing unit during the 20-second timeout.

As long as one HA group member remains functional, cryptographic service is maintained no matter how many other group members fail. As described in "Recovery" on the next page, members can be returned to service without restarting the application.

Mid-operation failures

Any operation that fails mid-point needs to be re-sent from the calling application. The entire operation returns a failure (CKR_DEVICE_ERROR). This is more likely to happen in a multi-part operation, but a failure could conceivably happen during a single atomic operation as well.

For example, multi-part operations could be block encryption/decryption or any other command where the previous state of the HSM is critical to the processing of the next command. These operations must be re-sent, since the HA group does not synchronize partitions' internal memory state, only the stored key material.

> **NOTE** You must ensure that your applications can deal with the rare possibility of a mid-operation failure, by re-issuing the affected commands.

Possible Causes of Failure

In most cases, a failure is a brief service interruption, like a system reboot. These temporary interruptions are easily dealt with by the failover and auto-recovery functions. In some cases, additional actions may be required before auto-recovery can take place. For example, if a partition becomes deactivated, it must be reactivated by the Crypto Officer (see "Activation on Multifactor Quorum-Authenticated Partitions" on page 207). Some permanent failures may require manual recovery (see "Recovery" below). Possible failure events include:

> **HSM-side failures**
- HSM card failure
- HSM re-initialization
- HSM reboot
- HSM power failure
- Deactivated partition
- NTLS service failure
- STC service failure

> **Client-side failures**
- Client workstation power failure
- Client workstation reboot

Recovery

Recovery of a failed HA group member is designed to be automatic in as many cases as possible. You can configure your auto-recovery settings to require as much manual intervention as is convenient for you and your organization. In either an automated or manual recovery process, there is no need to restart your application. As part of the recovery process:

> Any cryptographic objects created while the member was offline are automatically replicated to the recovered partition.

> The recovered partition becomes available for its share of load-balanced cryptographic operations.

Auto-recovery

When auto-recovery is enabled, Luna HSM Client performs periodic recovery attempts when it detects a member failure. You can adjust the frequency (maximum once per minute) and the total number of retries (no limit). If the failed partition is not recovered within the scheduled number of retries, it remains a member of the HA group, but the client will no longer attempt to recover it. You must then address whatever equipment or network issue caused the failure, and execute a manual recovery of the member partition.

With each recovery attempt, a single application thread experiences a slight latency delay of a few hundred milliseconds while the client uses the thread to recover the failed member partition.

There are two HA auto-recovery modes:

> **activeBasic** – uses a separate, non-session-based Active Recovery Thread to perform background checks of HA member availability, recover failed members, and synchronize the contents of recovered members with the rest of the group. It does not restore existing sessions if all members fail simultaneously and are recovered.

> **activeEnhanced** – works the same as activeBasic, but restores existing sessions and login states if all members fail and are recovered.

HA auto-recovery is disabled by default. It is automatically enabled when you set the recovery retry count (see "Configuring HA Auto-Recovery" on page 251). Thales recommends enabling auto-recovery in all configurations.

> **NOTE** If a member partition loses Activation when it fails (it remains offline for more than two hours) you must present the black Crypto Officer PED key to re-cache the authentication secret before the member can be recovered.

Manual Recovery

When auto-recovery is disabled, or fails to recover the partition within the scheduled number of retries, you must execute a manual recovery in LunaCM. Even if you use manual recovery, you do not need to restart your application. When you execute the recovery command, the client makes a recovery attempt the next time the application uses the group member (see "Manually Recovering a Failed HA Group Member" on page 264).

Even with auto-recovery enabled and configured for a large number of retries, there are some rare occasions where a manual recovery may be necessary (for example, when a member partition and the client application fail at the same time).

> **CAUTION!** Never attempt a manual recovery while the application is running and auto-recovery is enabled. This can cause multiple concurrent recovery processes, resulting in errors and possible key corruption.

Failure of All Group Members

If all members of an HA group fail (and no standby members are configured), all logged-in sessions are lost, and operations that were active when the last member failed are terminated. If you have set the HA auto-recovery mode to activeEnhanced, all sessions will be restarted when one or more members are recovered, and normal operations will resume. Otherwise, you must restart the client application once the group members have been recovered.

Permanent Failures

Sometimes an HSM failure is permanent (from the perspective of the HA group). For example, if the HSM is re-initialized, the member partition is erased and must be recreated. In this case, you can decide to recreate the original member or deploy a new member to the group. The client automatically replicates cryptographic objects to the new member and begins assigning operations to it (see "Replacing an HA Group Member" on page 265).

Standby Members

After you add member partitions to an HA group, you can designate some as standby members. Cryptographic objects are replicated on all members of the HA group, including standby members, but standby members do not perform any cryptographic operations unless all the active members go offline. In this event, all standby members are immediately promoted to active service, and operations are load-balanced across them. This provides an extra layer of assurance against a service blackout for your application.

Since standby members replicate keys but do not perform operations, they can also serve as an automatic backup partition for the cryptographic objects on the HA group. The contents of standby partitions are always kept up-to-date, so it is not possible to keep multiple backups (different generations of preserved material) using an HA group (see "Planning Your HA Group Deployment" on page 242). You can consider HA standby members to be your backup only in the case where the most recent sync always replicates all objects you are interested in preserving and recovering.

If you have audit-compliance rules or other mandate to preserve earlier partition contents (keys and objects), then you should perform intentional backups with dedicated backup devices (see "Partition Backup and Restore" on page 278).

Process Interaction

At the lowest communication level, the transport protocol (TCP) maintains communication between the client and the appliance (whether HA is involved or not). For HA groups involving member partitions on Luna PCIe HSM 7, the protocol timeout is 10 seconds. This means:

> In a period of no activity by client or appliance, the appliance's TCP sends a packet after 10 seconds of silence.

> If that packet is acknowledged, the 10-second TCP timer restarts, and the cycle repeats indefinitely.

> If the packet is not acknowledged, TCP sends another every 10 seconds. If there is no response after 2 minutes, the connection is considered dead, and higher levels are alerted to perform their cleanup.

Above that level, the NTLS/STC layer provides the connection security and some other services. Any time a client sends a request for a cryptographic operation, the HSM on the appliance begins working on that operation.

While the HSM processes the request, appliance-side NTLS/STC sends a "keep-alive" ping every 2 seconds, until the HSM completes the request. NTLS/STC does not perform any interpretation of the ping, but simply keeps the TCP layer active. If your client application requests a lengthy operation (for example, an 8192-bit keygen), the random-number-generation portion of that operation could take multiple minutes, during which the HSM would legitimately be sending nothing back to the client. The NTLS ping ensures that the connection remains alive during long pauses.

Application Object Handles

Application developers should be aware that the PKCS #11 object handle model is fully virtualized when using an HA slot. The application must not assume fixed handle numbers across instances of an application. A handle's value remains consistent for the life of a process; but it might be a different value the next time the application is executed.

When you use an HA slot with your applications, the client behaves as follows when interacting with the application:

1. Intercept the call from the application.
2. Translate virtual object handles to physical object handles using the mappings specified by the virtual object table. The virtual object table is created and updated for the current session only, and only contains of list of the objects accessed in the current session.
3. Launch any required actions on the appropriate HSM or partition.
4. Receive the result from the HSM or partition and forward the result to your application,
5. Propagate any changes in objects on the physical HSM that performed the action to all of the other members of the HA group.

Virtual slots and virtual objects

When an application uses a non-HA physical slot, it addresses all objects in the slot by their physical object handles. When an application uses an HA slot, however, a virtual layer of abstraction overlays the underlying physical slots that make up the HA group, and the HA group is presented to the application as a virtual slot. This virtual slot contains virtual objects that have virtual object handles. The object handles in an HA slot are virtualized since the object handles on each of the underlying physical slots might be different from slot to slot. Furthermore, the physical object handles could change if a member of the HA group drops out (fails or loses communication) and is replaced.

The virtual object table

HA slots use a virtual object table to map the virtual objects in the virtual HA slot to the real objects in the physical slots that make up the HA group. The HA client builds a virtual object table for each application that loads the library. The table is ephemeral, and only exists for the current session. It is created and updated, if necessary, each time an application makes a request to access an object. To maximize performance and efficiency, the table only contains a list of the objects accessed in the current session. For example, the first time an application accesses an object after application start up, the table is created, a look up is performed to map the virtual object to its underlying physical objects, and an entry for the object is added to the table. For each subsequent request for that object, the data in the table is used and no look up is required. If the application then accesses a different object that is not listed in the table, a new look up is performed and the table is updated to add an entry for the new object.

C_FindObjects behavior and application performance

Since the client must perform a lookup to create the virtual object table, the way you use the C_FindObjects function can have a significant impact on the performance of your applications. For example, if you use the C_FindObjects function to ask for specific attributes, the client only needs to update the table to include the requested objects. If, however, you use the C_FindObjects function to find all objects, the client queries each HSM/partition in the group, for each object, to create the table. This can take a significant amount of time if the slot contains a large number of objects, or if the HA group includes many members.

To mitigate performance degradation when using the C_FindObjects function to list the objects on an HA slot, we recommend that you structure your applications to search by description or other attributes, rather than searching for all objects. Doing so minimizes the number of objects returned and the time required to create or update the table. If your application must find all objects, we recommend that you add the C_FindObjects all function call to the beginning of your application so that the table is built on application start up, so that the table is available to the application for all subsequent C_FindObjects function calls.

Example: Database Encryption

This section walks through a sample use case of some of the HA logic with a specific application – a transparent database encryption.

Typical Database Encryption Key Architecture

Database engines typically use a two-layered key architecture. At the top layer is a master encryption key that is the root of data protection. Losing this key is equivalent to losing the database, so it obviously needs to be highly durable. At the second layer are table keys used to protect table-spaces and/or columns. These table keys are stored with the database as blobs encrypted by the master encryption key (MEK). This architecture maps to the following operations on the HSM:

1. Initial generation of master key for each database.
2. Generation and encryption of table keys with the master key.
3. Decryption of table keys when the database needs to access encrypted elements.
4. Generation of new master keys during a re-key and then re-encrypting all table keys with it.
5. Generation and encryption of new table keys for storage in the database (often done in a software module).

The HSM is not involved in the use of table keys. Instead it provides the strong protection of the MEK which is used to protect the table keys. Users must follow backup procedures to ensure their MEK is as durable as the database itself ("Partition Backup and Restore" on page 278).

HSM High Availability with Database Encryption

When the HSMs are configured as an HA group, the database's master key is automatically and transparently replicated to all the members when the key is created or re-keyed. If an HSM group member was offline or fails during the replication, it does not immediately receive a copy of the key. Instead the HA group proceeds after replicating to all of the active members. Once a member is re-joined to the group the HSM client automatically replicates the new master keys to the recovered member.

Before every re-key event, the user must ensure the HA group has sufficient redundancy. A re-key will succeed as long as one HA group member exists, but proceeding with too few HSMs will result in an availability risk. For example, proceeding with only one HSM means the new master key will be at risk since it exists only on a single HSM. Even with sufficient redundancy, Thales Group recommends maintaining an offline backup of a database's master key.

HSM Load Balancing with Database Encryption

While a database is up and running, the master key exists on all members in the HA group. Requests to encrypt or decrypt table keys are distributed across the entire group. The load-balancing feature is able to deliver

improved performance and scalability when the database requires a large number of accesses to the table keys. Most deployments will not need much load balancing as the typical database deployment results in a small number of table keys.

While the table keys are re-keyed, new keys are generated in the HSM and encrypted for storage in the database. Within an HA group, these keys are generated on the primary member and then replicated to the entire HA group, even though they exist on the HSM for only a moment. These events are infrequent enough that this extra replication has minimal impact.

Planning Your HA Group Deployment

This section describes important considerations and constraints to keep in mind as you plan your High-Availability (HA) group deployment. The benefits of HA are described in detail in "High-Availability Groups" on page 230. There are several sample configurations described in this section that take advantage of different HA features. Depending on your organization's security needs, you might choose one of these configurations, or your own variation.

> "HSM and Partition Prerequisites" below

> "Sample Configuration" on the next page

- "Performance and Load Balancing" on the next page

HSM and Partition Prerequisites

The HSM partitions you plan to use in an HA group must meet the following prerequisites before you can use them in an HA group.

Compatible HSM Firmware Versions

All HSMs in an HA group must have the same firmware version installed.

Common Cloning Domain

All key replication in an HA group uses the Luna cloning protocol, which provides mutual authentication, confidentiality, and integrity for each object that is copied from one partition to another. Therefore, all HA group member partitions must be initialized with the same cloning domain. If you are planning to combine already-existing partitions into an HA group, you must first re-initialize them using the same domain string or red PED key.

Common Crypto Officer Credentials

An HA group essentially allows you to log in to all its member partitions simultaneously, using a single credential. Password-authenticated partitions must all be initialized with the same Crypto Officer password. Multifactor Quorum-authenticated partitions must all be initialized with the same black Crypto Officer PED key and activated with the same CO challenge password.

It is not possible to create an HA group made up of both password- and multifactor quorum-authenticated partitions.

Common HSM/Partition Policies (FIPS Mode)

Generally, all HSMs/partitions used in an HA group must have the same policy configuration.

If you are planning to set up an HA group with a mix of FIPS and non-FIPS partitions as members, note the following:

> If you are using Luna HSM Client 10.4.0 or newer, you *can* set up an HA group with a mix of FIPS and non-FIPS partitions as members. However, some limitations must be considered. For more information, refer to "Key Replication" on page 235.

> If you are using Luna HSM Client 10.3.0 or older, you *cannot* set up an HA group with a mix of FIPS and non-FIPS partitions as members.

Functionality Modules

If you intend to use Functionality Modules (FMs) with your HA group, all HSMs containing HA group members must have FMs enabled and they must all have the same FM(s) loaded. See FM Deployment Constraints for details. FMs are not supported for Luna Cloud HSM services.

Sample Configuration

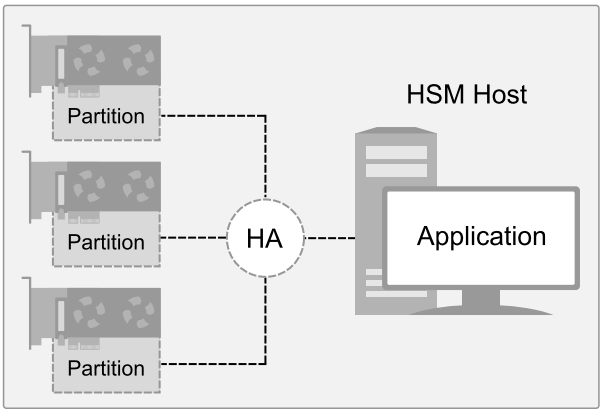
Your ideal HA group configuration depends on the number of HSMs you have available and the purpose of your application(s).

Performance and Load Balancing

If your application is designed to perform many cryptographic operations as quickly as possible, using keys or other objects that do not change often, you can create a large HA group using partitions on many HSMs. This deployment uses load balancing to provide linear performance gains for each HSM added to the group.

For example: your application uses keys stored on the HSM to perform many encrypt/decrypt or sign/verify operations. You want to minimize transaction latency by providing enough HSMs to handle capacity.

The Luna HSM Client allows HA groups with up to 32 member partitions. The best approach in this example is to add enough group members to handle the usual number of operations, plus enough extra members to handle periods of high demand.



Setting Up an HA Group

Use LunaCM to create an HA group from partitions assigned to your client. This procedure is completed by the Crypto Officer. Ensure that you have met all necessary prerequisites before proceeding with group creation. For a detailed description of HA functionality, see "High-Availability Groups" on page 230.

> **NOTE** Your LunaCM instance needs to update the **Chrystoki.conf** (Linux/UNIX) or **crystoki.ini** file (Windows) when setting up or reconfiguring HA. Ensure that you have Administrator privileges on the client workstation.
>
> **V1 partitions:** If you add an application partition with an existing SMK to an HA group, the primary member's SMK overwrites the existing SMK of the joining partition.If a partition's SMK has ever been used to encrypt important SKS objects, save a backup of the SMK before adding that partition to any HA group.

Prerequisites

HA groups are set up in LunaCM by the Crypto Officer. Before the CO can perform this setup, however, all HSMs and member partitions must meet the following prerequisites, completed by the HSM and Partition Security Officers.

HSMs

The HSM SO must ensure that all HSMs containing HA group member partitions meet the following prerequisites:

- All HSMs must use the same authentication method (password/multifactor quorum). Luna Cloud HSM Services support HA groups using password authentication only.
- HA groups cannot contain both Luna PCIe HSM 7s and Luna Network HSM 7s.
- All must be running one of the supported software/firmware versions. Generally, Thales recommends using HSMs with the same software/firmware for HA. However, mixed-version HA groups containing Luna 6 and 7 member partitions and Luna Cloud HSM services are supported. See "Cloning Keys Between Luna 6, Luna 7, and Luna Cloud HSM, Password or Multifactor Quorum" on page 76 for more information.
- For Luna PCIe HSM 7s, all HSMs must have the same firmware version installed and must be installed in the same host server that will create the HA group.
- HSM policies **7: Allow Cloning** and **16: Allow Network Replication** must be set to **1**(see Setting HSM Policies Manually).
- HSM policies must be consistent across all HSMs.

> **NOTE** For HSM policy **12: Allow non-FIPS algorithms**, note the following:
>
> - If you are using Luna HSM Client 10.4.0 or newer, you *can* set up an HA group with a mix of FIPS and non-FIPS partitions as members. However, some limitations must be considered. For more information, refer to "Key Replication" on page 235.
> - If you are using Luna HSM Client 10.3.0 or older, you *cannot* set up an HA group with a mix of FIPS and non-FIPS partitions as members.

A client can have a session with an STC slot, making use of only one appID. When running an HA command if you are already logged in or have a session open with an appID to a member of that HA slot, you will not be able to log into that slot at this time. When you run a command like "ha list", lunacm logs into each member using a randomly created appID. If any one of these slots already has a login session, such an attempt is rejected with CKR_ACCESS_ID_ALREADY_EXISTS. The workaround is to close the problem session first.

Partitions

The Partition SO must ensure that all partitions in an HA group meet the following prerequisites:

> All partitions must be visible in LunaCM on the host workstation.

> All partitions must be initialized with the same cloning domain:

- Password-authenticated partitions must share the same domain string.
- multifactor quorum-authenticated partitions must share the same red domain PED key.

> Partition policies **0: Allow private key cloning** and **4: Allow secret key cloning** must be set to **1** on all partitions.

> Partition policies must be consistent across all member partitions.

> The Crypto Officer role on each partition must be initialized with the same CO credential (password or black PED key).

> PED-authenticated partitions must have partition policies **22: Allow activation** and **23: Allow auto-activation** set to **1**. All partitions must be activated and have auto-activation enabled, so that they can retain their login state after failure/recovery. Each partition must have the same activation challenge secret set (see "Activation on Multifactor Quorum-Authenticated Partitions" on page 207)

> **NOTE** If HSM policy **21: Force user PIN change after set/reset** is set to **1** (the default setting), the Crypto Officer must change the initial CO credential before using the partition for cryptographic operations. This applies to the activation challenge secret as well (see role changepw).

To set up an HA group

1. Decide which partition will serve as the primary member (see "The Primary Partition" on page 234). Create a new HA group, specifying the following information:
   - the group label (do not call the group "HA")
   - the Serial number OR the slot number of the primary member partition
   - the Crypto Officer password or challenge secret for the partition

   lunacm:>**hagroup creategroup -label** <label> {**-slot** <slotnum> | **-serialnumber** <serialnum>}

```
lunacm:> hagroup creategroup -label myHAgroup -slot 0

        Enter the password: ********

        New group with label "myHAgroup" created with group number 1154438865287.
        Group configuration is:


         HA Group Label:  myHAgroup
        HA Group Number:  1154438865287
       HA Group Slot ID:  Not Available
        Synchronization:  enabled
          Group Members:  154438865287
             Needs sync:  no
        Standby Members:  <none>
```

```
Slot #    Member S/N                      Member Label    Status
======    ==========                      ============    ======
     0  154438865287                              par0     alive


Command Result : No Error
```

LunaCM generates a serial number for the HA group (by adding a "1" before the primary partition serial number), assigns it a virtual slot number, and automatically restarts.

```
lunacm (64-bit) v7.3.0. Copyright (c) 2018 SafeNet. All rights reserved.


        Available HSMs:

        Slot Id ->              0
        Label ->                par0
        Serial Number ->        154438865287
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key
                                Export With Cloning Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              1
        Label ->                par1
        Serial Number ->        1238700701509
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key
                                Export With Cloning Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              5
        HSM Label ->            myHAgroup
        HSM Serial Number ->    1154438865287
        HSM Model ->            LunaVirtual
        HSM Firmware Version -> 7.3.0
        HSM Configuration ->    Luna Virtual HSM (PW) Key Export With
                                Cloning Mode
        HSM Status ->           N/A - HA Group


Current Slot Id: 0
```

2. Add another partition to the HA group, specifying either the slot or the serial number. If the new member contains cryptographic objects, you are prompted to decide whether to replicate the objects within the HA group, or delete them.

   lunacm:>**hagroup addmember** **-group** <grouplabel> {**-slot** <slotnum> | **-serialnumber** <serialnum>}

```
lunacm:> hagroup addmember -group myHAgroup -slot 1


        Enter the password: ********


Warning:  There are objects currently on the new member.
          Do you wish to propagate these objects within the HA
          group, or remove them?
```

```
          Type 'copy' to keep and propagate the existing
          objects, 'remove' to remove them before continuing,
          or 'quit' to stop adding this new group member.
          >  copy

        Member 1238700701509 successfully added to group myHAgroup. New group
        configuration is:

         HA Group Label:  myHAgroup
        HA Group Number:  1154438865287
       HA Group Slot ID:  5
        Synchronization:  enabled
          Group Members:  154438865287, 1238700701509
             Needs sync:  no
        Standby Members:  <none>


Slot #    Member S/N                      Member Label    Status
======    ==========                      ============    ======
     0  154438865287                              par0     alive
     1  1238700701509                             par1     alive


        Please use the command "ha synchronize" when you are ready
        to replicate data between all members of the HA group.
        (If you have additional members to add, you may wish to wait
        until you have added them before synchronizing to save time by
        avoiding multiple synchronizations.)

Command Result : No Error
```

Repeat this step for each additional HA group member.

3. If you are adding member partitions that already have cryptographic objects stored on them, initiate a manual synchronization. You can tell whether this step is required by checking the line **Needs Sync : yes/no** in the HA group output. This will also confirm that the HA group is functioning correctly.

   lunacm:> **hagroup synchronize -group** <grouplabel>

4. [Optional] If you created an HA group out of empty partitions, and you want to verify that the group is functioning correctly, see "Verifying an HA Group" on the next page.

5. Specify which member partitions, if any, will serve as standby members.

   See "Setting an HA Group Member to Standby" on page 249.

6. Set up and configure auto-recovery (recommended). If you choose to use manual recovery, you will have to execute a recovery command whenever a group member fails.

   See "Configuring HA Auto-Recovery" on page 251.

7. [Optional] Enable HA Only mode (recommended).

   See "Enabling/Disabling HA Only Mode" on page 251.

8. [Optional] Configure HA logging.

   See "HA Logging" on page 256 for procedures and information on reading HA logs.

The HA group is now ready for your application.

Verifying an HA Group

After creating an HA group in LunaCM, you can see the group represented as a virtual slot alongside the physical slots:

```
lunacm (64-bit) v7.3.0. Copyright (c) 2018 SafeNet. All rights reserved.


        Available HSMs:

        Slot Id ->              0
        Label ->                par0
        Serial Number ->        154438865287
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              1
        Label ->                par1
        Serial Number ->        1238700701509
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              5
        HSM Label ->            myHAgroup
        HSM Serial Number ->    1154438865287
        HSM Model ->            LunaVirtual
        HSM Firmware Version -> 7.3.0
        HSM Configuration ->    Luna Virtual HSM (PW) Key Export With Cloning Mode
        HSM Status ->           N/A - HA Group


Current Slot Id: 0
```

The following procedure is one way to verify that your HA group is working as intended:

To verify an HA group

1. Exit LunaCM and run **multitoken** against the HA group slot number (slot 5 in the example) to create some objects on the HA group partitions.

   ./multitoken -mode <keygen_mode> **-key** <key_size> **-nodestroy -slots** <HA_virtual_slot>

   You can hit **Enter** at any time to stop the process before the partitions fill up completely. Any number of created objects will be sufficient to show that the HA group is functioning.

2. Run LunaCM and check the partition information on the two physical slots. Check the object count under "Partition Storage":

   lunacm:> **partition showinfo**

   ```
           Current Slot Id: 0

   lunacm:> partition showinfo

   ...(clip)...
   ```

```
        Partition Storage:
                Total Storage Space:  325896
                Used Storage Space:   22120
                Free Storage Space:   303776
                Object Count:         14
                Overhead:             9648

Command Result : No Error


lunacm:> slot set slot 1

        Current Slot Id:    1     (Luna User Slot 7.0.1 (PW) Signing With Cloning Mode)

Command Result : No Error


lunacm:> partition showinfo

...(clip)...

        Partition Storage:
                Total Storage Space:  325896
                Used Storage Space:   22120
                Free Storage Space:   303776
                Object Count:         14
                Overhead:             9648

Command Result : No Error
```

3. To remove the test objects, login to the HA virtual slot and clear the virtual partition.

   lunacm:> **slot set -slot** <HA_virtual_slot>

   lunacm:> **partition login**

   lunacm:> **partition clear**

If you are satisfied that your HA group is working, you can begin using your application against the HA virtual slot. The virtual slot assignment will change depending on how many more application partitions are added to your client configuration. If your application invokes the HA group label, this will not matter. If you have applications that invoke the slot number, see "Enabling/Disabling HA Only Mode" on page 251.

Setting an HA Group Member to Standby

Some HA group members can be designated as standby members. Standby members do not perform any cryptographic operations unless all active members have failed (see "Standby Members" on page 239 for details). They are useful as a last resort against loss of application service.

Prerequisites

> The partition you want to designate as a standby member must already be a member of the HA group (see "Adding/Removing an HA Group Member" on page 261).

> The Crypto Officer must perform this procedure.

