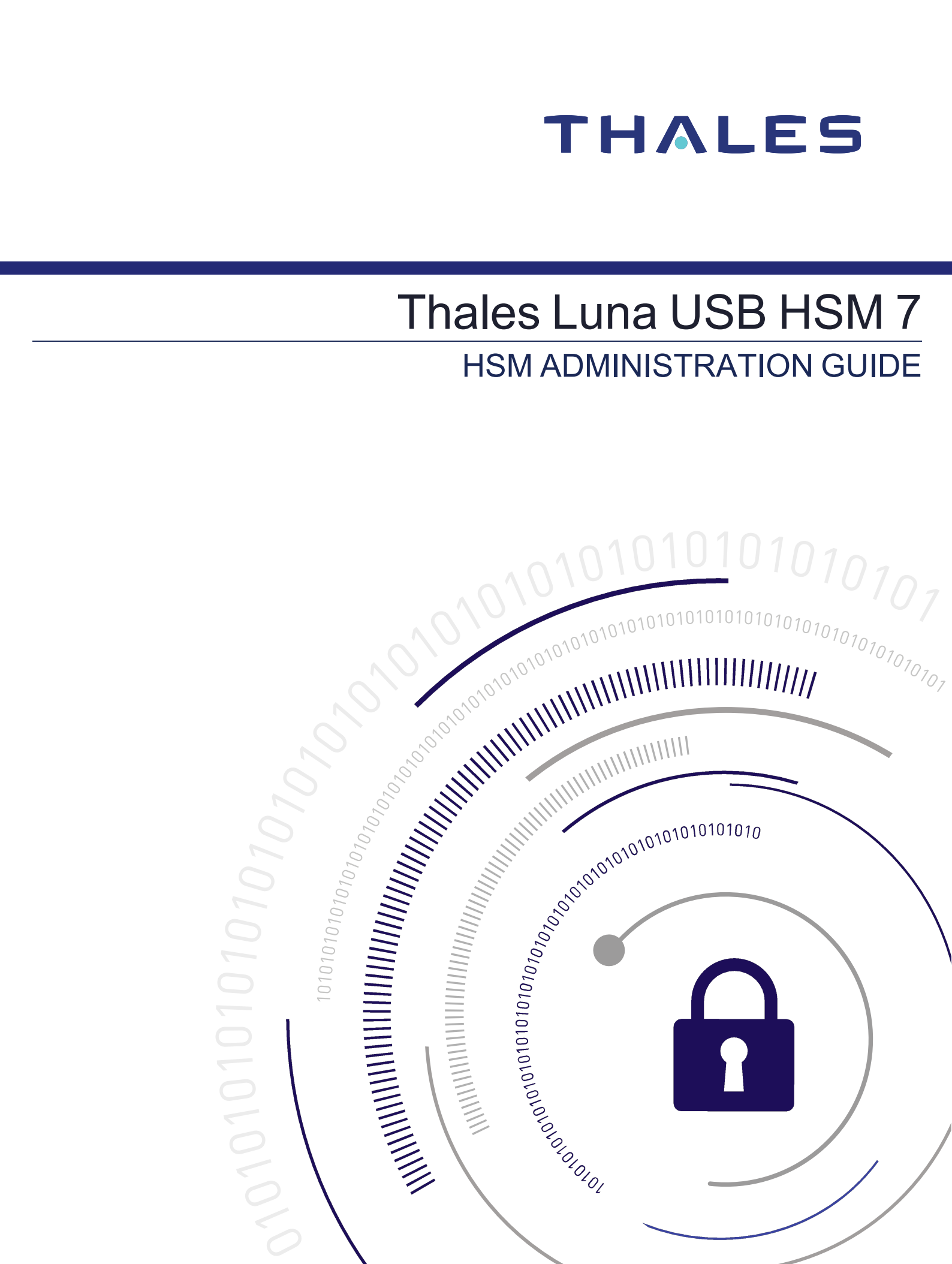
THALES

# Thales Luna USB HSM 7

## HSM ADMINISTRATION GUIDE



# Document Information

| | |
|---|---|
| **Last Updated** | 2025-05-28 09:08:49 GMT-05:00 |



**Disclaimer**
All information herein is either public information or is the property of and owned solely by Thales Group and/or its subsidiaries who shall have and keep the sole right to file patent applications or any other kind of intellectual property protection in connection with such information.

Nothing herein shall be construed as implying or granting to you any rights, by license, grant or otherwise, under any intellectual and/or industrial property rights of or concerning any of Thales Group's information.

This document can be used for informational, non-commercial, internal, and personal use only provided that:

- The copyright notice, the confidentiality and proprietary legend and this full warning notice appear in all copies.
- This document shall not be posted on any publicly accessible network computer or broadcast in any media, and no modification of any part of this document shall be made.

Use for any other purpose is expressly prohibited and may result in severe civil and criminal liabilities.

The information contained in this document is provided "AS IS" without any warranty of any kind. Unless otherwise expressly agreed in writing, Thales Group makes no warranty as to the value or accuracy of information contained herein.

The document could include technical inaccuracies or typographical errors. Changes are periodically added to the information herein. Furthermore, Thales Group reserves the right to make any change or improvement in the specifications data, information, and the like described herein, at any time.

Thales Group hereby disclaims all warranties and conditions with regard to the information contained herein, including all implied warranties of merchantability, fitness for a particular purpose, title and non-infringement. In no event shall Thales Group be liable, whether in contract, tort or otherwise, for any indirect, special or consequential damages or any damages whatsoever including but not limited to damages resulting from loss of use, data, profits, revenues, or customers, arising out of or in connection with the use or performance of information contained in this document.

Thales Group does not and shall not warrant that this product will be resistant to all possible attacks and shall not incur, and disclaims, any liability in this respect. Even if each product is compliant with current security standards in force on the date of their design, security mechanisms' resistance necessarily evolves according to the state of the art in security and notably under the emergence of new attacks. Under no circumstances, shall Thales Group be held liable for any third party actions and in particular in case of any successful attack against systems or equipment incorporating Thales products. Thales Group disclaims any liability with respect to security for direct, indirect, incidental or consequential damages that result from any use of its products. It is further stressed

that independent testing and verification by the person using the product is particularly encouraged, especially in any application in which defective, incorrect or insecure functioning could result in damage to persons or property, denial of service, or loss of privacy.



### Regulatory Compliance

This product complies with the following regulatory regulations. To ensure compliancy, ensure that you install the products as specified in the installation instructions and use only Thales-supplied or approved accessories.

### USA, FCC

This equipment has been tested and found to comply with the limits for a “Class B” digital device, pursuant to part 15 of the FCC rules.

### Canada

This class B digital apparatus meets all requirements of the Canadian interference-causing equipment regulations.

### Europe

This product is in conformity with the protection requirements of EC Council Directive 2014/30/EU. This product satisfies the CLASS B limits of EN55032.

# CONTENTS

# PREFACE: About the HSM Administration Guide

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



The preface includes the following information about this document:



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.**

## Command syntax and typeface conventions

| Format | Convention |
|---|---|
| **bold** | The bold attribute is used to indicate the following:<br>> Command-line commands and options (Type **dir /p**.)<br>> Button names (Click **Save As**.)<br>> Check box and radio button names (Select the **Print Duplex** check box.)<br>> Dialog box titles (On the **Protect Document** dialog box, click **Yes**.)<br>> Field names (**User Name**: Enter the name of the user.)<br>> Menu names (On the **File** menu, click **Save**.) (Click **Menu** > **Go To** > **Folders**.)<br>> 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**]<br>[<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**}<br>{<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**]<br>[<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: Luna USB HSM 7 Hardware Installation

This chapter describes how to install and connect a Luna USB HSM 7. To ensure a successful installation, perform the following tasks in the order indicated:

1. Before unpacking your new hardware, refer to "Verifying the Integrity of Your Shipment" below for safe unpacking instructions.
2. Ensure that you have all of the required components, as listed in "Luna USB HSM 7 Required Items" on page 15.
3. Install and connect the hardware, as described in "Installing the Luna USB HSM 7 Hardware" on page 18.
4. Familiarize yourself with the hardware features as described in "Luna USB HSM 7 Hardware Functions" on page 18.

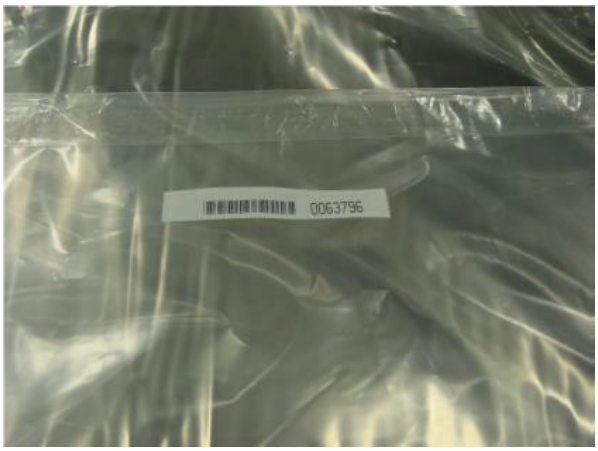
If you encounter further issues, please contact Thales Technical Support.

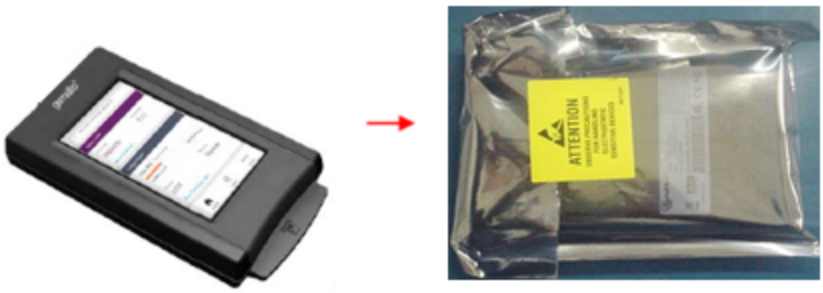
## Verifying the Integrity of Your Shipment

> **CAUTION!** Thales employs a number of security measures to allow you to verify that your new hardware was not intercepted in transit or otherwise tampered with before you received it. To verify the authenticity and handling history of your received items, review the following checklist before you unpack your new hardware, and then follow the checklist as you unpack each item.

| Step | Yes | No |
|---|---|---|
| 1. Do the items received (individual items, part numbers) match those listed in the enclosed packing list? If yes, go to the next step. If no, contact Thales support. | | |
| 2. Before you received the product, did you receive an advanced shipping notification providing details regarding the shipment (part numbers and serial numbers for the product, and for tamper-evident bag(s))? If yes, go to the next step. If no, contact Thales support. | | |

| Step | Yes | No |
|---|---|---|
| **3.** Are any tamper-evident bag serial numbers that are listed in the advanced shipping notification present, and do they match the actual bag(s) received? The tamper-evident bag serial numbers appear as shown below.<br>  <br><br>If yes, go to the next step. If no, contact Thales support.<br>**NOTE** The serial number of the bag is tracked. Serial numbers of additional stickers on the bag are not tracked, and are meant only for inspection against physical alteration. | | |
| **4.** Did you receive any tamper-evident bags that are *not* listed on the advance shipping notification? If yes, contact Thales support. If no, go to the next step. | | |

| Step | Yes | No |
|---|---|---|
| **5.** Are the correct number of tamper seals affixed to the tamper-evident bag? There are no tamper labels on the device itself. The device is in an anti-static bag and then that bag and device are inside an anti-tamper bag. There should be a serial number seal on the closure end of the bag.<br>  <br>  <br>If no, contact Thales support. If yes, go to the next step.<br>**NOTE** The serial number of the bag is tracked. Serial numbers of additional stickers on the bag are not tracked, and are meant only for inspection against physical alteration. | | |
| **6.** Are there any tamper seals affixed to the device that are *not* listed on the advance shipping notification? If yes, contact Thales support. If no, go to the next step. | | |
| **7.** Are there any signs of physical tampering? The tamper seals on the sides indicate tampering if they show the **ALERT** markings as illustrated.<br>  <br>If yes, contact Thales support. If no, go to the next step. | | |
| **8.** Once you have verified all of the received items, you can proceed with the installation. | | |

# Luna USB HSM 7 Required Items

This section provides a list of the components you should have received with your Luna USB HSM 7 order, as well as descriptions of some optional items you may have ordered.

## Basic Luna USB HSM 7 order items

The standard items that you should have received as your basic order for a Luna USB HSM 7 are:

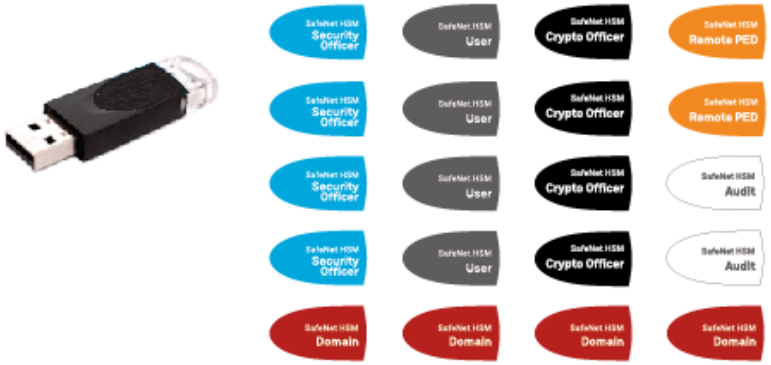
| Qty | Item |
|---|---|
| 1 | **Luna USB HSM 7**   |
| 1 | **5V Power Supply** with replaceable plug modules for international use  |

| Qty | Item |
|---|---|
| 1 | **USB-C to USB 3 connector cable**<br>  |
| 1 | **USB 3 to USB-C adapter**<br>  <br>Used to connect iKeys to the Luna USB HSM 7. |

## Optional Multifactor Quorum-Authentication Items

Your order may include iKeys for multifactor quorum authentication.

| Qty | Item |
|---|---|
| 1 | **Set of iKeys and Labels**<br>  <br><br>Your order may include a set of iKeys and peel-and-stick labels. |

# Installing the Luna USB HSM 7 Hardware

This section describes how to connect the Luna USB HSM 7 to a client computer.

### Prerequisites

> Ensure that the Luna HSM Client software with the **USB** option is installed on the client (see "Luna HSM Client Software Installation" on page 20). This includes the necessary device drivers.

> **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.

### To connect the Luna USB HSM 7 to a client

1. Use the included USB-C to USB cable to connect the Luna USB HSM 7 to a USB port on the client computer.

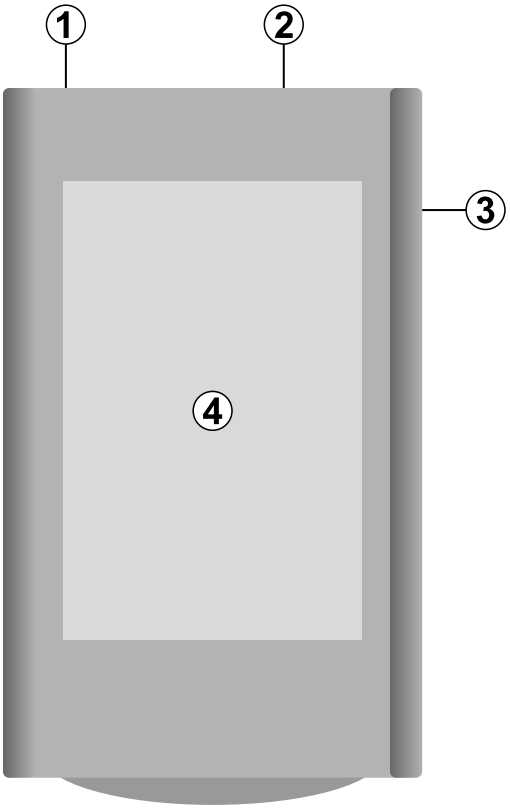
> **NOTE** On most Luna HSM Client computers, the USB port provides adequate power, and connecting the provided power supply is not recommended. Wait and confirm that the HSM boots properly. If the HSM fails to boot up:
>
> **1.** Disconnect the HSM from the USB port.
>
> **2.** Connect the HSM to power 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. Run LunaCM on the client computer to ensure the Luna USB HSM 7 is visible to the client.

```
Available HSMs:

Slot Id ->              4
Label ->
Serial Number ->        556677
Model ->                Luna G7
Firmware Version ->     7.7.2
Bootloader Version ->   1.6.0
Configuration ->        Luna HSM Admin Partition (PW) Key Export With Cloning Mode
Slot Description ->     Admin Token Slot
HSM Status ->           L3 Device, Zeroized



Current Slot Id: 4
```

# Luna USB HSM 7 Hardware Functions

The Luna USB 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 USB HSM 7. |
| **2** | USB-C connector. Used for connecting to the client computer and for file transfer to the Luna USB HSM 7. |
| **3** | USB-C connector. Used for connecting iKeys to authenticate roles on the HSM. Requires the included USB-A to USB-C adapter. |
| **4** | LED touchscreen. Displays information about the Luna USB HSM 7 and is used to input role-specific information like PINs. |

The Luna USB HSM 7 does not contain an internal battery, and maintains the integrity of its stored key material without being connected to power.