To set an HA group member to standby

1. [Optional] Check the serial number of the member you wish to set to standby mode.

   lunacm:> **hagroup listgroups**

2. Set the desired member to standby mode by specifying the serial number.

   lunacm:> **hagroup addstandby -group** <label> **-serialnumber** <member_serialnum>

```
lunacm:> hagroup addstandby -group myHAgroup -serialnumber 2855496365544

        The member 2855496365544 was successfully added to the standby list for the HA Group
myHAgroup.


Command Result : No Error
```

To make a standby HA member active

> **NOTE** By default, a Luna Cloud HSM service from Thales DPoD is always added to an HA group as a standby member. If you prefer to use the Luna Cloud HSM service as an active HA member, you must first edit the following toggle in the **Chrystoki.conf/crystoki.ini** configuration file (see Configuration File Summary):
>
> ```
> [Toggles]
> lunacm_cv_ha_ui = 0
> ```

1. [Optional] Check the serial number of the standby member.

   lunacm:> **hagroup listgroups**

```
        If you would like to see synchronization data for group myHAgroup,
        please enter the password for the group members. Sync info
        not available in HA Only mode.

        Enter the password: ********


             HA auto recovery:  disabled
             HA recovery mode:  activeBasic
   Maximum auto recovery retry:  0
   Auto recovery poll interval:  60 seconds
                   HA logging:  disabled
           Only Show HA Slots:  no

               HA Group Label:  myHAgroup
              HA Group Number:  11238700701509
             HA Group Slot ID:  5
              Synchronization:  enabled
                Group Members:  154438865287, 1238700701509
                    Needs sync:  no
             Standby Members:  2855496365544


Slot #    Member S/N                      Member Label    Status
======    ==========                      ============    ======
```

```
    0  154438865287                              par0     alive
    1  1238700701509                             par1     alive
    2  2855496365544                             par2     alive
```

2. Remove the member from standby and return it to active HA use.

   lunacm:> **hagroup removestandby** **-group** <label> **-serialnumber** <member_serialnum>

```
lunacm:> hagroup removestandby -group myHAgroup -serialnumber 2855496365544

        The member 2855496365544 was successfully removed from the standby list for the HA
Group myHAgroup.


Command Result : No Error
```

Configuring HA Auto-Recovery

When auto-recovery is enabled, Luna HSM Client performs periodic recovery attempts when it detects a member failure. HA auto-recovery is disabled by default for new HA groups. To enable it, you must set a maximum number of recovery attempts. You can also set the frequency of recovery attempts, and the auto-recovery mode (**activeBasic** or **activeEnhanced**). These settings will apply to all HA groups configured on the client.

To configure HA auto-recovery

1. Set the desired number of recovery attempts by specifying the retry count as follows:
   - Set a value of **0** to disable HA auto-recovery
   - Set a value of **-1** for unlimited retries
   - Set any specific number of retries from **1** to **500**

   lunacm:> **hagroup retry** **-count** <retries>
2. [Optional] Set the desired frequency of recovery attempts by specifying the time in seconds. The acceptable range is **60-1200** seconds (default: **60**).

   lunacm:> **hagroup interval** **-interval** <seconds>
3. [Optional] Set the auto-recovery mode. The default is **activeBasic**.

   lunacm:> **hagroup recoverymode** **-mode** {**activeBasic** | **activeEnhanced**}
4. [Optional] Check that auto-recovery has been enabled. You are prompted for the Crypto Officer password/challenge secret.

   lunacm:> **hagroup listgroups**

Enabling/Disabling HA Only Mode

By default, client applications can see both physical slots and virtual HA slots. Directing applications at the physical slots bypasses the high availability and load balancing functionality. An application must be directed at

the virtual HA slot to use HA load balancing and redundancy. HA Only mode hides the physical slots and leaves only the HA group slots visible to applications, simplifying the PKCS#11 slot numbering (see "Slot Numbering and Behavior" on page 341), especially "Settings Affecting Slot Order" on page 342.

If an HA group member partition fails and/or is recovered, *while HAonly is enabled*, then slot numbers do not change.

If an HA group member partition fails and/or is recovered, *while HAonly is **not** enabled*, all visible slot numbers can change, including the HA group virtual slots. This can cause applications to direct operations to the wrong slot.

If a physical slot in the HA group receives a direct request, the results will not be replicated on the other partitions in the group (see "HA Troubleshooting" on page 274) When HA Only mode is enabled, the HA virtual slots are not affected by partition slot changes.

The virtual slot defaults to slot 0, unless this behavior is modified by
*Thales recommends **enabling HAonly mode on all clients running HA groups**.*

> **NOTE** Individual partition slots are still visible in LunaCM when HA Only mode is enabled. They are hidden only from client applications. Use **CKdemo** (Option **11**) to see the slot numbers to use with client applications.

To enable HA Only mode

1. Enable HA Only mode in LunaCM.

   lunacm:> **hagroup haonly -enable**

2. [Optional] Since LunaCM still displays the partitions, you can check the status of HA Only mode at any time.

   lunacm:> **hagroup haonly -show**

To disable HA Only mode

1. Disable HA Only mode in LunaCM.

   lunacm:> **hagroup haonly -disable**

Example config file for a large HA group

This chrystoki.conf file and the 16 network HSMs (with slightly altered IP addresses) were used in our testing.

```
Chrystoki2 = {
 LibUNIX = /usr/safenet/lunaclient/lib/libCryptoki2.so;
 LibUNIX64 = /usr/safenet/lunaclient/lib/libCryptoki2_64.so;
}
Luna = {
 DefaultTimeOut = 500000;
 PEDTimeout1 = 100000;
 PEDTimeout2 = 200000;
```

```
  PEDTimeout3 = 20000;
  KeypairGenTimeOut = 2700000;
  CloningCommandTimeOut = 300000;
  CommandTimeOutPedSet = 720000;
}
  CardReader = {
  RemoteCommand = 1;
}
Misc = {
  PE1746Enabled = 0;
  ValidateHost = 0;
  ToolsDir = /usr/safenet/lunaclient/bin;
  PartitionPolicyTemplatePath = /usr/safenet/lunaclient/data/partition_policy_templates;
  ProtectedAuthenticationPathFlagStatus = 0;
  MutexFolder = /usr/safenet/lunaclient/lock;
  PluginModuleDir = /usr/safenet/lunaclient/plugins;
}
LunaSA Client = {
  ReceiveTimeout = 20000;
  SSLConfigFile = /usr/safenet/lunaclient/bin/openssl.cnf;
  ClientPrivKeyFile = /usr/safenet/lunaclient/cert/client/192.168.143.48Key.pem;
  ClientCertFile = /usr/safenet/lunaclient/cert/client/192.168.143.48.pem;
  ServerCAFile = /usr/safenet/lunaclient/cert/server/CAFile.pem;
  NetClient = 1;
  TCPKeepAlive = 1;
  ServerName00 = 192.121.10.63;
  ServerPort00 = 1792;
  ServerHtl00 = 0;
  ServerName01 = 192.121.10.53;
  ServerPort01 = 1792;
  ServerHtl01 = 0;
  ServerName02 = 192.121.10.62;
  ServerPort02 = 1792;
  ServerHtl02 = 0;
  ServerName03 = 192.121.10.59;
```

```
ServerPort03 = 1792;
ServerHtl03 = 0;
ServerName04 = 192.121.10.52;
ServerPort04 = 1792;
ServerHtl04 = 0;
ServerName05 = 192.121.10.64;
ServerPort05 = 1792;
ServerHtl05 = 0;
ServerName06 = 192.121.10.50;
ServerPort06 = 1792;
ServerHtl06 = 0;
ServerName07 = 192.121.10.51;
ServerPort07 = 1792;
ServerHtl07 = 0;
ServerName08 = 192.121.10.65;
ServerPort08 = 1792;
ServerHtl08 = 0;
ServerName09 = 192.121.10.58;
ServerPort09 = 1792;
ServerHtl09 = 0;
ServerName10 = 192.121.10.60;
ServerPort10 = 1792;
ServerHtl10 = 0;
ServerName11 = 192.121.10.56;
ServerPort11 = 1792;
ServerHtl11 = 0;
ServerName12 = 192.121.10.57;
ServerPort12 = 1792;
ServerHtl12 = 0;
ServerName13 = 192.121.10.55;
ServerPort13 = 1792;
ServerHtl13 = 0;
ServerName14 = 192.121.10.54;
ServerPort14 = 1792;
ServerHtl14 = 0;
```

```
  ServerName15 = 192.121.10.61;
  ServerPort15 = 1792;
  ServerHtl15 = 0;
  ServerName16 = 192.168.141.93;
  ServerPort16 = 1792;
  ServerHtl16 = 0;
  ServerName17 = 192.168.141.198;
  ServerPort17 = 1792;
  ServerHtl17 = 0;
}
Secure Trusted Channel = {
  SoftTokenDir = /usr/safenet/lunaclient/configData/token;
  ClientIdentitiesDir = /usr/safenet/lunaclient/data/client_identities;
  PartitionIdentitiesDir = /usr/safenet/lunaclient/data/partition_identities;
  ClientTokenLib = /usr/safenet/lunaclient/lib/libSoftToken.so;
}
PedServer = {
  ServerCAFile = /usr/safenet/lunaclient/PEDserver/CAFile.pem;
  PedConfigFile = /etc/pedServer.conf;
}
VirtualToken = {
  VirtualToken00Label=My_HA;
  VirtualToken00SN = 11287408863039;
  VirtualToken00Members =
1287408863039,1327020333026,1335064630247,1335062301941,1377509648637,1327024989629,137877
8575411,1378780903715,1305890956067,1305921224049,1372948497173,1459759386384,123865646369
6,1485871338177,1358801709921,1259264300111,1382217483700,1335066958603;
}
HASynchronize = {
}
  HAConfiguration = {
  haLogStatus = enabled;
  reconnAtt = -1;
  haLogPath = /usr/safenet/lunaclient/;
}
  CkLog2 = {
```

```
  Enabled = ;
  NewFormat = ;
  File = ;
  FileSize = ;
  Error = ;
  LibUNIX = ;
  LibUNIX64 = ;
}
  Ped Server = {
  PedConfigFile = /etc/pedServer.conf;
}
RBS = {
  CmdProcessor = /usr/safenet/lunaclient/rbs/lib/librbs_processor2.so;
  DaemonName = RBSD;
  HostPort = 1792;
  ClientAuthFile = /usr/safenet/lunaclient/rbs/clientauth.dat;
  ServerSSLConfigFile = /usr/safenet/lunaclient/rbs/server/server.cnf;
  ServerPrivKeyFile = /usr/safenet/lunaclient/rbs/server/serverkey.pem;
  ServerCertFile = /usr/safenet/lunaclient/rbs/server/server.pem;
  NetServer = 1;
  HostName = 0.0.0.0;
}
```

HA Logging

Logging of HA-related events takes place on the Luna HSM Client workstation. The log file **haErrorLog.txt** shows HA errors, as well as add-member and delete-member events. It does not record status changes of the group as a whole (like adding or removing the group). Some information is recorded in the log file to help Thales customer support staff troubleshoot operational issues.

The HA log rotates after the configured maximum length is reached. When it finishes writing the current record (even if that record slightly exceeds the configured maximum), the file is renamed to include the timestamp and the next log entry begins a new haErrorLog.txt.

> "Configuring HA Logging" on the next page

> "HA Log Messages" on page 258

Configuring HA Logging

Using Luna HSM Client 7.2.0 or newer, logging is automatically enabled when you configure an HA group (see "Setting Up an HA Group" on page 243), but you must configure a valid destination path before logging can begin. HA groups are configured on the client using LunaCM. The HA configuration settings are saved to the **Chrystoki.conf** (Linux/Unix) or **crystoki.ini** (Windows) file, as illustrated in the following example:

```
VirtualToken = {
VirtualToken00Label = haGroup1; // The label of the HA group.
VirtualToken00SN = 11234840370164; // The pseudo serial number of the HA group.
VirtualToken00Members = 1234840370164, 1234924189183; // The serial number of the members.
VirtualTokenActiveRecovery = activeEnhanced; // The recovery mode.
}
HASynchronize = {
haGroup1 = 1; // Enable automatic synchronization of objects.
}
HAConfiguration = {
HAOnly = 1; // Enable listing HA groups only via PKCS#11 library.
haLogPath = /tmp/halog; // Base path of the HA log file; i.e., "/tmp/halog/haErrorLog.txt".
haLogStatus = enabled; // Enable HA log.
logLen = 100000000; // Maximum size of HA log file in bytes.
failover_on_deactivation = 1; // if a partition becomes deactivated then the client will
immediately
                              // failover and resume its operation on the other HA partitions.
This
                              // is currently an alpha feature
reconnAtt = 120; // Number of recovery attempts.
}
HARecovery = {
haGroup1 = 1; // Deprecated in this release as auto recovery will cover the use case. When
cryptoki
              // loads into memory it reads the number and if the number changes (gets
incremented)
              // then cryptoki interprets this as a manual recovery attempt.
}
```

To configure HA logging

Use the LunaCM command **hagroup halog**.

1. Set a valid path for the log directory. You must specify an existing directory.

   lunacm:> **hagroup halog -path** <filepath>

   ```
   lunacm:> hagroup halog -path "C:\Program Files\Safenet\Lunaclient\halog"

           HA Log path successfully set to C:\Program Files\Safenet\Lunaclient\halog.

   Command Result : No Error
   ```

2. [Optional] Set the maximum length for individual log files.

   lunacm:> **hagroup halog -maxlength** <max_file_length>

   ```
   lunacm:> hagroup halog -maxlength 500000

           HA Log maximum file size was successfully set to 500000.

   Command Result : No Error
   ```

3. [Optional] Enable or disable HA logging at any time.

lunacm:> **hagroup halog -disable**

lunacm:> **hagroup halog -enable**

```
lunacm:> hagroup halog -disable

        HA Log was successfully disabled.

Command Result : No Error
```

4. [Optional] View the current status of the HA logging configuration.

   lunacm:> **hagroup halog -show**

```
lunacm:> hagroup halog -show

         HA Log: enabled
       Log File: C:\Program Files\Safenet\Lunaclient\halog\haErrorLog.txt
Max File Length: 500000 bytes

Command Result : No Error
```

HA Log Messages

The following table provides descriptions of the messages generated by the HA sub-system and saved to the HA log. The HA log is saved to the location specified by **haLogPath** in the **Chrystoki.conf** (Linux/Unix) or **crystoki.ini** (Windows) file.

Message Format

Every HA log message has a consistent prefix consisting of the date, time, process id, and serial number (of the affected HA group). For example:

```
Wed Oct  4 16:29:21 2017 : [17469] HA group: 11234840370164 …
```

Message Descriptions

In the message descriptions, the term **connection** refers to the connection between the Luna HSM Client and the Luna Network HSM 7 appliance. A connection is considered **valid** if the appliance responds correctly on the IP address and port. The connection can transition to **invalid** for a number of reasons. Some examples include if the appliance Ethernet cable is detached, if the appliance is shutdown/rebooted, or if the NTLS service is stopped/restarted.

Message ID	Message/Description
HALOG_CONFIGURED_AS_PASSWORD	`<MessagePrefix> configured as a "PASSWORD Based" virtual device` **Description:** Message advising that the virtual partition is password-authenticated. This means that you cannot add a PED-authenticated member to the group.
HALOG_CONFIGURED_AS_PED	`<MessagePrefix> configured as a "PED Based" virtual device` **Description:** Message advising that the virtual partition is PED-authenticated. This means that you cannot add a password-authenticated member to the group.

Message ID	Message/Description
HALOG_DROPMEMBER	`<MessagePrefix> has dropped member: <SerialNumber>` **Description:** The connection changed from valid to invalid, determined after an HSM command (such as C_Sign) fails.
HALOG_ DROPUNRECOVERABLE	`<MessagePrefix> unable to reach member: <SerialNumber>. Manual Recover or Auto Recovery will be able to recover this member` **Description:** The connection is invalid, as determined during a call to C_ Initialize.
HALOG_LOGINFAILED	`<MessagePrefix> can not login to member: <SerialNumber>, autorecovery will be disabled. Code: <ErrorCodeHex> : <ErrorCodeString>` **Description:** The connection changed from valid to invalid, as determined during a call to C_Login.
HALOG_MEMBER_ DEACTIVATED	`<MessagePrefix> member: <SerialNumber> deactivated` **Description:** The user manually deactivated the partition, as determined after an HSM command (such as C_Sign) fails.
HALOG_MEMBER_NOW_ ACTIVATED	`<MessagePrefix> recovery attempt <AttemptNumber> member <SerialNumber> is now activated and will be reintroduce back into the HA group.` **Description:** Additional info about the recovered partition, which was deactivated and is now becoming activated.
HALOG_MEMBER_ REVOKED	`<MessagePrefix> member: <SerialNumber> revoked` **Description:** The user manually revoked the partition, as determined during a periodic recovery attempt.
HALOG_MEMBERS_ OFFLINE	`<MessagePrefix> all members gone offline.` **Description:** A situation where all members go offline. Recovery is not possible at this point.
HALOG_MGMT_THREAD_ START	`<MessagePrefix> management thread started` **Description:** This thread is responsible for managing all members and HA in general while the HA group is active. The thread starts up when the application first launches.
HALOG_MGMT_THREAD_ TERMINATE	`<MessagePrefix> management thread terminated` **Description:** This thread is responsible for managing all members and HA in general while the HA group is active. If the client application shuts down, this thread will simply terminate. The thread will start up again once the application re-launches.
HALOG_NEWMEMBER	`<MessagePrefix> detected new member member: <SerialNumber>` **Description:** The user manually added a member to the HA group without restarting the application, as determined during a periodic recovery attempt.

Message ID	Message/Description
HALOG_RECOVERED	`<MessagePrefix> recovery attempt <Integer> succeeded for member: <SerialNumber>` **Description:** The connection changed from invalid to valid, as determined during a periodic recovery attempt.
HALOG_RECOVERY_ ATTEMPT_#_ REINTRODUCING	`<MessagePrefix> recovery attempt <AttemptNumber> reintroducing <Number> token objects to recovered token <TokenNumber>` **Description:** Additional info about the recovered partition at which some objects were cloned.

HALOG_RECOVERYFAILED	`<MessagePrefix> recovery attempt <Integer> failed for member: <SerialNumber>. Code: <ErrorCodeHex> : <ErrorCodeString>.`
	If autorecovery fails, then a second message is logged, as follows:
	`<MessagePrefix> exceeded maximum number of autorecovery attempts for member: <SerialNumber>. Autorecovery will be disabled`
	Description: The connection remains invalid, as determined during a periodic recovery attempt.

HALOG_RENABLEMEMBER (deprecated)	`<MessagePrefix> Re-enable auto recovery process for member: <SerialNumber>` **Description:** The user manually requested partition recovery, as determined during a periodic recovery attempt before an HSM command.
HALOG_UNRECOVERABLE (deprecated)	`<MessagePrefix> recovery attempt <Integer> failed for member: <SerialNumber>. Manual Recover or Auto Recovery will not be able to recover this member. Code: <ErrorCodeHex> : <ErrorCodeString>` **Description:** The connection is invalid and is not eligible for recovery.
No ID*	`<MessagePrefix> member <SerialNumber> is not activated and is excluded from the HA group` **Description:** The HA member was not activated at the time when a C_Initialize call was made, and is therefore excluded from the HA group. Once the partition is activated, the HA group will attempt an automatic recovery, resulting in one of the two messages below
No ID*	`<MessagePrefix> recovery attempt <SerialNumber> is not activated and cannot be reintroduced back into the HA group\n` **Description:** Recovery failed
No ID*	`<MessagePrefix> recovery attempt <SerialNumber> is now activated and will be reintroduce back into the HA group.\n` **Description:** Recovery succeeded

* You might encounter these extra messages in the HA logs. They were added for HA development testing and therefore have no Message IDs assigned to them. They could duplicate information covered by other log messages as defined above.

Adding/Removing an HA Group Member

You can add a new member to an HA group at any time using LunaCM, even if your application is running. Cryptographic objects will be replicated on the new partition and operations will be scheduled according to the load-balancing algorithm (see "Load Balancing" on page 234).

Likewise, you can remove a member at any time, and currently-scheduled operations will fail over to the rest of the group members (see "Failover" on page 236).

> **NOTE** If you remove the partition that was used to create the group, the HA group serial number changes to reflect this. This is to prevent another HA group from being assigned the same serial number as the original. If your application queries the HA group serial number, it must redirect operations to the new serial.

Prerequisites

The new member partition must:

- be assigned to the client and visible in LunaCM
- be initialized with the same domain string/red domain PED key as the other partitions in the group
- have the Crypto Officer role initialized with the same credentials as the other partitions in the group
- be activated and have auto-activation enabled (multifactor quorum-authenticated)

> **NOTE** **V1 partitions:** If you add an application partition with an existing SMK to an HA group, the primary member's SMK overwrites the existing SMK of the joining partition.
>
> If a partition's SMK has ever been used to encrypt important SKS objects, save a backup of the SMK before adding that partition to any HA group.

To add an HA group member

1. Open LunaCM on the client workstation and ensure that the new partition is visible.

```
lunacm (64-bit) v7.3.0. Copyright (c) 2018 SafeNet. All rights reserved.


        Available HSMs:

        Slot Id ->              0
        Label ->                par0
        Serial Number ->        154438865287
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning
Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              1
        Label ->                par1
        Serial Number ->        1238700701509
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning
```

```
Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              2
        Label ->                par2
        Serial Number ->        2855496365544
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning
Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              5
        HSM Label ->            myHAgroup
        HSM Serial Number ->    1154438865287
        HSM Model ->            LunaVirtual
        HSM Firmware Version -> 7.3.0
        HSM Configuration ->    Luna Virtual HSM (PW) Key Export With Cloning Mode
        HSM Status ->           N/A - HA Group


Current Slot Id: 0
```

2. Add the new partition to the HA group by specifying either the slot or the serial number. You are prompted for the Crypto Officer password/challenge secret.

   lunacm:> **hagroup addmember** **-group** <label> {**-slot** <slotnum> | **-serial** <serialnum>}

```
lunacm:> hagroup addmember -group myHAgroup -slot 2

        Enter the password: ********
        Member 2855496365544 successfully added to group myHAgroup. New group
        configuration is:

         HA Group Label:  myHAgroup
        HA Group Number:  1154438865287
       HA Group Slot ID:  5
       Synchronization: enabled
          Group Members:  154438865287, 1238700701509, 2855496365544
              Needs sync:  no
        Standby Members:  <none>


Slot #    Member S/N                      Member Label    Status
======    ==========                      ============    ======
     0  154438865287                              par0     alive
     1  1238700701509                              par1     alive
     2  2855496365544                              par2     alive


        Please use the command "ha synchronize" when you are ready
        to replicate data between all members of the HA group.
        (If you have additional members to add, you may wish to wait
        until you have added them before synchronizing to save time by
        avoiding multiple synchronizations.)

Command Result : No Error
```

To remove an HA group member

1. Remove the partition from the group by specifying either the slot or the serial number.

   lunacm:> **hagroup removemember** **-group** <label> {**-slot** <slotnum> | **-serial** <serialnum>}

```
lunacm:> hagroup removemember -group myHAgroup -slot 0

        Member 154438865287 successfully removed from group myHAgroup.


        Note: Serial number for the group changed to 11238700701509.
Command Result : No Error
```

> **NOTE** If you remove the partition that was used to create the group, the HA group serial number changes to reflect this. This is to prevent another HA group from being assigned the same serial number as the original. If your application queries the HA group serial number, it must redirect operations to the new serial.

   LunaCM restarts.

```
lunacm (64-bit) v7.3.0. Copyright (c) 2018 SafeNet. All rights reserved.


        Available HSMs:

        Slot Id ->              0
        Label ->                par0
        Serial Number ->        154438865287
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning
Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              1
        Label ->                par1
        Serial Number ->        1238700701509
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning
Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              2
        Label ->                par2
        Serial Number ->        2855496365544
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning
Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              5
        HSM Label ->            myHAgroup
        HSM Serial Number ->    11238700701509
        HSM Model ->            LunaVirtual
```

```
        HSM Firmware Version -> 7.3.0
        HSM Configuration ->    Luna Virtual HSM (PW) Key Export With Cloning Mode
        HSM Status ->           N/A - HA Group


Current Slot Id: 0
```

2. [Optional] Check that the partition was removed from the group.

   lunacm:> **hagroup listgroups**

Manually Recovering a Failed HA Group Member

Thales recommends using auto-recovery for all HA group configurations (see "Configuring HA Auto-Recovery" on page 251). If you do not enable auto-recovery and a member partition fails, or if the recovery retry count expires before the partition comes back online, you must recover the partition manually using LunaCM. You do not need to pause your application(s) to perform a manual recovery; the HA group handles load-balancing and automatically replicates any new or changed keys to the recovered member.

To perform a manual recovery of a failed HA group member

1. [Optional] Ensure that the failed member is available and visible in LunaCM by addressing the problem that caused the failure. Display the HA group to see the failed members. You are prompted for the Crypto Officer password/challenge secret.

   lunacm:> **hagroup listgroups**

```
         HA Group Label:  myHAgroup
        HA Group Number:  1154438865287
       HA Group Slot ID:  5
       Synchronization: enabled
          Group Members:  154438865287, 1238700701509
             Needs sync:  no
        Standby Members:  <none>


Slot #    Member S/N                      Member Label    Status
======    ==========                      ============    ======
------  154438865287                              par0     alive
------  1238700701509                      ------------      down
```

2. If you are using a multifactor quorum-authenticated partition with auto-activation disabled, or if the partition was down for longer than two hours, log in to the partition as Crypto Officer and present the black CO PED key.

   lunacm:> **slot set -slot** <slotnum>

   lunacm:> **role login -name co**

3. Execute the manual recovery command, specifying the HA group label.

   lunacm:>**hagroup recover**

   If you have an application running on the HA group, the failed members will be recovered the next time an operation is scheduled. Load-balancing and key replication is automatic.

4. If you do not currently have an application running, you can manually synchronize the contents of the HA group.

> **CAUTION!** Never use manual synchronization if you have an application running. The HA group performs this automatically. Using this command on an HA group that is running an application could create conflicting key versions.

lunacm:> **hagroup synchronize -group** <label>

Replacing an HA Group Member

Sometimes an HSM failure is permanent (from the perspective of the HA group). For example, if the HSM is re-initialized, the member partition is erased and must be recreated. In this case, you can recreate a partition on the same HSM or another HSM, and deploy the new member to the group. You do not need to pause your application to replace an HA group member.

Prerequisites

The Crypto Officer must complete this procedure, but any new member partition must first be created and assigned to the client by the HSM SO, and initialized by the Partition SO. All the prerequisites listed in "Setting Up an HA Group" on page 243 must be met.

> **NOTE V1 partitions:** If you add an application partition with an existing SMK to an HA group, the primary member's SMK overwrites the existing SMK of the joining partition.
>
> If a partition's SMK has ever been used to encrypt important SKS objects, save a backup of the SMK before adding that partition to any HA group.

To replace an HA group member

1. [Optional] Display the HA group to see the failed member. You are prompted for the Crypto Officer password/challenge secret.

   lunacm:> **hagroup listgroups**

```
          HA Group Label:  myHAgroup
         HA Group Number:  1154438865287
        HA Group Slot ID:  5
        Synchronization: enabled
           Group Members:  154438865287, 1238700701509
              Needs sync:  no
         Standby Members:  <none>


Slot #    Member S/N                      Member Label    Status
======    ==========                      ============    ======
------  154438865287                             par0     alive
------  1238700701509                     ------------      down
```

2. Prepare the new HA group member, whether that means creating a new partition on the original HSM or configuring a new Luna PCIe HSM 7, and assign the new partition to the HA client. Ensure that the new

member partition and the HSM on which it resides meet the prerequisites outlined in "Setting Up an HA Group" on page 243 and is visible in LunaCM.

```
lunacm (64-bit) v7.3.0. Copyright (c) 2018 SafeNet. All rights reserved.


        Available HSMs:

        Slot Id ->              0
        Label ->                par0
        Serial Number ->        154438865287
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning
Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              1
        Label ->                par1
        Serial Number ->        1238700701510
        Model ->                LunaSA 7.3.0
        Firmware Version ->     7.3.0
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning
Mode
        Slot Description ->     Net Token Slot

        Slot Id ->              5
        HSM Label ->            myHAgroup
        HSM Serial Number ->    1154438865287
        HSM Model ->            LunaVirtual
        HSM Firmware Version -> 7.3.0
        HSM Configuration ->    Luna Virtual HSM (PW) Key Export With Cloning Mode
        HSM Status ->           N/A - HA Group


Current Slot Id: 0
```

3. Add the new partition to the HA group by specifying either the slot or the serial number. You are prompted for the Crypto Officer password/challenge secret.

   lunacm:> **hagroup addmember -group** <label> {**-slot** <slotnum> | **-serial** <serialnum>}

```
lunacm:> hagroup addmember -group myHAgroup -slot 1

        Enter the password: ********
        Member 1238700701510 successfully added to group myHAgroup. New group
        configuration is:

         HA Group Label:  myHAgroup
        HA Group Number:  1154438865287
       HA Group Slot ID:  5
       Synchronization: enabled
          Group Members:  154438865287, 1238700701509, 1238700701510
             Needs sync:  no
        Standby Members:  <none>


Slot #    Member S/N                      Member Label    Status
======    ==========                      ============    ======
```

```
     0  154438865287                              par0     alive
------  1238700701509                        ------------      down
     1  1238700701510                             par1     alive


        Please use the command "ha synchronize" when you are ready
        to replicate data between all members of the HA group.
        (If you have additional members to add, you may wish to wait
        until you have added them before synchronizing to save time by
        avoiding multiple synchronizations.)

Command Result : No Error
```

The new partition is now an active member of the HA group. If you have an application currently running, cryptographic objects are automatically replicated to the new member and it is assigned operations according to the load-balancing algorithm.

4. Remove the old partition from the group by specifying the serial number.

   lunacm:> **hagroup removemember -group** <label> **-serial** <serialnum>

   LunaCM restarts.

5. [Optional] If you do not currently have an application running, you can manually synchronize the contents of the HA group.

   > **CAUTION!** Never use manual synchronization if you have an application running. The HA group performs this automatically. Using this command on an HA group that is running an application could create conflicting key versions.

   lunacm:> **hagroup synchronize -group** <label>

6. [Optional] If you intend to have the new partition serve as a standby member, see "Setting an HA Group Member to Standby" on page 249.

Deleting an HA Group

Use LunaCM to delete an HA group from your configuration.

> **NOTE** This procedure only removes the HA group virtual slot; the member partitions and all their contents remain intact. Only the HSM SO can delete individual partitions.

To delete an HA group

1. Stop any applications currently using the HA group.
2. Delete the group by specifying its label (see **hagroup listgroups**).

   lunacm:> **hagroup deletegroup -label** <label>

```
lunacm:> hagroup deletegroup -label myHAgroup

        The HA group myHAgroup was successfully deleted.
Command Result : No Error
```

Changing passwords for an HA group

Changing CO passwords has previously been an operation performed on a single HSM application partition by means of the role changepw command, which is fine for situations where a partition is used in stand-alone fashion. HA groups require all member partitions to have the same password. Performing the multiple operations in quick sequence invites human error. Changing the password of one member, while an HA group is in use in a production scenario, breaks the group functionality.

The usual approach has been to individually remove all but one member, change their passwords while they are not part of the group, change the password of the single member in the group, and then re-add the other members, one-by-one, which is labor-intensive and leaves the operation of your application at risk with diminished or no redundancy until the group membership is restored.

Beginning with Luna HSM Client version 10.7.0, the partition changepw [for HA] command is added to LunaCM, to change the passwords for an entire HA group, quickly and efficiently, with minimum disruption and downtime. This is especially significant where organizational security regimes mandate regular rotation of credentials.

The **partition changepw** command operates on the current virtual slot for the HA group, to perform password change for the entire group.

For description of command options see partition changepw [for HA].

Caveats

If your application generates new connections during the execution of the group CO password change, some authentication failures could occur, in which case see below for appropriate responses. If you are sure that no such new-connection attempts will be made (since you control your application), you could use the **-noRollback** option. Otherwise, we suggest that allowing the automatic rollback of an interrupted/failed PW change for a group is the best option, so that you can simply try again. With -noRollback, the members are in whatever old/new password state they attained before the update failure, and any new connections are refused until the mismatch of passwords within the group is corrected.

Change the password for an HA group

Prerequisites

The HA group is functional.

All members are connected.

To change the CO password on all members of an HA group

1. On your client, open lunacm.

```
lunacm (64-bit) v10.7.0. Copyright (c) 2023 Thales Group. All rights reserved.


        Available HSMs:

        Slot Id ->              0
        Label ->                par
        Serial Number ->        1385675017771
        Model ->                LunaSA 7.8.4
        Firmware Version ->     7.8.4
```

```
        Bootloader Version ->   1.1.5
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning
  Mode
        Slot Description ->     Net Token Slot
        FM HW Status ->         FM Ready

        Slot Id ->              1
        Label ->                par1
        Serial Number ->        1238696044902
        Model ->                LunaSA 7.8.4
        Firmware Version ->     7.8.4
        Bootloader Version ->   1.1.5
        Configuration ->        Luna User Partition With SO (PW) Key Export With Cloning
  Mode
        Slot Description ->     Net Token Slot
        FM HW Status ->         FM Ready

        Slot Id ->              2
        HSM Label ->            HA
        HSM Serial Number ->    11385675017771
        HSM Model ->            LunaVirtual
        HSM Firmware Version -> 7.8.4
        HSM Configuration ->    Luna Virtual HSM (PW) Key Export With Cloning Mode
        HSM Status ->           N/A - HA Group
        HSM Certificates ->     *** Test Certs ***
```

2. Select the virtual slot of the HA group.

```
lunacm> slot set slot 2
```

3. Use the partition changePw command to launch password change for all of the HSM partitions managed by the HA virtual slot.

```
lunacm> partition changePw -n co -oldPw userpin123 -newPw userpin1234 -logoutOther

  Confirming all members of HA are online... [OK]

  Confirming all members of HA can be logged into... [OK]

  Changing password of all members of HA group... [OK]

  Final summary of members:


Member S/N           Member Label                  Password Status
==========           ============                  ===============
1213473506146        LNH_143.184_NTLS_v0_par1      Changed
91351086532          LNH_10.202_NTLS_v0_par1       Changed

Command Result : No Error
```

What to do in the event of a failure

Failure of the initial check

```
lunacm> partition changePw -n co -oldPw userpin123 -newPw userpin1234 -logoutOther

        Confirming all members of HA are online... [OK]
```

```
        Confirming all members of HA can be logged into... [FAILED]

        Failed at member: 1213473506146

        The role is logged out due to incorrect old password.

        Final summary of members:


Member S/N            Member Label                   Password Status
=========             ============                   ===============
1213473506146         LNH_143.184_NTLS_v0_par1       Unchanged
91351086532           LNH_10.202_NTLS_v0_par1        Unchanged

Command Result : 0xa0 (CKR_PIN_INCORRECT)
```

Response: ensure that all members are logged in and redo. If any member cannot be corrected and logged in, then remove it from the group, proceed with the remaining members, and afterward add the failed member or a new/replacement member that has the new group CO password.

Unsuccessful password change on all members with the -noRollback flag specified

```
 lunacm> partition changePw -n co -oldPw userpin123 -newPw userpin1234 -noRollback

         Confirming all members of HA are online... [OK]

         Confirming all members of HA can be logged into... [OK]

         Changing password of all members of HA group... [FAILED]

         The following member(s) failed: 91351086532

         The role is logged out due to incorrect old password.

         Final summary of members:


Member S/N            Member Label                   Password Status
==========            ============                   ===============
1213473506146         LNH_143.184_NTLS_v0_par1       Changed
91351086532           LNH_10.202_NTLS_v0_par1        Unchanged

Command Result : 0xa0 (CKR_PIN_INCORRECT)
```

Response: Change the password for the partition that failed. Use **partition changePw** with the **-memberlist** option and the serial number of the failed partition. Until you do that, existing crypto operations against the group continue uninterrupted, because the prior session (using the oldPw) has not closed, but any attempt at a new operation against the virtual slot will fail while any members do not have the updated newPw.

Unsuccessful password change *without* the -noRollback flag specified, and a successful rollback

```
lunacm> partition changePw -n co -oldPw userpin123 -newPw userpin1234

        Confirming all members of HA are online... [OK]

        Confirming all members of HA can be logged into... [OK]

        Changing password of all members of HA group... [FAILED]
```

```
        Failed at member: 91351086532

        Rolling back members to old password... [OK]

        Members have successfully been rolled back to their original password.

        The role is logged out due to incorrect old password.

        Final summary of members:


Member S/N            Member Label                  Password Status
==========            ============                  ===============
1213473506146         LNH_143.184_NTLS_v0_par1      Unchanged
91351086532           LNH_10.202_NTLS_v0_par1       Unchanged

Command Result : 0xa0 (CKR_PIN_INCORRECT)
```

Response: remove the failed member from the HA group and try again. The remaining members can function with your client application both before and after a successful group password change. The failed one[former] member can be diagnosed and corrected, while separated from the group, then have its password updated so it can rejoin the group at your convenience.

Monitoring HA Status

Rapid HA group status checking

To check the status of HA group members, the old PKCS#11 Extensions function `CA_GetHAState` has been superseded by `CA_GetCurrentHaState()`, which is invoked programmatically and is demonstrated by CKDemo option 49, as in the following example.

Environment Requirements

When an HA group member becomes unavailable, the `CA_GetCurrentHaState()` function (once called) detects its unavailability within 3 seconds (in optimal conditions, depending on various factors including network hazards). For performance near the speed that was verified in testing, your operational environment must embody good IT conditions (network, CPU, RAM, storage) and reasonable perturbations (<=20% of optimal conditions). When those conditions are met, `CA_GetCurrentHaState()` can be repeated quickly and continually for ongoing monitoring. Requires Luna HSM Client 10.7.0 or newer.

When a previously unavailable HA group member becomes available again, the recovery process must detect the member and then confirm that it can be used for PKCS#11 operations. The recovery process is affected by several configuration file parameters, including AutoReconnectInterval and statusTimeout; if the status takes longer than the time specified by **statusTimeout**, the API terminates and reports the status of all members fetched so far.

Example of HA Current Status check using CKDemo

Assume that the group (12 members in this example) is already created and the Crypto Officer is logged in.

1. Initially, all members are connected and working. Check the status.

```
(TITLE) menu titles, (99 or FULL) Full Help, (NONE) No help, (0 or EXIT) Quit


Status: Doing great, no errors (CKR_OK)
Enter your choice : 49

Slots available:
        slot#0 - Net Token Slot
        slot#1 - Net Token Slot
        slot#2 - Net Token Slot
        slot#3 - Net Token Slot
        slot#4 - Net Token Slot
        slot#5 - Net Token Slot
        slot#6 - Net Token Slot
        slot#7 - Net Token Slot
        slot#8 - Net Token Slot
        slot#9 - Net Token Slot
        slot#10 - Net Token Slot
        slot#11 - Net Token Slot
        slot#12 - Net Token Slot
        slot#19 - HA Virtual Card Slot
Select a slot (last selected slot = 19): 19

HA group 11327020333032 status:

     HSM 1327020333032   - CKR_OK
     HSM 1327024989635   - CKR_OK
     HSM 1378778575417   - CKR_OK
     HSM 1378780903721   - CKR_OK
     HSM 1305890956073   - CKR_OK
     HSM 1305921224055   - CKR_OK
     HSM 1372948497179   - CKR_OK
     HSM 1459759386390   - CKR_OK
     HSM 1238656463702   - CKR_OK
     HSM 1485871338183   - CKR_OK
     HSM 1358801709927   - CKR_OK
     HSM 1259264300119   - CKR_OK
     HSM 1382217483713   - CKR_OK
Status: Doing great, no errors (CKR_OK)
```

2. Some members are disconnected or disabled, and the scan is repeated.

```
Enter your choice : 49

Slots available:
        slot#0 - Net Token Slot
        slot#1 - Net Token Slot
        slot#2 - Net Token Slot
        slot#3 - Net Token Slot
        slot#4 - Net Token Slot
        slot#5 - Net Token Slot
        slot#6 - Net Token Slot
        slot#7 - Net Token Slot
        slot#8 - Net Token Slot
        slot#9 - Net Token Slot
        slot#10 - Net Token Slot
        slot#11 - Net Token Slot
        slot#12 - Net Token Slot
        slot#19 - HA Virtual Card Slot
```

```
Select a slot (last selected slot = 19): 19

HA group 11327020333032 status:

     HSM 1327020333032   - CKR_OK
     HSM 1327024989635   - CKR_OK
     HSM 1378778575417   - CKR_TOKEN_NOT_PRESENT
     HSM 1378780903721   - CKR_TOKEN_NOT_PRESENT
     HSM 1305890956073   - CKR_OK
     HSM 1305921224055   - CKR_OK
     HSM 1372948497179   - CKR_OK
     HSM 1459759386390   - CKR_TOKEN_NOT_PRESENT
     HSM 1238656463702   - CKR_TOKEN_NOT_PRESENT
     HSM 1485871338183   - CKR_TOKEN_NOT_PRESENT
     HSM 1358801709927   - CKR_TOKEN_NOT_PRESENT
     HSM 1259264300119   - CKR_OK
     HSM 1382217483713   - CKR_TOKEN_NOT_PRESENT
Status: Doing great, no errors (CKR_OK)
```

The HA group remains in operation, with reduced functional members, with non-functional members identified.

Assume that the connection, routing, or other problems are corrected, as indicated by log entries...

```
Mon Nov 27 16:56:28 2023 : [14686] HA group: 11327020333032 recovery attempt #3 succeeded
for member: 1378778575417
Mon Nov 27 16:56:31 2023 : [14686] HA group: 11327020333032 recovery attempt #3 succeeded
for member: 1378780903721
Mon Nov 27 16:56:33 2023 : [14686] HA group: 11327020333032 recovery attempt #3 succeeded
for member: 1459759386390
Mon Nov 27 16:56:35 2023 : [14686] HA group: 11327020333032 recovery attempt #3 succeeded
for member: 1238656463702
Mon Nov 27 16:56:38 2023 : [14686] HA group: 11327020333032 recovery attempt #3 succeeded
for member: 1485871338183
Mon Nov 27 16:56:41 2023 : [14686] HA group: 11327020333032 recovery attempt #3 succeeded
for member: 1358801709927
Mon Nov 27 16:56:48 2023 : [14686] HA group: 11327020333032 recovery attempt #5 succeeded
for member: 1382217483713
```

3. Check status again.

> **NOTE** Checking could have been performed every few seconds while corrective actions were in progress.

```
Enter your choice : 49

Slots available:
        slot#0 - Net Token Slot
        slot#1 - Net Token Slot
        slot#2 - Net Token Slot
        slot#3 - Net Token Slot
        slot#4 - Net Token Slot
        slot#5 - Net Token Slot
        slot#6 - Net Token Slot
        slot#7 - Net Token Slot
        slot#8 - Net Token Slot
        slot#9 - Net Token Slot
        slot#10 - Net Token Slot
```

```
        slot#11 - Net Token Slot
        slot#12 - Net Token Slot
        slot#19 - HA Virtual Card Slot
Select a slot (last selected slot = 19): 19

HA group 11327020333032 status:

     HSM 1327020333032   - CKR_OK
     HSM 1327024989635   - CKR_OK
     HSM 1378778575417   - CKR_OK
     HSM 1378780903721   - CKR_OK
     HSM 1305890956073   - CKR_OK
     HSM 1305921224055   - CKR_OK
     HSM 1372948497179   - CKR_OK
     HSM 1459759386390   - CKR_OK
     HSM 1238656463702   - CKR_OK
     HSM 1485871338183   - CKR_OK
     HSM 1358801709927   - CKR_OK
     HSM 1259264300119   - CKR_OK
     HSM 1382217483713   - CKR_OK
Status: Doing great, no errors (CKR_OK)

(TITLE) menu titles, (99 or FULL) Full Help, (NONE) No help, (0 or EXIT) Quit


Status: Doing great, no errors (CKR_OK)
Enter your choice :
```

And the log entries for that action say:

```
Mon Nov 27 16:56:59 2023 : [14686] HA group: 11327020333032 Initializing HA State API
Mon Nov 27 16:56:59 2023 : [14686] HA group: 11327020333032 Retrieved Current HA Status
```

HA Troubleshooting

If you encounter problems with an HA group, refer to this section.

Administration Tasks on HA Groups

Do not attempt to run administrative tasks on an HA group virtual slot (such as altering partition policies). These virtual slots are intended for cryptographic operations only. It is not possible to use an HA group to make administrative changes to all partitions in the group simultaneously; the exception is partition changepw for HA from Luna HSM Client 10.6.1 onward.

Unique Object IDs (OUID)

If two applications using the same HA group modify the same object using different members, the object fingerprint might conflict.

Client-Side Limitations

New features or abilities, or new cryptographic mechanisms added by firmware update, or previously usable mechanisms that become restricted for security reasons, can have an impact on the working of an HA group, when the Luna HSM Clientversion is older. Luna Clients are "universal" in the sense that they are able to work

fully with current Luna HSMs/partitions, and with earlier versions, as well as with cloud crypto solutions (DPoD Luna Cloud HSM service), but a client version cannot be aware of HSM versions that were not yet developed when the Client was released.

Client-Side Failures

Any failure of the client (such as operating system problems) that does not involve corruption or removal of files, should resolve itself when the client is rebooted.

If the client workstation seems to be working fine otherwise, but you have lost visibility of the HSMs in LunaCM or your client, try the following remedies:

> verify that the Thales drivers are running, and retry

> reboot the client workstation

> restore your client configuration from backup

> re-install Luna HSM Client and re-configure the HA group

For Luna PCIe HSM 7, the client is the HSM host. If HA has been working, any sudden failure is likely to be OS or driver related (restart) or file corruption (re-install). If a re-installation is necessary, you must recreate and reconfigure the HA group.

Avoid direct access to individual HA group members when securing with STC

Effect of Luna PED Operations

Luna PED operations can block some cryptographic operations, so that while a member of an HA group is performing a PED operation, it could appear to the HA group as a failed member. When the PED operation is complete, failover and recovery HA logic are invoked to return the member to normal operation.

Some security settings and implications

> **TIP Security Note -***Cloning policies (**0** and **4**)* permit or deny the ability to securely copy keys and objects into and out of a partition.
> The *Key Management Functions policy (**28**)* controls the ability to create, delete, generate, derive, or modify cryptographic objects in the current partition.
>
> These controls are independent of each other. With Key Management functions denied, you can still clone objects in and out of partitions where Cloning policy is allowed. Thus HA (high availability) operation can clone keys into a partition that disallows Key Management functions (creation, deletion, etc.). **Cloning a key or object into a partition is not considered creation** - the key or object already existed within the security / cloning domain that encompasses the partition.
>
> Ultimately the security administrators define where keys can exist by controlling distribution of the security / cloning domain, and by defining policies around those keys.
>
> Additionally, key owners can choose to make their keys non-modifiable and non-extractable, if those options are indicated by your use-case.

Guidelines and Recommendations For Updating or Converting HA Member Partitions

This section lists some general guidelines for users that are updating High Availability (HA) member partitions to a new firmware version or converting them to V0 or V1. Refer to the following relevant topics before reading the information in this section:

> Updating the Luna PCIe HSM 7 Firmware

> Special Considerations for Luna HSM Firmware 7.7.0 and Newer

> "V0 and V1 Partitions" on page 17

> "Converting Partitions from V0 to V1 or V1 to V0" on page 29

Adhere to the following guidelines and recommendations when you are updating or converting HA member partitions:

> Before beginning the update or conversion process, remove the partition from the HA group and stop all ongoing operations with HA.

> Update or convert members one at a time, leaving the primary member for last.

> **NOTE** You must update/convert secondary partitions first and the primary partition last. If you do not adhere to this guideline, you may experience issues while updating/converting.

> Resume HA group operation after *all* members have been updated or converted.

> If HA operation *cannot* be stopped for an update or conversion, you must be aware of the following constraints and guidelines:

- Expect HA functionality (with some caveats) when members have been updated, but not *during* firmware update to Luna HSM Firmware 7.7.0 (or newer) or *during* conversion of member partitions from V0 to V1.
- Thales does not recommend operating HA groups with mixed firmware and partition versions because the HA group will not work as expected. For proper HA functionality, all members of a working HA group should have the following properties:
  - Identical firmware versions. As a result, firmware updates should take place while the partition is *not* a member of an HA group.
  - Identical partition types; that is, either all partitions are V0 or all partitions are V1. As a result, partition conversions to V0 (which happens as a result of updating from pre-7.7.0 firmware to Luna HSM Firmware 7.7.0 or newer) or V1 should take place while the partition is *not* a member of an HA group.
  - Identical history of functionality module (FM) deployment; that is, either all members are FM-enabled or all members are FM-never-enabled, but not some of each.
- Converting a partition from V1 to V0 is destructive, so the partition *cannot* remain an HA member.
- Cloning of keys and objects can proceed only from a lower-security environment to a higher-security environment but not in the other direction; that is, cloning of keys and objects can proceed in the following directions:
  - Older firmware to newer firmware.
  - Pre-7.7.0 partitions to V0 partitions.

- V0 partitions to V1 partitions.
- Partitions of an HSM that has had FMs enabled to partitions that have never had functionality modules enabled.

The above constraint has implications for the update and conversion process; that is, the primary partition must be at the same firmware and partition version as the remaining HA member partitions, or lower. If this requirement is not met, attempts to synchronize the HA group will fail. For example, V1 partition can be added to an existing HA group that already has HA members made up of partitions from a pre-7.7.0-firmware HSM. However, when V1 partition becomes the primary member of the HA group, synchronization with remaining member of the HA group will no longer function.

> For best results, the client library that enables HA among several HSMs should be up-to-date.

CHAPTER 12: Partition Backup and Restore

Luna PCIe HSM 7 allows secure creation, storage, and use of cryptographic data (keys and other objects). It is critically important to safeguard your important cryptographic objects against unforeseen damage or data loss. No device can offer total assurance against equipment failure, physical damage, or human error. Therefore, a comprehensive strategy for making regular backups is essential. There are multiple ways to perform these operations, depending on your implementation.

This section contains the following information:

> "Key Concepts for Backup and Restore Operations" below
- "Credentials Required to Perform Backup and Restore Operations" on the next page
- "Client Software Required to Perform Backup and Restore Operations" on the next page
- "Multifactor Quorum Authentication with Luna Backup HSM 7 v1" on page 280

> "Planning Your Backup HSM Deployment" on page 280

> "Backup and Restore Best Practices" on page 282

Luna PCIe HSM 7 can perform backup and restore operations using the legacy "Luna Backup HSM G5" on page 320, the updated "Luna Backup HSM 7" on page 284, or a "Backup to Luna Cloud HSM" on page 283 service. Refer to the section describing the variant you wish to use:

> "Backup to Luna Cloud HSM" on page 283

> "Luna Backup HSM 7" on page 284

> "Luna Backup HSM G5" on page 320

Key Concepts for Backup and Restore Operations

A Crypto Officer (CO) can use the backup HSM to back up and restore the objects in any partition they can log in to, provided that:

> The application partition and the backup HSM partition share the same domain.

> The application partition and the backup HSM use the same authentication method (multifactor quorum or password).

> The CO has the required credentials on the backup HSM.

You can perform backup/restore operations on your application partitions by connecting the backup HSM to the Luna HSM Client workstation. When you connect the backup HSM to a Luna HSM Client workstation, the backup HSM Admin partition is added to the slots listed in LunaCM, allowing you to clone objects between the source application partition and the target backup partition.

> **NOTE** To perform backup operations on Luna HSM Firmware 7.7.0 or newer (V0 or V1 partitions) you require at minimum:
>
> > Luna Backup HSM 7 Firmware 7.7.1
> >
> > Luna Backup HSM G5 Firmware 6.28.0
>
> You can use a Luna Backup HSM with older firmware to restore objects to a V0 or V1 partition, but this is supported for purposes of getting your objects from the older partitions onto the newer V0 or V1 partitions only. V0 and V1 partitions are considered more secure than partitions at earlier firmware versions - any attempt to restore from a higher-security status to lower-security status fails gracefully.

Backups are created and stored as partitions within the Admin partition on the backup HSM.

Credentials Required to Perform Backup and Restore Operations

You require the following credentials to perform backup/restore operations:

Luna PCIe HSM 7	**Remote PED (orange) PED key**. Required for multifactor quorum-authenticated backups only, using a local or remote Luna Backup HSM 7 v1, or a remote Luna Backup HSM G5 or Luna Backup HSM 7 v2.
Source Luna PCIe HSM 7 partition	**Crypto Officer (CO)**. Required to access the objects in the source application partition that will be backed up. **Domain**. Required to allow objects to be cloned between the sourceapplication partition and target backup partition. The domains for the source application partition and target backup partition must match, otherwise the backup will fail.
Target Backup HSM	**HSM Security Officer (SO)**. Required to create or access the target backup partition in the Admin slot, where all backups are archived. **Remote PED (orange) PED key**. Required for multifactor quorum-authenticated backups only, using a local or remote Luna Backup HSM 7 v1, or a remote Luna Backup HSM 7 v2 or Luna Backup HSM G5, to establish a remote PED connection to the HSM that hosts the target backup partition. **Note:** You create new credentials for both roles on HSM initialization, and use them for subsequent backups to the target backup HSM.
Target Backup Partition	**Partition Security Officer (PO)**. Required to access the target backup partition on a Luna Backup HSM 7. **Crypto Officer (CO)**. Required to access the objects in the target backup partition. **Note:** You create new credentials on the initial backup, and use them for subsequent backups to the target backup partition.

Client Software Required to Perform Backup and Restore Operations

You must install the Luna HSM Client software and USB driver for the backup HSM on the workstation you intend to use to perform backup and restore operations. The Luna Backup HSM 7 v1 requires minimum Luna HSM Client 10.1.0. The Luna Backup HSM 7 v2 requires minimum Luna HSM Client 10.4.0. Refer to Luna HSM Client Software Installation.

> **NOTE** Ensure that the backup HSM is not connected to the Luna HSM Client workstation when you install or uninstall the client software. Failure to do so may result in the backup HSM becoming unresponsive.

When you install the client software, you must select the following options:

- The **Backup** option. This installs the driver for the backup HSM and components required for the Remote Backup Service (RBS).
- The **USB** option. This installs the driver for the backup HSM.
- The **Network** and/or **PCIe** options, depending on which type of HSM you intend to back up.
- The **Remote PED** option, if you want to back up multifactor quorum-authenticated partitions. Note that you can install and use a remote PED on the same workstation used to host the backup HSM, or on a different workstation. This option is mandatory for the Luna Backup HSM 7 v1, but a local PED connection can be used for the Luna Backup HSM 7 v2 or Luna Backup HSM G5.

Multifactor Quorum Authentication with Luna Backup HSM 7 v1

The Luna Backup HSM 7 v1 is equipped with a single USB port that is used to connect the backup HSM to a Luna HSM Client workstation. As such, any PED connections to the backup HSM must use a remote PED and the **pedserver** service.