# CHAPTER 2: Luna HSM Client Software Installation

You can install the client for all Luna General Purpose HSMs, or for a specific type (Network, PCIe, or USB). Install the client as follows:

- For Luna Network HSM 7, install the Luna HSM Client on any computer that must connect to the appliance as a client.
- For Luna PCIe HSM 7, install the Luna HSM Client on the workstation into which the Luna PCIe HSM 7 is installed.
- For Luna USB HSM 7, install the Luna HSM Client on the workstation connected to the Luna USB HSM 7.
- Install the Luna HSM Client on any computer that is to have a Remote Luna PED connected.
- Install the Luna HSM Client on any computer that is to serve as a Remote Backup server.

For a list of supported operating systems by client version, refer to the CRN:

- Customer Release Notes

Choose the instructions for your operating system:

# Windows Luna HSM Client Installation

This section describes how to invoke the Windows Luna HSM Client perform unattended or scripted installations on Windows platforms.

> **NOTE** The GUI interactive installer (see "Windows Interactive Luna HSM Client Installation" on page 28) is deprecated, and will be removed from a future release.

Use the **/quiet** switch (see below) to ensure no pauses or prompting during installation. The following procedures are described:



If you want to perform an interactive installation, using the graphical, interactive installer, see "Windows Interactive Luna HSM Client Installation" on page 28

> **NOTE** Unattended installation stores the root certificate in the certificate store and marks the publisher (Thales) as trusted for future installations. You are not prompted to trust Thales as a driver publisher during unattended installation.

## Command line options overview

The following command-line options are available:

| Option | Values | Description |
|---|---|---|
| addlocal= | Various (see below) | Takes one-or-more device values, and one-or-more feature values, as a comma-separated list. Case insensitive. Values may be quoted or not. |
| installdir= | A fully qualified folder path to install the client software | Case insensitive. Default value is “c:\program files\safenet\lunaclient”. Enclose paths containing spaces in “”. |
| /install | N/A | Install the product and features. |

| Option | Values | Description |
|---|---|---|
| /uninstall | N/A | Remove the product and features. |
| /quiet | N/A | Performs a silent installation; no prompts or messages.<br>**NOTE** Windows defaults to launching the interactive graphical installer, unless you specify **/quiet** at the command line. Always include the **/quiet** option for scripted/unattended Luna HSM Client installation. |
| /norestart | N/A | Prevents a reboot, post-installation. Any reboots must be performed manually. |
| /log | The name of a log file | Generates a highly detailed series of logs of the installation progress. This is required only for product support. |

The following devices or components are available for use with the addlocal= option:

| Device identifier value | Can be used with these installable features |
|---|---|
| NETWORK | CSP_KSP, JSP, SDK, JCProv* |
| PCI | CSP_KSP, JSP, SDK, JCProv |
| USB | CSP_KSP, JSP, SDK, JCProv |
| BACKUP | SNMP (this device performs backup and restore operations and is not enabled for cryptographic applications) |
| PED | N/A (Used for remotely authenticating to multifactor quorum-authenticated HSMs; not used by cryptographic applications - use of this device requires hands-on presence) |

The device names are not case-sensitive.

The following features are available for use with the addlocal= option:

| Feature identifier value | Can be installed with these Luna devices | Description |
|---|---|---|
| CSP_KSP | NETWORK, PCI, USB | Microsoft CSP and KSP |
| FMSDK | NETWORK, PCIe * | Functionality Modules Software Development Kit |
| FMTOOLS | NETWORK, PCIe * | Tools for use when preparing Functionality Modules |
| JCProv | NETWORK, PCIe, USB | JCPROV PKCS#11 |

| Feature identifier value | Can be installed with these Luna devices | Description |
|---|---|---|
| JSP | NETWORK, PCIe, USB | Java Provider component |
| SDK | NETWORK, PCIe, USB | Software SDK – Java / C++ samples |

The features can be installed together with the listed device(s) only - they cannot be installed separately - and need to be included only once in the command line. For example, if you are installing the NETWORK and PCI devices and you wish to install the CSP / KSP feature, specify CSP_KSP one time. The feature names are not case-sensitive.

**NOTE** * If you install FMTOOLS for NETWORK only, then just **mkfm** and the **library** are installed.

If you install FMTOOLS for PCI, then **mkfm** and the **library** along with **ctfm** and **fmrecover** are installed.

If you install FMTOOLS for both NETWORK and PCIe devices, then all four elements are installed.

If you install the FM SDK, the Luna SDK is installed as well, to satisfy dependencies.

Options for **addlocal=** are separated by spaces. Device and feature values are separated by commas, with no spaces, unless the whole list is enclosed between quotation marks. If a space is encountered, outside of paired quotation marks, the next item found is treated as a command option.

## Installing all components and features

> **NOTE** CSP or KSP registration includes a step that verifies the DLLs are signed by our certificate that chains back to the DigiCert root of trust G4 (in compliance with industry security standards).
>
> This step can fail if your Windows operating system does not have the required certificate. If you have been keeping your Windows OS updated, you should already have that certificate.
>
> If your Luna HSM Client host is connected to the internet, use the following commands to update the certificate manually:
>
> **certutil -urlcache -f** http://cacerts.digicert.com/DigiCertTrustedRootG4.crt
>
> **certutil -addstore -f root** DigiCertTrustedRootG4.crt
>
> **To manually update a non-connected host**
>
> 1. Download the DigiCert Trusted Root G4 (http://cacerts.digicert.com/DigiCertTrustedRootG4.crt) to a separate internet-connected computer.
> 2. Transport the certificate, using your approved means, to the Luna HSM Client host into a <downloaded cert path> location of your choice
> 3. Add the certificate to the certificate store using the command:
>
>    **certutil -addstore -f root** <downloaded cert path>

Subsequent sections detail how to install the Luna HSM Client software, drivers (if necessary), and optional features (like Java support and the SDK), for individual HSMs. This section describes how to install everything at once, so that all Luna HSMs and Remote PED are supported and all the optional features are available.

Use the **ADDLOCAL=** option together with the value **all** to install the base client software and the drivers for all Luna devices, along with all the features.

### To install the Luna HSM Client software and drivers for *all* Luna devices and *all* features

From the location of **LunaHSMClient.exe** run the following command:

> Install the full Luna HSM Client software with drivers for all Luna HSMs (Luna Network HSM 7, Luna PCIe HSM 7, Luna Backup HSM, Remote PED), as well as all the features (CSP/KSP, JSP, JCProv, C++ SDK, SNMP Subagent)
>
> **LunaHSMClient.exe /install /quiet ADDLOCAL=all**

> **NOTE** You can omit the **/quiet** option to see all options in the GUI dialog.

> [Optional logging] Install the full Luna HSM Client software with drivers for all Luna HSMs (Luna Network HSM 7, Luna PCIe HSM 7, Luna Backup HSM, Remote PED, as well as all the features (CSP/KSP, JSP, JCProv, C++ SDK, SNMP Subagent), and log the process.
>
> **LunaHSMClient.exe /install /log install.log /quiet ADDLOCAL=all**

> **NOTE** The setting **/log** is optional and saves the installation logs to the file named **install.log** in the example. The **install.log** file (whatever name you give it) is required only if troubleshooting an issue with Thales GroupTechnical Support.

## Installing the Luna HSM Client for the Luna Network HSM 7

Use the **ADDLOCAL=NETWORK** option to install the base client software for the Luna Network HSM 7. Include the values for any optional, individual software components you desire. The base software must be installed first.

### To install the Luna HSM Client for the Luna Network HSM 7

From the location of **LunaHSMClient.exe** run one of the following commands:

> Install the base Luna HSM Client software necessary to communicate with Luna Network HSM 7

**LunaHSMClient.exe /install /quiet ADDLOCAL=NETWORK**

[Optional] Install the base Luna HSM Client software and any of the optional components for the Luna Network HSM 7 that you desire:

For example, the following command installs the base software and all of the optional components:

**LunaHSMClient.exe /install /quiet ADDLOCAL=NETWORK,CSP_KSP,JSP,SDK,JCProv**

If you wish to install only some of the components, just specify the ones you want after the product name (NETWORK in this example).

## Installing the Luna HSM Client for the Luna PCIe HSM 7

Use the **ADDLOCAL=PCI** option to install the base client software for the Luna PCIe HSM 7. Include any features you desire. The base software must be installed first.

### To install the Luna HSM Client for the Luna PCIe HSM 7

From the location of **LunaHSMClient.exe** run one of the following commands:

> Install the base Luna HSM Client software for Luna PCIe HSM 7

**LunaHSMClient.exe /install /quiet ADDLOCAL=PCI**

> Install the base Luna HSM Client software and any of the optional features for the Luna PCIe HSM 7 that you desire:

For example, the following command installs the base software and all of the optional components:

**LunaHSMClient.exe /install /quiet ADDLOCAL=PCI,CSP_KSP,JSP,SDK,JCProv,SNMP**

If you wish to install only some of the components, just specify the ones you want after the product name (PCI in this example).

## Installing the Luna HSM Client for the Luna USB HSM 7

Use the **ADDLOCAL=USB** option to install the base client software for the Luna USB HSM 7. Include any features you desire. The base software must be installed first.

**To install the Luna HSM Client for the Luna USB HSM 7**

From the location of **LunaHSMClient.exe** run one of the following commands:

> Install for Luna USB HSM 7

**LunaHSMClient.exe /install /quiet ADDLOCAL=USB**

> Install the base Luna HSM Client software and any of the optional features for the Luna USB HSM 7 that you desire:

For example, the following command installs the base software and all of the optional components:

**LunaHSMClient.exe /install /quiet ADDLOCAL=USB,CSP_KSP,JSP,SDK,JCProv**

If you wish to install only some of the components, just specify the ones you want after the product name (USB in this example).

## Installing the Luna HSM Client for the Luna Backup HSM

Use the **ADDLOCAL=BACKUP** option to install the base client software for the Luna Backup HSM, and the optional feature, if desired. For the Backup HSM, which performs backup and restore operations and is not enabled for use with cryptographic applications, the feature you might add is SNMP, if applicable in your environment.

**To install the Luna HSM Client for the Luna Backup HSM**

From the location of **LunaHSMClient.exe** run one of the following commands:

> Install the base Luna HSM Client software for Luna Backup HSM

**LunaHSMClient.exe /install /quiet /norestart ADDLOCAL=BACKUP**

> Install the base Luna HSM Client software and an optional component for the Luna Backup HSM:

For example, the following command installs the base software and the optional component:

**LunaHSMClient.exe /install /quiet /norestart ADDLOCAL=backup**

## Installing the Luna HSM Client for Remote PED

Use the **ADDLOCAL=** option with component value **PED**to install the client software for the Remote PED Server.

**To install the Luna HSM Client for the Remote PED Server**

> From the location of **LunaHSMClient.exe** run the following command:

**LunaHSMClient.exe /install /quiet addlocal=ped**

## Installation Location

Specify the installation location, if the default location is not suitable for your situation.

This applies to installation of any Luna Device. Provide the **INSTALLDIR=** option, along with a fully qualified path to the desired target location. For example:

**LunaHSMClient.exe /install /quiet addlocal=all installdir=c:\lunaclient**

That command silently installs all of the Luna device software and features to the folder c:\lunaclient (in this example). The software is installed into the same subdirectories per component and feature, under that named folder, as would be the case if **INSTALLDIR** was not provided. That is, **INSTALLDIR** changes the prefix or primary client installation folder to the one you specify, and the libraries, devices, tools, certificate folders, etc. are installed in their predetermined relationship, but under the new main folder location.

## ChrystokiConfigurationPath Environment Variable

During installation of Luna HSM Client components, a new entry is added to the Windows environment variables: **ChrystokiConfigurationPath**. This variable contains the path to the Luna HSM Client configuration file, **Chrystoki.ini** (see "Configuration File Summary" on page 51 for a full description).

> **NOTE** After first-time installation or a re-installation where the path to **Chrystoki.ini** changed, any open command prompts must be closed and reopened to recognize the new **ChrystokiConfigurationPath** environment variable setting.

## Logging

If problems are encountered during installation or uninstallation of the software and you wish to determine the reason, or if Thales Technical Support has requested you to do so, detailed logs can be generated and captured by specifying the /log option and providing a filename to capture the log output. Two logs are generated – one according to the name given and the other similarly named, with a number appended. Both log files must be sent to Thales support if assistance is required.

Example commands that include logging are:

**LunaHSMClient.exe /install /quiet /log install.log /norestart ADDLOCAL=backup,snmp**

**LunaHSMClient.exe /uninstall /quiet /log uninstall.log**

## Uninstalling the Luna HSM Client

You can also perform scripted/unattended uninstallation.

### To uninstall the Luna HSM Client

> From the location of **LunaHSMClient.exe** run the following command:

**LunaHSMClient.exe /uninstall /quiet**

> To log the uninstallation process, run the following command:

**LunaHSMClient.exe /uninstall /quiet /log uninstall.log**

# Windows Interactive Luna HSM Client Installation

> **NOTE** The GUI interactive installer (see "Windows Interactive Luna HSM Client Installation" above) is deprecated, and will be removed from a future release.

This section describes how to install the Luna HSM Client software on Windows, using the GUI interactive installer. It contains the following topics:



Applicability to specific versions of Windows is summarized in the Customer Release Notes for this release.

> **NOTE** Before installing a Luna HSM system, confirm that the product you have received is in factory condition and has not been tampered with in transit. Refer to the Startup Guide included with your product shipment. If you have any questions about the condition of the product that you have received, contact Technical Support immediately.

## Required Client Software

Each computer that contains, or is connected to a Luna PCIe HSM 7 or a Luna USB HSM 7 must have the cryptoki library and other utilities and supporting files installed.

## Prerequisites

The Luna HSM Client installer requires the Microsoft Universal C Runtime (Universal CRT) to run properly. Universal CRT requires your Windows machine to be up to date. Before running the installer, ensure that you have the Universal C Runtime in Windows (KB2999226) update and its prerequisites installed on your machine. The following updates must be installed in order:

1. March 2014 Windows servicing stack update (see https://support.microsoft.com/en-us/help/2919442)
2. April 2014 Windows update (see https://support.microsoft.com/en-us/help/2919355)
3. Visual C++ Redistributable for Visual Studio 2015 (see https://www.microsoft.com/en-in/download/details.aspx?id=481450)

**NOTE** CSP or KSP registration includes a step that verifies the DLLs are signed by our certificate that chains back to the DigiCert root of trust G4 (in compliance with industry security standards).

This step can fail if your Windows operating system does not have the required certificate. If you have been keeping your Windows OS updated, you should already have that certificate.

If your Luna HSM Client host is connected to the internet, use the following commands to update the certificate manually:

**certutil -urlcache -f** http://cacerts.digicert.com/DigiCertTrustedRootG4.crt

**certutil -addstore -f root** DigiCertTrustedRootG4.crt

**To manually update a non-connected host**

1. Download the DigiCert Trusted Root G4 (http://cacerts.digicert.com/DigiCertTrustedRootG4.crt) to a separate internet-connected computer.
2. Transport the certificate, using your approved means, to the Luna HSM Client host into a <downloaded cert path> location of your choice
3. Add the certificate to the certificate store using the command:

   **certutil -addstore -f root** <downloaded cert path>

## Installing the Luna HSM Client Software

Luna HSM Client can be installed on 64-bit Windows operating systems. Hardware drivers are 64-bit only. Older client versions include 32-bit libraries and binaries.

For compatibility of our HSMs with Windows CAPI we have Luna CSP, and for the newer Windows CNG we have Luna KSP. See "Luna CSP and KSP" on page 32 for more information.