Planning Your Backup HSM Deployment

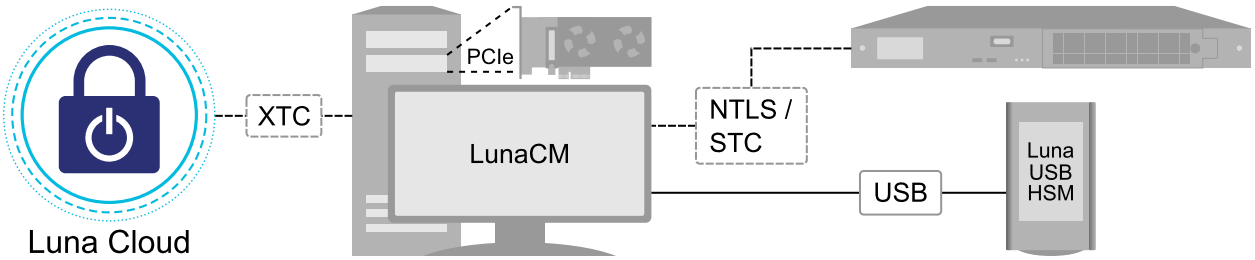
When setting up your backup deployment, you have multiple configuration options. This section will help you choose the right configuration, depending on where you prefer to keep your backups. You can use a Luna Backup HSM, Luna Cloud HSM service, or an application partition on another Luna HSM for backup/restore operations.

Backup and restore operations require that cloning be enabled.

- "Partition to Partition" below
- "Backup to Luna Cloud HSM" on the next page
- "Client Software Required to Perform Backup and Restore Operations" on the previous page
- "Backup HSM Installed Using Remote Backup Service" on page 282

Partition to Partition

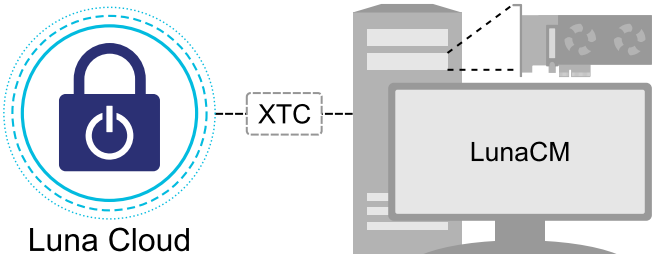
You can clone objects from any Luna 7 application partition to any other Luna 7 partition that shares its cloning domain. You must have the Crypto Officer credential for both partitions. Both partitions must use the same authentication method (either password or PED key).



See "Cloning Objects to Another Application Partition" on page 68.

Backup to Luna Cloud HSM

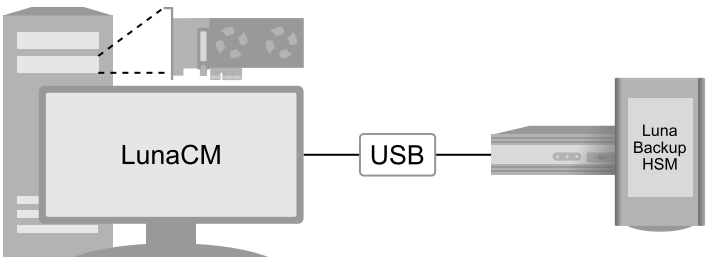
You can securely back up the contents of any password- or multifactor quorum-authenticated Luna 7 partition to a Luna Cloud HSM service.



See "Cloning Objects to Another Application Partition" on page 68.

Backup HSM Connected to the Client Workstation

In this configuration, the Luna Backup HSM is connected to a USB port on the client workstation. It is useful in deployments where the partition Crypto Officer keeps backups at the client. This allows you to perform backup/restore operations for all application partitions that appear as visible slots in LunaCM. You can restore a partition backup to the original source partition or to another existing Luna application partition that shares the same cloning domain.

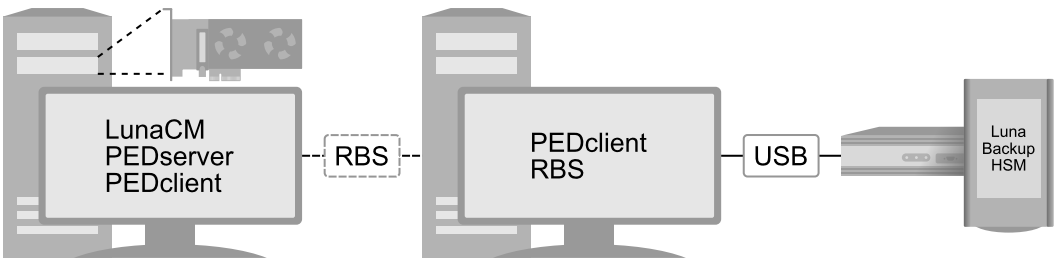


Depending on your Luna Backup HSM and Luna HSM Client version, refer to:

Hardware/Software Requirements	Available Procedures
> "Luna Backup HSM 7" on page 284 **v2** > Luna HSM Client 10.4.0 or newer	> "Luna Backup HSM 7 Using Direct Multifactor Quorum Authentication" on page 292 > "Luna Backup HSM 7 Using Remote Multifactor Quorum Authentication" on page 302 > "Luna Backup HSM 7 Using Password Authentication" on page 313
> "Luna Backup HSM 7" on page 284 **v1 or v2** > Luna HSM Client 10.1.0 or newer	> "Luna Backup HSM 7 Using Remote Multifactor Quorum Authentication" on page 302 > "Luna Backup HSM 7 Using Password Authentication" on page 313
> "Luna Backup HSM G5" on page 320	> "Backup/Restore Using Luna Backup HSM G5" on page 333

Backup HSM Installed Using Remote Backup Service

In this configuration, the Luna Backup HSM is connected to a remote client workstation that communicates with the Luna PCIe HSM 7 client via the Remote Backup Service (RBS). It is useful in deployments where backups are stored in a separate location from the Luna PCIe HSM 7, to mitigate the consequences of catastrophic loss (fire, flood, etc).



Refer to "Configuring a Remote Backup Server" on page 338.

Backup and Restore Best Practices

To ensure that your data is protected in the event of a failure or other catastrophic event, Thales recommends that you use the following best practices as part of a comprehensive backup strategy:

> **CAUTION!** Failure to develop and exercise a comprehensive backup and recovery plan may prevent you from being able to recover from a catastrophic event. Although Thales provides a robust set of backup hardware and utilities, we cannot guarantee the integrity of your backed-up key material, especially if stored for long periods. Thales strongly recommends that you exercise your recovery plan at least semi-annually (every six months) to ensure that you can fully recover your key material.

Develop and document a backup and recovery plan

This plan should include the following:

- What is being backed up
- The backup frequency
- Where the backups are stored
- Who is able to perform backup and restore operations
- Frequency of exercising the recovery test plan

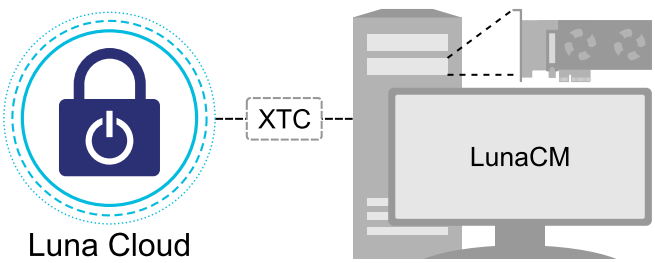
Make multiple backups
To ensure that your backups are always available, build redundancy into your backup procedures.

Use off-site storage
In the event of a local catastrophe, such as a flood or fire, you might lose both your working HSMs and locally-stored backup HSMs. To fully protect against such events, always store a copy of your backups at a remote location.

Regularly exercise your disaster recovery plan
Execute your recovery plan at least semi-annually (every six months) to ensure that you can fully recover your key material. This involves retrieving your stored Backup HSMs and restoring their contents to a test partition, to ensure that the data is intact and that your recovery plan works as documented.

Backup to Luna Cloud HSM

Luna Cloud HSM services allow you to back up your partition objects securely in the cloud, with no additional HSM hardware. With Universal Cloning(includes Extended Domain Management and CPv4, and requires Luna HSM Firmware 7.8.0 or newer for the on-premises HSM and Luna HSM Client 10.5.0 or newer), Luna Cloud HSM can now clone keys from both password-and multifactor quorum-authenticated Luna HSMs. You can create Luna Cloud HSM backups using slot-to-slot cloning, or set up an HA group to synchronize your partition contents with Luna Cloud HSM.



Refer to the following sections to set up and use this backup method:

- Adding a Luna Cloud HSM Service for instructions on adding and initializing Luna Cloud HSM for use with your deployment.
- "Cloning Objects to Another Application Partition" on page 68 for instructions on creating Luna Cloud HSM backups.
- "Setting Up an HA Group" on page 243 for instructions on setting up a synchronized Luna Cloud HSM service.

> "Cloning Keys Between Luna 6, Luna 7, and Luna Cloud HSM, Password or Multifactor Quorum" on page 76 for additional information about mixed-environment cloning.

Luna Backup HSM 7

The Luna Backup HSM 7 is a full-featured, hand-held, USB-attached backup HSM that includes an informational full-color display. The Luna Backup HSM 7 connects easily to a client workstation using the included USB 3.0 Type C cable, and includes a universal 5V external power supply, which may be required to power the device in some instances.

The refreshed v2 model includes a USB-C port, which, combined with a USB-A to USB-C adapter, allows you to insert PED keys directly into the HSM, greatly simplifying the multifactor quorum authentication procedure and, depending on your configuration, eliminating the need for a Luna PED in backup/restore operations.

The Luna Backup HSM 7 is available in the following models. All models can be initialized in multifactor quorum or password-authenticated mode for backing up either multifactor quorum or password authenticated partitions. In-field storage upgrades are not available.

B700	32 MB storage, up to 100 partitions of the same authentication type
B750	128 MB storage, up to 100 partitions of the same authentication type
B790	256 MB storage, up to 100 partitions of the same authentication type

For setup, management, and backup/restore procedures, refer to the following sections:

> "Luna Backup HSM 7 Hardware Installation" on the next page

> "Managing the Luna Backup HSM 7" on page 288

> "Configuring a Remote Backup Server" on page 338

Refer to the following procedures depending on your authentication method, Luna Backup HSM 7 hardware, and Luna HSM Client versions:

Multifactor Quorum Authentication

> "Luna Backup HSM 7 Using Direct Multifactor Quorum Authentication" on page 292 (requires "Luna Backup HSM 7" on the previous page **v2** and Luna HSM Client 10.4.0 or newer)

> "Luna Backup HSM 7 Using Remote Multifactor Quorum Authentication" on page 302 (requires Luna HSM Client 10.1.0 or newer)

Password Authentication

> "Luna Backup HSM 7 Using Password Authentication" on page 313 (requires Luna HSM Client 10.1.0 or newer)

Luna Backup HSM 7 Hardware Installation

The following topics describe how to install and connect a Luna Backup HSM 7:

> "Luna Backup HSM 7 Required Items" below

> "Luna Backup HSM 7 Hardware Functions" on page 287

> "Installing the Luna Backup HSM 7 Hardware" on page 288

The Luna Backup HSM 7 complies with the following:

Luna Backup HSM 7 Required Items

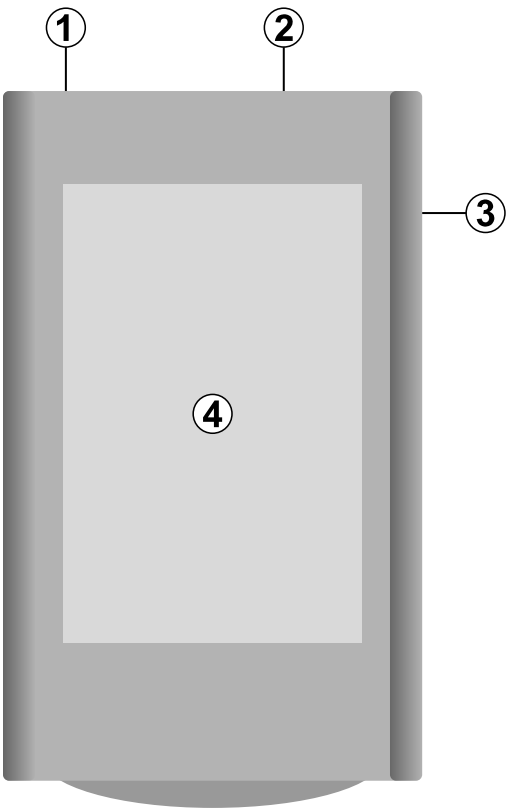
This section provides a list of the components you should have received with your Luna Backup HSM 7 order.

Qty	Item
1	**Luna Backup HSM 7 v1 or v2**
1	**USB 3.0 Cable: Type A to Type C**
1	**5V Power Supply** with replaceable plug modules for international use.

Qty	Item
1	**USB-A to USB-C adapter (included with v2 only)** Used to connect PED keys to the Luna Backup HSM 7 v2.

Luna Backup HSM 7 Hardware Functions

The Luna Backup HSM 7 hardware is illustrated below, with important features labeled.



1	5V power supply connector. Required only if the USB port connected to (**2**) does not supply adequate power to the Luna Backup HSM 7.
2	USB-C connector. Used for USB power and connecting to the client computer.
3	USB-C connector (v2 only). Used for connecting PED keys to authenticate roles on the HSM. Requires the included USB-A to USB-C adapter.
4	LED touchscreen. Displays information about the Luna Backup HSM 7 and is used to input role-specific information like PINs.

The Luna Backup HSM 7 does not contain an internal battery, and maintains the integrity of its stored key material without being connected to power.

Installing the Luna Backup HSM 7 Hardware

The backup HSM is a USB device. To install the backup HSM, connect it to a USB port on a Luna HSM Client workstation using the included USB cable. The workstation must be running Luna HSM Client software that supports the backup HSM and provides the required drivers.

> **NOTE** On most Luna HSM Client computers, the USB port provides adequate power, and connecting the provided power supply is not recommended. Wait and confirm that the HSM boots properly. If the HSM fails to boot up:
>
> **1.** Disconnect the HSM from the USB port.
>
> **2.** Connect the HSM to power using the provided power supply. Wait for it to boot completely.
>
> **3.** Reconnect the HSM to the USB port on the client.
>
> If the HSM is connected to the USB port before the power supply, you may encounter an issue where the HSM occasionally loses contact with the client, and must be power cycled.

> **NOTE** If you are installing Luna HSM Client on Windows, the driver may not be installed unless the Luna device is connected to the computer first; refer to Backup/USB/PCIe Drivers Not Installed on Windows 10 or Windows Server 2022 Unless Device is Connected.

Managing the Luna Backup HSM 7

This section contains the following procedures for maintaining and using the Luna Backup HSM 7:

> "Recovering the Luna Backup HSM 7 from Secure Transport Mode" below

> "Configuring the Luna Backup HSM 7 for FIPS Compliance" on the next page

> "Updating the Luna Backup HSM 7 Firmware" on page 290

> "Rolling Back the Luna Backup HSM 7 Firmware" on page 291

Recovering the Luna Backup HSM 7 from Secure Transport Mode

The Luna Backup HSM 7 is shipped in Secure Transport Mode (STM). STM provides a logical check on the firmware and critical security parameters (such as configuration, keys, policies, roles, etc.) so that the authorized recipient can determine if these have been altered while the HSM was in transit.

> **NOTE** This procedure requires connection to a client machine with Luna HSM Client 10.1.0 or newer installed. This operation is not possible while the Backup HSM is connected to the Luna Network HSM 7 appliance.

To recover the Luna Backup HSM 7 from STM

1. Connect the Luna Backup HSM 7 to a USB port on a Luna HSM Client workstation with the **Backup** option installed (refer to Luna HSM Client Software Installation for your client operating system).

2. Launch LunaCM on the client workstation.
3. Select the slot assigned to the Luna Backup HSM 7 Admin partition.

   lunacm:> **slot set -slot** <slot_id>
4. Recover the HSM from Secure Transport Mode. See Secure Transport Mode for more information about the Random User String:

   lunacm:> **stm recover -randomuserstring** <string>

> **NOTE** Recovering a Luna Backup HSM 7 from STM may take up to three minutes.

Configuring the Luna Backup HSM 7 for FIPS Compliance

Luna Backup HSM Firmware 7.7.1 and newer uses the same updated cloning protocol as Luna HSM Firmware 7.7.0 and newer. For the Luna Backup HSM 7 to be FIPS-compliant, it must restrict restore operations to application partitions that use the new protocol. This restriction is applied by setting **HSM policy 55: Enable Restricted Restore** to **1** on the backup HSM. The Luna Backup HSM 7 must be initialized and connected to a Luna HSM Client computer to set this policy.

When this policy is enabled on the Luna Backup HSM 7, objects that have been backed up from partitions using firmware older than Luna HSM Firmware 7.7.0 can be restored to Luna HSM Firmware 7.7.0 or newer (V0 or V1) partitions only.

> **CAUTION!** FIPS compliance requires that objects are never cloned or restored to an HSM using less secure firmware, and this includes restoring from Luna Backup HSM 7 firmware.
>
> If you have backups already stored on the Luna Backup HSM 7 that were taken from pre-7.7.0 partitions, turning this policy ON will prevent you from restoring them to the same source partition. You must update the HSM containing the source partition to Luna HSM Firmware 7.7.0 or newer before restoring from backup.

> **NOTE** **HSM policy 12: Allow non-FIPS algorithms**, which is used to set FIPS-compliant mode on other Luna HSMs, does not apply to the Luna Backup HSM 7. Attempts to change this policy will fail with the error `CKR_CANCEL`.

To configure the Luna Backup HSM 7 for FIPS compliance

1. On the Luna HSM Client computer, run LunaCM.
2. Set the active slot to the Luna Backup HSM 7.

   lunacm:> **slot set -slot** <slot_id>
3. Log in as Backup HSM SO.

   lunacm:> **role login -name so**
4. Set **HSM policy 55: Enable Restricted Restore** to **1**.

   lunacm:> **hsm changehsmpolicy -policy 55 -value 1**
5. [Optional] Check that the Luna Backup HSM 7 is now in FIPS approved operation mode.

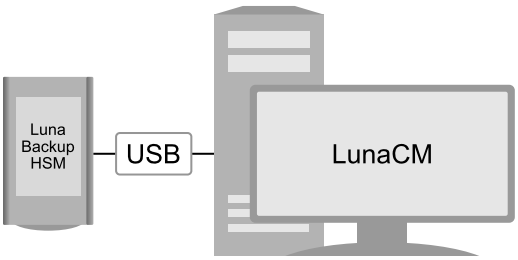
   lunacm:> **hsm showinfo**

```
*** The HSM is in FIPS 140-2 approved operation mode. ***
```

Updating the Luna Backup HSM 7 Firmware

To update the Luna Backup HSM 7, download the desired firmware version from the Thales Support Portal.

Use the following procedure to update the Luna Backup HSM 7 firmware using LunaCM. The Backup HSM SO must complete this procedure.



> **NOTE** This functionality requires minimum Luna HSM Client 10.3.0.

Prerequisites

> Luna Backup HSM 7 firmware update file (<filename>**.fuf**)

> firmware update authentication code file (<filename>**.txt**)

> If you have backups currently stored on the Backup HSM, they must take up less than 60% of storage capacity, or the firmware upgrade will not proceed.

> **NOTE** If you are updating from Luna Backup HSM 7 Firmware 7.3.2, objects and partitions must be re-sized to include additional object overhead associated with the new V1 partitions - this action is automatic (see "V0 and V1 Partitions" on page 17). This conversion can take a long times, depending on the number of objects stored on the Backup HSM (a few minutes to several hours). Ensure that you can leave the update operation uninterrupted for this amount of time. Do not interrupt the procedure even if the operation appears to have stalled.

To update the Luna Backup HSM 7 firmware using LunaCM

1. Copy the firmware file (<filename>**.fuf**) and the authentication code file (<filename>**.txt**) to the Luna HSM Client root directory.
   - Windows: C:\Program Files\SafeNet\LunaClient
   - Linux: /usr/safenet/lunaclient/bin
   - Solaris: /opt/safenet/lunaclient/bin

   > **NOTE** On some Windows configurations, you might not have authority to copy or unzip files directly into **C:\Program Files\...**. If this is the case, put the files in a known location that you can reference in a LunaCM command.

2. Launch LunaCM.
3. If more than one HSM is installed, set the active slot to the Admin partition of the HSM you wish to update.

lunacm:> **slot set -slot** <slot_number>

4. [Multifactor Quorum-Authenticated]
   - If you are updating a Luna Backup HSM 7 v2, you will insert PED keys directly into the Backup HSM; skip to step 5.
   - If you are updating a Luna Backup HSM 7 v1, connect to the Remote PED server.

     lunacm:> **ped connect** [**-ip** <IP_address>] [**-port** <port#>]
5. Log in as HSM SO.

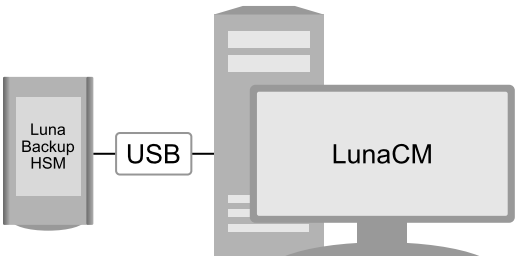
   lunacm:> **role login -name so**
6. Apply the new firmware update by specifying the update file and the authentication code file. If the files are not located in the Luna HSM Client root directory, specify the full filepaths.

   lunacm:> **hsm updatefw -fuf** <filename>**.fuf -authcode** <filename>**.txt**

The previous version of the firmware is stored in reserve on the HSM. To restore the previous firmware version, see "Rolling Back the Luna Backup HSM 7 Firmware" below.

Rolling Back the Luna Backup HSM 7 Firmware

When you update the Luna Backup HSM 7 firmware, the previous version of the firmware is stored in reserve on the HSM. If required, you can use the following procedure to roll back the HSM firmware to the previous version.



> **CAUTION!** Firmware rollback is destructive; earlier firmware versions might have older mechanisms and security vulnerabilities that a new version does not. Ensure that you do not have any important backups stored on the HSM before you proceed. This procedure zeroizes the HSM and all backups are erased.

Prerequisites

> Connect theLuna Backup HSM 7 to a Luna HSM Client workstation.

To roll back the Luna Backup HSM 7 firmware to the previous version

1. At the LunaCM prompt, set the active slot to the Backup HSM.

   lunacm:> **slot set -slot** <slot_number>
2. Check the previous firmware version that is available on the HSM.

   lunacm:> **hsm showinfo**
3. [Multifactor Quorum-Authenticated]

- If you are rolling back a Luna Backup HSM 7 v2, you can insert PED keys directly into the Backup HSM; skip to step 5.
- If you are rolling back a Luna Backup HSM 7 v1, connect to the Remote PED server.

  lunacm:> **ped connect** [**-ip** <IP_address>] [**-port** <port#>]

4. Log in as HSM SO.

   lunacm:> **role login -name so**

5. Roll back the Backup HSM firmware.

   lunacm:> **hsm rollbackfw**

Luna Backup HSM 7 Using Direct Multifactor Quorum Authentication

In this configuration, you connect the Luna Backup HSM 7 to a USB port on the Luna HSM Client, and insert PED keys directly into the Luna Backup HSM 7. This allows you to perform backup/restore operations for all application partitions that can be accessed by the client. You can restore a partition backup to the original source partition or to another existing Luna application partition that shares the same cloning domain. To use this method, you require:

> "Luna Backup HSM 7" on page 284 **v2**

> Luna HSM Client 10.4.0 or newer

This section provides instructions for the following procedures:

> "Initializing the Luna Backup HSM 7" below

> "Configuring the Luna Backup HSM 7 for FIPS Compliance" on page 294

> "Backing Up a Multifactor Quorum-Authenticated Partition" on page 295

> "Restoring To a Multifactor Quorum-Authenticated Partition" on page 299

Initializing the Luna Backup HSM 7

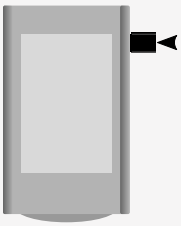
You must initialize the Luna Backup HSM 7 prior to first use. You can initialize the backup HSM by connecting it to a Luna HSM Client and using LunaCM commands to perform the initialization.

Prerequisites

You need the following PED keys:

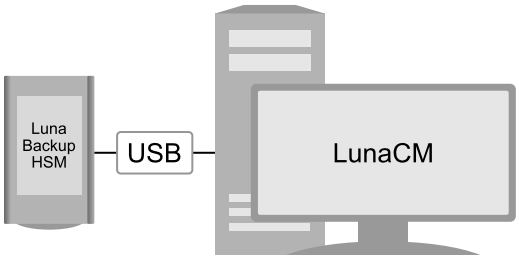
> N number of blue (HSM SO) PED keys, as defined by the M of N scheme you choose for the HSM SO role, plus the number required to create duplicate PED keys as necessary.

> Blank or reused red (Domain) PED key(s)

> **NOTE** Use the USB-C adapter in the USB port on the right side of the Luna Backup HSM 7 to insert PED keys:
>
> 

To initialize the Luna Backup HSM 7

1. Connect your Luna Backup HSM 7 to a workstation:



   a. Install the required Luna HSM Client software on the workstation, including the **Backup** option. See "Client Software Required to Perform Backup and Restore Operations" on page 279 for details.

   > **NOTE** If you are installing Luna HSM Client on Windows, the driver may not be installed unless the Luna device is connected to the computer first; refer to Backup/USB/PCIe Drivers Not Installed on Windows 10 or Windows Server 2022 Unless Device is Connected.

   b. Connect the backup HSM directly to the Luna HSM Client workstation using the included USB cable.

   > **NOTE** On most Luna HSM Client computers, the USB port provides adequate power, and connecting the provided power supply is not recommended. Wait and confirm that the HSM boots properly. If the HSM fails to boot up:
   >
   > **1.** Disconnect the HSM from the USB port.
   >
   > **2.** Connect the HSM to power using the provided power supply. Wait for it to boot completely.
   >
   > **3.** Reconnect the HSM to the USB port on the client.
   >
   > If the HSM is connected to the USB port before the power supply, you may encounter an issue where the HSM occasionally loses contact with the client, and must be power cycled.

2. Launch LunaCM on the client workstation.
3. Select the slot assigned to the backup HSM Admin partition.

   lunacm:> **slot set -slot** <slot_id>

4. If necessary, recover the HSM from Secure Transport Mode. See Secure Transport Mode for more information:

   lunacm:> **stm recover -randomuserstring** <string>

> **NOTE** Recovering a Luna Backup HSM 7 from secure transport mode may take up to three minutes.

5. Initialize the selected backup HSM, specifying a label and the **-iped** authentication mode.

   lunacm:> **hsm init -iped -label** <label>

> You are prompted by the touchscreen for the blue HSM SO PED key(s) and red Domain PED key(s). Respond to the prompts and insert and set the PINs on the required keys when requested. Ensure that you label any new PED keys that you create during this process.

Configuring the Luna Backup HSM 7 for FIPS Compliance

Luna Backup HSM Firmware 7.7.1 and newer uses the same updated cloning protocol as Luna HSM Firmware 7.7.0 and newer. For the Luna Backup HSM 7 to be FIPS-compliant, it must restrict restore operations to application partitions that use the new protocol. This restriction is applied by setting **HSM policy 55: Enable Restricted Restore** to **1** on the backup HSM. The Luna Backup HSM 7 must be initialized and connected to a Luna HSM Client computer to set this policy.

When this policy is enabled on the Luna Backup HSM 7, objects that have been backed up from partitions using firmware older than Luna HSM Firmware 7.7.0 can be restored to Luna HSM Firmware 7.7.0 or newer (V0 or V1) partitions only.

> **CAUTION!** FIPS compliance requires that objects are never cloned or restored to an HSM using less secure firmware, and this includes restoring from Luna Backup HSM 7 firmware.
>
> If you have backups already stored on the Luna Backup HSM 7 that were taken from pre-7.7.0 partitions, turning this policy ON will prevent you from restoring them to the same source partition. You must update the HSM containing the source partition to Luna HSM Firmware 7.7.0 or newer before restoring from backup.

> **NOTE** **HSM policy 12: Allow non-FIPS algorithms**, which is used to set FIPS-compliant mode on other Luna HSMs, does not apply to the Luna Backup HSM 7. Attempts to change this policy will fail with the error `CKR_CANCEL`.

To configure the Luna Backup HSM 7 for FIPS compliance

1. On the Luna HSM Client computer, run LunaCM.
2. Set the active slot to the Luna Backup HSM 7.

   lunacm:> **slot set -slot** <slot_id>

3. Log in as Backup HSM SO.

   lunacm:> **role login -name so**

4. Set **HSM policy 55: Enable Restricted Restore** to **1**.

   lunacm:> **hsm changehsmpolicy -policy 55 -value 1**

5. [Optional] Check that the Luna Backup HSM 7 is now in FIPS approved operation mode.

   lunacm:> **hsm showinfo**

   ```
   *** The HSM is in FIPS 140-2 approved operation mode. ***
   ```

Backing Up a Multifactor Quorum-Authenticated Partition

Backups are created and stored as partitions within the Admin partition on the Luna Backup HSM 7. A new backup partition is created on initial backup. For subsequent backups, you can choose to replace the contents of the existing backup partition with the current source partition objects, or add new objects in the source partition to the existing backup partition. Like all cloning operations, the source and target backup partitions must be initialized with the same domain.

Prerequisites

> You have the required credentials:

If the source partition is not activated:

- [Remote PED authentication] The Remote PED Vector (orange) PED key(s) for the source HSM
- The Crypto Officer (black) PED key(s) for the source partition

> **TIP** If the source partition is activated, only the source partition Crypto Officer's challenge secret is required. To simplify the backup process and minimize interactions with the PED, it is recommended that you activate the CO role on the user partitions you want to backup. See "Activation on Multifactor Quorum-Authenticated Partitions" on page 207 for more information.

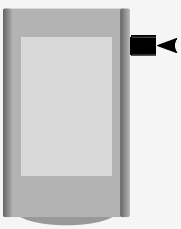
If you are creating a new backup partition:

- New or reused Partition SO (blue) PED key(s) to initialize the backup partition
- The Domain (red) PED key(s) for the source partition, to initialize the domain on the backup
- New or reused Crypto Officer (black) PED key(s) to initialize the CO role on the backup partition

If you are backing up to an existing backup partition whose domain matches the source partition:

- The existing Partition SO (blue) PED key(s) for the backup partition, to log in
- The existing Crypto Officer (black) PED key(s) for the backup partition

> **NOTE** Use the USB-C adapter in the USB port on the right side of the Luna Backup HSM 7 to insert PED keys:

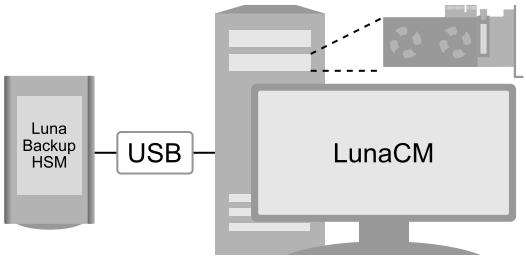


> The following policies are set:

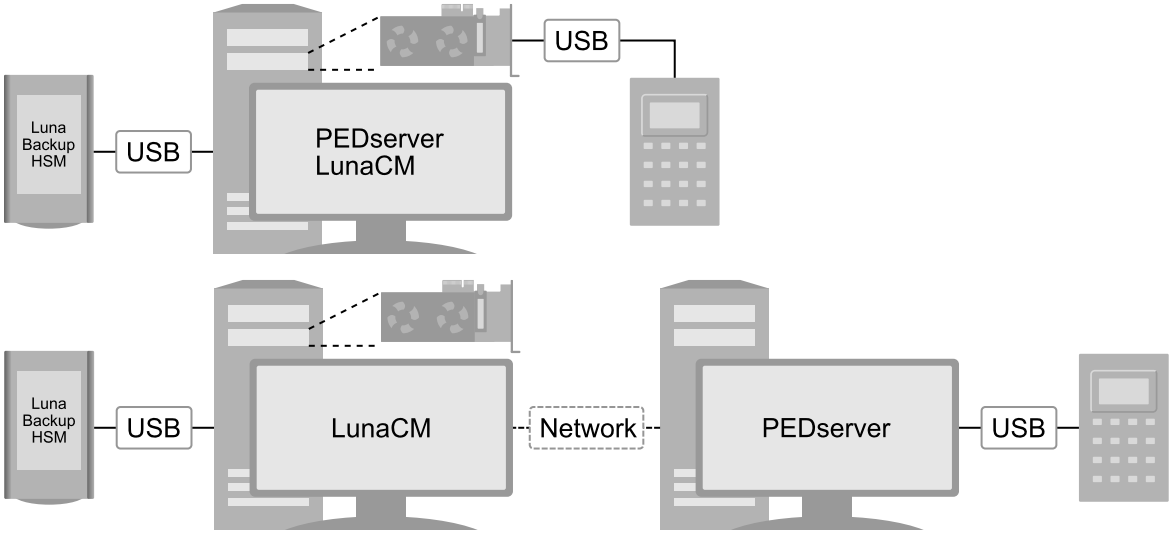
- **HSM policy 16:** Allow network replication must be set to **1** (ON) on the HSM that hosts the user partition.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 0:** "Allow private key cloning" on page 178 is set to **1** (ON) on the user partition.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 4:** "Allow secret key cloning" on page 180 is set to **1** (ON) on the user partition.

To back up a multifactor quorum-authenticated partition

1. Configure your Luna HSM Client workstation using one of the following configurations:
   - Activated source partition:



   - Non-activated source partition:



   a. If you have not already done so, install the required client software on the Luna HSM Client workstation. See "Client Software Required to Perform Backup and Restore Operations" on page 279 for details.

   > **NOTE** If you are installing Luna HSM Client on Windows, the driver may not be installed unless the Luna device is connected to the computer first; refer to Backup/USB/PCIe Drivers Not Installed on Windows 10 or Windows Server 2022 Unless Device is Connected.

   b. Connect the backup HSM directly to the Luna HSM Client workstation using the included USB cable.

   > **NOTE** On most Luna HSM Client computers, the USB port provides adequate power, and connecting the provided power supply is not recommended. Wait and confirm that the HSM boots properly. If the HSM fails to boot up:
   >
   > **1.** Disconnect the HSM from the USB port.
   >
   > **2.** Connect the HSM to power using the provided power supply. Wait for it to boot completely.
   >
   > **3.** Reconnect the HSM to the USB port on the client.
   >
   > If the HSM is connected to the USB port before the power supply, you may encounter an issue where the HSM occasionally loses contact with the client, and must be power cycled.

c. [Non-activated source partition, Local PED] Connect the PED to the USB port on the Luna PCIe HSM 7 card, using the PED USB cable.

d. [Non-activated source partition, Remote PED] Connect the PED to the Luna HSM Client workstation used to host the remote PED, using the PED USB cable.

> **NOTE** You connect to the remote PED using the IP address of the workstation used to host the PED. This can be the same workstation that hosts the user and backup partition slots, or a different workstation. The workstation used to host the PED must be running PEDserver.

2. [Non-activated source partition, Remote PED] Start the **pedserver** service on the workstation used to host the remote PED:

Windows	C:\Program Files\Safenet\LunaClient> **"pedserver -mode start" on page 158**
Linux	/usr/safenet/lunaclient> **"pedserver -mode start" on page 158**

3. Launch LunaCM on the workstation that hosts the Luna PCIe HSM 7 partition slots.
4. Identify the slot assignments for:
   - The Luna PCIe HSM 7 partition you want to back up.
   - The Luna Backup HSM 7 admin partition (where all backups are stored).

   lunacm:> **slot list**

   If you cannot see both slots, check your connections or configure your client as required.
5. Select the Luna PCIe HSM 7 partition:

   lunacm:> **slot set -slot** <slot_id>
6. Log in to the partition as Crypto Officer (CO):
   - If the partition is activated, use the following command and provide the Crypto Officer (CO) challenge secret as prompted:

     lunacm:> **role login -name co**
   - If the partition is not activated, and you are authenticating with a local PED:

     lunacm:> **role login -name co**

     Respond to the prompts on the PED to provide the black (CO) key(s) and PIN for the CO role on the application partition.
   - If the partition is not activated, and you are authenticating with Remote PED:

     i. Connect to the Luna HSM Client workstation that hosts the PED. If defaults are not set using lunacm:> **ped set**, specify an IP address (and port if required; 1503 is default).

     lunacm:> **ped connect** [**-ip** <pedserver_host_ip>]

     ii. Log in to the selected Luna PCIe HSM 7 partition as the Crypto Officer (CO):

     lunacm:> **role login -name co**

     iii. Respond to the prompts on the PED to provide the orange (PED vector) PED key(s) and PIN for the Luna PCIe HSM 7 and the black (CO) key(s) and PIN for the CO role on the application partition.

iv. Disconnect the remote PED session. Note that you will remain logged in to the Luna PCIe HSM 7 partition:

lunacm:> **ped disconnect**

7. Initiate the backup:

lunacm:> **partition archive backup -slot** <backup_HSM_admin_slot> [**-partition** <target_backup_label>] [**-append**] [**-replace**] [**-smkonly**]

If you omit the **-partition** option when creating a new backup, the partition is assigned a default name (<source_partition_name>_<YYYYMMDD>) based on the source HSM's internally-set time and date.

If you are backing up a V1 partition, include **-smkonly** to back up the SMK only. By default, the SMK and any encrypted cryptographic material on the partition are backed up.

The backup begins once you have completed the authentication process. Objects are backed up one at a time. If you are backing up to an existing backup partition, you can use the following options to define how individual objects are backed up:

-append	Add only new objects to an existing backup.
-replace	Delete the existing objects in a target backup partition and replace them with the contents of the source user partition. This is the default.
-append -replace	Add new objects and replace existing objects that have the same OUID but a different fingerprint (such as would occur if any of the object attributes were changed since the previous backup).

> **NOTE** If the backup operation is interrupted (if the Backup HSM is unplugged, or if you fail to respond to PED prompts, for example), the Backup HSM's full available space can become occupied with a single backup partition. If this occurs, delete the backup partition with lunacm:> **partition archive delete** before reattempting the backup operation.

8. Respond to the prompts on the Luna Backup HSM 7 touchscreen to insert the following PED keys:

If you are creating a new backup partition:

i. The blue HSM SO PED key(s) for the backup HSM.

ii. You are prompted to initialize the backup Partition SO role by creating a new blue PED key or reusing an existing key. After you initialize the role, you are prompted to insert the key again to log in as Partition SO.

iii. The red Domain PED key(s). This must be the same PED key(s) used for the Luna PCIe HSM 7 partition, otherwise the backup will fail.

iv. The blue Partition SO PED key(s) for the backup partition, to log in again.

v. You are prompted to initialize the Crypto Officer role for the backup by creating a new black PED key or reusing an existing key. After you initialize the role, you are prompted to insert the key again to log in as Crypto Officer.

If you are backing up to an existing backup partition whose domain matches the source partition:

i. The blue HSM SO PED key(s) for the backup HSM.

ii. The blue Partition SO PED key(s) for the backup.

iii. The black Crypto Officer PED key(s) for the backup.

Restoring To a Multifactor Quorum-Authenticated Partition

You can restore the objects from a multifactor quorum-authenticated backup partition to the same partition that was originally backed up, or to another partition that has been initialized with the same domain (red PED key).

Prerequisites

> The target partition must be initialized using the same domain (red PED key) as the backup partition, the Crypto Officer role must be initialized and the CO role credential changed from its initial value.

> You require the Crypto Officer challenge secret for the target partition.

If the target partition is not activated, you also require:

- [Remote PED authentication] The Remote PED Vector (orange) PED key(s) for the target HSM
- The Crypto Officer (black) PED key(s) for the target partition

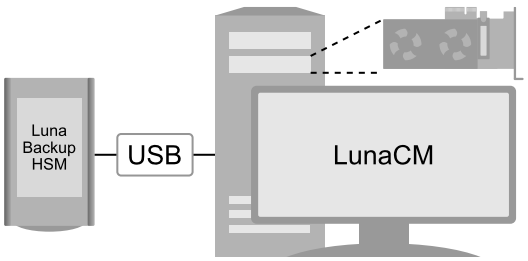
> **TIP** If the target partition is activated, only the Crypto Officer's challenge secret is required. To simplify the backup process and minimize interactions with the PED, it is recommended that you activate the CO role on the user partitions you want to restore from backup. See "Activation on Multifactor Quorum-Authenticated Partitions" on page 207 for more information.

> The following policies are set:

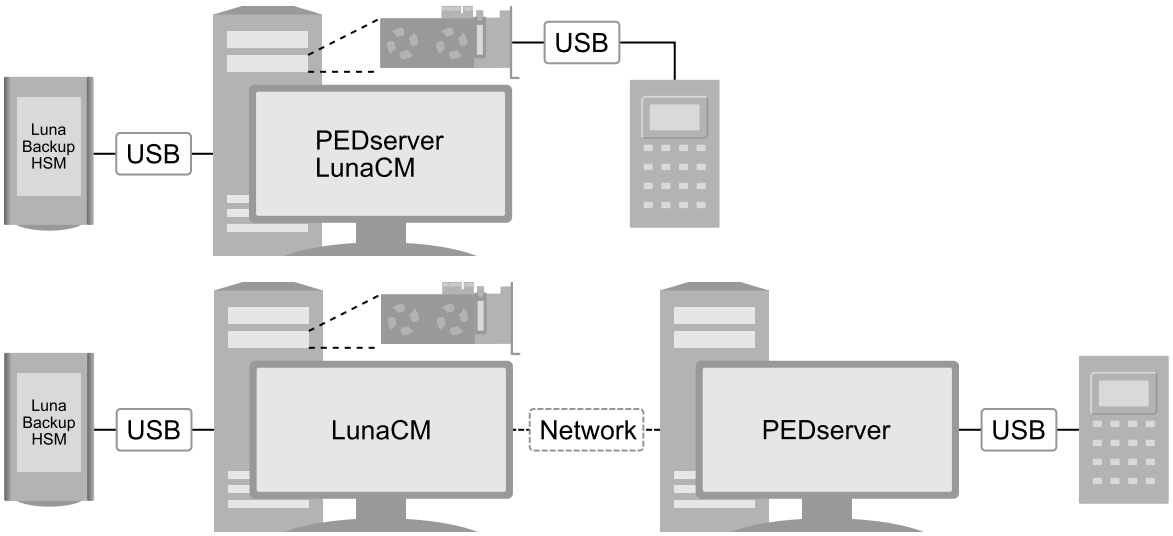
- **HSM policy 16:** Allow network replication must be set to **1** (ON) on the HSM that hosts the user partition you want to restore to.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 0:** "Allow private key cloning" on page 178 is set to **1** (ON) on the user partition you want to restore to.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 4:** "Allow secret key cloning" on page 180 is set to **1** (ON) on the user partition you want to restore to.

To restore a multifactor quorum-authenticated partition

1. Configure your Luna HSM Client workstation using one of the following configurations:
   - Activated destination partition:



   - Non-activated destination partition:



a. If you have not done so already, install the required client software on the Luna HSM Client workstation. See Luna HSM Client Software Installation for details.

> **NOTE** If you are installing Luna HSM Client on Windows, the driver may not be installed unless the Luna device is connected to the computer first; refer to Backup/USB/PCIe Drivers Not Installed on Windows 10 or Windows Server 2022 Unless Device is Connected.

b. Connect the backup HSM directly to the Luna HSM Client workstation using the included USB cable.

> **NOTE** On most Luna HSM Client computers, the USB port provides adequate power, and connecting the provided power supply is not recommended. Wait and confirm that the HSM boots properly. If the HSM fails to boot up:
>
> **1.** Disconnect the HSM from the USB port.
>
> **2.** Connect the HSM to power using the provided power supply. Wait for it to boot completely.
>
> **3.** Reconnect the HSM to the USB port on the client.
>
> If the HSM is connected to the USB port before the power supply, you may encounter an issue where the HSM occasionally loses contact with the client, and must be power cycled.

c. [Non-activated source partition, Local PED] Connect the PED to the USB port on the Luna PCIe HSM 7 card, using the PED USB cable.

d. [Non-activated source partition, Remote PED] Connect the PED to the Luna HSM Client workstation used to host the remote PED, using the PED USB cable.

> **NOTE** You connect to the remote PED using the IP address of the workstation used to host the PED. This can be the same workstation that hosts the user and backup partition slots, or a different workstation. The workstation used to host the PED must be running PEDserver.

2. [Non-activated source partition, Remote PED] Start the **pedserver** service on the workstation used to host the remote PED:

Windows	C:\Program Files\Safenet\LunaClient> **"pedserver -mode start" on page 158**
Linux	/usr/safenet/lunaclient> **"pedserver -mode start" on page 158**

3. Launch LunaCM on the workstation that hosts the Luna PCIe HSM 7 and backup partition slots.
4. Identify the slot assignments for:
   - the Luna PCIe HSM 7 partition you want to restore to.
   - the backup HSM admin partition (where all backups are stored).

   lunacm:> **slot list**

   If you cannot see both slots, check your connections or configure your client as required.
5. Select the Luna PCIe HSM 7 partition you want to restore from backup:

   lunacm:> **slot set -slot** <slot_id>
6. Log in to the partition as Crypto Officer (CO):
   - If the partition is activated, use the following command and provide the Crypto Officer (CO) challenge secret as prompted:

     lunacm:> **role login -name co**
   - If the partition is not activated, and you are authenticating with a local PED:

     lunacm:> **role login -name co**

     Respond to the prompts on the PED to provide the black (CO) key(s) and PIN for the CO role on the application partition.
   - If the partition is not activated, and you are authenticating with Remote PED:
     i. Connect to the Luna HSM Client workstation that hosts the PED. If defaults are not set using lunacm:> **ped set**, specify an IP address (and port if required; 1503 is default).

        lunacm:> **ped connect** [**-ip** <pedserver_host_ip>]
     ii. Log in to the selected Luna PCIe HSM 7 partition as the Crypto Officer (CO):

        lunacm:> **role login -name co**
     iii. Respond to the prompts on the PED to provide the orange (PED vector) PED key(s) and PIN for the Luna PCIe HSM 7 and the black (CO) key(s) and PIN for the CO role on the application partition.
     iv. Disconnect the remote PED session. Note that you will remain logged in to the Luna PCIe HSM 7 partition:

        lunacm:> **ped disconnect**
7. List the available backups on the Backup HSM by specifying the Backup HSM's slot number. You will require the backup partition label to perform the restore operation.

   lunacm:> **partition archive list-slot** <backup_HSM_admin_slot>
8. Initiate the restore operation. Respond to the prompts on the Luna Backup HSM 7 touchscreen to insert the required PED keys.

   lunacm:> **partition archive restore -slot** <backup_HSM_admin_slot> **-partition** <backup_partition_label> [**-smkonly**]

CAUTION! The **-replace** option is deprecated and has been removed in Luna HSM Client 10.7.0 and newer. If you wish to restore an earlier version of an object, Thales recommends deleting the object(s) manually before restoring the partition from backup.

Ensure that the target partition can receive objects from the backup HSM before deleting objects or using partition archive restore with the **-replace** option; the cloning protocol may prevent objects from being restored, even if LunaCM states that `X objects will be restored`. This may occur if **HSM policy 55: Enable Restricted Restore** was enabled on the Luna Backup HSM 7 since the original backup was taken. If your partition is on an HSM with firmware older than Luna HSM Firmware 7.7.0, you must update to 7.7.0 or newer to restore objects from this backup.

NOTE If you are restoring a V1 backup to a V1 partition, include **-smkonly** to restore the SMK only (see "V0 and V1 Partitions" on page 17 for more information). By default, the SMK and any cryptographic material on the backup are restored.

The restore operation begins once you have completed the authentication process. Objects are restored one at a time.

Luna Backup HSM 7 Using Remote Multifactor Quorum Authentication

In this configuration, you connect the Luna Backup HSM 7 to a USB port on the Luna HSM Client, and insert PED keys into a Remote Luna PED. This allows you to perform backup/restore operations for all application partitions that can be accessed by the client. You can restore a partition backup to the original source partition or to another existing Luna application partition that shares the same cloning domain. To use this method, you require:

> "Luna Backup HSM 7" on page 284 **v1 or v2**

> Luna HSM Client 10.1.0 or newer

This section provides instructions for the following procedures:

> "Initializing the Luna Backup HSM 7 for Multifactor Quorum Authentication" below

> "Configuring the Luna Backup HSM 7 for FIPS Compliance" on page 305

> "Backing Up a Multifactor Quorum-Authenticated Partition" on page 306

> "Restoring To a Multifactor Quorum-Authenticated Partition" on page 310

Initializing the Luna Backup HSM 7 for Multifactor Quorum Authentication

You must initialize the Luna Backup HSM 7 prior to first use. You can initialize the backup HSM by connecting it to a Luna HSM Client and using LunaCM commands to perform the initialization.

Prerequisites

You will need the following PED keys:

> A blank orange (PED vector) PED key, plus the number required to create duplicate PED keys as necessary.

> **CAUTION!** Always make copies of your orange PED keys, or declare MofN as one-of-several, and store at least one safely. For the Luna Backup HSM 7 v1, *the orange PED key is as important as the HSM SO blue key or the Domain red key*.
>
> The orange PED key is required for all Luna Backup HSM 7 v1 operations. If this key is lost, your backups will become irretrievable. Thales recommends keeping multiple backups of all PED keys stored in a secure location.

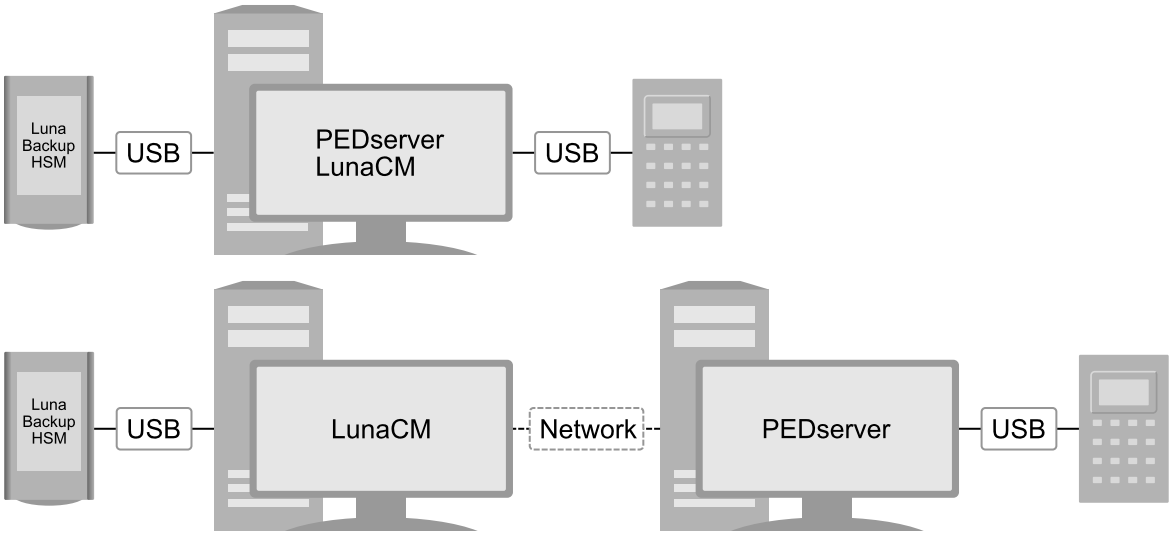
> N number of blue (HSM SO) PED keys, as defined by the M of N scheme you choose for the HSM SO role, plus the number required to create duplicate PED keys as necessary.

> Blank or reused red (Domain) PED key(s)

> [Luna Backup HSM 7 Firmware 7.7.1 and newer only] Set the value of **-pedwritedelay** to **2000** to avoid experiencing frequent CKR_CALLBACK_ERRORS, which will prevent you from completing the procedure below. For more information about this error, refer to "Intermittent CKR_CALLBACK_ERROR: PED Cannot Service its USB Data Channel Fast Enough to Communicate with PEDserver" on page 119.

To initialize a Luna Backup HSM 7 for multifactor quorum authentication

1. Configure your Luna HSM Client workstation using one of the following configurations:



   a. Install the required client software on the Luna HSM Client workstation. See "Client Software Required to Perform Backup and Restore Operations" on page 279 for details.

   > **NOTE** If you are installing Luna HSM Client on Windows, the driver may not be installed unless the Luna device is connected to the computer first; refer to Backup/USB/PCIe Drivers Not Installed on Windows 10 or Windows Server 2022 Unless Device is Connected.

   b. Connect the backup HSM directly to the Luna HSM Client workstation using the included USB cable.

> **NOTE** On most Luna HSM Client computers, the USB port provides adequate power, and connecting the provided power supply is not recommended. Wait and confirm that the HSM boots properly. If the HSM fails to boot up:
>
> **1.** Disconnect the HSM from the USB port.
>
> **2.** Connect the HSM to power using the provided power supply. Wait for it to boot completely.
>
> **3.** Reconnect the HSM to the USB port on the client.
>
> If the HSM is connected to the USB port before the power supply, you may encounter an issue where the HSM occasionally loses contact with the client, and must be power cycled.

c. Connect the Luna PED to the Luna HSM Client workstation used to host the remote PED, using the PED USB cable.

> **NOTE** You connect to the remote PED using the IP address of the workstation used to host the PED. This can be the same workstation that hosts the user and backup partition slots, or a different workstation. The workstation used to host the PED must be running pedServer.

2. Start the **pedserver** service on the workstation used to host the remote PED:

Windows	C:\Program Files\Safenet\LunaClient> **"pedserver -mode start" on page 158**
Linux	/usr/safenet/lunaclient> **"pedserver -mode start" on page 158**

3. Launch LunaCM on the workstation that hosts the user and backup partition slots.

4. Select the slot assigned to the backup HSM Admin partition.

lunacm:> **slot set -slot** <slot_id>

5. If necessary, recover the HSM from Secure Transport Mode. See Secure Transport Mode for more information:

lunacm:> **stm recover -randomuserstring** <string>

> **NOTE** Recovering a Luna Backup HSM 7 from secure transport mode may take up to three minutes.

6. Connect to the Luna HSM Client workstation that hosts the PED. If defaults are not set using lunacm:> **ped set**, specify an IP address (and port if required; 1503 is default).

lunacm:> **ped connect -ip** <ip_address> **-pwd**

LunaCM generates and displays a one-time password that is used to set up a secure channel between the backup HSM and the PED, allowing you to securely initialize the orange (Remote PED Vector) PED key. Enter the displayed password on the PED when prompted to complete setup of the secure channel.