Interactive (prompted, this page) and non-interactive (no prompts "Windows Luna HSM Client Installation" on page 21) installation options are available.

**NOTE Compatibility of Luna PCIe HSM 7 version, Client version, and Windows OS versions**

Luna HSM Client 10.3.0 was the last client version to support Windows Server 2012 R2, which accepts the Luna PCIe HSM 7 6.x driver.

If you have Windows Server 2012 R2 computer with a Luna PCIe HSM 7 6.x onboard, do not install Luna HSM Client 10.4.0 or newer there; these client versions will not load the Luna PCIe HSM 7 6.x driver.

If you have Luna PCIe HSM 7 6.x and 7.x HSM card in the same system, failure of the 6.x driver would prevent loading of the 7.x driver as well. If your application works with Linux, the Luna PCIe HSM 7 6.x will continue to work there, and will not block Luna PCIe HSM 7 7.x.

### To install the Luna HSM Client software

1. Log into Windows as **Administrator**, or as a user with administrator privileges (see "Troubleshooting" on page 34).

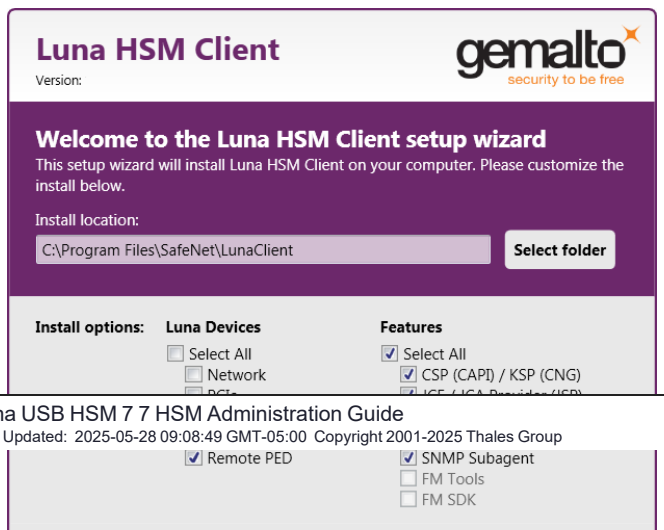
2. Uninstall any previous versions of the Client software before you proceed (see "Uninstalling the Luna HSM Client Software" on page 33).

> **NOTE** If you do not uninstall previous Luna HSM Client versions, you might face installation issues, such as failure to install the new client.

3. Download the Luna HSM Client from the Thales Support Portal at https://supportportal.thalesgroup.com.

> **TIP** Thales recommends verifying the integrity of the Luna HSM Client packages, by calculating their SHA256 hash values and comparing with the hash values posted on the Support Portal, before installing them on your client machines.
>
> You can use the sha256sum tool on Linux machines to calculate the SHA256 hash values.

4. Extract the .zip to an appropriate folder.
5. In the extracted directory, locate the folder for your Windows architecture and double click **LunaHSMClient.exe**.
6. The Custom Setup dialog allows you to choose which software components you wish to install. Click a product to select the components to install, or click Select All to install all available components.

After you select the components you want to install, click **Install**.

a. Agree to the terms of the License Agreement to proceed with installation. To view the agreement text, click the link in the dialog. The installer loads a PDF version if a PDF reader is available; otherwise it launches a text editor and a plain-text version of the agreement.

b. If Windows presents a security notice asking if you wish to install the device driver from Thales, click "Always trust software from Thales DIS CPL USA, Inc." and click **Install** to accept.

c. If you choose not to install the driver(s), your Luna HSM Client cannot function with any locally-connected Luna hardware (which includes Luna PCIe HSM 7, Luna USB HSM 7, or Luna Backup HSMs).

7. When the installation completes, the button options are Uninstall, Modify, or Quit; click **Quit** to finish.

8. [Optional] For easy use of the Luna HSM Client command-line tools, add the directory to the system PATH variable.

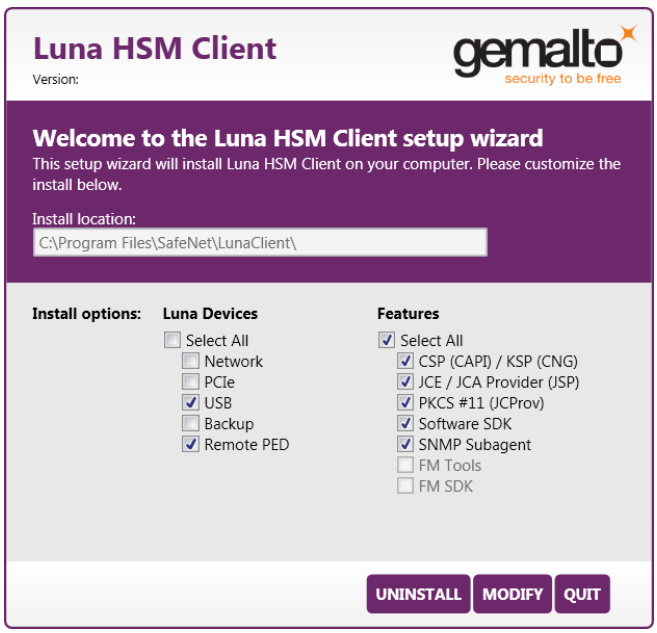
   **"C:\Program Files\SafeNet\Lunaclient"**

## Modifying the Installed Windows Luna HSM Client Software

If you wish to modify the installation (perhaps to add a component or product that you did not previously install), you must re-run the current installer and ensure that the desired options are selected.

### To modify the installed Luna HSM Client software

1. Run the **LunaHSMClient.exe** program again. Because the software is already installed on your computer, the following dialog is displayed (in this example, devices and features were previously installed, and the task is to uninstall a couple of items):




2. Select or deselect individual Devices or Features, as desired.

3. Click **Modify**. The client software is updated (items are added or removed).

   If you are uninstalling some items, or if you are adding features, the dialog shows a progress bar briefly, and then shows the current status.

If you are adding a Luna Device, then you might be prompted with the operating system pop-up to accept/trust the driver.

4. Click **Quit** when the modification is complete.

> **NOTE** You can also use **Programs and Features** in the Windows Control Panel to launch the Uninstall/Modify dialog for the client software.

## Java

If you install the Luna Java Security Provider (JSP), refer to Luna JSP Overview and Installation for additional setup procedures for your operating system.

## Luna CSP and KSP

Thales provides Luna CSP for applications running in older Windows crypto environments running Microsoft Certificate Services (CAPI), and Luna KSP for newer Windows clients running Cryptography Next Generation (CNP). Consult Microsoft documentation to determine which one is appropriate for your client operating system.

> Luna CSP Registration Utilities

> Luna KSP for CNG Registration Utilities

If the **Luna CSP (CAPI) / Luna KSP(CNG)** option is selected at installation time, the **SafeNetKSP.dll** file is installed in **C:\Windows\System32** (used for 64-bit KSP). If you are installing a Luna HSM Client version older than 10.1, **SafeNetKSP.dll** is also installed in **C:\Windows\SysWOW64** (used for 32-bit KSP).

> **NOTE** The **cryptoki.ini** file, which specifies many configuration settings for your HSM and related software, includes a line that specifies the path to the appropriate libNT for use with your application(s). Verify that the path is correct.

## Modifying the Number of Luna Backup HSM Slots

By default, the Luna HSM Client allows for three slots reserved for each model of Luna Backup HSM. You can edit **crystoki.ini** to modify the number of reserved slots. See also "Configuration File Summary" on page 51.

### To modify the number of reserved Backup HSM slots

1. Navigate to the **crystoki.ini** file and open in a text editor.
2. Add the following line(s) to the **CardReader** section of the file:
   - For Luna Backup HSM G5:

     **LunaG5Slots =** <value>**;**
   - For Luna Backup HSM 7:

     **LunaG7Slots =** <value>**;**

## Uninstalling the Luna HSM Client Software

You need to uninstall Luna HSM Client before installing a new version. If you wish to modify the installation (perhaps to add a component or product that you did not previously install), you must uninstall the current installation and re-install with the desired options. If you have a Luna Backup HSM connected to the client workstation, either disconnect it or stop the PEDclient service (pedclient mode stop) before you proceed.

### To uninstall the Luna HSM Client software

1. Run the **LunaHSMClient.exe** program again. Because the software is already installed on your computer, the following dialog is displayed, showing which components are currently installed (for this example, all Devices and all Features were previously installed):

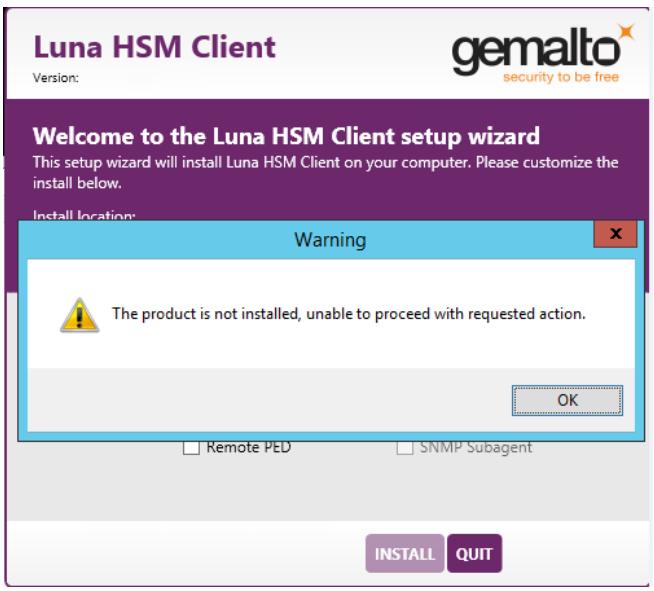

2. Click **Uninstall**. The client software is uninstalled.

3. When the uninstallation is complete, click **OK** to dismiss the operating system's confirmation dialog.

> **NOTE** You can also use **Programs and Features** in the Windows Control Panel to uninstall the client software.

### Uninstall if not present

If the Luna HSM Client software has been uninstalled, and you launch the installer in uninstall mode, from the command line, the installer starts, looks for the installed software, fails to find it, and presents a Windows dialog to that effect.




If the Luna HSM Client software has been uninstalled, nothing related to the client appears in Windows Control Panel, so nothing exists to launch from that avenue.

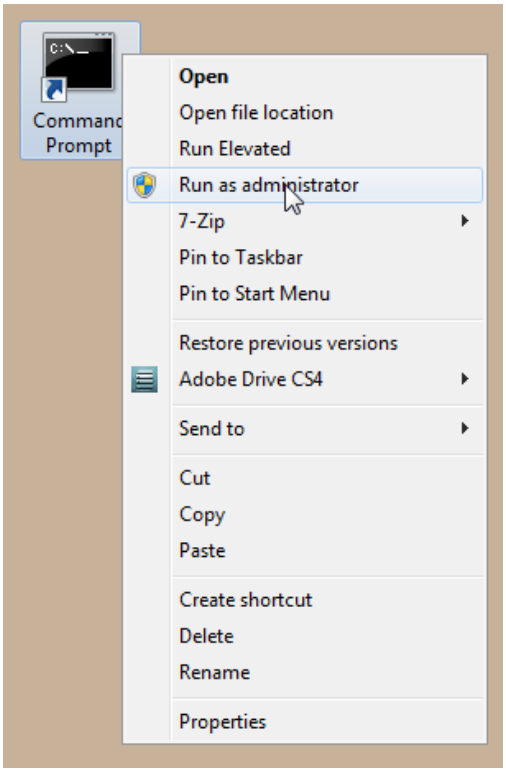
## After Installation

Open a new command-line/console window to allow the library path to be found before you run LunaCM or other utilities that require the library.

## Troubleshooting

If you are not the Administrator of the computer on which Luna HSM Client is being installed, or if the bundle of permissions in your user profile does not allow you to launch the installer with "Run as Administrator", then some services might not install properly. One option is to have the Administrator perform the installation for you.

Another approach might be possible. If you have sufficient elevated permissions, you might be able to right-click and open a Command Prompt window as Administrator.




If that option is available, then you can use the command line to move to the location of the **LunaHSMClient.exe** file and launch it there, which permits the needed services to load for PEDclient. See "Windows Luna HSM Client Installation" on page 21 for instructions on how to install the client software from the command line.

# Linux Luna HSM Client Installation

You must install the Luna HSM Client software on each client workstation you will use to access a Luna HSM. This section describes how to install the client on a workstation running Linux, and contains the following topics:



Refer to the Customer Release Notes for a complete list of the supported Linux operating systems. These instructions assume that you have already acquired the Luna HSM Client software.

## Prerequisites

Before starting the installation, ensure that you have satisfied the following prerequisites:

### CentOS 8.4 Missing Dependency

Due to a missing dependency on CentOS 8.4 [specifically the symlink (libnsl.so.1) to libnsl was removed], when installing Luna HSM Client 10.5.0 or newer, you must install an additional rpm package first:

Run **yum install libnsl** before invoking the **install.sh** script.

### Components Required to Build the PCIe Driver and the Backup HSM Driver

On Linux, the PCIe driver module (and optionally the Backup HSM driver) is built by the client as part of the installation if you choose to install the Luna PCIe HSM 7 component or the Backup HSM. To build the driver, the client requires the following items:

> Kernel headers for build
> **kernel-devel** package
> **rpmbuild** package
> C and C++ compilers
> **make** command
> **libelf-dev**, **libelf-devel**, or **elfutils-libelf-devel**

If any one of these items is missing, the driver build will fail and the client software will not be installed.

> **NOTE** The installed *kernel* and *kernel-devel* versions on the Client system must match, in order for the drivers to compile successfully. In general, if the versions do not match, or if you are not sure, use this command **yum install kernel-devel-`uname -r`** before installing Luna HSM Client. Note the required backticks, (the key to the left of the 1/! key on the keyboard) surrounding **`uname –r`** (or equivalent command **yum install kernel-devel-$(uname -r)**).
>
> To check installed versions related to the currently running kernel: **rpm -qa kernel * | grep $(uname -r)**.

For the PCIe, USB, or Backup HSM drivers to be available immediately after installation on RHEL, you must install **chkconfig** *before* the Luna HSM Client software. If this package is not installed, you must reboot the client computer after installing the client.

**Debian Requires alien**

The Luna HSM Client software is provided as RPM packages. If you are installing on a Debian system, you must have **alien** installed to allow the Luna HSM Client installation script to convert the RPM packages to DEB packages. The installation script will stop with a message if you attempt to install on a Debian system without **alien** installed. This applies to any other supported Debian-based Linux distribution, such as Ubuntu.

**SUSE Linux on IBM PPC**

JCE un-restriction files must be downloaded from IBM, not from SUN, for this platform. Attempting to use SUN JCE un-restriction files on IBM PowerPC systems with SUSE Linux causes signing errors.

## Where to install, and SELinux

The instructions on this page assume that much of the installation goes into /usr. You can change that install location (see "Flexible Install paths" on page 39). There might be some interaction with SELinux that you would need to consider. Security Enhanced Linux or SELinux is a security mechanism built into the Linux kernel used by RHEL-based distributions. By default, in CentOS 8 and newer, SELinux is enabled and in enforcing mode.

SELinux adds an additional layer of security to the system by allowing administrators and users to control access to objects based on policy rules. SELinux policy rules specify how processes and users interact with each other as well as how processes and users interact with files. When there is no rule explicitly allowing access to an object, such as for a process opening a file, access is denied.

SELinux has three modes of operation:

- Enforcing: SELinux allows access based on SELinux policy rules.
- Permissive: SELinux only logs actions that would have been denied if running in enforcing mode. This mode is useful for debugging and creating new policy rules.
- Disabled: No SELinux policy is loaded, and no messages are logged.

So if, for example, your non- /usr installation completes uneventfully, but pedclient errors show up in the logs, then consider setting SELinux to "Permissive" mode. Or set explicit rules that will comply with SELinux's Enforcing mode.

**NOTE** **MutexFolder**: For Luna clients on Linux, the callback service (CBS) employed by pedclient originally placed mutex entries in /tmp. This was fine in most cases, but could be an issue if operating system services cleared the /tmp folder, causing the cbs process to stop. The workaround was to restart the service. A solution was provided that moved the mutex folder to /var/log. However, this was found to be an issue for installations by non-root users, where the service did not have permission to write into /var/log.