7. Create an orange (Remote PED vector) PED key for the backup HSM. The PED vector key is required for subsequent multifactor quorum-authenticated sessions to the HSM. Ensure that you label any new PED keys that you create during this process.

lunacm:> **ped vector init**

> **CAUTION!** The orange PED key is required for all Luna Backup HSM 7 v1 operations. If this key is lost, your backups will become irretrievable. Thales recommends keeping multiple backups of all PED keys stored in a secure location.

8. Tear down the one-time, password-protected secure channel between the backup HSM and the PED you used to create the orange (Remote PED vector) PED key.

   lunacm:> **ped disconnect**

   You are prompted to enter the one-time password that was generated when you performed **ped connect**. Enter the password and press Enter to proceed.

9. Set up a new secure channel between the backup HSM and the PED. If defaults are not set using lunacm:> **ped set**, specify an IP address (and port if required; 1503 is default). You are prompted to insert the orange PED key you created in step 7.

   lunacm:> **ped connect**

10. Initialize the selected backup HSM in multifactor quorum-authenticated mode. You are prompted by the PED for the red Domain PED key(s) and blue HSM SO PED key(s). Respond to the PED prompts and insert and set the PINs on the required keys when requested. Ensure that you label any new PED keys that you create during this process.

    lunacm:> **hsm init -iped -label** <label>

11. Use the **Duplicate** function on the PED to create and label duplicates of the new PED keys, as required. See "Duplicating Existing PED keys" on page 140 for details.

12. Disconnect the PED when done.

    lunacm:> **ped disconnect**

Configuring the Luna Backup HSM 7 for FIPS Compliance

Luna Backup HSM Firmware 7.7.1 and newer uses the same updated cloning protocol as Luna HSM Firmware 7.7.0 and newer. For the Luna Backup HSM 7 to be FIPS-compliant, it must restrict restore operations to application partitions that use the new protocol. This restriction is applied by setting **HSM policy 55: Enable Restricted Restore** to **1** on the backup HSM. The Luna Backup HSM 7 must be initialized and connected to a Luna HSM Client computer to set this policy.

When this policy is enabled on the Luna Backup HSM 7, objects that have been backed up from partitions using firmware older than Luna HSM Firmware 7.7.0 can be restored to Luna HSM Firmware 7.7.0 or newer (V0 or V1) partitions only.

> **CAUTION!** FIPS compliance requires that objects are never cloned or restored to an HSM using less secure firmware, and this includes restoring from Luna Backup HSM 7 firmware.
>
> If you have backups already stored on the Luna Backup HSM 7 that were taken from pre-7.7.0 partitions, turning this policy ON will prevent you from restoring them to the same source partition. You must update the HSM containing the source partition to Luna HSM Firmware 7.7.0 or newer before restoring from backup.

> **NOTE** **HSM policy 12: Allow non-FIPS algorithms**, which is used to set FIPS-compliant mode on other Luna HSMs, does not apply to the Luna Backup HSM 7. Attempts to change this policy will fail with the error `CKR_CANCEL`.

To configure the Luna Backup HSM 7 for FIPS compliance

1. On the Luna HSM Client computer, run LunaCM.
2. Set the active slot to the Luna Backup HSM 7.

   lunacm:> **slot set -slot** <slot_id>
3. Log in as Backup HSM SO.

   lunacm:> **role login -name so**
4. Set **HSM policy 55: Enable Restricted Restore** to **1**.

   lunacm:> **hsm changehsmpolicy -policy 55 -value 1**
5. [Optional] Check that the Luna Backup HSM 7 is now in FIPS approved operation mode.

   lunacm:> **hsm showinfo**

   ```
   *** The HSM is in FIPS 140-2 approved operation mode. ***
   ```

Backing Up a Multifactor Quorum-Authenticated Partition

Backups are created and stored as partitions within the Admin partition on the Luna Backup HSM 7. A new backup partition is created on initial backup. For subsequent backups, you can choose to replace the contents of the existing backup partition with the current source partition objects, or add new objects in the source partition to the existing backup partition. Like all cloning operations, the source and target backup partitions must be initialized with the same domain.

Prerequisites

> You have the required credentials:

If you are creating a new backup partition:

- The Remote PED Vector (orange) PED key(s) for the Backup HSM
- New or reused Partition SO (blue) PED key(s) to initialize the backup partition
- New or reused Crypto Officer (black) PED key(s) to initialize the CO role on the backup partition
- The Domain (red) PED key(s) for the source partition, to initialize the domain on the backup

If you are backing up to an existing backup partition whose domain matches the source partition:

- The Remote PED Vector (orange) PED key(s) for the Backup HSM
- The existing Partition SO (blue) PED key(s) for the backup partition, to log in
- The existing Crypto Officer (black) PED key(s) for the backup partition

> The following policies are set:

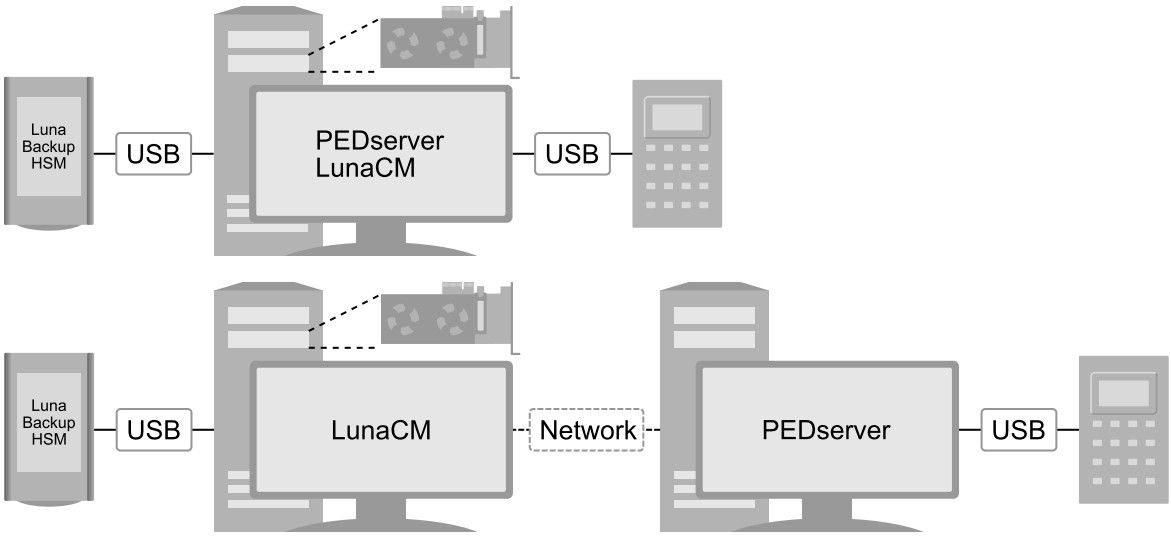
- **HSM policy 16:** Allow network replication must be set to **1** (ON) on the HSM that hosts the user partition.

- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 0:** "Allow private key cloning" on page 178 is set to **1** (ON) on the user partition.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 4:** "Allow secret key cloning" on page 180 is set to **1** (ON) on the user partition.

> [Luna Backup HSM 7 Firmware 7.7.1 and newer only] Set the value of **-pedwritedelay** to **2000** to avoid experiencing frequent CKR_CALLBACK_ERRORS, which will prevent you from completing the procedure below. For more information about this error, refer to "Intermittent CKR_CALLBACK_ERROR: PED Cannot Service its USB Data Channel Fast Enough to Communicate with PEDserver" on page 119.

To back up a multifactor quorum-authenticated partition

1. Configure your Luna HSM Client workstation using one of the following configurations:



   a. Install the required client software on the Luna HSM Client workstation. See "Client Software Required to Perform Backup and Restore Operations" on page 279 for details.

   > **NOTE** If you are installing Luna HSM Client on Windows, the driver may not be installed unless the Luna device is connected to the computer first; refer to Backup/USB/PCIe Drivers Not Installed on Windows 10 or Windows Server 2022 Unless Device is Connected.

   b. Connect the backup HSM directly to the Luna HSM Client workstation using the included USB cable.

   > **NOTE** On most Luna HSM Client computers, the USB port provides adequate power, and connecting the provided power supply is not recommended. Wait and confirm that the HSM boots properly. If the HSM fails to boot up:
   >
   > **1.** Disconnect the HSM from the USB port.
   >
   > **2.** Connect the HSM to power using the provided power supply. Wait for it to boot completely.
   >
   > **3.** Reconnect the HSM to the USB port on the client.
   >
   > If the HSM is connected to the USB port before the power supply, you may encounter an issue where the HSM occasionally loses contact with the client, and must be power cycled.

c. Connect the PED to the Luna HSM Client workstation used to host the remote PED, using the PED USB cable.

> **NOTE** You connect to the remote PED using the IP address of the workstation used to host the PED. This can be the same workstation that hosts the user and backup partition slots, or a different workstation. The workstation used to host the PED must be running PEDserver.

2. Start the **pedserver** service on the workstation used to host the remote PED:

Windows	C:\Program Files\Safenet\LunaClient> **"pedserver -mode start" on page 158**
Linux	/usr/safenet/lunaclient> **"pedserver -mode start" on page 158**

3. Launch LunaCM on the workstation that hosts the Luna PCIe HSM 7 partition slots.
4. Identify the slot assignments for:
   - The Luna PCIe HSM 7 partition you want to backup.
   - The Luna Backup HSM 7 admin partition (where all backups are stored).

   lunacm:> **slot list**

   If you cannot see both slots, check your connections or configure your client as required.
5. Select the Luna PCIe HSM 7 partition:

   lunacm:> **slot set -slot** <slot_id>
6. Log in to the partition as Crypto Officer (CO):
   - If the partition is activated, use the following command and present the black Crypto Officer PED key(s) to the Luna PCIe HSM 7 as directed:

     lunacm:> **role login -name co**
   - If the partition is not activated:

     i. Connect to the Luna HSM Client workstation that hosts the PED. If defaults are not set using lunacm:> **ped set**, specify an IP address (and port if required; 1503 is default).

     lunacm:> **ped connect** [**-ip** <pedserver_host_ip>]

     ii. Log in to the selected Luna PCIe HSM 7 partition as the Crypto Officer (CO):

     lunacm:> **role login -name co**

     iii. Respond to the prompts on the PED to provide the orange (PED vector) PED key(s) and PIN for the Luna PCIe HSM 7 and the black (CO) key(s) and PIN for the CO role on the application partition.

     iv. Disconnect the remote PED session. Note that you will remain logged in to the Luna PCIe HSM 7 partition:

     lunacm:> **ped disconnect**
7. Select the backup HSM Admin partition:

   lunacm:> **slot set -slot** <slot_id>
8. Connect to the Luna HSM Client workstation that hosts the PED. If defaults are not set using lunacm:> **ped set**, specify an IP address (and port if required; 1503 is default):

   lunacm:> **ped connect** [**-ip** <pedserver_host_ip>]

9. Select the Luna PCIe HSM 7 partition:

   lunacm:> **slot set** **-slot** <slot_id>

10. Initiate the backup:

    lunacm:> **partition archive backup** **-slot** <backup_HSM_admin_slot> [**-partition** <target_backup_label>] [**-append**] [**-replace**] [**-smkonly**]

    If you omit the **-partition** option when creating a new backup, the partition is assigned a default name (<source_partition_name>_<YYYYMMDD>) based on the source HSM's internally-set time and date.

    If you are backing up a V1 partition, include **-smkonly** to back up the SMK only. By default, the SMK and any encrypted cryptographic material on the partition are backed up.

    The backup begins once you have completed the authentication process. Objects are backed up one at a time. For existing backups, you can use the following options to define how individual objects are backed up:

-append	Add only new objects to an existing backup.
-replace	Delete the existing objects in a target backup partition and replace them with the contents of the source user partition. This is the default.
-append -replace	Add new objects and replace existing objects that have the same OUID but a different fingerprint (such as would occur if any of the object attributes were changed since the previous backup).

> **NOTE** If the backup operation is interrupted (if the Backup HSM is unplugged, or if you fail to respond to PED prompts, for example), the Backup HSM's full available space can become occupied with a single backup partition. If this occurs, delete the backup partition with lunacm:> **partition archive delete** before reattempting the backup operation.

11. You are prompted for the following credentials in the following order:Respond to the prompts on the Luna PED to insert the following PED keys:

    If you are creating a new backup partition:

    i. The blue HSM SO PED key(s) for the backup HSM.

    ii. You are prompted to initialize the backup Partition SO role by creating a new blue PED key or reusing an existing key. After you initialize the role, you are prompted to insert the key again to log in as Partition SO.

    iii. The red Domain PED key(s). This must be the same PED key(s) used for the Luna PCIe HSM 7 partition, otherwise the backup will fail.

    iv. The blue Partition SO PED key(s) for the backup partition, to log in again.

    v. You are prompted to initialize the Crypto Officer role for the backup by creating a new black PED key or reusing an existing key. After you initialize the role, you are prompted to insert the key again to log in as Crypto Officer.

    If you are backing up to an existing backup partition whose domain matches the source partition:

    i. The blue HSM SO PED key(s) for the backup HSM.

    ii. The blue Partition SO PED key(s) for the backup.

    iii. The black Crypto Officer PED key(s) for the backup.

12. Disconnect the PED from the Luna PCIe HSM 7 and Luna Backup HSM 7:
    a. Disconnect the PED from the backup HSM:

       lunacm:> **ped disconnect**
    b. Select the slot for the Luna PCIe HSM 7 partition:

       lunacm:> **slot set -slot** <slot_id>
    c. Disconnect the PED from the Luna PCIe HSM 7 partition:

       lunacm:> **ped disconnect**
13. If this is the first backup to the backup partition, use the **Duplicate** function on the PED to create and label a set of backup keys for the new backup partition PO (blue) and CO (black) PED keys. See "Duplicating Existing PED keys" on page 140 for details.

Restoring To a Multifactor Quorum-Authenticated Partition

You can restore the objects from a multifactor quorum-authenticated backup partition to the same partition that was originally backed up, or to another partition that has been initialized with the same domain (red PED key).

Prerequisites

> The target partition must be initialized using the same domain (red PED key) as the backup partition, the Crypto Officer role must be initialized and the CO role credential changed from its initial value.

> You have the required credentials:

- The Remote PED Vector (orange) PED key(s) for the backup HSM
- The Crypto Officer challenge secret for the target partition
- The Crypto Officer (black) PED key(s) for the backup partition

> **TIP** If the target partition is activated, only the Crypto Officer's challenge secret is required. To simplify the backup process and minimize interactions with the PED, it is recommended that you activate the CO role on the user partitions you want to restore from backup. See "Activation on Multifactor Quorum-Authenticated Partitions" on page 207 for more information.

If the target partition is not activated, you also need:

- The Remote PED Vector (orange) PED key(s) for the target HSM
- The Crypto Officer (black) PED key(s) for the target partition

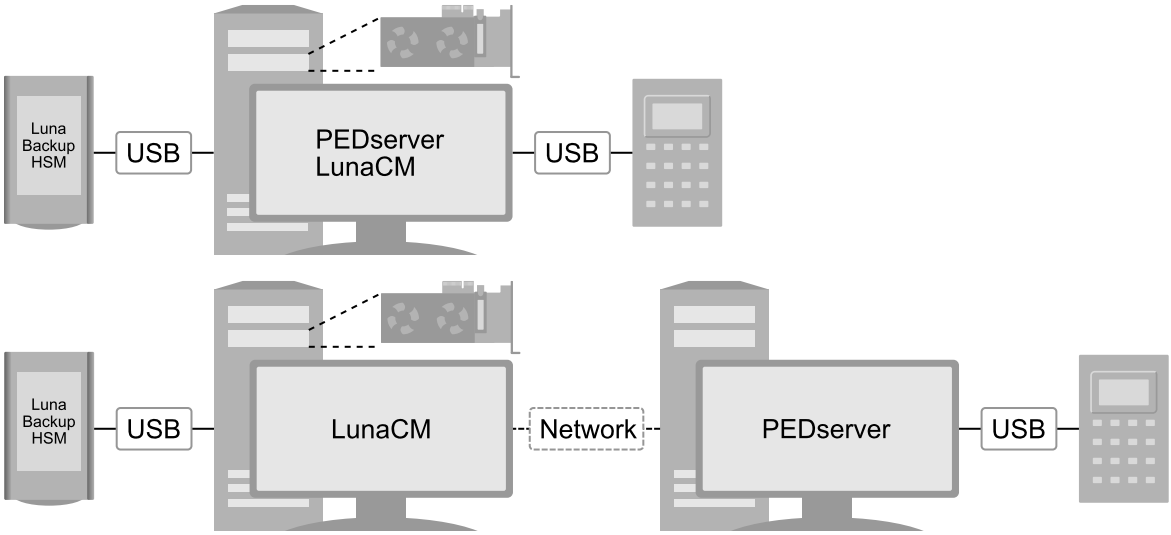
> The following policies are set:

- **HSM policy 16:** Allow network replication must be set to **1** (ON) on the HSM that hosts the user partition you want to restore to.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 0:** "Allow private key cloning" on page 178 is set to **1** (ON) on the user partition you want to restore to.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 4:** "Allow secret key cloning" on page 180 is set to **1** (ON) on the user partition you want to restore to.

> [Luna Backup HSM 7 Firmware 7.7.1 and newer only] Set the value of **-pedwritedelay** to **2000** to avoid experiencing frequent CKR_CALLBACK_ERRORS, which will prevent you from completing the procedure below. For more information about this error, refer to "Intermittent CKR_CALLBACK_ERROR: PED Cannot Service its USB Data Channel Fast Enough to Communicate with PEDserver" on page 119.

To restore a multifactor quorum-authenticated partition

1. Configure your Luna HSM Client workstation using one of the following configurations:



   a. Install the required client software on the Luna HSM Client workstation. See Luna HSM Client Software Installation for details.

   > **NOTE** If you are installing Luna HSM Client on Windows, the driver may not be installed unless the Luna device is connected to the computer first; refer to Backup/USB/PCIe Drivers Not Installed on Windows 10 or Windows Server 2022 Unless Device is Connected.

   b. Connect the backup HSM directly to the Luna HSM Client workstation using the included USB cable.

   > **NOTE** On most Luna HSM Client computers, the USB port provides adequate power, and connecting the provided power supply is not recommended. Wait and confirm that the HSM boots properly. If the HSM fails to boot up:
   >
   > **1.** Disconnect the HSM from the USB port.
   >
   > **2.** Connect the HSM to power using the provided power supply. Wait for it to boot completely.
   >
   > **3.** Reconnect the HSM to the USB port on the client.
   >
   > If the HSM is connected to the USB port before the power supply, you may encounter an issue where the HSM occasionally loses contact with the client, and must be power cycled.

   c. Connect the PED to the Luna HSM Client workstation used to host the remote PED, using the PED USB cable.

> **NOTE** You connect to the remote PED using the IP address of the workstation used to host the PED. This can be the same workstation that hosts the user and backup partition slots, or a different workstation. The workstation used to host the PED must be running **pedserver**.

2. Start the **pedserver** service on the workstation used to host the remote PED:

Windows	C:\Program Files\Safenet\LunaClient> **"pedserver -mode start" on page 158**
Linux	/usr/safenet/lunaclient> **"pedserver -mode start" on page 158**

3. Launch LunaCM on the workstation that hosts the Luna PCIe HSM 7 and backup partition slots.
4. Identify the slot assignments for:
   - the Luna PCIe HSM 7 partition you want to restore to.
   - the backup HSM admin partition (where all backups are stored).

   lunacm:> **slot list**

   If you cannot see both slots, check your connections or configure your client as required.
5. Select the Luna PCIe HSM 7 partition you want to restore from backup:

   lunacm:> **slot set -slot** <slot_id>
6. Log in to the partition as Crypto Officer (CO):
   - If the partition is activated, use the following command and enter the Crypto Officer challenge secret:

     lunacm:> **role login -name co**
   - If the partition is not activated:
     i. Connect to the Luna HSM Client workstation that hosts the PED. If defaults are not set using lunacm:> **ped set**, specify an IP address (and port if required; 1503 is default).

        lunacm:> **ped connect** [**-ip** <pedserver_host_ip>]

     ii. Log in to the selected Luna PCIe HSM 7 partition as the Crypto Officer (CO):

        lunacm:> **role login -name co**

     iii. Respond to the prompts on the PED to provide the orange (PED vector) PED key(s) and PIN for the Luna PCIe HSM 7 and the black (CO) key(s) and PIN for the CO role on the application partition.

     iv. Disconnect the remote PED session. Note that you will remain logged in to the Luna PCIe HSM 7 partition:

        lunacm:> **ped disconnect**
7. Connect the PED to the backup HSM. If defaults are not set using lunacm:> **ped set**, specify an IP address (and port if required; 1503 is default):

   lunacm:> **ped connect** [**-ip** <pedserver_host_ip>]
8. List the available backups on the Backup HSM by specifying the Backup HSM's slot number. You will require the backup partition label to perform the restore operation.

   lunacm:> **partition archive list-slot** <backup_HSM_admin_slot>
9. Initiate the restore operation. Respond to the prompts on the PED to insert the required PED keys.

lunacm:> **partition archive restore** **-slot** <backup_HSM_admin_slot> **-partition** <backup_partition_label> [**-smkonly**]

> **CAUTION!** The **-replace** option is deprecated and has been removed in Luna HSM Client 10.7.0 and newer. If you wish to restore an earlier version of an object, Thales recommends deleting the object(s) manually before restoring the partition from backup.
>
> Ensure that the target partition can receive objects from the backup HSM before deleting objects or using partition archive restore with the **-replace** option; the cloning protocol may prevent objects from being restored, even if LunaCM states that `X objects will be restored`. This may occur if **HSM policy 55: Enable Restricted Restore** was enabled on the Luna Backup HSM 7 since the original backup was taken. If your partition is on an HSM with firmware older than Luna HSM Firmware 7.7.0, you must update to 7.7.0 or newer to restore objects from this backup.

> **NOTE** If you are restoring a V1 backup to a V1 partition, include **-smkonly** to restore the SMK only (see "V0 and V1 Partitions" on page 17 for more information). By default, the SMK and any cryptographic material on the backup are restored.

The restore operation begins once you have completed the authentication process. Objects are restored one at a time.

Luna Backup HSM 7 Using Password Authentication

In this configuration, you connect the Luna Backup HSM 7 to a USB port on the Luna HSM Client, and enter passwords in LunaCM. This configuration allows you to perform backup/restore operations for all application partitions that can be accessed by the client. You can restore a partition backup to the original source partition or to another existing Luna application partition that shares the same cloning domain. To use this method, you require:

- "Luna Backup HSM 7" on page 284 **v1 or v2**
- Luna HSM Client 10.1.0 or newer

This section provides instructions for the following procedures:

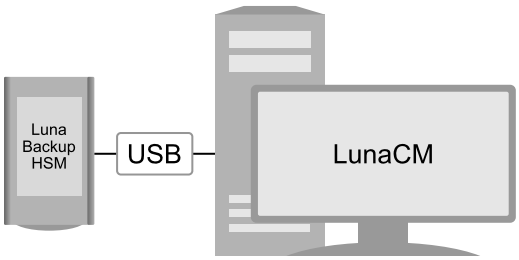
- "Initializing the Luna Backup HSM 7 for Password Authentication" below
- "Configuring the Luna Backup HSM 7 for FIPS Compliance" on page 315
- "Backing Up a Password-Authenticated Partition" on page 315
- "Restoring to a Password-Authenticated Partition" on page 318

Initializing the Luna Backup HSM 7 for Password Authentication

You must initialize the Luna Backup HSM 7 prior to first use. You can initialize the backup HSM by connecting it to a Luna HSM Client and using LunaCM commands to perform the initialization.

To initialize a Luna Backup HSM 7 for password authentication

1. Configure your Luna HSM Client workstation as illustrated below:



a. Install the required client software on the Luna HSM Client workstation. See "Client Software Required to Perform Backup and Restore Operations" on page 279 for details.

> **NOTE** If you are installing Luna HSM Client on Windows, the driver may not be installed unless the Luna device is connected to the computer first; refer to Backup/USB/PCIe Drivers Not Installed on Windows 10 or Windows Server 2022 Unless Device is Connected.

b. Connect the backup HSM directly to the Luna HSM Client workstation using the included USB cable.

> **NOTE** On most Luna HSM Client computers, the USB port provides adequate power, and connecting the provided power supply is not recommended. Wait and confirm that the HSM boots properly. If the HSM fails to boot up:
>
> **1.** Disconnect the HSM from the USB port.
>
> **2.** Connect the HSM to power using the provided power supply. Wait for it to boot completely.
>
> **3.** Reconnect the HSM to the USB port on the client.
>
> If the HSM is connected to the USB port before the power supply, you may encounter an issue where the HSM occasionally loses contact with the client, and must be power cycled.

2. Launch LunaCM on the workstation that hosts the user and backup partition slots.
3. Select the slot assigned to the backup HSM Admin partition:

   lunacm:> **slot set -slot** <slot_id>
4. If necessary, recover the HSM from Secure Transport Mode. See Secure Transport Mode for more information:

   lunacm:> **stm recover**

> **NOTE** Recovering a Luna Backup HSM 7 from secure transport mode may take up to three minutes.

5. Initialize the selected backup HSM in password-authenticated mode.

   lunacm:> **hsm init -ipwd -label** <label>

   You are prompted for the new HSM SO password and the HSM domain string (existing or new):

Configuring the Luna Backup HSM 7 for FIPS Compliance

Luna Backup HSM Firmware 7.7.1 and newer uses the same updated cloning protocol as Luna HSM Firmware 7.7.0 and newer. For the Luna Backup HSM 7 to be FIPS-compliant, it must restrict restore operations to application partitions that use the new protocol. This restriction is applied by setting **HSM policy 55: Enable Restricted Restore** to **1** on the backup HSM. The Luna Backup HSM 7 must be initialized and connected to a Luna HSM Client computer to set this policy.

When this policy is enabled on the Luna Backup HSM 7, objects that have been backed up from partitions using firmware older than Luna HSM Firmware 7.7.0 can be restored to Luna HSM Firmware 7.7.0 or newer (V0 or V1) partitions only.

> **CAUTION!** FIPS compliance requires that objects are never cloned or restored to an HSM using less secure firmware, and this includes restoring from Luna Backup HSM 7 firmware.
>
> If you have backups already stored on the Luna Backup HSM 7 that were taken from pre-7.7.0 partitions, turning this policy ON will prevent you from restoring them to the same source partition. You must update the HSM containing the source partition to Luna HSM Firmware 7.7.0 or newer before restoring from backup.

> **NOTE** **HSM policy 12: Allow non-FIPS algorithms**, which is used to set FIPS-compliant mode on other Luna HSMs, does not apply to the Luna Backup HSM 7. Attempts to change this policy will fail with the error `CKR_CANCEL`.

To configure the Luna Backup HSM 7 for FIPS compliance

1. On the Luna HSM Client computer, run LunaCM.
2. Set the active slot to the Luna Backup HSM 7.

   lunacm:> **slot set -slot** <slot_id>
3. Log in as Backup HSM SO.

   lunacm:> **role login -name so**
4. Set **HSM policy 55: Enable Restricted Restore** to **1**.

   lunacm:> **hsm changehsmpolicy -policy 55 -value 1**
5. [Optional] Check that the Luna Backup HSM 7 is now in FIPS approved operation mode.

   lunacm:> **hsm showinfo**

   ```
   *** The HSM is in FIPS 140-2 approved operation mode. ***
   ```

Backing Up a Password-Authenticated Partition

Backups are created and stored as partitions within the Admin partition on the Luna Backup HSM 7. A new backup partition is created on initial backup. For subsequent backups, you can choose to replace the contents of the existing backup partition with the current source partition objects, or add new objects in the source partition to the existing backup partition. Like all cloning operations, the source and target backup partitions must be initialized with the same domain.