Beginning with Luna HSM Client 10.4.0, a chrystoki.conf entry "MutexFolder =" is added. If access to the default folder /tmp is not desired or is restricted, the MutexFolder= entry allows an administrator to specify an accessible folder.

```
Misc = {
…
  MutexFolder = /usr/lock;
}
```

However, the indicated folder must exist. If this is set to a non-existent folder, the service fails to start properly, such as in this example of logs for the cbs service:

(MutexFolder = /nosuchfolder/lock)

```
..  daemon info  systemd: Starting CallBack Server...
...  user notice  root: cbs started.
...  daemon info  cbs: Starting cbs:[  OK  ]#015LunaNamedSystemMutex: open()
failed: No such file or directory
...  daemon info  cbs: LOGGER_init failed
...  daemon info  cbs: Failed to initialize the logger.  Exiting.
...  user crit  pedClient: Failed to initialize the logger.  Exiting.
...  daemon info  systemd: Started CallBack Server.
```

## About Installing the Luna HSM Client Software

It is recommended that you refer to the Customer Release Notes for any installation-related issues or instructions before installing the client software.

**CAUTION!** You must install the client software using root-level privileges. For security reasons, we recommend that you do not log in as root (or use su root) to run the installation script, but instead use the sudo command to run the installation script, as detailed below.

### The installation script

The installation script is **install.sh** and is usually launched with **sh install.sh** followed by any options or parameters.

> interactive: **sh install.sh** [**-install_directory** <prefix>]

> all: **sh install.sh all** [**-install_directory** <prefix>]

> scriptable: **sh install.sh -p** [**network**|**pci**|**usb**|**backup**|**ped**] [**-c sdk**|**jsp**|**jcprov**|**snmp**]|**fmsdk**|**fm_tools** [**-install_directory** </usr>]

The options on the script are:

> device(s)

- **network** is the Luna Network HSM 7 (software only, no drivers)
- **pci** is the Luna PCIe HSM 7 (software plus PCI driver)

- **usb** is the Luna USB and Backup HSMs (software plus driver for the USB-connected HSMs)
- **backup** is software to enable Remote Backup
- **ped** is software for the Luna Remote PED

> components include the optional Software Development kit, Java providers, SNMP instance (not needed for Luna Network HSM 7 which has it built in), Functionality Module tools, and the Functionality Module SDK

### Install.sh syntax and options:

```
[myhost]$ sh install.sh help

usage:
install.sh      - Luna HSM Client install through menu
install.sh help - Display scriptable install options
install.sh all  - Complete Luna HSM Client install

install.sh -p [network|pci|usb|backup|ped] [-c sdk|jsp|jcprov|snmp|fmsdk|fm_tools] [-install_
directory </usr>]

  -p <list of Luna products>
  -c <list of Luna components|all> - Optional. Default components are installed if not provided
  -install_directory <Defaults to /usr> - Optional. Sets the installation directory prefix.
Non-root install is restricted to installation of Luna Network HSM
product and Luna SDK, Luna JSP (Java) and Luna JCPROV (Java) components.

Luna products options
   network - Luna Network HSM
   pci     - Luna PCIe HSM
   usb     - Luna USB HSM
   backup  - Luna Backup HSM
   ped     - Luna Remote PED

Luna components options
   sdk     - Luna SDK
   jsp     - Luna JSP (Java) --> Luna Network HSM, Luna PCIe HSM and Luna USB HSM default
component
   jcprov  - Luna JCPROV (Java) --> Luna Network HSM, Luna PCIe HSM and Luna USB HSM default
component
   snmp    - Luna SNMP subagent
```

By default, the Client programs are installed in the **/usr/safenet/lunaclient** directory.

### Flexible Install paths

An administrative (root) user, in charge of installing and uninstalling the software, has access wherever the installed material eventually resides. However, the operational, application-level use of Luna HSM Client might be assigned to a non-root user with constrained access and privileges. That non-root user might be a person or a departmental function or an application. By changing the install path to (for example) **%home/bigapplication/safenet/luna** you allow that non-root user access to tools and files for connecting to the HSM and using HSM partitions.

You can change the installation path for scriptable (non-interactive) installs by changing the prefix with the script option **-install_directory** <prefix>

The prefix, or major location is your choice, and replaces the /usr default portion. (See mention of SELinux, earlier on this page)

> **NOTE** Avoid the use of space characters in directory names.

The script option **-install_directory** <prefix> is available for scriptable installation, where either "all" or a list of products and components is specified on the command line. The script option **-install_directory** <prefix> is not used with interactive installation; instead, you are prompted.

The **/safenet/lunaclient** portion is appended by the install script, and provides a predictable structure for additional subdirectories to contain certificate files, and optionally STC files.

Regardless of **-install_directory** <prefix> provided, some files are not affected by that option (for example, the Chrystoki.conf configuration file goes under /etc, service files need to be in the service directory expected by Linux in order to run at boot time, and so on).

> **TIP** Thales recommends verifying the integrity of the Luna HSM Client packages, by calculating their SHA256 hash values and comparing with the hash values posted on the Support Portal, before installing them on your client machines.
>
> You can use the sha256sum tool on Linux machines to calculate the SHA256 hash values.

# Scripted or Unattended Installation

If you prefer to provide all installation options from the command-line (script), rather than interactively, do the following.

### To install the Luna HSM Client software in non-interactive or scripted fashion on a Linux workstation

1. Ensure that you have **sudo** privileges on the client workstation.
2. Access the installation software:

   Copy or move the **.tar** archive to a suitable directory where you can untar the archive and extract the contents:

   **tar xvf** <filename>**.tar**
3. Go to the untarred directory for your operating system (**32** or **64**-bit):

   **cd /**<untarred_dir>**/**<**32**/**64**>
4. To see the syntax and all available options, run the command with **help**
5. To install the software, run the **install.sh** installation script with the options **-p** <list of Luna products> and **-c** <list of Luna components>.

   ```
   install.sh -p [network|pci|usb|backup|ped] [-c sdk|jsp|jcprov|snmp|fmsdk|fm_tools] [-install_directory </usr>]
   ```

   Be sure to include the -install_directory option.

> **NOTE** Following the "-c" option, you can provide a space-separated list of components to include in the installation. If JSP and JCProv are not explicitly listed, they are installed by default, but if one is explicitly listed, then only the listed component is included.
>
> If the SNMP component is selected, it works with Luna PCIe HSM, Luna USB HSM, and Luna Backup HSM products only.
>
> Following the "-p" option, you can provide a space-separated list of HSM products to include in the installation.

For scripted/automated installation, your script will need to capture and respond to the License Agreement prompt, and to the confirmation prompt. For example:

```
[myhost]$ sudo sh install.sh all

IMPORTANT: The terms and conditions of use outlined in the software
license agreement (Document #008-010005-001_053110) shipped with the product
("License") constitute a legal agreement between you and SafeNet Inc.
Please read the License contained in the packaging of this
product in its entirety before installing this product.

Do you agree to the License contained in the product packaging?

If you select 'yes' or 'y' you agree to be bound by all the terms
and conditions se out in the License.

If you select 'no' or 'n', this product will not be installed.

(y/n) y

Complete Luna Client will be installed. This includes Luna Network HSM,
Luna PCIe HSM, Luna USB HSM, Luna Backup HSM and Luna Remote PED.

Select 'yes' or 'y' to proceed with the install.

Select 'no' or 'n', to cancel this install.

Continue (y/n)?  y
```

## Interrupting the Installation

Do not interrupt the installation script in progress, and ensure that your host computer is served by an uninterruptible power supply (UPS). If you press [CTRL] [C], or otherwise interrupt the installation (OS problem, power outage, other), some components will not be installed. It is not possible to resume an interrupted install process. The result of an interruption depends on where, in the process, the interruption occurred (what remained to install before the process was stopped).

As long as the cryptoki RPM package is installed, any subsequent installation attempt results in refusal with the message "A version of Luna HSM Client is already installed."

If components are missing or are not working properly after an interrupted installation, or if you wish to install any additional components at a later date (following an interrupted installation, as described), you would need to uninstall everything first. If **sh uninstall.sh** is unable to do it, then you must uninstall all packages manually.

### To install the Luna HSM Client software interactively on a Linux workstation

1. Ensure that you have **sudo** privileges on the client workstation.
2. Access the installation software:

   Copy or move the **.tar** archive to a suitable directory where you can untar the archive and extract the contents:

   **tar xvf** <filename>**.tar**
3. Go to the untarred directory for your operating system (**32** or **64**-bit):

   **cd /**<untarred_dir>**/<32/64>**
4. To install the software, run the **install.sh** installation script. You can run the script in interactive mode, or you can script the installation, as described in "Scripted or Unattended Installation" on page 40.
   - To display the help, or a list of available installer options, type:

     **sudo sh install.sh -?** or **sudo sh install.sh help**
   - To install all available products and optional components, type:

     **sudo sh install.sh all**
   - To selectively install individual products and optional components, type the command without arguments:

     **sudo sh install.sh**

   > **NOTE** Do not interrupt the installation script in progress. An uninterruptible power supply (UPS) is recommended. See "Interrupting the Installation" on the previous page for more information.
5. Type **y** if you agree to be bound by the license agreement. You must accept the license agreement before you can install the software.
6. A list of installable Luna devices is displayed. Select as many as you require, by typing the number of each (in any order) and pressing **Enter**. As each item is selected, the list updates, with a * in front of any item that has been selected.

   This example shows items 1 and 3 have been selected, and item 4 is about to be selected. The selections work as a toggle - if you wish to make a change, simply type a number again and press **Enter** to de-select it.

```
Products
Choose Luna Products to be installed

    *[1]: Luna Network HSM

     [2]: Luna PCIe HSM

    *[3]: Luna USB HSM

     [4]: Luna Backup HSM

     [5]: Luna Remote PED

     [N|n]: Next

     [Q|q]: Quit
Enter selection: 4
```

When selection is complete, type **N** or **n** for "Next", and press **Enter**. The "Advanced" menu is displayed.

```
Advanced
Choose Luna Components to be installed

  [1]: Luna SDK

  [2]: Luna JSP (Java)

  [3]: Luna JCProv (Java)

  [4]: Luna SNMP subagent

  [5]: Luna Functionality Module Tools

  [6]: Luna Functionality Module Software Development Kit

  [B|b]: Back to Products selection

  [I|i]: Install

  [Q|q]: Quit

 Enter selection:
```

7. Select or de-select any additional items you want to install. Selected items are indicated with a *. Some items might be pre-selected to provide the optimum experience for the majority of customers, but you can change any selection in the list. When the Components list is adjusted to your satisfaction, press **Enter**.

   > **NOTE** The installer includes the Luna SNMP Subagent as an option. If you select this option, you will need to move the SafeNet MIB files to the appropriate directory for your SNMP application after installation is complete, and you will need to start the SafeNet subagent and configure it for use with your agent.

   If the script detects an existing cryptoki library, it stops and suggests that you uninstall your previous Luna software before starting the Luna HSM Client installation again.

8. The system installs all packages related to the products and any optional components that you selected.
9. [Optional] For easy use of the Luna HSM Client tools, add their directories to the $PATH.
   a. Edit your system's **bash_profile** file using an editing tool.

      **vi ~/.bash_profile**

   b. Add the following lines to the end of the file:

      **export PATH="$PATH:/usr/safenet/lunaclient/bin"**

      **export PATH="$PATH:/usr/safenet/lunaclient/sbin"**

   c. Source the updated **bash_profile**.

      **source ~/.bash_profile**

## Controlling User Access to Your Attached HSMs and Partitions

By default, only the root user has access to your attached HSMs and partitions. You can specify a set of non-root users that are permitted to access your attached HSMs and partitions, by adding them to the **hsmusers** group.

> **NOTE** The Luna HSM Client software installation automatically creates the **hsmusers** group if one does not already exist on your system. The **hsmusers** group is retained when you uninstall the client software, allowing you to upgrade your client software while retaining your hsmusers group configuration.

> **TIP** Users on your system that are not members of **hsmusers** group are not able to see the slots/partitions when using lunacm, other Luna tools, or your applications. If you open lunacm, expecting to see one or more slots, and none are visible, check that your current user is a member of **hsmusers** before doing other troubleshooting.

### Adding users to hsmusers group

To allow non-root users or applications access your attached HSMs and partitions, assign the users to the **hsmusers** group. The users you assign to the **hsmusers** group must exist on the client workstation. Users you add to the **hsmusers** group are able to access your attached HSMs and partitions. Users who are not part of the **hsmusers** group are not able to access your attached HSMs and partitions.

#### To add a user to hsmusers group

1. Ensure that you have **sudo** privileges on the client workstation.
2. Add a user to the hsmusers group:

   **sudo gpasswd --add** <username> **hsmusers**

   where <username> is the name of the user you want to add to the hsmusers group.

### Removing users from hsmusers group

Should you wish to rescind a user's access to your attached HSMs and partitions, you can remove them from the **hsmusers** group.

> **NOTE** The user you delete will continue to have access to the HSM until you reboot the client workstation.

#### To remove a user from hsmusers group

1. Ensure that you have **sudo** privileges on the client workstation.
2. Remove a user from the hsmusers group:

   **sudo gpasswd -d** <username> **hsmusers**

   where <username> is the name of the user you want to remove from the **hsmusers** group. You must log in again to see the change.

## Uninstalling the Luna HSM Client Software or Removing Components

You may need to uninstall the client software before upgrading to a new version, or if it is no longer required.

### To uninstall the client software

1. Ensure that you have **sudo** privileges on the client workstation.
2. Go to the client installation directory:

   **cd /usr/safenet/lunaclient/bin**
3. Run the uninstall script:

   **sudo sh uninstall.sh**

> **CAUTION!** The **hsmusers** group is not removed when the client software is uninstalled. Should you install the client again on the same system, all users previously in the group will have access to your attached HSMs and partitions by default. You must remove users from the group if you want to restrict their access. See "Removing users from hsmusers group" on the previous page.

### To remove individual components

To uninstall the JSP component or the SDK component, you must uninstall Luna HSM Client completely, then re-run the installation script without selecting the unwanted component(s).

## Java

If you install the Luna Java Security Provider (JSP), refer to Luna JSP Overview and Installation for additional setup procedures for your operating system.

## Modifying the Number of Luna Backup HSM Slots

By default, the Luna HSM Client allows for three slots reserved for each model of Luna Backup HSM. You can edit **Chrystoki.conf** to modify the number of reserved slots. See also "Configuration File Summary" on page 51.

### To modify the number of reserved Backup HSM slots

1. Navigate to the **Chrystoki.conf** file and open in a text editor.
2. Add the following line(s) to the **CardReader** section of the file:
   - For Luna Backup HSM G5:

     **LunaG5Slots =** <value>**;**
   - For Luna Backup HSM 7:

     **LunaG7Slots =** <value>**;**

## Effects of Kernel Upgrades

If you upgrade the Linux kernel after successful installation of Luna HSM Client, then you must install the kernel-headers for the new kernel and build the UHD, K6 and K7 drivers again for the new kernel. The new kernel takes effect after reboot.

**To update the kernel and then bring the system back to readiness:**

1. Install development tools if not already installed.
2. Update kernel if needed.
3. Reboot.
4. Install kernel-headers for the new kernel, example: **yum install kernel-headers-$(uname -r)**
5. Rebuild the drivers for the new kernel: **rpmbuild --rebuild uhd-7.3.0-165.src**
   Do the same for k6 and k7 drivers.

## Troubleshooting

**Problem #1A:** No slots visible for Luna Network HSM 7 = user can't read certs directory.
**Problem #1B:** No slots visible for Luna PCIe HSM 7 or Luna USB HSM 7 = user can't read device (/dev/k7pf0, /dev/viper0, or /dev/lunauhd0).
**Solution:** You might have left a user out of **hsmusers** group, or you might have set an overly restrictive umask.

**Problem #2:** You receive the following error: **./setenv:24: = not found**

**Solution:**The setenv command is only supported while using bash.

# Adding a Luna Cloud HSM Service

Luna HSM Client allows you to use both Luna partitions and Thales Data Protection on Demand (DPoD) Luna Cloud HSM services. Using a single client workstation, you can back up or migrate your keys between Luna and the Luna Cloud HSM service, or combine partitions and services into an HA group.

> **NOTE** Refer to the Luna HSM Client Releases for supported client versions. Thales recommends keeping your Luna HSM Client software updated to the latest version, especially if your deployment includes Luna Cloud HSM.