Prerequisites

Before you begin, ensure that you have satisfied the following prerequisites:

> You have the required credentials:

If you are creating a new backup:

- The Crypto Officer password and domain string for the source partition
- The HSM SO password for the backup HSM

If you are adding to an existing backup initialized with the same domain string as the source partition:

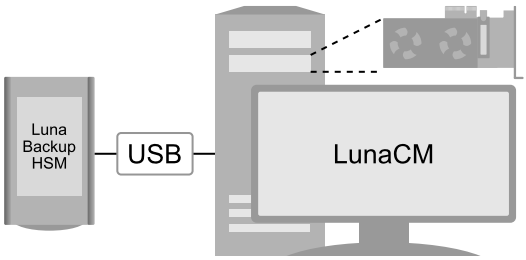
- The Crypto Officer password for the source partition
- The Crypto Officer password for the existing backup
- The HSM SO password for the backup HSM

> The following policies are set:

- **HSM policy 16:** Allow network replication must be set to **1** (ON) on the HSM that hosts the user partition.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 0:** "Allow private key cloning" on page 178 is set to **1** (ON) on the user partition.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 4:** "Allow secret key cloning" on page 180 is set to **1** (ON) on the user partition.

To back up a password-authenticated partition

1. Configure your Luna HSM Client workstation as illustrated below:



   a. If you have not already done so, install the required client software on the Luna HSM Client workstation and start LunaCM. See "Client Software Required to Perform Backup and Restore Operations" on page 279 for more information.

   > **NOTE** If you are installing Luna HSM Client on Windows, the driver may not be installed unless the Luna device is connected to the computer first; refer to Backup/USB/PCIe Drivers Not Installed on Windows 10 or Windows Server 2022 Unless Device is Connected.

   b. Connect the backup HSM directly to the Luna HSM Client workstation using the included USB cable.

> **NOTE** On most Luna HSM Client computers, the USB port provides adequate power, and connecting the provided power supply is not recommended. Wait and confirm that the HSM boots properly. If the HSM fails to boot up:
>
> **1.** Disconnect the HSM from the USB port.
>
> **2.** Connect the HSM to power using the provided power supply. Wait for it to boot completely.
>
> **3.** Reconnect the HSM to the USB port on the client.
>
> If the HSM is connected to the USB port before the power supply, you may encounter an issue where the HSM occasionally loses contact with the client, and must be power cycled.

2. Launch LunaCM on the workstation that hosts the user and backup partition slots.

3. Identify the slots assigned to:

- The Luna PCIe HSM 7 partition slot (to be backed up).
- The Luna Backup HSM 7 admin slot (where all backups are stored).

lunacm:> **slot list**

If you cannot see both slots, check your connections or configure your client as required.

4. Select the Luna PCIe HSM 7 partition:

lunacm:> **slot set -slot** <slot_id>

5. Log in to the Luna PCIe HSM 7 partition as the Crypto Officer (CO):

lunacm:> **role login -name co**

6. Initiate backup of the Luna PCIe HSM 7 partition to the backup partition:

lunacm:> **partition archive backup -slot** <backup_hsm_admin_partition_slot_id> [**-partition** <target_backup_partition_label>] [**-append**] [**-replace**] [**-smkonly**]

If you omit the **-partition** option when creating a new backup, the backup is assigned a default name (<source_partition_name>_<YYYYMMDD>) based on the source HSM's internally-set time and date.

If you are backing up a V1 partition, include **-smkonly** to back up the SMK only. By default, the SMK and any encrypted cryptographic material on the partition are backed up.

The backup begins once you have completed the authentication process. Objects are backed up one at a time. For existing backups, you can use the following options to define how individual objects are backed up:

-replace	Delete the target backup partition and replace it with a new backup with the same label, with the contents of the source partition. This is the default.
-append	Add only new objects to the existing backup.
-append -replace	Add new objects and replace existing objects that have the same OUID but a different fingerprint (such as would occur if any of the object attributes were changed since the previous backup).

> **NOTE** If the backup operation is interrupted (if the Backup HSM is unplugged, for example), the Backup HSM's full available space can become occupied with a single backup partition. If this occurs, delete the backup partition with lunacm:> **partition archive delete** before reattempting the backup operation.

7. You are prompted for the following passwords, unless you specified them in the **partition archive backup** options:
   a. The HSM SO password for the backup HSM. This is required to create or access the backup partition in the Admin slot.
   b. The Crypto Officer password for the target partition on the backup HSM (if you specified an existing backup). If you are creating a new backup, you must set its CO password now.
   c. [If creating a new backup] The domain string for the backup partition. The domain must match the domain configured on the source partition.

Restoring to a Password-Authenticated Partition

You can restore the objects from a password-authenticated backup to the same partition that was originally backed up, or to another partition that has been initialized with the same domain string.

Prerequisites

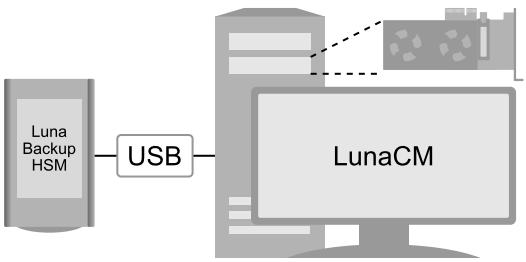
> The backup and the partition you want to restore to must be members of the same domain.

> You need the following credentials:
- The Crypto Officer password for the target partition.
- The Crypto Officer password for the backup

> The following policies are set:
- **HSM policy 16:** Allow network replication must be set to **1** (ON) on the HSM that hosts the user partition.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 0:** "Allow private key cloning" on page 178 is set to **1** (ON) on the partition you want to restore to.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 4:** "Allow secret key cloning" on page 180 is set to **1** (ON) on the partition you want to restore to.

To restore a password-authenticated partition

1. Configure your Luna HSM Client workstation as illustrated below:



   a. Install the required client software on the Luna HSM Client workstation and start LunaCM. See "Client Software Required to Perform Backup and Restore Operations" on page 279 for more information.

> **NOTE** If you are installing Luna HSM Client on Windows, the driver may not be installed unless the Luna device is connected to the computer first; refer to Backup/USB/PCIe Drivers Not Installed on Windows 10 or Windows Server 2022 Unless Device is Connected.

b. Connect the backup HSM directly to the Luna HSM Client workstation using the included USB cable.

> **NOTE** On most Luna HSM Client computers, the USB port provides adequate power, and connecting the provided power supply is not recommended. Wait and confirm that the HSM boots properly. If the HSM fails to boot up:
>
> **1.** Disconnect the HSM from the USB port.
>
> **2.** Connect the HSM to power using the provided power supply. Wait for it to boot completely.
>
> **3.** Reconnect the HSM to the USB port on the client.
>
> If the HSM is connected to the USB port before the power supply, you may encounter an issue where the HSM occasionally loses contact with the client, and must be power cycled.

2. Identify the slots assigned to:

- The Luna PCIe HSM 7 partition slot (to be restored).
- The Luna Backup HSM 7 admin slot (where all backups are stored).

lunacm:> **slot list**

If you cannot see both slots, check your connections or configure your client as required.

3. Select the Luna PCIe HSM 7 partition you want to restore to:

lunacm:> **slot set -slot** <slot_id>

4. Log in to the partition as Crypto Officer (CO):

lunacm:> **role login -name co**

5. List the available backups on the Backup HSM by specifying the Backup HSM's slot number. You will require the backup partition label to perform the restore operation.

lunacm:> **partition archive list -slot** <backup_HSM_slot>

6. Initiate the restore operation. Respond to the prompts to provide the required passwords, as detailed in the summary above.

lunacm:> **partition archive restore -slot** <backup_HSM_admin_slot> **-partition** <backup_partition_label> [**-smkonly**]

You are prompted for the Crypto Officer password for the backup. The restore operation begins once you have completed the authentication process. Objects are restored one at a time.

> **CAUTION!** The **-replace** option is deprecated and has been removed in Luna HSM Client 10.7.0 and newer. If you wish to restore an earlier version of an object, Thales recommends deleting the object(s) manually before restoring the partition from backup.
>
> Ensure that the target partition can receive objects from the backup HSM before deleting objects or using partition archive restore with the **-replace** option; the cloning protocol may prevent objects from being restored, even if LunaCM states that `X objects will be restored`. This may occur if **HSM policy 55: Enable Restricted Restore** was enabled on the Luna Backup HSM 7 since the original backup was taken. If your partition is on an HSM with firmware older than Luna HSM Firmware 7.7.0, you must update to 7.7.0 or newer to restore objects from this backup.

> **NOTE** If you are restoring a V1 backup to a V1 partition, include **-smkonly** to restore the SMK only (see "V0 and V1 Partitions" on page 17 for more information). By default, the SMK and any encrypted cryptographic material on the backup are restored.

Luna Backup HSM G5

The Luna Backup HSM G5 allows you to safeguard your important cryptographic objects by making secure backups, and restoring those backups to an application partition.

For setup, management and backup/restore procedures, refer to the following sections:

> "Luna Backup HSM G5 Hardware Installation" on the next page

> "Backup/Restore Using Luna Backup HSM G5" on page 333

> "Managing the Luna Backup HSM G5" on page 324

> "Configuring a Remote Backup Server" on page 338

The Luna Backup HSM G5 can be configured to back up either password- or multifactor quorum-authenticated partitions. You must specify the authentication method when you initialize the Luna Backup HSM G5. Once initialized, the backup HSM can only be used with partitions sharing the same authentication type. The only way to change the authentication method is to restore the backup HSM to factory condition and re-initialize it.

The storage capacity and maximum number of backup partitions allowed on the backup HSM is determined by the firmware. You can check the capacity using lunacm:> **hsm showinfo**. To update the backup HSM firmware to a version that allows more backups, see "Updating the Luna Backup HSM G5 Firmware" on page 326.

> **NOTE** Objects stored on a Backup HSM may be smaller than their originals. For example, symmetric keys are 8 bytes smaller when stored on a Backup HSM. This size difference has no effect on backup and restore operations.

Considerations when Performing Cloning and Backup-Restore Operations, when SKS is Involved

If you invoked scalable key storage (SKS) for your applications to create and store large numbers of keys, then the partition is V1. If you perform cloning operations (including HA) or Backup and Restore, see "Cloning or Backup / Restore with SKS" on page 81.

Luna Backup HSM G5 Hardware Installation

This section contains instructions for installing your Luna Backup HSM G5.

> "Luna Backup HSM G5 Required Items" below

> "Physical Features" on the next page

> "Installing the Luna Backup HSM G5" on page 323

Luna Backup HSM G5 Required Items

This section provides a list of the components you should have received with your Luna Backup HSM G5 order.

Qty	Item
1	**Luna Backup HSM G5**
1	**External Power Supply** The Luna Backup HSM G5 now ships with an external power supply. Previously, these HSMs relied on an internal power supply, requiring the HSM to be periodically powered on to recharge internal capacitors. Failure to charge the capacitors could result in an inability to power on the HSM. With the introduction of external power supplies, periodically powering on the HSM is no longer required. A failed external power supply can be replaced and there is no need to return the HSM for repair (RMA). **NOTE** External power supplies do contain capacitors which may be affected by extended periods of being unpowered, but they are more easily replaced in the event of failure.

Qty	Item
1	**Power Supply Cord** Your order should include one power supply cord for the Luna Backup HSM G5. The actual cord received depends on the country for which you ordered the Luna Backup HSM G5.
1	**USB cable (USB A to USB mini B)** Your order should include one USB A to 5-pin (Mini-B) cable.

Optional Items

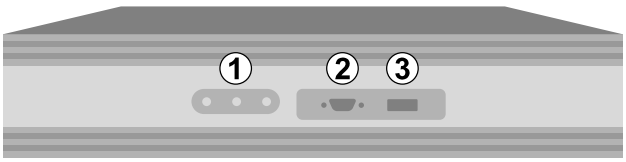
Your order may also include the following optional item

Luna Backup HSM G5 Rack-Mount Shelf

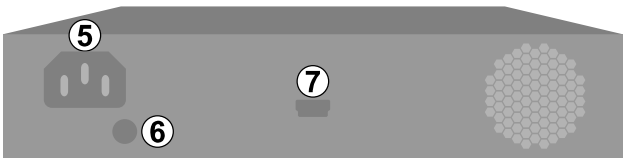
The Luna Backup HSM G5 rack-mount shelf (available by separate order) fits a standard 19-inch equipment rack, allowing you to install up to two Luna Backup HSM G5 units side-by side in server-room racks. For office use, without rack mounting, Luna Backup HSM G5 units can be placed on a desktop and are stackable.

Physical Features

The front panel of the Luna Backup HSM G5 is illustrated below, with important features labeled. In the second image, the front bezel has been removed, exposing the battery enclosure.



The rear panel of the Luna Backup HSM G5 is illustrated below, with important features labeled. The first image depicts a backup HSM with an internal power supply. The second image depicts one that ships with an external power supply.



1	Status LEDs. When illuminated, they indicate: > **Active:** The backup HSM is performing a procedure. Do not disconnect or unplug the device when this light is illuminated. > **Tamper:** The backup HSM is in a tamper state. You must clear the tamper state before backing up or restoring partitions. > **Error:** HSM device driver error. Contact Thales Customer Support (see "Support Contacts" on page 16).
2	Serial port for attaching a local Luna PED using a 9-pin Micro-D to Micro-D cable.
3	USB port. Not applicable to backup/restore functions.
4	Battery enclosure. See "Installing or Replacing the Luna Backup HSM G5 Battery" on page 328.
5	Power connector for a Luna Backup HSM with an internal power supply. See "Storage and Maintenance" on the next page for more information.
6	Index hole. Engages with the index post on a Luna Backup HSM rack shelf.
7	Mini-USB port for connecting the Luna Backup HSM G5 to a Luna HSM or client workstation. See "Installing the Luna Backup HSM G5" below.
8	Power source connector for a Luna Backup HSM G5 with an external power supply (included).

Installing the Luna Backup HSM G5

You can connect the Luna Backup HSM to a Luna Network HSM, a Luna HSM Client workstation, or a host machine containing a Luna PCIe HSM. Refer to "Planning Your Backup HSM Deployment" on page 280 for detailed descriptions of the configuration options.

To install the Luna Backup HSM G5

1. Connect the Luna Backup HSM G5 to power using the external power source or a standard power cable.

2. If you are connecting the Luna Backup HSM G5 to a client workstation or Luna PCIe HSM 7 host, ensure that you have installed the **Backup** option in the Luna HSM Client installer (see Luna HSM Client Software Installation for details).
3. [Local PED] If you plan to authenticate the Luna Backup HSM G5 with a local Luna PED, connect the PED using a 9-pin Micro-D to Micro-D cable (see "Physical Features" on page 322).

   To use the same local PED to authenticate both the Backup HSM and Luna PCIe HSM 7, connect the PED to the Luna PCIe HSM 7 using a USB Mini-B to USB cable (see "Physical Features" on page 322). You can switch between the two using PED modes (see "Modes of Operation" on page 102).
4. Connect the Luna Backup HSM G5 using the included Mini-USB to USB cable. If you are connecting the Backup HSM to:
   - **Luna Network HSM 7:** Connect to one of the USB ports on the front or rear panel of the appliance.
   - **Luna HSM Client:** Connect to a USB port on the client workstation. Run LunaCM on the client workstation to confirm that the Luna Backup HSM G5 appears in a slot.
   - **Luna PCIe HSM 7 host:** Connect to a USB port on the host workstation. Run LunaCM on the host workstation to confirm that the Luna Backup HSM G5 appears in a slot.
5. If your Backup HSM was shipped in Secure Transport Mode, see "Recovering From a Tamper Event or Secure Transport Mode" on page 332.

Managing the Luna Backup HSM G5

This section contains the following procedures for maintaining and using the Luna Backup HSM G5:

> "Storage and Maintenance" below

> "Initializing the Luna Backup HSM G5 Remote PED Vector" on the next page

> "Updating the Luna Backup HSM G5 Firmware" on page 326

> "Resetting the Luna Backup HSM G5 to Factory Conditions" on page 327

> "Installing or Replacing the Luna Backup HSM G5 Battery" on page 328

> "About Luna Backup HSM G5 Secure Transport and Tamper Recovery" on page 330

- "Creating a Secure Recovery Key" on page 331
- "Setting Secure Transport Mode" on page 332
- "Recovering From a Tamper Event or Secure Transport Mode" on page 332
- "Disabling Secure Recovery" on page 333

Storage and Maintenance

The Luna Backup HSM G5 can be safely stored, containing backups, when not in use. When stored properly, the hardware has a lifetime of 10+ years. Newer Luna Backup HSM G5s ship with an external power supply.

> **CAUTION!** The internal power supply on older Luna Backup HSM G5s uses capacitors that may be affected if they are left unpowered for extended periods of time.If your Luna Backup HSM G5 has an internal power supply, power it on occasionally to recharge the capacitors. If the capacitors lose function, the Luna Backup HSM G5 will no longer receive power.
>
> With the introduction of external power supplies, this is no longer a requirement. If the external power supply fails from being left unpowered, it can be easily replaced.

The Luna Backup HSM G5 Battery

The battery powers the NVRAM and Real-Time-Clock (RTC), and must be installed for use. The battery can be removed for storage, and this is generally good practice. Thales uses high-quality, industrial-grade batteries that are unlikely to leak and damage the HSM hardware, but an externally-stored battery will last longer. The battery must be stored in a clean, dry area (less than 30% Relative Humidity). Temperature should not exceed +30 ºC. When properly stored, the battery has a shelf life of 10 years.

If the battery dies or is removed, and the main power is not connected, NVRAM and the RTC lose power. Battery removal triggers a tamper event. After replacing the battery, the HSM SO must clear the tamper event before operation can resume. The working copy of the Master Tamper Key (MTK) is lost (see "About Luna Backup HSM G5 Secure Transport and Tamper Recovery" on page 330). Backup objects are stored in non-volatile memory, so they are preserved and remain uncorrupted.

There is no low battery indicator, or other provision for checking the battery status. The voltage remains constant until the very end of battery life.

Your stored (backed-up) content is in long-term memory and is not affected by the state of the battery. A failure or removal of the battery does cause a tamper event, but this is intended as an alert to bring the condition to your attention for action, and does not affect the stored content. A situation where battery removal *could* affect your ability to recover archived data from the Luna Backup HSM G5 is where you have previously extracted a portion of the MTK onto an iKey (PED Key) and then have lost/destroyed/overwritten all copies of that key, leaving the MTK unrecoverable.

Initializing the Luna Backup HSM G5 Remote PED Vector

The Remote PED (via PEDserver) authenticates itself to the Luna Backup HSM G5 with a randomly-generated encrypted value stored on an orange PED key. The orange key proves to the HSM that the Remote PED is authorized to perform authentication. The HSM SO can create this key using LunaCM.

If the Luna Backup HSM G5 is already initialized, the HSM SO must log in to complete this procedure.

Prerequisites

- Luna PED with firmware 2.7.1 or newer
- USB mini-B to USB-A connector cable
- Luna PED DC power supply (if included with your Luna PED)
- Blank or reusable orange PED key (or multiple keys, if you plan to make extra copies or use an M of N security scheme). See "Creating PED keys" on page 129 for more information.
- Install the Luna Backup HSM G5 at the client and connect it to power (see "Luna Backup HSM G5 Hardware Installation" on page 321).

> Connect the PED to the Luna Backup HSM G5 using a 9-pin Micro-D to Micro-D cable. Set the PED to **Local PED-SCP** mode (see "Modes of Operation" on page 102).

To initialize the RPV and create the orange PED key

1. Launch LunaCM on the client workstation.
2. Set the active slot to the Luna Backup HSM G5.

   lunacm:> **slot set -slot** <slotnum>
3. If the Luna Backup HSM G5 is initialized, log in as HSM SO. If not, continue to the next step.

   lunacm:> **role login -name so**
4. Ensure that you have the orange PED key(s) ready. Initialize the RPV.

   lunacm:> **ped vector init**
5. Attend to the Luna PED and respond to the on-screen prompts. See "Creating PED keys" on page 129 for a full description of the key-creation process.

```
SLOT
SETTING RPV...
Would you like to
reuse an existing
keyset?(Y/N)
```

   - If you have an orange PED key with an existing RPV that you wish to use for this HSM, press **Yes**.
   - If you are creating a new RPV, press **No**.

```
SLOT
SETTING RPV...
Insert a
RPK / Remote
PED Key (ORANGE)
Press ENTER.
```

   Continue following the prompts for PED PIN, M of N, and duplication options.

To set up a Remote PED server, see "Configuring a Remote Backup Server" on page 338.

Updating the Luna Backup HSM G5 Firmware

To update Luna Backup HSM G5 firmware, use LunaCM on a client computer that is connected to the Luna Backup HSM G5. You require:

> Luna Backup HSM G5 firmware update file (<filename>**.fuf**)

> the firmware update authentication code file(s) (<filename>**.txt**)

> **CAUTION!** Use an uninterruptible power supply (UPS) to power your HSM. There is a small chance that a power failure during an update could leave your HSM in an unrecoverable condition.

> **NOTE** To perform backup operations on Luna HSM Firmware 7.7.0 or newer (V0 or V1 partitions) you require at minimum:
>
> > Luna Backup HSM 7 Firmware 7.7.1
> >
> > Luna Backup HSM G5 Firmware 6.28.0
>
> You can use a Luna Backup HSM with older firmware to restore objects to a V0 or V1 partition, but this is supported for purposes of getting your objects from the older partitions onto the newer V0 or V1 partitions only. V0 and V1 partitions are considered more secure than partitions at earlier firmware versions - any attempt to restore from a higher-security status to lower-security status fails gracefully.

To update the Luna Backup HSM G5 firmware

1. Copy the firmware file (<filename>**.fuf**) and the authentication code file (<filename>**.txt**) to the Luna HSM Client root directory.
   - Windows: **C:\Program Files\SafeNet\LunaClient**
   - Linux/AIX: **/usr/safenet/lunaclient/bin**
   - Solaris: **/opt/safenet/lunaclient/bin**

   > **NOTE** On some Windows configurations, you might not have authority to copy or unzip files directly into **C:\Program Files\...**. If this is the case, put the files in a known location that you can reference in a LunaCM command.

2. Launch LunaCM.
3. If more than one HSM is installed, set the active slot to the Admin partition of the HSM you wish to update.

   lunacm:> **slot set -slot** <slot_number>
4. Log in as HSM SO. Depending on the currently-installed firmware version, use one of the following two commands:
   - lunacm:> **role login -name so**
   - lunacm:> **hsm login**
5. Apply the new firmware update by specifying the update file and the authentication code file. If the files are not located in the Luna HSM Client root directory, specify the filepaths.

   lunacm:> **hsm updatefw -fuf** <filename>**.fuf -authcode** <filename>**.txt**

Resetting the Luna Backup HSM G5 to Factory Conditions

These instructions will allow you to restore your Luna Backup HSM G5 to its original factory conditions, erasing its contents. This could be necessary if you have old backups that you do not wish to keep, or if you want to re-initialize the Backup HSM to store backups using a different authentication method (password or multifactor quorum). If you have performed firmware updates, they are unaffected. Factory reset can be performed via LunaCM.

To reset the Luna Backup HSM G5 to factory conditions

1. Launch LunaCM on the Luna Backup HSM G5 workstation.

2. Set the active slot to the Luna Backup HSM G5.

   lunacm:> **slot set -slot** <slotnum>

3. Reset the Backup HSM.

   lunacm:> **hsm factoryreset**

Installing or Replacing the Luna Backup HSM G5 Battery

The Luna Backup HSM G5 must have a functioning battery installed to preserve the NVRAM and RTC in case of primary power loss. You can purchase a replacement battery from any supplier who can match the following specifications:

> 3.6 V Primary lithium-thionyl chloride (Li-SOCl2)

> Fast voltage recovery after long term storage and/or usage

> Low self discharge rate

> 10 years shelf life

> Operating temperature range -55 ºC to +85 ºC

> U.L. Component Recognition, MH 12193

Prerequisites

> Removing the battery causes a tamper event. If you have created a Secure Recovery Vector (purple PED key) and enabled Secure Recovery, you will need this key to clear the tamper after replacing the battery.

To install or replace the Luna Backup HSM G5 battery

1. Remove the front bezel. It is held in place by two spring clips.

2. The battery compartment is spring-loaded and can be removed without much pressure. Use a coin or your fingers to press in the compartment cover and turn counter-clockwise to remove it.

3. If you are replacing the old battery, remove it from the battery compartment.

4. Insert the new battery, negative end first. The positive end should be visible.

5. Use the battery compartment cover to push the battery into the compartment, aligning the tabs on the cover with the compartment slots. Twist the cover clockwise to lock the compartment.

6. Replace the front bezel by aligning the clips with their posts and pushing it into place.

   Removing the battery causes a tamper event on the Luna Backup HSM G5.

7. To clear the tamper, see "Recovering From a Tamper Event or Secure Transport Mode" on page 332.

About Luna Backup HSM G5 Secure Transport and Tamper Recovery

The Luna Backup HSM G5 recognizes a similar list of tamper conditions to the Luna PCIe HSM 7 (see Tamper Events). When a tamper event occurs, a tamper state is reported in the **HSM Status** field in LunaCM's list of slots.

By default, tamper events are cleared automatically when you reboot the Luna Backup HSM G5 and log in as HSM SO. However, you can choose to prevent any further operations on theLuna Backup HSM G5. The following procedures will allow you to create a purple Secure Recovery Key (SRK) that the Backup HSM SO must present to unlock the HSM after a tamper event. This key contains part of the Master Tamper Key (MTK), which encrypts all sensitive data stored on the Backup HSM. By splitting the MTK and storing part of it on an SRK (purple PED key), you ensure that none of the stored material can be accessible until the SRK is presented.

You can create the purple SRK even for a Luna Backup HSM G5 that is initialized for password authentication. There is no password-based SRK equivalent; you must have a Luna PED and a purple PED key to use Secure Tamper Recovery and Secure Transport Mode.

Initializing the SRK also allows you to place the Luna Backup HSM G5 in Secure Transport Mode (STM). STM on the Luna Backup HSM G5 functions differently from STM on the Luna PCIe HSM 7 (see Secure Transport Mode for comparison). When the SRK is initialized and secure recovery enabled, STM on the Backup HSM is effectively a voluntary tamper state, where no operations are possible until you present the purple PED key.

> **CAUTION!** Always keep a securely-stored backup copy of the purple PED key. If you lose this key, the Backup HSM is permanently locked and you will have to obtain an RMA for the Backup HSM.

This section provides directions for the following procedures:

> "Creating a Secure Recovery Key" below
> "Setting Secure Transport Mode" on the next page
> "Recovering From a Tamper Event or Secure Transport Mode" on the next page
> "Disabling Secure Recovery" on page 333

Creating a Secure Recovery Key

To enable secure recovery, you must create the Secure Recovery Key (purple PED key). This procedure will zeroize the SRK split on the Backup HSM, so that you must present the purple PED key to recover from a tamper event or Secure Transport Mode.

Prerequisites

> Install the Backup HSM at the client and connect it to power (see "Luna Backup HSM G5 Hardware Installation" on page 321).

> You require the Backup HSM SO credential (blue PED key).

> Ensure that the Backup HSM can access PED service (Local or Remote PED), and that you have enough blank or rewritable purple PED keys available for your desired authentication scheme (see "Creating PED keys" on page 129).

- [Local PED] Connect the PED using a 9-pin Micro-D to Micro-D cable. Set the PED to **Local PED-SCP** mode (see "Modes of Operation" on page 102).
- [Remote PED] Set up a Remote PED server to authenticate the Backup HSM (see "Configuring a Remote Backup Server" on page 338).
- [Remote PED] Initialize the Backup HSM RPV (see "Initializing the Luna Backup HSM G5 Remote PED Vector" on page 325). You require the orange PED key.

To create a Secure Recovery Key

1. Launch LunaCM on the client workstation.
2. Set the active slot to the Luna Backup HSM.

   lunacm:> **slot set -slot** <slotnum>
3. [Remote PED] Connect the Luna Backup HSM G5 to the Remote PED server.

   lunacm:> **ped connect -ip** <PEDserver_IP> **-port** <portnum>
4. Create a new split of the MTK on the Luna Backup HSM G5.

   lunacm:> **srk generate**
5. Log in as Backup HSM SO.

   lunacm:> **role login -name so**
6. Enable secure recovery.

   lunacm:> **srk enable**

   Attend to the Luna PED prompts to create the purple PED key. Secure Recovery is now enabled on the Luna Backup HSM G5.

Setting Secure Transport Mode

The following procedure will allow you to set Secure Transport Mode on the Luna Backup HSM G5.

Prerequisites

> Ensure the Luna Backup HSM G5 can access PED services.

> Secure Recovery must be enabled on the Backup HSM (see "Creating a Secure Recovery Key" on the previous page). You require the Secure Recovery Key (purple PED key) for the Luna Backup HSM G5.

To set Secure Transport Mode on the Luna Backup HSM G5

1. Launch LunaCM on the client workstation.
2. Set the active slot to the Luna Backup HSM G5.

   lunacm:> **slot set -slot** <slotnum>
3. [Remote PED] Connect the Luna Backup HSM G5 to the Remote PED server.

   lunacm:> **ped connect -ip** <PEDserver_IP> **-port** <portnum>
4. Set Secure Transport Mode.

   lunacm:> **srk transport**

   a. You are prompted for the SRK (purple PED key). This is to ensure that you have the key that matches the SRK split on the HSM.

   b. The Luna PED displays a 16-digit verification code. Write this code down as an additional optional check.

   The SRK is zeroized on the Luna Backup HSM G5 and STM is now active.

Recovering From a Tamper Event or Secure Transport Mode

With Secure Recovery Mode enabled, the procedure to recover from a tamper event or to exit STM is the same.

Prerequisites

> Ensure the Luna Backup HSM G5 can access PED services.

> You require the Secure Recovery Key (purple PED key) for the Luna Backup HSM G5.

> If you are recovering from a tamper event, reboot the Backup HSM and LunaCM before recovering.

lunacm:> **hsm restart**

lunacm:> **clientconfig restart**

To recover from a tamper event or exit STM

1. Launch LunaCM on the client workstation.
2. Set the active slot to the Luna Backup HSM G5.

   lunacm:> **slot set -slot** <slotnum>
3. [Remote PED] Connect the Luna Backup HSM G5 to the Remote PED server.

   lunacm:> **ped connect -ip** <PEDserver_IP> **-port** <portnum>

4. Recover the Luna Backup HSM G5 from the tamper event or STM.

   lunacm:> **srk recover**

   Attend to the Luna PED prompts:

   a. You are prompted for the SRK (purple PED key).

   b. [STM] The Luna PED displays a 16-digit verification code. If this code matches the one that was presented when you set STM, you can be assured that the Luna Backup HSM G5 has remained in STM since then.

   The Luna Backup HSM G5 is recovered from the tamper/STM state and you can resume backup/restore operations.

Disabling Secure Recovery

To disable secure recovery, you must present the Secure Recovery Key (purple PED key) so that it can be stored on the Luna Backup HSM G5. You will no longer need to present the purple key to recover from a tamper event.

Prerequisites

> Ensure the Luna Backup HSM G5 can access PED services.

> You require the Secure Recovery Key (purple PED key) for the Luna Backup HSM G5.

To disable secure recovery

1. Launch LunaCM on the client workstation.
2. Set the active slot to the Luna Backup HSM G5.

   lunacm:> **slot set -slot** <slotnum>
3. [Remote PED] Connect the Luna Backup HSM G5 to the Remote PED server.

   lunacm:> **ped connect -ip** <PEDserver_IP> **-port** <portnum>
4. Log in as Backup HSM SO.

   lunacm:> **role login -name so**
5. Disable secure recovery.

   lunacm:> **srk disable**

   You are prompted for the SRK (purple PED key).

Backup/Restore Using Luna Backup HSM G5

You can connect the Luna Backup HSM G5 to a USB port on the client workstation. This configuration allows you to perform backup/restore operations for all application partitions that appear as visible slots in LunaCM. It is useful in deployments where the partition Crypto Officer wants to keep backups at the client. You can restore a partition backup to the original source partition or to another existing Luna application partition that shares the same cloning domain.

This section provides instructions for the following procedures using this kind of deployment:

> "Initializing the Luna Backup HSM G5" on the next page

> "Backing Up an Application Partition" on the next page

> "Restoring an Application Partition from Backup" on page 337

> **NOTE** To perform backup operations on Luna HSM Firmware 7.7.0 or newer (V0 or V1 partitions) you require at minimum:
>
> > Luna Backup HSM 7 Firmware 7.7.1
>
> > Luna Backup HSM G5 Firmware 6.28.0
>
> You can use a Luna Backup HSM with older firmware to restore objects to a V0 or V1 partition, but this is supported for purposes of getting your objects from the older partitions onto the newer V0 or V1 partitions only. V0 and V1 partitions are considered more secure than partitions at earlier firmware versions - any attempt to restore from a higher-security status to lower-security status fails gracefully.

> **NOTE** The size of the partition header is different for a Luna PCIe HSM 7 partition and its equivalent backup partition stored on a Luna Backup HSM G5. As a result, the value displayed in the `Used` column in the output of the **partition list** command (for the backed-up Luna PCIe HSM 7 partition) is different than the value displayed in the `Used` column in the output of the **token backup partition list** command (for the backup partition on the Backup HSM).

Initializing the Luna Backup HSM G5

Before you can use the Luna Backup HSM G5 to back up your partition objects, it must be initialized. This procedure is analogous to the standard HSM initialization procedure.

Prerequisites

> Install the Luna Backup HSM G5 at the client and connect it to power (see "Installing the Luna Backup HSM G5" on page 323).

> Ensure that the Backup HSM is not in Secure Transport Mode and that any tamper events are cleared (see "Recovering From a Tamper Event or Secure Transport Mode" on page 332).

> [Multifactor Quorum Authentication] Ensure that you have enough blank or rewritable blue and red PED keys available for your desired authentication scheme (see "Creating PED keys" on page 129).

- [Local PED] Connect the Luna PED using a 9-pin Micro-D to Micro-D cable. Set the PED to **Local PED-SCP** mode (see "Modes of Operation" on page 102).
- [Remote PED] Initialize the Backup HSM RPV (see "Initializing the Luna Backup HSM G5 Remote PED Vector" on page 325). You require the orange PED key.
- [Remote PED] Set up a Remote PED server to authenticate the Luna Backup HSM G5 (see "About Remote PED" on page 106).

To initialize a client-connected Luna Backup HSM G5

1. Launch LunaCM on the client workstation.
2. Set the active slot to the Luna Backup HSM G5.

   lunacm:> **slot set -slot** <slotnum>

3. [Remote PED] Connect the Luna Backup HSM G5 to the Remote PED server.

   lunacm:> **ped connect -ip** <PEDserver_IP> **-port** <portnum>

4. Initialize the Luna Backup HSM G5, specifying a label and the method of authentication (**-initwithped** or **-initwithpwd**). You must initialize the HSM with the same authentication method as the partition(s) you plan to back up.

   lunacm:> **hsm init -label** <label> {**-initwithped** |**-initwithpwd**}

   You are prompted to set an HSM SO credential and cloning domain for the Backup HSM.

> **NOTE** After initializing a client-connected Luna Backup HSM G5 to use PED authentication, the HSM erroneously requests a password to log in with any role. This issue occurs when Luna HSM Client 10.3.0 or newer is used with HSM firmware 6.10.9 or older.
>
> **Workaround:** Press ENTER to bypass the password prompt, and present the PED key as usual. Alternatively, use an older client or upgrade to Luna Backup HSM G5 Firmware 6.24.7 or newer to avoid this.

Backing Up an Application Partition

You can use LunaCM to back up the contents of an application partition to the client-connected Luna Backup HSM G5. You can use this operation to create a backup on the Backup HSM, or add objects from the source partition to an existing backup.

Prerequisites

> The Luna Backup HSM G5 must be initialized (see "Initializing the Luna Backup HSM G5" on the previous page).

> The following policies are set:

- **HSM policy 16:** Allow network replication must be set to **1** (ON) on the HSM that hosts the user partition.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 0:** "Allow private key cloning" on page 178 is set to **1** (ON) on the user partition.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 4:** "Allow secret key cloning" on page 180 is set to **1** (ON) on the user partition.

> You must have the Crypto Officer credential (black PED key) and domain (red PED key) for the source partition.

> You must have the Backup HSM SO credential (blue PED key).

> [Multifactor Quorum Authentication] This procedure is simpler if the source partition is activated (see "Activation on Multifactor Quorum-Authenticated Partitions" on page 207), since you require a Luna PED only for the Backup HSM.

- [Local PED] Connect the PED to the Backup HSM using a 9-pin Micro-D to Micro-D cable. If the source partition is not activated, also connect the PED to the Luna PCIe HSM 7 using a Mini-B to USB-A cable (see "Local PED Setup" on page 104), and set the PED to **Local PED-USB** mode (see "Modes of Operation" on page 102).

- [Remote PED] You must have the orange PED key for the Backup HSM (see "Initializing the Luna Backup HSM G5 Remote PED Vector" on page 325). If the source partition is not activated, you may need the orange PED key for the Luna PCIe HSM 7 as well.
- [Remote PED] Set up Remote PED on the workstation you plan to use for multifactor quorum authentication (see "About Remote PED" on page 106). If the partition is not activated, you must connect to PEDserver with **ped connect** before logging in, and disconnect with **ped disconnect** before initiating the backup.

If you invoked scalable key storage (SKS) for your applications to create and store large numbers of keys, then the partition is V1. If you perform cloning operations (including HA) or Backup and Restore, see "Cloning or Backup / Restore with SKS" on page 81.

To back up an application partition to a client-connected Luna Backup HSM G5

1. Launch LunaCM on the client workstation.
2. Set the active slot to the source partition and log in as Crypto Officer.

   lunacm:> **slot set -slot** <slotnum>

   lunacm:> **role login -name co**
3. [Multifactor Quorum Authentication] Connect the Luna Backup HSM G5 to the Luna PED.
   - [Local PED] Set the mode on the Luna PED to **Local PED-SCP** (see "Modes of Operation" on page 102).
   - [Remote PED] Connect the Luna Backup HSM G5 slot to PEDserver.

     lunacm:> **ped connect -slot** <Backup_HSM_slotnum> **-ip** <PEDserver_IP> **-port** <portnum>
4. Back up the partition, specifying the Luna Backup HSM G5 slot and a label for the backup (either a new or existing label). If you specify an existing backup label, include the **-append** option to add only new objects to the backup (duplicate objects will not be cloned). By default, the existing backup will be overwritten with the current contents of the source partition.

   lunacm:> **partition archive backup -slot** <Backup_HSM_slotnum> [**-partition** <backup_label>] [**-append**] [**-replace**] [**-smkonly**]

   If you omit the **-partition** option when creating a new backup, the partition is assigned a default name (<source_partition_name>_<YYYYMMDD>) based on the source HSM's internally-set time and date.

   If you are backing up a V1 partition, include **-smkonly** to back up the SMK only. By default, the SMK and any encrypted cryptographic material on the partition are backed up.

   The backup begins once you have completed the authentication process.

   Objects are backed up one at a time. For existing backups, you can use the following options to define how individual objects are backed up:

-append	Add only new objects to an existing backup.
-replace	Delete the existing objects in a target backup partition and replace them with the contents of the source user partition. This is the default.
-append -replace	Add new objects and replace existing objects that have the same OUID but a different fingerprint (such as would occur if any of the object attributes were changed since the previous backup).

   You are prompted to present or set the following credentials:

- [Remote PED] Backup HSM Remote PED vector (orange PED key)
- Backup HSM SO (password or blue PED key)
- Crypto Officer (password or black PED key) for the backup (can be the same as the source partition)
- Cloning domain (string or red PED key) for the backup (must be the same as the source partition)

The partition contents are cloned to the backup.

5. [Remote PED] Disconnect the Backup HSM from PEDserver.

   lunacm:> **ped disconnect**

Restoring an Application Partition from Backup

You can use LunaCM to restore the contents of a backup to the original application partition, or any other Luna application partition that shares the same cloning domain.

Prerequisites

> The target partition must be initialized with the same cloning domain as the backup partition.

> The following policies are set:

- **HSM policy 16:** Allow network replication must be set to **1** (ON) on the HSM that hosts the user partition you want to restore to.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 0:** "Allow private key cloning" on page 178 is set to **1** (ON) on the user partition you want to restore to.
- [V0 partitions or firmware older than Luna HSM Firmware 7.7.0] **Partition policy 4:** "Allow secret key cloning" on page 180 is set to **1** (ON) on the user partition you want to restore to.

> You must have the Crypto Officer credentials for the backup partition and the target partition.

> [Multifactor Quorum Authentication] This procedure is simpler if the application partition is activated (see "Activation on Multifactor Quorum-Authenticated Partitions" on page 207), since you require a Luna PED only for the Backup HSM.

- [Local PED] Connect the PED to the Backup HSM using a 9-pin Micro-D to Micro-D cable. If the source partition is not activated, also connect the PED to the Luna PCIe HSM 7 using a Mini-B to USB-A cable (see "Local PED Setup" on page 104), and set the PED to **Local PED-USB** mode instead (see "Modes of Operation" on page 102).
- [Remote PED] Set up Remote PED on the workstation you plan to use for multifactor quorum authentication (see "About Remote PED" on page 106). If the partition is not activated, you must connect to PEDserver with **ped connect** before logging in, and disconnect with **ped disconnect** before initiating the backup.

To restore the contents of a backup to an application partition

1. Launch LunaCM on the client workstation.
2. Set the active slot to the target partition and log in as Crypto Officer.

   lunacm:> **slot set -slot** <slotnum>

   lunacm:> **role login -name co**

3. [PED Authentication] Connect the Luna Backup HSM G5 to the Luna PED.
   - [Local PED] Set the mode on the Luna PED to **Local PED-SCP** (see "Modes of Operation" on page 102).
   - [Remote PED] Connect the Luna Backup HSM G5 slot to PEDserver.

     lunacm:> **ped connect -slot** <Backup_HSM_slotnum> **-ip** <PEDserver_IP> **-port** <portnum>
4. [Optional] Display the available backups by specifying the Luna Backup HSM G5 slot. Each available backup also appears as a slot in LunaCM.

   lunacm:> **partition archive list -slot** <Backup_HSM_slotnum>
5. [Optional] Display the contents of a backup by specifying the Luna Backup HSM G5 slot and the backup partition label in LunaCM.

   lunacm:> **partition archive contents -slot** <backup_slotnum> **-partition** <backup_label>
6. Restore the partition contents, specifying the Luna Backup HSM G5 slot and the backup you wish to use. By default, duplicate backup objects with the same OUID as objects currently existing on the partition are not restored.

   If you have changed attributes of specific objects since your last backup and you wish to revert these changes, include the **-replace** option.

   If you are restoring a V1 partition and you only want to restore the SMK, include the **-smkonly** option.

   lunacm:> **partition archive restore -slot** <Backup_HSM_slotnum> **-partition** <backup_label> [**-replace**] [**-smkonly**]

   You are prompted for the backup's Crypto Officer credential.

   The backup contents are cloned to the application partition.

Configuring a Remote Backup Server

The Remote Backup Service (RBS) is an optional Luna client component that allows you to connect one or more backup HSMs to a remote Luna HSM Client workstation to back up slots on any local Luna HSM Client workstations that are registered with the RBS server. RBS is useful in deployments where backups are stored in a separate location from the Luna PCIe HSM 7, to protect against catastrophic loss (fire, flood, etc).

RBS is a utility, included with the Luna HSM Client software, that runs on a workstation hosting one or more Backup HSMs. When RBS is configured and running, other clients or HSMs registered to it can see its Backup HSM(s) as slots in LunaCM.

Installing and Configuring the Remote Backup Service

RBS is installed using the Luna HSM Client installer. You must create a certificate for the RBS workstation and register it on all clients/appliances that will use the remote Backup HSMs. These instructions will allow you to install and configure RBS.

> **NOTE** The Luna HSM Client version installed on the RBS workstation must be the same version installed on the client workstation(s). Ensure that you use a client version that is compatible with your Backup HSM firmware.
>
> RBS with Luna Backup HSM 7 requires minimum Luna HSM Client 10.1.0, or Luna HSM Client 10.3.0 if you are using Luna Backup HSM 7 Firmware 7.7.1 or newer.

Prerequisites

> Install the following Luna HSM Client components on any Luna PCIe HSM 7 client workstation that hosts slots for the partitions you want to backup using RBS (see Luna HSM Client Software Installation):

- **Network:** The Network component includes utilities that are required for remote backups.
- **Remote PED:** if you are backing up multifactor quorum-authenticated partitions.

> Connect the backup HSM(s) directly to the Luna HSM Client workstation that will host RBS using the included USB cable.

> **NOTE** On most workstations, the USB 3.0 connection provides adequate power to the backup HSM and it will begin the boot sequence. If you are using a low-power workstation, such as a netbook, the USB connection may not provide adequate power, in which case you will also need to connect the external power supply. It is recommended that you use the power supply for all backup HSMs connected to the RBS host workstation. If you are connecting multiple backup HSMs, you can use an external USB 3.0 hub if required.

> Initialize the backup HSMs if necessary.

> **HSM policy 16:** Allow network replication must be set to **1** (ON) on the HSMs that hosts the user partitions to be backed up.

To install and configure RBS

1. On the workstation hosting the Backup HSM(s), install the **Backup** component of the Luna HSM Client (see Luna HSM Client Software Installation). If this workstation will also host a Remote PED, install the **Remote PED** component as well (Windows only).
2. Navigate to the Luna HSM Client home directory (**/usr/safenet/lunaclient/rbs/bin** on Linux/Unix) and generate a certificate for the RBS host.

   > **rbs --genkey**

   You are prompted to enter and confirm an RBS password. The certificate is generated in:

   - Linux/UNIX: <LunaClient_install_directory>/rbs/server/**server.pem**
   - Windows: <LunaClient_install_directory>\cert\server**server.pem**
3. Specify the Backup HSM(s) that RBS will make available to clients.

   > **rbs --config**

   RBS displays a list of Backup HSMs currently connected to the workstation. Select the ones you want to provide remote backup services. When you have specified your selection, enter **X** to exit the configuration tool.
4. Launch the RBS daemon (Linux/UNIX) or console application (Windows).

- Linux/UNIX: **# rbs --daemon**
- Windows: Double-click the **rbs** application. A console window will remain open.

You are prompted to enter the RBS password.

5. Securely transfer the RBS host certificate (**server.pem**) to your Luna HSM Client workstation using **pscp** or **scp**.
6. On the client workstation, register the RBS host certificate to the server list.

   > **vtl addServer -n** <Backup_host_IP> **-c server.pem**
7. [Optional] Launch LunaCM on the client to confirm that the Backup HSM appears as an available slot.

> **NOTE** If you encounter issues, try changing the RBS and PEDclient ports from their default values. Check that your firewall is not blocking ports used by the service.

You can now use the Backup HSM(s) as though they were connected to the client workstation locally, using Remote PED.

CHAPTER 13: Slot Numbering and Behavior

Administrative partitions and application partitions are identified as PKCS#11 cryptographic slots in Thales utilities, such as LunaCM and **multitoken**, and for applications that use the Luna library.

Order of Occurrence for Different Luna HSMs

A host computer with Luna HSM Client software and Luna libraries installed can have Luna HSMs connected in any of three ways:

- PCIe embedded/inserted Luna PCIe HSM 7 card (one or multiple HSMs installed - administrative partitions and application partitions are shown separately)
- USB-connected Luna USB HSM 7s (one or multiple - administrative partitions and application partitions are shown separately)
- Luna Network HSM 7 application partitions*, registered and connected via NTLS or STC.

Any connected HSM partitions are shown as numbered slots. Slots are numbered from zero or from one, depending on configuration settings (see "Settings Affecting Slot Order" on the next page, below), and on the firmware version of the HSM(s).

* One or multiple application partitions. Administrative partitions on Luna Network HSM 7s are not visible via LunaCM or other client-side tools. Only registered, connected application partitions are visible. The number of visible partitions (up to 100) depends on your model's capabilities. That is, a remote Luna Network HSM 7 might support 100 application partitions, but your application and LunaCM will see only partitions that have established certificate-exchange NTLS links or STC links with the current Client computer.

In LunaCM, a slot list would normally show:

- Luna Network HSM 7 application partitions for which NTLS links or STC links are established with the current host, followed by
- Luna PCIe HSM 7 cards, followed by
- Luna USB HSM 7s

For Luna Network HSM 7, as seen from a client (via NTLS), only application partitions are visible. The HSM administrative partition of a remote Luna Network HSM 7 is never seen by a Luna HSM Client. The Luna Network HSM 7 slots are listed in the order they are polled, dictated by the entries in the **Luna Network HSM** section of the Crystoki.ini / chrystoki.conf file, like this:

```
ServerName00=192.20.17.200
ServerPort00=1792
ServerName01=192.20.17.220
ServerPort01=1793
```

For Luna PCIe HSM 7 and Luna USB HSM 7, if you have multiple of either HSM type connected on a single host, then the order in which they appear is the hardware slot number, as discovered by the host computer.

For Luna PCIe HSM 7 and Luna USB HSM 7, the HSM administrative slot always appears immediately after the application partition. If no application partition has yet been created, a space is reserved for it, in the slot numbering.

Settings Affecting Slot Order

Settings in the **Presentation** section of the configuration file (Chrystoki.conf for UNIX/Linux, crystoki.ini for Windows) can affect the numbering that the API presents to Luna tools (like LunaCM) or to your application.

[Presentation]
ShowUserSlots=<slot>(<serialnumber>)

- Sets starting slot for the identified partition.
- Default, when ShowUserSlots is not specified, is that all available partitions are visible and appear in default order.
- Can be applied, individually, to multiple partitions, by a single entry containing a comma-separated list (with partition serial numbers in brackets):
  ShowUserSlots=1(351970018022), 2(351970018021), 3(351970018020),....
- If multiple partitions on the same HSM are connected to the Luna HSM Client host computer, redirecting one of those partitions with ShowUserSlots= causes all the others to disappear from the slot list, unless they are also explicitly re-ordered by the same configuration setting.

ShowAdminTokens=yes

- Default is yes. Admin partitions of local HSMs are visible in a slot listing.
- Remotely connected partitions (Luna Network HSM 7) are not affected by this setting, because NTLS connects only application partitions, not HSM SO (Admin) partitions to clients, so a Luna Network HSM SO administrative partition would never be visible in a client-side slot list, regardless.

ShowEmptySlots=1

- Controls how C_GetSlotList - as used by lunacm slot list command, or ckdemo command 14, and by your PKCS#11 application - displays, or does not display unused potential slots, when the number of partitions on an HSM is not at the limit.

OneBaseSlotId=1

- Causes basic slot list to start at slot number 1 (one) instead of default 0 (zero).
  (Any submitted number other than zero is treated as "1". Any letter or other non-numeric character is treated as "0".)

Effects of Settings on Slot List

Say, for example, you have multiple HSMs connected to your host computer (or installed inside), with any combination of Luna HSM Firmware 7.0.1 and newer, and no explicit entries exist for slot order in the config file. The defaults prevail and the slot list would start at zero.

If you set OneBaseSlotId=1 in the configuration file, then the slot list starts at "1" instead of at "0". You could set this for personal preference, or according to how your application might expect slot numbering to occur (or if you have existing scripted solutions that depend on slot numbering starting at zero or starting at one). OneBaseSlotId affects the starting number for all slots, including the HA virtual slot, regardless of firmware.

> **TIP VISIBILITY OF PARTITION SLOTS**
>
> Slot numbering is affected by setting the LunaCM command hagroup haonly (recommended) - with HAonly set, only the virtual slot of an HA group is visible *to your applications* ***see Note below***. This is important if your application relies on stable slot numbers to access partitions or services. HAonly locks the virtual slot number, such that it remains fixed when other slots are added or removed (including the primary for a group).
>
> In situations where you have multiple HA groups configured on a client, and hagroup haonly is applied, each of the several resulting virtual slots remains in its number/position as members of any group are added/removed/dropped/restored. However the numbering *would* change if you explicitly deleted an entire group from the client. In that case, the assumption is that it's a planned activity and you are prepared for movement of other slot number assignments.
>
> If HAonly is not set, then removing or adding a physical slot causes slots to renumber, including the HA virtual slot, which might not be what you want.
>
> Individual partition slots remain visible in LunaCM when HA Only mode is enabled. They are hidden only from *client* applications. Use **CKdemo** (Option **11**) to see the slot numbers to use with client applications.

If you set ShowUserSlots=20(17923506), then the identified token or HSM or application partition would appear at slot 20, regardless of the locations of other HSMs and partitions.

Options for an application to access a partition

Review the other sections on this page, while considering the requirements of your application, to decide how your application will access a partition.

> Identify a partition by reference to the partition label
> For example, the Java keytool utility references by label when using the “tokenlabel:” option in the keystore file [Keytool Usage and Examples]
>
> - unaffected by changes to slot numbering
> - partitions might inadvertently be given the same label.

> Identify a partition by referring to its slot number
> For example, the Java keytool utility references by slot nmber when using the “slot:” option in the keystore file [Keytool Usage and Examples]
>
> - a reliable identifier while slot numbers are stable - if HA is invoked, the hagroup haonly command removes physical slots from view by your application and locks the slot number of the virtual partition.
> - slot numbering can change if physical partitions are exposed and a partition is added to, or removed from, the slot list.

> Identify a partition by its serial number (see Note below)
>
> - always a unique identifier, and is unaffected by changes to slot numbering,
> - your application might not include that ability (example, use of KSP or EKM in an application integration).

> **NOTE** For developers, you could use C_getTokenInfo to get a partition's serial number.

Effects of New Firmware on Slot Login State

Slots retain login state when current-slot focus changes. You can use the LunaCM command **slot set** to shift focus among slots, and whatever login state existed when you were previously focused on a slot is still in effect when you return to that slot.