### Prerequisites

> If Luna HSM Client is not installed at the default location, the **ChrystokiConfigurationPath** must be set for the Luna Cloud HSM service to use the correct location.

> DPoD Luna Cloud HSM services support Windows and Linux operating systems only. This procedure presumes that you have already set up Luna HSM Client on your Windows or Linux workstation:

- "Windows Luna HSM Client Installation" on page 21
- "Windows Interactive Luna HSM Client Installation" on page 28
- "Linux Luna HSM Client Installation" on page 36

> For more information on Luna/Luna Cloud HSM service compatibility, refer to Cloning Keys Between Luna 6, Luna 7, and Luna Cloud HSM.

### To add a DPoD Luna Cloud HSM service to an existing Luna HSM Client

1. After purchasing a Luna Cloud HSM service, refer to the DPoD Luna Cloud HSM documentation for instructions on downloading the Luna Cloud HSM service client. Transfer the zip file to your workstation using **pscp**, **scp**, or other secure means.
2. Extract the zip file into a directory on your client workstation.
3. Extract or untar the appropriate client package for your operating system. Do not extract to a new subdirectory; place the files in the Luna Cloud HSM service client install directory. The other client package can be safely deleted.
   - [Windows] **cvclient-min.zip**
   - [Linux] **cvclient-min.tar**

     **# tar -xvf cvclient-min.tar**

     Run the provided **setenv** script to automatically copy the necessary Luna Cloud HSM service configuration entries to the existing Luna HSM Client configuration file. The existing Luna HSM Client configuration file must be writable to execute **setenv**.

     **CAUTION!** Running **setenv** will overwrite any existing Luna Cloud HSM service configurations in the Luna HSM Client configuration file.

     **NOTE** If Luna HSM Client is not installed in the default directory, or if **setenv** was run previously, you must clear the **ChrystokiConfigurationPath** environment variable or update it to point to the location of the correct configuration file:

     > [Windows] In the Control Panel, search for "environment" and select **Edit the system environment variables**. Click **Environment Variables**. In both the list boxes for the current user and system variables, edit **ChrystokiConfigurationPath** to point to the **crystoki.ini** file in the correct client install directory.

     > [Linux] Either open a new shell session, or reset the environment variable for the current session to the location of the correct **Chrystoki.conf** file:

     **# export ChrystokiConfigurationPath=/etc/**

   - [Windows **cmd** prompt] Open a command prompt as **Administrator** and run the script with the **-addcloudhsm** option.

     **> .\setenv.cmd -addcloudhsm**
   - [Linux] Source the **setenv** script with the **--addcloudhsm** option.

     **# source ./setenv --addcloudhsm**
4. Launch or relaunch LunaCM to verify that both your Luna partitions and Luna Cloud HSM service are available. Once the Luna Cloud HSM service has been added to the Luna HSM Client, you can delete the client package downloaded from Thales DPoD.

# Initializing a Luna Cloud HSM Service

You must now initialize the Luna Cloud HSM service for use with your existing Luna partitions. If your Luna HSMs are password-authenticated, the cloning domain you set on the Luna Cloud HSM service must match the partition(s) with which it will share keys.

> Initializing the Application Partition

> Initializing the Crypto Officer and Crypto User Roles

If you will be using the Luna Cloud HSM service with multifactor quorum-authenticated Luna partitions, LunaCM provides the option to import the credential from a red domain iKey to Luna Cloud HSM, as described below.

> **NOTE** This feature requires minimum Luna HSM Client 10.4.1, and is available for Luna Cloud HSM only. For cloning between password- and multifactor quorum-authenticated Luna HSMs, see Universal Cloning.

## Prerequisites

> The uninitialized Luna Cloud HSM service must be available in LunaCM on a client computer with Luna HSM Client 10.4.1 or newer installed.

> The client computer must have the Luna PED driver installed:

  **Windows:** "Modifying the Installed Windows Luna HSM Client Software" on page 31 (**Remote PED** package)

  **Linux:** "About Installing the Luna HSM Client Software" on page 38 (**[5] Luna Remote PED** package or **-p ped** in scripted installation)

> Connect a Luna PED to the client computer and set it to **Local PED-USB** mode.

> If you were previously using this client computer as a Remote PED server, you must stop PEDserver before continuing:

  **pedserver -mode stop**

> If your Luna partition domain uses an M of N iKey scheme, ensure that you have enough keys on hand to provide the M of N quorum.

### To initialize a Luna Cloud HSM service using an imported domain secret

1. Launch LunaCM on the client computer.
2. Set the active slot to the uninitialized Luna Cloud HSM service.

   lunacm:> **slot set -slot** <slot#>
3. Initialize the Luna Cloud HSM service, specifying an identifying label and including the **-importpeddomain** option.

   lunacm:> **partition init -label** <label> **-importpeddomain**

   Follow the prompts in LunaCM and on the Luna PED to import the domain secret and complete the initialization process.

> **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.

> Initializing the Application Partition

> Initializing the Crypto Officer and Crypto User Roles

Refer to Cloning Keys Between Luna 6, Luna 7, and Luna Cloud HSM before migrating keys or using the Luna Cloud HSM service in an HA group. You can migrate keys to your new Luna Cloud HSM service using direct slot-to-slot cloning, a Luna Backup HSM, or by setting up an HA group.

> Cloning Objects to Another Application Partition

> Partition Backup and Restore

> Configuring a High-Availability Group

## Dynamic Partition Loading for Luna Cloud HSM Services

Luna HSM Client 10.5.0 and newer provide access to dynamic partition loading for Luna Cloud HSM services. Dynamic partition loading allows you to add additional sets of client UserIDs (combination of unique AuthTokenClientID, AuthTokenClientSecret, AuthTokenConfigURI) to the crystoki.conf or Chrystoki.ini file and automatically access the added partitions without restarting LunaCM or impacting other applications using LunaCM. Deleted partitions will not be removed from the LunaCM list until you restart LunaCM.

The default maximum number of users that can be added to a crystoki.conf or Chrystoki.ini file is 100. For more information about configuring the maximum number of client UserIDs see MaxUserIDCount in the "Configuration File Summary" on page 51.

### Prerequisites

> Luna HSM Client 10.5.0 or newer

- An HSM client downloaded from the Thales Support Portal. If using an HSM client this procedure assumes that you have already set up your HSM client on your Windows or Linux workstation. In addition, this procedure requires the REST and XTC sections of the Luna Cloud HSM service be available in the client configuration file. See "Adding a Luna Cloud HSM Service" on page 46 for more information about adding your first Luna Cloud HSM service and the necessary configuration file entries to an existing HSM client.
  - "Windows Interactive Luna HSM Client Installation" on page 28
  - "Linux Luna HSM Client Installation" on page 36
- A minimal client downloaded from Thales Data Protection on Demand.

> A Luna Cloud HSM service partition to load dynamically.

> If HSM client is not installed at the default location, the ChrystokiConfigurationPath must be set for the Luna Cloud HSM service to use the correct location.

### To dynamically load a partition

1. Open the client configuration file (the Chrystoki.conf (Linux) or crystoki.ini/crystoki-template.ini (Windows)), for the HSM client that you are adding the Luna Cloud HSM service partition to, in a text editor.

2. In the REST section, add the client UserID values for the new partition. Append the client UserID values with a unique numerical value to associate the client UserID values with each other.

> **TIP** The client UserID values can be accessed from the Chrystoki.conf (Linux) or crystoki.ini/crystoki-template.ini (Windows) configuration files included in the Luna Cloud HSM service client package.

Linux example:

```
REST = {
AuthTokenConfigURI=********
AuthTokenClientId=********
AuthTokenClientSecret=********
AuthTokenConfigURI2=********
AuthTokenClientId2=********
AuthTokenClientSecret2=********
AuthTokenConfigURI3=********
AuthTokenClientId3=********
AuthTokenClientSecret3=********
RestClient=1
ClientTimeoutSec=120
ClientPoolSize=32
ClientEofRetryCount=15
ClientConnectRetryCount=900
ClientConnectIntervalMs=1000
PartitionData00=1334054167371, na.hsm.dpondemand.io, 443
SSLClientSideVerifyFile=.\\server-certificate.pem;
}
```

Windows example:

```
[REST]
AuthTokenConfigURI=********
AuthTokenClientId=********
AuthTokenClientSecret=********
AuthTokenConfigURI2=********
AuthTokenClientId2=********
AuthTokenClientSecret2=********
AuthTokenConfigURI3=********
AuthTokenClientId3=********
AuthTokenClientSecret3=********
RestClient=1
ClientTimeoutSec=120
ClientPoolSize=32
ClientEofRetryCount=15
ClientConnectRetryCount=900
ClientConnectIntervalMs=1000
PartitionData00=1334054167371, na.hsm.dpondemand.io, 443
SSLClientSideVerifyFile=.\\server-certificate.pem;
```

3. Execute the "slot list" command in LunaCM to display the additional partitions.

> **TIP** Additional sets of client UserIDs can be exported and secured as described in "Configuration File Summary" on the next page.

# Configuration File Summary

The Luna HSM Client software installation includes a configuration file that controls many aspects of client operation. The fields in the configuration file are used to alter the default behavior of the library. So the default value is the value that would result in the normal (non-altered) behavior (but see TIP below). The configuration file can be found in the following default locations:

> **Luna HSM Client**

- Windows: C:Program Files\SafeNet\LunaClient\crystoki.ini
- Linux/UNIX: /etc/Chrystoki.conf

> **Luna Cloud HSM**

- Windows: <service_client_path>\crystoki.ini
- Linux: <service_client_path>/Chrystoki.conf

> **NOTE** The crystoki.ini and Chrystoki.conf files included with the Luna Cloud HSM service client provide a default set of configuration options.

The configuration file is organized into named sections, containing various configuration entries. It is installed with the default settings described in the table below. In addition to the default sections and entries, some additional sections/entries can be added to customize functionality. Generally, Thales does not recommend editing the configuration file directly; many entries are changed by entering commands in LunaCM or **vtl**. However, some entries can only be edited manually.

If you update the Luna HSM Client software by running the uninstaller and then installing a newer version, the existing configuration file is saved. This preserves your configuration settings, including the location of certificates necessary for your partition NTLS/STC connections for Luna products.

The following table describes all valid sections and entries in the configuration file. When editing the file, ensure that you maintain the applicable syntax conventions for your operating system (use existing sections/entries as a template for new entries). Where applicable, entries are listed with the valid range of values and the default setting.

**TIP Configuration settings and Section Headings**

Some of the sections and entries listed here do not appear in the base configuration file as you would receive it via download; in many use-cases, your application's employment of the HSM would not require any direct intervention in the configuration file. "Factory" settings would be sufficient. If an application would benefit from a setting that differs from the stock values, and a visible entry is not already in the configuration file on your host system, then you must add a relevant entry in order to change the behavior described in the table below.

- If the configuration file contains no explicit entries that would reside under a particular heading, then the heading itself would also not be present.
- If you intend to add a setting to the file, and there is no pre-existing section-heading for it, then create a heading as indicated in the table, below, following the format of the other sections in your config file, appropriate for the host operating system (Linux/UNIX or Windows).

The majority of fields are Boolean (true/false or 0/1), or a range of values.

Some of the entries listed include a default setting that is observed if the entry is not included in the configuration file by default; you must add the entry explicitly, only in the case where you need to change the default behavior.

**Exceptions:**

- If an explicit location is not set for the library location (which is normally inserted as part of installation if you use the Client installer), or if you moved the library after a path value was included, an error message is generated about the field/path/file not being found, and you must provide a proper library location in order to proceed.
- If you intend to use an NTLS connection (Luna Network HSM 7) or an XTC connection (Luna Cloud HSM), then the relevant settings must be present to define that connection, or the connection does not take place.

**Do not edit the Chrystoki.conf or crystoki.ini file unless you need to do so.** If you need to edit, refer to the guidance in the table below, and ask for help from our technical support engineers if this document is not sufficient.

| Section/Setting | Description |
|---|---|
| **Chrystoki2** | |
| LibNT | Path to the Chrystoki2 library on Windows operating systems.<br>**Default: C:\Program Files\SafeNet\LunaClient\cryptoki.dll** |

| Section/Setting | Description |
|---|---|
| LibNT32 | Path to the Chrystoki2 library on 32-bit Windows systems only.<br>**Default: C:\Program Files\SafeNet\LunaClient\win32\libCryptoki2.dll**<br>**NOTE** Luna HSM Client 10.1.0 and newer includes libraries for 64-bit operating systems only. |
| LibUNIX64 | Path to the Chrystoki2 library on 64-bit Linux/UNIX operating systems.<br>**Default:**<br>> **Linux/AIX: /usr/safenet/lunaclient/libs/64/libCryptoki2_64.so**<br>> **Solaris: /opt/safenet/lunaclient/libs/64/libCryptoki2_64.so** |
| **Luna (see * below this table)** | |
| CloningCommandTimeout | The amount of time (in milliseconds) the library allows for the HSM to respond to a cloning command.<br>**Default: 300000** |
| CommandTimeoutPedSet | This is an exception to DefaultTimeout (below). It defines the time (in milliseconds) allowed for all PED-related HSM commands. PED-related commands can take longer than ordinary commands governed by DefaultTimeOut.<br>Generally, the following formula applies:<br>CommandTimeOutPedSet = DefaultTimeOut + PEDTimeout1 + PEDTimeout2 + PEDTimeout3<br>**Default: 720000** |
| DefaultTimeOut | Defines the time (in milliseconds) the HSM driver in the host system waits for HSM commands to return a result. If a result is not returned in that time, the driver halts the HSM and returns DEVICE_ERROR to all applications using the HSM. The only exceptions are when a command's timeout is hard-coded in the Cryptoki library, or the command falls into a class governed by one of the other timeout intervals described elsewhere in this section.<br>**Default: 500000** |
| DomainParamTimeout | Timeout (in milliseconds) for Domain Parameter Generation.<br>**Default: 5400000** |

| Section/Setting | Description |
|---|---|
| KeypairGenTimeOut | Defines the time (in milliseconds) the library waits for a keypair generation operation to return a value. The randomization component of keypair generation can cause large keypairs to take a long time to generate, and this setting keeps the attempts within a reasonable time. You can change this value to manage your preferred balance between long waits and the inconvenience of restarting a keygen operation.<br>**Default: 2700000** |
| PEDTimeout1 | Defines the time (in milliseconds) the HSM attempts to ping the PED before sending a PED operation request. If the PED is unreachable, the HSM returns a code indicating that the PED is not connected.<br>**Default: 100000** |
| PEDTimeout2 | Defines the time (in milliseconds) that the HSM waits for the local PED to respond to a PED operation request. If the local PED does not respond to the request within the span of PEDTimeout2, the HSM returns an appropriate result code (such as PED_TIMEOUT). This is the timeout you might increase from the Default value if you were initializing larger MofN PED Key sets - the HSM allows M and N to each be up to 16 splits - maybe applying PED PINS, and making a duplicate set as well.<br>**Default: 200000** |
| PEDTimeout3 | Defines the additional time (in milliseconds) the HSM waits for a remote PED to respond to a PED operation request. Therefore, the actual time the firmware waits for a remote PED response is PEDTimeout2 + PEDTimeout3.<br>**Default: 20000** |
| **CardReader** | |
| LunaG5Slots | Number of Luna Backup HSM G5 slots reserved so that the library will check for connected devices.<br>**Valid Values:**<br>> **0**: If you have no Luna Backup HSM G5s and wish to eliminate the reserved spaces in your slot list, use this setting.<br>> **1-N**: Can be set to any number, but is effectively limited by the number of external USB devices supported by your client workstation.<br>**Default: 3** |

| Section/Setting | Description |
|---|---|
| LunaG7Slots | Number of Luna Backup HSM 7 slots reserved so that the library will check for connected devices.<br>**Valid Values:**<br>> **0**: If you have no Luna Backup HSM 7s and wish to eliminate the reserved spaces in your slot list, use this setting.<br>> **1-N**: Can be set to any number, but is effectively limited by the number of external USB devices supported by your client workstation.<br>**Default: 3** |
| RemoteCommand | This setting was used when debugging older Luna products. For modern products it is ignored.<br>**Valid Values:**<br>> **0**: false<br>> **1** (default): true |
| CKLog2 | |
| **NOTE** See Using CKlog. Config is done using the vtl utility or by editing this config file directly. | |
| **RBS** | **NOTE** RBS is not supported with Luna Cloud HSM services. |
| CmdProcessor | The location of the RBS library.<br>**Default:**<br>> **Windows: C:\Program Files\SafeNet\LunaClient\rbs_processor2.dll**<br>> **Linux/AIX: /usr/safenet/lunaclient/rbs/lib/librbs_processor2.dll**<br>> **Solaris: /opt/safenet/lunaclient/rbs/lib/librbs_processor2.dll** |
| HostPort | The port number used by the RBS server.<br>**Valid Values:** any unassigned port<br>**Default: 1792** |

| Section/Setting | Description |
|---|---|
| ClientAuthFile | The location of the RBS Client authentication file.<br>**Default:**<br>> **Windows: C:\Program Files\SafeNet\LunaClient\config\clientauth.dat**<br>> **Linux/AIX: /usr/safenet/lunaclient/rbs/clientauth.dat**<br>> **Solaris: /opt/safenet/lunaclient/rbs/clientauth.dat** |
| ServerSSLConfigFile | The location of the OpenSSL configuration file used by RBS Server or Client.<br>**Default:**<br>> **Windows: C:\Program Files\SafeNet\LunaClient\rbs\server.cnf**<br>> **Linux/AIX: /usr/safenet/lunaclient/rbs/server/server.cnf**<br>> **Solaris: /opt/safenet/lunaclient/rbs/server/server.cnf** |
| ServerPrivKeyFile | The location of the RBS Server certificate private key file.<br>**Default:**<br>> **Windows: C:\Program Files\SafeNet\LunaClient\cert\server\serverkey.pem**<br>> **Linux/AIX: /usr/safenet/lunaclient/rbs/server/serverkey.pem**<br>> **Solaris: /opt/safenet/lunaclient/rbs/server/serverkey.pem** |
| ServerCertFile | The location of the RBS Server certificate file.<br>**Default:**<br>> **Windows: C:\Program Files\SafeNet\LunaClient\cert\server\server.pem**<br>> **Linux/AIX: /usr/safenet/lunaclient/rbs/server/server.pem**<br>> **Solaris: /opt/safenet/lunaclient/rbs/server/server.pem** |
| NetServer | Determines whether RBS acts as a server or client.<br>**Valid Values:**<br>> **0**: Client<br>> **1** (default): Server |

| Section/Setting | Description |
|---|---|
| HostName | The hostname or IP address that the RBS server will listen on.<br>**Valid Value:** any hostname or IP address<br>**Default:** 0.0.0.0 (any IP on the local host) |
| Available | Lists the serial numbers of Luna Backup HSMs available on the RBS server. |
| **LunaSA Client** | |
| ReceiveTimeout | Time in milliseconds before a receive timeout.<br>**Default:** 20000 |
| SSLConfigFile | Location of the OpenSSL configuration file.<br>**Default:**<br>> **Windows: C:\Program Files\SafeNet\LunaClient\openssl.cnf**<br>> **Linux/AIX: /usr/safenet/lunaclient/bin/openssl.cnf**<br>> **Solaris: /opt/safenet/lunaclient/bin/openssl.cnf** |
| ClientPrivKeyFile | Location of the client private key. This value is set by **vtl** or lunacm:> **clientconfig deploy**.<br>**Default:**<br>> **Windows: C:\Program Files\SafeNet\LunaClient\cert\client** <ClientName>**Key.pem**<br>> **Linux/AIX: /usr/safenet/lunaclient/cert/client/** <ClientName>**Key.pem**<br>> **Solaris: /opt/safenet/lunaclient/cert/client/** <ClientName>**Key.pem** |

| Section/Setting | Description |
|---|---|
| ClientCertFile | Location of the client certificate that is uploaded to Luna Network HSM 7 for NTLS. This value is set by **vtl** or lunacm:> **clientconfig deploy**.<br>**Default:**<br>> **Windows: C:\Program Files\SafeNet\LunaClient\cert\client** <ClientName>**Cert.pem**<br>> **Linux/AIX: /usr/safenet/lunaclient/cert/client/** <ClientName>**Cert.pem**<br>> **Solaris: /opt/safenet/lunaclient/cert/client/** <ClientName>**Cert.pem** |
| LNHServerKeepAliveTimer## | Set the keepalive timer (in milliseconds) for connections to the cluster, specified by ## (refer to " LNHServer##" on the next page).<br>**Valid Range: 10000-50000**<br>**Default: 30000**<br>**NOTE** This feature requires Luna HSM Client 10.5.2 or newer, and the **cluster** package (1.0.2) included with Luna Network HSM 7 Appliance Software 7.8.2 or newer. |
| LNHServerLoadBalancingMode## | Selects the load-balancing mode the client will use to distribute requests among the members of the cluster, specified by ## (refer to " LNHServer##" on the next page).<br>**Valid Values:**<br>> **pick_first** (default): Operation requests are sent to the first cluster member where a connection can be successfully made.<br>> **round_robin**: Connections are made to all active members, and operation requests are distributed to each active member in turn.<br>**NOTE** This feature requires Luna HSM Client 10.5.2 or newer, and the **cluster** package (1.0.2) included with Luna Network HSM 7 Appliance Software 7.8.2 or newer. |

| Section/Setting | Description |
|---|---|
| ServerCAFile | Location of the server certificate file on the client workstation. This value is set by **vtl** or lunacm:> **clientconfig deploy**.<br>**Default:**<br>> **Windows: C:\Program Files\SafeNet\LunaClient\cert\server\CAFile.pem**<br>> **Linux/AIX: /usr/safenet/lunaclient/cert/server/CAFile.pem**<br>> **Solaris: /opt/safenet/lunaclient/cert/server/CAFile.pem** |
| NetClient | Determines whether the library searches for network slots.<br>**Valid Values:**<br>> **0**: The library does not search for network slots.<br>> **1** (default): The library searches for network slots. |
| TCPKeepAlive | TCPKeepAlive is a TCP stack option, available at the Luna HSM Client and the Luna Network HSM 7 appliance. It is controlled via an entry in the Luna HSM Client configuration file, and an equivalent file on the Luna Network HSM 7.<br>The settings at the appliance and the client are independent. This allows a level of assurance, in case (for example) a firewall setting blocks communication in one direction.<br>**Valid Values:**<br>> **0**: false<br>> **1** (default): true |
| ServerName## | These entries identify NTLS-linked Luna Network HSM 7 servers/ports, and determines the order in which they are polled to create a slot list. These values are set by **vtl** or lunacm:> **clientconfig deploy**. |
| ServerPort## | |
| LNHServer## | The IP address and port of a Luna Network HSM 7 cluster member connected to this client. |
| LNHServerClientCert## | The location and filename of the Luna HSM Client certificate used to access this Luna Network HSM 7 cluster. |
| LNHServerClientKey## | The location and filename of the Luna HSM Client private key used to access this Luna Network HSM 7 cluster. |
| LNHServerCAFile## | The location and filename of the Luna Network HSM 7 cluster server certificate. |

| Section/Setting | Description |
|---|---|
| LNHServerCN## | The Common Name for the cluster certificate. |
| LNHStandbyServer## | Reports the affinity group the client is directing traffic to. See Moving a Member to a Different Affinity Group.<br>**NOTE** This feature requires Luna HSM Client 10.5.2 or newer, and the **cluster** package (1.0.2) included with Luna Network HSM 7 Appliance Software 7.8.2 or newer. |
| **Presentation** | **NOTE** This section is not created automatically. To change any of the following values, you must first create this section in the configuration file. |
| OneBaseSlotId | Determines whether slot listing begins at **0** or **1**.<br>**Default: 0** |
| ShowAdminTokens | Determines whether the Admin partitions of locally-installed Luna PCIe HSM 7s are visible in the slot list.<br>**Valid Values:**<br>> **no**: Admin slots are hidden.<br>> **yes** (default): Admin slots are visible. |
| ShowEmptySlots | Determines whether slot numbers are reserved for partitions that have not yet been created on the HSM. When this setting is enabled, slot numbers remain consistent over time, even when new partitions are created.<br>**Valid Values:**<br>> **no** (default): Only existing partitions are assigned slot numbers.<br>> **yes**: Slot numbers are reserved for the maximum number of partitions that can be created on HSMs connected to the client.<br>**NOTE** This does not apply to Luna Network HSM 7 partitions assigned to the client, which will always appear in the lowest-numbered slots, causing locally-connected and Luna Cloud HSM service slots to increment higher. |

| Section/Setting | Description |
|---|---|
| ShowUserSlots | Allows you to set permanent slot numbers for specific partitions. If you use this setting, you must specify a slot for all partitions on a specific HSM, or the partitions not listed here will not be visible to the client.<br>**Valid Values:** Comma-delimited list in the format <slotnum>**(**<serialnum>**)**<br>**Example:**<br>**ShowUserSlots=1(351970018022),2(351970018021),3(351970018020),**... |
| **VirtualToken** | **NOTE** This section is created only if the HA auto-recovery mode is set to **activeEnhanced**. See Configuring HA Auto-Recovery. |
| VirtualToken##Label | The label of the HA group.<br>This value is set by using the lunacm:> hagroup creategroup command to set up an HA group. See Configuring a High-Availability Group. |
| VirtualToken##SN | The pseudo serial number of the HA group.<br>This value is set by using the lunacm:> hagroup creategroup command to set up an HA group. See Configuring a High-Availability Group. |
| VirtualToken##Members | The serial number of the HA group members.<br>This value is set by using the lunacm:> hagroup addmember command to add a member to the HA group. See Configuring a High-Availability Group. |
| VirtualTokenActiveRecovery | The HA auto-recovery mode.<br>This value is set by using the lunacm:> hagroup recoverymode command to configure the HA auto-recovery mode. See Configuring HA Auto-Recovery. |
| **HAConfiguration** | |
| AutoReconnectInterval | Specifies the interval (in seconds) at which the library will attempt to reconnect with a missing HA member, until the set number of attempts is reached. This value is set using lunacm:> **hagroup interval**.<br>**Valid Values:**<br>> **60-1200**: Wait the specified number of seconds between reconnection attempts.<br>**Default: 60** seconds |

| Section/Setting | Description |
|---|---|
| HAOnly | Determines whether individual HA member slots are visible to client applications. Hiding individual members helps prevent synchronization errors by preventing applications from directing calls to individual member partitions. If a member partition fails, the other slots in the system change, which can cause applications to send calls to the wrong slot number. This setting prevents this by hiding all physical slots from applications.<br>**Valid Values:**<br>> **0** (default): All partitions are visible to applications as slots.<br>> **1**: Only HA virtual slots are visible to applications.<br>**NOTE** This setting does not affect how slots are numbered in LunaCM; you can still configure individual member partitions with HAOnly mode enabled. |
| ProbeTimeout | By default, if the HA probing thread makes a request to the Luna Network HSM 7 where the internal cryptographic module (HSM card) is locked up, the probing thread can also lock up, and failover does not occur. To deal with that possibility, this setting, with a value greater than 0, initiates a timeout (in seconds).<br>**Valid Values:**<br>> **0** (default): This is the same effect as the ProbeTimeout setting not existing in this configuration file - no timeout is set.<br>> **1 - ?**: A number of seconds greater than zero. This is a balancing decision, unique to your application situation. If you wish to set a ProbeTimeout, choose a value<br>• large enough to allow your usual crypto processes to complete normally, but<br>• not so large that a failover, from a failed HA-group member to a healthy member, is never triggered before your application concludes that the entire HA group has failed.<br>This feature requires Luna HSM Client 10.7.2 or newer (with the default 0 value for backward compatibility). |

| Section/Setting | Description |
|---|---|
| reconnAtt | Specifies the number of reconnection attempts the client makes to a missing HA member. Once this number is reached, you must manually reconnect the member when it becomes available (see Manually Recovering a Failed HA Group Member).<br>This value is set using lunacm:> **hagroup retry**.<br>**Valid Values:**<br>> **-1**: Perform infinite reconnection attempts.<br>> **0**: Disable HA auto-recovery.<br>> **1-500**: Perform the specified number of reconnection attempts. |
| statusTimeout | This value (in seconds) is the amount of time the CA_GetCurrentHAState function will try to verify the status of HA group members, before stopping and reporting the statuses collected up to that cutoff.<br>**Valid Values:**<br>> **3** (default): This is the shortest reasonable value in good network conditions.<br>> **4-60**: Any value between the default and 60 second.<br>**NOTE** After 60 seconds, the status check could conflict with other processes, so the cap is set at 60. |
| **Misc** | |
| AppId = <xxx> | Application IDs are generated when the application starts, and are 16 bytes for Luna HSM Firmware 7.7.0 and newer, and and Luna HSM Client 10.3.0 and newer. Application IDs are not supported for Luna Cloud HSM services. You can override this functionality and specify an AppId if desired.<br>For HSM firmware version 7.8.4 onward, see **NOTE below this table. |

| Section/Setting | Description |
|---|---|
| CopyRSAPublicValuesFromPrivateTemplate | Controls whether the public exponent of an RSA key can be copied from the private key template, if the public key template does not already have a public exponent attribute set.<br>**Valid Values:**<br>> **0**: if no public exponent is provided in the public template, an error is returned (expected behavior).<br>> **1**(default): if no public exponent is provided in the public template, the private exponent is copied from the private template to populate the public template.<br>For PKCS#11 compliance, this should be set to **0**. |
| ECCPointEncodingStrategy= | Allows you to force (or not) the assumption that an Elliptic Curve point is provided in RAW octet string format.<br>**Valid Values:**<br>> **1**: Queries HSM for correct EC Point Size, then determines whether encoding is required or not.<br>> **2**: Does not query the HSM for EC point size. Assumes EC point is RAW and always encodes it.<br>(Included in client since Luna HSM Client 10.5.0; available as a patch for Luna HSM Client 10.4.0 and 10.4.1. Beginning with HSM firmware version 7.8.1 this entry is no longer needed.) |
| FunctionBindLevel | Determines what action to take if a function binding fails during a CryptokiConnect() operation.<br>**Valid Values:**<br>> **0** (default): fail if not all functions can be resolved<br>> **1**: do not fail but issue warning for each function not resolved<br>> **2**: do not fail and do not issue warning (silent mode) |

| Section/Setting | Description |
|---|---|
| LoginAllowedOnFMEnabledHSMs | Determines whether the client can log in to a partition on an HSM that uses Functionality Modules (FMs). FMs consist of custom-designed code that introduces new functionality, which can be more or less secure than standard HSM functions.<br>Possible values include:<br>> **0**: the client does not allow login to an FM-enabled partition<br>> **1**: the client allows login to an FM-enabled partition<br>This entry is added to the configuration file the first time you initialize or log in to an FM-enabled partition using LunaCM. You are prompted to confirm that you want to allow login. |
| MutexFolder= | For non-Windows platforms. Several Luna features write temporary files to **/tmp**. If systemd service deletes the temporary files the affected services can be disrupted - example Remote PED callback service (cbs). An administrator can use this setting to specify an alternative location like this example:<br>`Misc = {`<br>`…`<br>`  MutexFolder = /usr/lock;`<br>`}`<br>The specified folder must exist, or the service fails to start properly.<br>> **Linux default: <install_dir>/lock** |
| PE1746Enabled | Enables the SafeXcel 1746 security co-processor on Luna 6 HSMs, which is used to offload packet processing and cryptographic computations from the host processor. Does not apply to Luna 7 HSMs or Luna Cloud HSM services.<br>**Valid Values:**<br>> **0**: SafeXcel co-processor is disabled on Luna 6 HSMs.<br>> **1** (default): SafeXcel co-processor is enabled on Luna 6 HSMs. |
| PluginModuleDir | Specifies the location of client plugins. This setting is required to use the cloud plugin to access Luna Cloud HSM services.<br>**Default:**<br>> **Windows: C:\Program Files\SafeNet\LunaClient\plugins**<br>> **Linux: /usr/safenet/lunaclient/libs/64/plugins** |

| Section/Setting | Description |
|---|---|
| ProtectedAuthenticationPathFlagStatus | Specifies which role to check for challenge request status.<br>**Valid Values:**<br>> **0** (default): no challenge request<br>> **1**: check for Crypto Officer challenge request<br>> **2**: check for Crypto User challenge request |
| ToolsDir | The location of the Luna HSM Client tools.<br>**Full Luna HSM Client Default:**<br>> **Windows: C:\Program Files\SafeNet\LunaClient**<br>> **Linux/AIX: /usr/safenet/lunaclient/bin/**<br>> **Solaris: /opt/safenet/lunaclient/bin/**<br>**Minimal Luna HSM Client Default:**<br>> **Linux: /usr/safenet/lunaclient/bin/64/** |
| ValidateHost= | Set this flag to have the Luna HSM Client validate the server's hostname/IP against the Subject Alternate Name (SAN) values in the server's certificate.<br>**Default: 0** |
| **Secure Trusted Channel** | **NOTE** Secure Trusted Channel is not supported with Luna Cloud HSM Services. |
| ClientTokenLib<br>(for 64-bit Windows systems) | Specifies the location of the token library on 64-bit Windows systems. This value must be correct in order to use a client token. If you are using a hard token, you must manually change this value to point to the hard token library for your operating system. The exact location of the hard token library may vary depending on your installer.<br>**Default: C:\Program Files\SafeNet\LunaClient\softtoken.dll** |

| Section/Setting | Description |
|---|---|
| ClientTokenLib32<br>(for 32-bit Windows systems) | Specifies the location of the token library on 32-bit Windows systems. This entry appears on Windows only.<br>By default, **ClientTokenLib32** points to the location of the soft token library. If you are using a hard token, you must manually change this value to point to the hard token library for your operating system. The exact location of the hard token library may vary depending on your installer.<br>**Soft Token Default: C:\Program Files\SafeNet\LunaClient\win32\softtoken.dll**<br>**Hard Token Default: C:\Windows\SysWOW64\etoken.dll**<br>**NOTE** Luna HSM Client 10.1.0 and newer includes libraries for 64-bit operating systems only. |
| **Session** | **NOTE** This section is not created automatically. To change any of the following values, you must first create this section in the configuration file. |
| AutoCleanUpDisabled | Determines whether AutoCleanUp closes orphaned sessions in the event that an application leaves sessions open. Useful for Luna PCIe HSM hosts. AutoCleanUp runs during C_Finalize on the client. Luna Network HSM 7 sessions are tracked and closed by the NTLS service.<br>**Valid Values:**<br>> **0** (default): Run AutoCleanUp if your application leaks sessions and you cannot rewrite the application.<br>> **1**: Disable AutoCleanUp if you have a Luna PCIe HSM 7 and your client application does proper housekeeping, or if your application is connecting via NTLS to a Luna Network HSM 7. |
| **Shim2** | **NOTE** This section is not created automatically. To change any of the following values, you must first create this section in the configuration file. |
| (Linux)<br>LibUNIX64=/usr/safenet/lunaclient/lib/libCryptoki2_64.so;<br>(Windows)<br>LibNT=C:\Program Files\SafeNet\LunaClient\cryptoki.dll | This section is required when a shim is to be used.<br>If the cryptoki library is not at the indicated location, then adjust the example path value to reflect the actual location. |

| Section/Setting | Description |
|---|---|
| **Toggles** | **NOTE** This section is not created automatically. To change any of the following values, you must first create this section in the configuration file. |
| legacy_memory_rep = | Controls the manner in which the HSM reports the available RAM space.<br>**Valid Values:**<br>> **0** (default): the public and private memory total/free values reported in the CK_TOKEN_INFO structure indicate the available flash memory for permanent (TOKEN) objects that are in either the public or private space respectively; this method is PKCS#11 compliant.<br>> **1**: the public memory values indicate the total/free RAM memory; this non-standard legacy method was used by some customers to determine space available for session based objects, and must be explicitly selected in order to continue using the legacy method. |
| lunacm_cv_ha_ui = | Controls whether Thales DPoD Luna Cloud HSM services can be active members of an HA group.<br>**Valid Values:**<br>> **0**: Luna Cloud HSM services can be added as active HA members.<br>> **1** (default): Luna Cloud HSM services can be added to HA groups as standby members only. This is the default behavior to maximize HA performance, which may suffer due to network latency. |
| fetch_partition_label = | Allows the client to refresh the slot list without requiring an application restart.<br>**Valid Values:**<br>> **0** (default): A new session must be opened (C_Initialize) to refresh the slot list cache.<br>> **1**: Slot list cache is refreshed without requiring C_ Initialize.<br>**NOTE** This functionality requires Luna HSM Client 10.5.1 or newer. |
| map_aes_cmac_general_old= | Allows the library to automatically map relevant values to the required mechanism CKM_AES_CMAC_GENERAL. Refer to resolved issue LUNA-30232.<br>**NOTE** This functionality requires Luna HSM Client 10.7.0 or newer. |

| Section/Setting | Description |
|---|---|
| **REST** | **NOTE** This section configures a connection to a Luna Cloud HSM and applies only to a Luna Cloud HSM. This section is not created automatically for clients obtained from the Thales Support Portal. See "Adding a Luna Cloud HSM Service" on page 46 for detailed instructions on adding a Luna Cloud HSM service client to a Luna HSM Client.<br>This section governs Luna Cloud HSM service functionality only and is not related to the Luna REST API. This functionality requires Luna HSM Client 10.2.0 or newer. |
| AppLogLevel | Defines the maximum severity level of application logs to be displayed in the application console.<br>**Valid Values:**<br>> **trace** (unavailable for Luna HSM Client 10.4.0 and newer)<br>> **debug** (unavailable for Luna HSM Client 10.4.0 and newer)<br>> **error**<br>> **warning**<br>> **info**<br>Application Error Logs are printed to the Event Viewer on Windows 10 and to the system and console on Linux.<br>**Windows**: Windows operating systems print application error logs to the Event Viewer. Access the logs by opening **Event Viewer** > **Windows Logs** > **Application** and filtering the results for *LunaClientEventProvider*.<br>**NOTE** To display Windows Logs in the Event Viewer as a non-administrator user you must register the **LunaClientEventProvider.dll**. Failure to register the **LunaClientEventProvider.dll** will result in the logs displaying to the console.<br>**Linux**: Linux operating systems print application error logs to **/var/log/message**. Access the logs by opening **/var/log/message** and searching the results for *lunacm*.<br>**Ubuntu**: Ubuntu operating systems print application error logs to **/var/log/syslog**. Access the logs by opening **/var/log/syslog** and searching the results for *lunacm*. |

| Section/Setting | Description |
|---|---|
| AuthTokenConfigURI | The identifier for the authentication service which issues the tokens required to validate the client's identity to the Luna Cloud HSM service. Your client host must have an internet connection to reach this resource. Do not edit the default value unless instructed to by customer support. |
| AuthTokenClientId | The client identity required by the authentication service to issue a token. Do not edit the default value unless instructed to by customer support. |
| AuthTokenClientSecret | The client passphrase required by the authentication service to issue a token. Do not edit the default value unless instructed to by customer support. |
| CurlLogsEnabled | Enables libcurl logging. This variable applies to Luna HSM Client 10.3.0 and newer.<br>**Valid Values:**<br>> **False**:Libcurl logging is disabled.<br>> **True**(default): Libcurl logging is enabled.<br>**NOTE** If using Luna HSM Client 10.4.0 or newer you **must** have AppLogLevel=info defined in your Chrystoki.conf\crystoki.ini to retrieve curl logs. See "AppLogLevel" on the previous page for more information.<br>Curl Logs are printed to the Event Viewer on Windows 10 and to the system and console on Linux.<br>**Windows**: Windows operating systems print application error logs to the Event Viewer. Access the logs by opening **Event Viewer** > **Windows Logs** > **Application** and filtering the results for *LunaClientEventProvider*.<br>**NOTE** To display Windows Logs in the Event Viewer as a non-administrator user you must register the **LunaClientEventProvider.dll**. Failure to register the **LunaClientEventProvider.dll** will result in the logs displaying to the console.<br>**Linux**: Linux operating systems print application error logs to **/var/log/message**. Access the logs by opening **/var/log/message** and searching the results for *lunacm*.<br>**Ubuntu**: Ubuntu operating systems print application error logs to **/var/log/syslog**. Access the logs by opening **/var/log/syslog** and searching the results for *lunacm*. |

| Section/Setting | Description |
|---|---|
| ClientConnectIntervalMs | Interval in milliseconds between client connection attempts.<br>**Default: 1000** |
| ClientConnectRetryCount | Maximum connection attempts between a client and a server.<br>**Default: 900** |
| ClientEofRetryCount | Maximum command retries.<br>**Default: 15** |
| ClientPoolSize | Number of threads in the thread pool available for client operations.<br>**Default: 32** |
| ClientTimeoutSec | Time in seconds that a client waits for a response. This timeout applies to each retry attempt individually.<br>**Default: 600**<br>**NOTE** This entry does not appear in the default configuration file, but the default value applies to this timeout. You can manually add the entry if you wish to edit the timeout. |

| Section/Setting | Description |
| --- | --- |
| PartitionData00 | The partition serial number, load balancer IP address or hostname, and load balancer port.<br>Executing setenv, when configuring the Luna HSM Client, removes PartitionData00 and replaces it with values for ServerName and ServerPort.<br>The following format is used:<br>PartitionData00=<partition_serial_number>, <service_ip_address/hostname>, <service_port>;<br>**NOTE** PartitionData00 is deprecated and included in the bundle to support legacy use cases. This may be removed in a future update.<br>**CAUTION!** The Luna Cloud HSM service failover to the redundant datacenter uses a change to DNS to direct client traffic to a secondary datacenter. The client configuration file includes the FQDN for the Luna Cloud HSM service datacenter in the `REST = PartitionData00` section or the `REST = ServerName` section after executing `setenv` (`eu.hsm.dpondemand.io` or `na.hsm.dpondemand.io`). In the event of a failover the DNS record for FQDN is updated to point to the secondary datacenter.<br>Ensure that the client is configured to use the domain name for the datacenter and to not configure any filtering based on the IP addresses. Failure to use the domain name and filtering IP addresses could result in the client being unable to failover to the secondary datacenter.<br>**NOTE** Using Luna Cloud HSM 10.7.2 or higher, users are no longer required to run **setenv** to configure the client to connect to the Cloud HSM Service. However, **setenv** may still be used to configure the client for hybrid use cases or integrations where setting the ChrystokiConfigurationPath is required. |

| Section/Setting | Description |
|---|---|
| RestClient | Indicates that cvclient and associated tools are acting as REST clients.<br>**Default: 1** |
| ServerName | The name of the Luna Cloud HSM server. |
| ServerPort | The port used for Luna Cloud HSM server traffic. |
| **XTC** | **NOTE** This section configures a connection to a Luna Cloud HSM and applies only to a Luna Cloud HSM. This section is not created automatically for clients obtained from the Thales Support Portal. See "Adding a Luna Cloud HSM Service" on page 46 for detailed instructions on adding a Luna Cloud HSM service client to a Luna HSM Client.<br>This section governs Luna Cloud HSM service functionality only and is not related to the Luna REST API. Requires Luna HSM Client 10.2.0 or newer. |
| Enabled | Indicates that XTC (Transferable Token Channel) is enabled. This channel must be enabled for the client to communicate with a Luna Cloud HSM service.<br>**Valid Values:**<br>> **0**: XTC is disabled.<br>> **1** (default): XTC is enabled. |
| TimeoutSec | Time (in seconds) before a cryptographic request expires. Timestamps are included in XTC headers, and the HSM rejects messages which have expired.<br>**Valid Values: 1-600** |
| **GemEngine** | **NOTE** This section is not created automatically. |

| Section/Setting | Description |
|---|---|
| DisableCheckFinalize | Determines how the gem engine behaves for finalizing the cryptoki library. If an application has forking processes, then this causes the connection with the HSM to be shared between the parent and the child process which must be addressed for Linux/UNIX.<br>**Valid Values:**<br>> **0** (default): Perform pre-fork checking -- when crypto calls are made in the parent process, the cryptoki library is finalized after each crypto call. However, in the child process, the library is initialized and the connection to the HSM is maintained after crypto calls. The parent and child will have different connections to the HSM.<br>> **1**: Perform post-fork checking -- the engine initializes the cryptoki library and maintains the connection to the HSM until the application terminates.<br>If your application (own or 3rd party) is using OpenSSL and has forking processes, set this value to 0. Otherwise, setting the option to 1 will improve performance.<br>Not used for Windows. |

* If you intend to invoke a large number N for an M of N keyset (maximum is 16 splits), including also a backup set, you will need to increase the various PED timeout values well beyond the default values, in order to have enough time to comfortably complete the task. As a rough example, increase the PED's timeout for creating a keyset by a factor of 10. Altogether, the combined value works out to:

```
CommandTimeOutPedSet  >= ( DefaultTimeOut + PEDTimeout1 + PEDTimeout2 + PEDTimeout3 )
```

So, for example, in the Luna section of the .conf file (similar for the .ini file in Windows):

```
Luna =
{ DefaultTimeOut = 500000; PEDTimeout1 = 100000; PEDTimeout2 = 2000000; PEDTimeout3 = 20000;
KeypairGenTimeOut = 2700000; CloningCommandTimeOut = 300000; CommandTimeOutPedSet = 2620000; }
```

The longest such activity would be creating a 16-key split of a new-format orange PED Key (RPK), with duplicates, which might take a little more than half an hour at a comfortable pace with no interruptions. This is considered an extreme edge-case. Your situation will probably require settings somewhere between the defaults and the values suggested above.

**

**NOTE** From HSM firmware version 7.8.4 onward, Application IDs (APPId) are *encrypted*, with the following effects:

- Whenever firmware is upgraded from a non-APPID encrypted version (before firmware 7.8.4) to an encrypted APPID firmware version, the access ID shown in the logs will change.
- After the new firmware starts, the *encrypted* value of the same access ID for that application (for example, LUNACM) is now shown.
- The access ID shown also changes after every reset/restart of firmware version 7.8.4 onward because a new APPID encryption key (AEK) is created each time firmware starts up. The AEK is used by the crypto library of the APP to encrypt the access ID.
- Also whenever an Application is started it creates a new random access ID each time (unless fixed to a value [set AppId= under the Misc section] in the Configuration file ).

## Dynamic UserID Loading for Luna Cloud HSM Services

The UC Dynamic Loading feature is introduced in Luna HSM Client 10.5.0 for Luna Cloud HSM services. This allows each User Account and Authentication (UAA) user to have the ability to have one or more partition(s) associated with them. The DPoD tenant role can now configure multiple UAA Users and manage them in one place instead of managing each one separately. This will also allow customers to add multiple UserID's (combination of unique authtokenclientsecret, authtokenclientid and URI) without the need to restart the application after the addition of a new UserID.

The ability to load multiple partitions to the same UserID without impacting service to other users is also supported. If an attempt is made to add the same partition ID to a different user that will be ignored and a warning log will be generated.

When a new configuration is added, running the "slot list" command will display the new partition ID for that user.

**NOTE** The maximum amount of users to be added using the "MaxUserIDCount" variable is defaulted at 100. Multiple partitions for the same user will **NOT** have a sequential slot ID.

### In Linux:

```
export AuthtokenConfigURI2=***********
export AuthTokenClientID2=**********
export AuthTokenClientSecret2=***********

export AuthtokenConfigURI3=***********
export AuthTokenClientID3=**********
export AuthTokenClientSecret3=***********
```

### In Windows:

```
set var=AuthTokenConfigURI2=***********
set var=AuthTokenClientID2=**********
set var=AuthTokenClientSecret2=***********

set var=AuthTokenConfigURI3=***********
set var=AuthTokenClientID3=**********
set var=AuthTokenClientSecret3=***********
```

# Updating the Luna HSM Client Software

To update the Luna HSM Client software, first uninstall any previous version of the Client. Then, run the new installer the same way you performed the original installation (refer to "Luna HSM Client Software Installation" on page 20).

The client uninstaller removes libraries, utilities, and other material related to the client, but does not remove configuration files and certificates. This allows you to install the newer version and resume operations without having to manually restore configuration settings and re-register client and appliance NTLS certificates.

> **TIP** Thales recommends verifying the integrity of the Luna HSM Client packages, by calculating their SHA256 hash values and comparing with the hash values posted on the Support Portal, before installing them on your client machines.
>
> You can use the sha256sum tool on Linux machines to calculate the SHA256 hash values.

# CHAPTER 3: Secure Transport Mode

Luna HSM 7 units are shipped from the factory in Secure Transport Mode (STM). The purpose of STM is to provide a logical check on the HSM 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.

The Secure Transport Mode capability provides an additional layer of protection beyond the physical security controls provided by tamper-evident shipping bags.

Thales sends customers control validation information in two separate emails prior to shipment:

> **Physical security control validation** - an email containing the serial number of the HSM and the serial number of the associated tamper evident bag that encloses the HSM.

> **Logical control validation** - an email containing the serial number of each HSM in the shipment, along with the STM Random User String and the STM Verification String associated with each HSM.

Customers can use the logical and physical HSM controls to verify that HSMs shipped from the factory have not been modified in transit. The Thales shipping procedures are designed to prevent a possible man-in-the-middle attack, as attackers would need unobserved direct access to the HSM while in transit, along with simultaneous possession of both the STM Random User String and the STM Verification String for that HSM.

Thales customers can also implement STM when shipping pre-configured HSMs between their office locations or when pre-configured HSMs are to be put into storage. Customers implementing STM have added protection because only the HSM Security Officer can place an initialized HSM into STM, or recover the HSM from STM, further increasing the difficulty of man-in-the-middle attacks.

> **CAUTION!** Do not place the HSM into secure transport mode (STM) when there is already an active tamper. Such action would cause a mismatch of the verification string when the HSM is brought out of transport mode. Use hsm tamperclear to clear a tamper, if one is present, before proceeding with STM.

## When STM is enabled on the HSM

1. The HSM generates a random string of 16 characters and presents that as the "Random User String" (suitable for copying and pasting into an e-mail).
2. The HSM gathers several sources of internal information reflecting the state of the HSM at that time, including a random nonce value generated for this purpose; the nonce value is not displayed, and never exists outside the HSM.
3. The HSM combines these items (the generated Random User String, the HSM state information, and the random nonce value), and produces the Verification String (suitable for copying and pasting into an e-mail).
4. The HSM then enters Secure Transport Mode, such that only limited operations are allowed until the HSM is brought out of STM.

5. The HSM can now be shipped from the factory to customers, or customers can place the HSM into storage or ship securely to another location. The HSM and the STM strings should not come together until they are in the possession of the intended recipient.

### STM verification email

As part of the delivery process for your new HSM, Thales Client Services will send you an email containing two 16-digit strings: a **Random User String** and a **Verification String**. You require these strings to verify that your HSM has not been altered while in transit.

> **NOTE** If the STM verification process fails due to a lost or incorrect verification string, customers do have the option of proceeding with the recovery of the HSM from STM mode. If the STM verification process fails due to a tamper, customers can also choose to factory-reset the HSM to bring it back to a Factory state, and then re-initialize.
>
> Refer to the **CAUTION** notes below to avoid inadvertently causing a spurious STM recovery failure that would mask whether a real event had occurred.

For information about the various tamper events, see "Tamper Events" on page 143.

## Recovering an HSM From Secure Transport Mode

Only the HSM SO can recover an initialized HSM that has been placed into STM. When the HSM is zeroized, HSM SO log in is not required.

### New HSMs

New HSMs are shipped from the factory in Secure Transport Mode (STM). You must recover from STM before you can initialize the HSM. As part of the delivery of your new HSM, you should have received an email from Thales Client Services containing two 16-digit strings:

> Random User String: XXXX-XXXX-XXXX-XXXX

> Verification String: XXXX-XXXX-XXXX-XXXX

### To recover an HSM from STM

1. Ensure that you have the two strings that were presented when the HSM was placed into STM, or that were emailed to you if this is a new HSM.
2. If the HSM is initialized, log in as the HSM SO (see "Logging In as HSM Security Officer" on page 127). If this is a new or zeroized HSM, skip to the next step.

   > **CAUTION!** Be very careful entering the HSM SO authentication. A single failed attempt increments a counter that results in a change of the generated comparison string, which will cause STM verification to fail during Secure Transport Mode recovery.

3. Recover from STM, specifying the random user string that was displayed when the HSM was placed in STM, or that was emailed to you if this is a new HSM:

   lunacm:> **stm recover -randomuserstring** <XXXX-XXXX-XXXX-XXXX>

> **NOTE** The random user string is for verification purposes only. If you do not require STM validation, or you wish to bypass the STM validation, you can enter a different string to proceed with the recovery of the HSM from STM mode.

4. You are presented with a verification string. **Visually compare** the string with the original verification string that was sent via e-mail (or other means).

   If the string matches the original verification string, the HSM has not been used or otherwise altered since STM was enabled, and can be safely re-deployed.

   Enter **proceed** to recover from STM.

### If the verification strings do not match

1. Reconfirm that you have entered the correct random user string for your HSM. Enter **quit** if you want to enter the string again.
2. If the verification strings still do not match:
   - If this is a new HSM, enter **quit** to leave the HSM in Secure Transport Mode, and contact Thales Technical Support.
   - Otherwise, if you feel that the verification failure was benign, enter **proceed** to release the HSM from Secure Transport Mode, and decide to either:
     - proceed with using the HSM
     - perform a factory reset and re-initialize the HSM as a safety precaution before proceeding further.

## Placing an HSM In Secure Transport Mode

Only the HSM SO can place an initialized HSM into STM. When the HSM is zeroized, HSM SO log in is not required.

> **CAUTION!** Using Luna HSM Firmware 7.7.1-20 or older, before placing a multifactor quorum-authenticated HSM in Secure Transport Mode, ensure that CO, LCO and CU roles are deactivated, using role deactivate with each role name. For Luna Network HSM 7s, roles must be deactivated for all partitions, from LunaCM in a connected client. Failure to do so can result in mismatch when the generated strings are later compared during Secure Transport Mode recovery.
>
> Using Luna HSM Firmware 7.7.2 or newer, this is not necessary, because placing the HSM in STM logs out and deactivates those roles, and prevents auto-reactivation. The sessions can be logged in and reactivated manually.

### To place an HSM into Secure Transport Mode

1. Log in as the HSM SO (see "Logging In as HSM Security Officer" on page 127).
2. Back up the contents of all application partitions.

   See Partition Backup and Restore for details.
3. Enter the following command to place the HSM into STM:

   lunacm:> **stm transport**

4. After confirming the action, you are presented with:
   - **Verification String:** <XXXX-XXXX-XXXX-XXXX>
   - **Random User String:** <XXXX-XXXX-XXXX-XXXX>

   Record both strings. They are required to verify that the HSM has not been altered while in STM.

> **CAUTION!** Transmit the verification string and random user string to the receiver of the HSM using a secure method, distinct from the transport of the physical HSM, so that it is not possible for an attacker to have access to both the HSM and the verification codes while the HSM is in STM.

> **TIP Why do my STM verification codes not match?**
>
> Be careful when resuming use of an HSM after transport. A single failed SO login attempt changes the state of the HSM firmware, because it increments the counter that tracks the number of login attempts remaining. The HSM uses the changed state when it calculates the verification code.
>
> That will cause a mismatch when you compare STM values.
>
> Entering an invalid PIN or Password is not covered by warranty, and is not cause for RMA.
>
> Before assuming that an attack has occurred, please review the logs.
>
> The above is also why you must deactivate partitions on a multi-factor quorum authenticated (PED) HSM before invoking STM and powering off. If the HSM has partitions that are Activated, and it is powered off for more than two hours, the partitions become deactivated, which makes a change in the firmware (activated state to deactivated state), again changing the calculated verification string.

# CHAPTER 4: Multifactor Quorum Authentication

The Luna USB HSM 7 can be initialized to use multifactor quorum authentication for all roles on the HSM. The authentication secrets are stored on USB iKeys, and are presented by inserting them directly into the Luna USB HSM 7. This means that the iKeys and direct access to the Luna USB HSM 7 are the only method of accessing the HSM's administrative functions. This prevents key-logging exploits on workstations connected to the client HSM, because authentication takes place entirely within the device itself. No password is entered via computer keyboard.

This section contains the following information about Luna USB HSM 7 multifactor quorum authentication:



## Multifactor Quorum Authentication Architecture

The multifactor quorum authentication architecture consists of the following components:

> Luna USB HSM 7**:** Role secrets stored on iKeys are presented directly to the Luna USB HSM 7 by connecting them to the USB-C input.

> **Authentication secrets:** Cryptographic secrets generated by the HSM and stored on iKeys. 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.

> **iKeys:** physical USB-connected devices that contain authentication secrets, created by the HSM (see "iKeys" on the next page). iKeys have the following custom authentication features:

- **Shared Secrets:** iKeys of the same type can be reused or shared among HSMs or partitions, allowing domain sharing (necessary for backup configurations) and other custom configurations. See "Shared iKey Secrets" on page 84.
- **iKey PINs:** optional PINs associated with specific iKeys, set by the owner of the iKey at the time of creation. iKey PINs offer an extra layer of security for iKeys which could be lost or stolen. See "iKey PINs" on page 85.

- **M of N Split Key Scheme:** optional configuration which allows a role to split its authentication secret across multiple iKeys, 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 "M of N Split Secrets (Quorum)" on page 85.

## 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<br>> For backup/restore, knowledge of partition domain password is sufficient | > Ownership of the black Crypto Officer iKey is mandatory<br>> For backup/restore, ownership of both black CO and red domain iKeys is mandatory<br>> The Crypto User role is available to restrict access to read-only, with no key management authority<br>> Option to associate a PIN with any iKey, imposing a two-factor authentication requirement on any role |
| **Dual Control** | > Not available | > 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 |
| **Key-custodian responsibility** | > Password knowledge only | > Linked to partition password knowledge<br>> Linked to black iKey(s) ownership and optional PIN knowledge |
| **Two-factor authentication for remote access** | > Not available | > Remote PED and orange (Remote PED Vector) iKey deliver highly secure remote management of HSM, including remote backup |

# iKeys

The iKey is a USB authentication device, embedded in a molded plastic body. It 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 USB HSM 7 does not hold the authentication secrets. They reside only on the portable iKeys.

iKeys are created when an HSM, partition, or role is initialized. Each iKey can contain only one authentication secret at a time, but it can be overwritten with a new authentication secret. See "iKey Management Using Luna USB HSM 7" on page 86.

> **CAUTION!** Do not subject iKeys to extremes of temperature, humidity, dust, or vibration. Use the included key cap to protect the USB connector.

## iKey Types and Roles

Once initialized for multifactor quorum authentication, the Luna USB HSM 7 uses iKeys for all credentials. You can apply the appropriate labels included with your iKeys, according to the table below, as you create them.

The iKey colors correspond with the HSM roles described in "HSM Roles" on page 126 and Partition Roles. The following table describes the keys associated with the various roles:

| Lifecycle | iKey | 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.<br>**Mandatory** |
| | **Red**<br>  | HSM Domain or Key Cloning Vector | Cryptographically defines the set of HSMs that can participate in cloning for backup. See "Domain iKeys" on page 85.<br>**Mandatory** |
| HSM Auditing | **White**<br>  | Auditor (AU) secret | Authenticates the Auditor role, responsible for audit log management. This role has no access to other HSM services.<br>**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.<br>**NOTE:** If you want the HSM SO to also perform Partition SO duties, you can use the same blue key to initialize both roles.<br>**Mandatory** |
| | **Red**<br>  | Partition Domain or Key Cloning Vector | Cryptographically defines the set of partitions that can participate in cloning for backup or high-availability. See "Domain iKeys" on page 85.<br>**Mandatory** |

| Lifecycle | iKey | Secret | Function |
|---|---|---|---|
| Partition Operation | **Black**<br>  | 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.<br>**Mandatory** |
| | **Gray**<br>  | 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.<br>**Optional (used in eIDAS-compliant schemes)** |
| | **Gray**<br>  | 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.<br>**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.<br>**Optional** |

**NOTE** 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 iKeys.

## Shared iKey Secrets

The Luna USB HSM 7 identifies the type of authentication secret on an inserted iKey, 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 iKey(s) to authenticate multiple HSMs or partitions. This is useful for:

- 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 iKeys" 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 iKey secret to authenticate multiple roles, HSMs, or partitions is less secure than giving each its own iKey. Refer to your organization's security policy for guidance.

**Domain iKeys**

A red domain iKey holds the key-cloning vector (the domain identifier) that allows key cloning between HSMs and partitions, and is therefore the iKey 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 the 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 or partition.

## iKey PINs

The Luna USB HSM 7 allows the holder of a iKey to set a numeric PIN, 4-48 characters long, to be associated with that iKey. This PIN must then be entered on the touchscreen for all future authentication. The PIN provides two-factor authentication and ensures security in case an iKey is lost or stolen. If you forget your PIN, it is the same as losing the iKey entirely; you cannot authenticate the role.

PINs can be set only at the time of key creation, and can be changed only by changing the secret on the iKey. Duplicate keys are true copies with the same PIN, intended as backups for one person (see "Duplicating an Existing iKey Using Luna USB HSM 7" on page 92). Duplicates of the iKey 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 iKeys" on page 90.

## M of N Split Secrets (Quorum)

The Luna USB HSM 7 can split an authentication secret among multiple 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.

This can be likened to a club 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 between 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 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 scenario, the HSM SO authentication secret is split among five blue iKeys, and at least three of those keys must be presented to the Luna USB HSM 7 to log in as HSM SO.

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 an 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 recommended only when you want multiple people to access the role, each with their own unique iKey PIN.

> **NOTE** Using an M of N split secret can greatly increase the number of iKeys you require. Ensure that you have enough blank or rewritable iKeys on hand before you begin initializing your M of N scheme.

**Activated Partitions and 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 iKey (see Activation and Auto-activation on Multifactor Quorum-Authenticated Partitions). 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 iKeys) before normal operations can resume.

# iKey Management Using Luna USB HSM 7

Once you have connected your Luna USB HSM 7 to a workstation and installed Luna HSM Client, you can proceed with initializing roles on the HSM using multifactor quorum authentication. The procedures in this section will guide you through the touchscreen prompts at each stage of iKey creation, authentication, and other iKey operations with the Luna USB HSM 7.



## Creating iKey Using Luna USB HSM 7

When you initialize an HSM, partition, or role, the Luna USB HSM 7 issues a series of prompts for you to follow to create your iKeys. iKey actions have a timeout setting (default: 120 seconds); ensure that you have everything you need before issuing an initialization command. The requirements for the operation depend on the iKey scheme you have chosen in advance, based on your organization's security policy. Consider these guidelines before you begin:

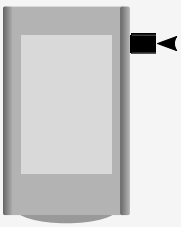
> If you are reusing an existing iKey or keyset, the owners of those keys must be present with their iKey and PINs ready.

> 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. It is advisable for each iKey holder to create backup duplicates, so you must have a sufficient number of blank or rewritable iKeys ready before you begin.

> If you plan to make backup duplicates of iKeys, you must have a sufficient number of blank or rewritable iKeys ready.

> If you plan to use PINs, ensure that they can be privately entered on the Luna USB HSM 7 and memorized, or written down and securely stored.

**NOTE** Whenever the Luna USB HSM 7 prompts you to insert an iKey, use the USB-C adapter in the USB port on the right side of the Luna USB HSM 7:



### To initiate iKey creation

1. Issue one of the following LunaCM commands to initialize the applicable role, domain, or vector.
   - **Blue HSM SO and Red HSM Domain Keys**:

     lunacm:> **hsm init -label** <label> **-iped**
   - **Orange Remote iKey**:

     lunacm:> **ped vector init**
   - **Blue Partition SO and Red Partition Domain iKeys**:

     lunacm:> **partition init**
   - **Black Crypto Officer iKey**:

     lunacm:> **role init -name co**
   - **Gray Limited Crypto Officer iKey**

     lunacm:> **role init -name lco**
   - **Gray Crypto User iKey**:

     lunacm:> **role init -name cu**
   - **White Audit User iKey**:

     lunacm:> **role init -name au**
2. Follow the touchscreen prompts in the following four stages.

### Stage 1: Reusing Existing iKeys

If you want to use an iKey or quorum of iKeys with an existing authentication secret, have them ready to present to the HSM. Reasons for reusing iKeys may include:

- You want to use the same iKey to authenticate multiple HSMs/partitions
- You want to initialize a partition in an already-existing cloning domain (to allow cloning of cryptographic objects between partitions)

> **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 iKey Secrets" on page 84 and "Domain iKeys" on page 85 for more information.

The first touchscreen prompt asks if you want to create a new quorum of iKeys or reuse an existing quorum. Make your selection and follow the instructions on the touchscreen. If you are creating a new quorum, go to "Stage 2: Defining M of N" below.

### Stage 2: Defining M of N

If you chose to create a new keyset, the Luna USB HSM 7 prompts you to define the M of N scheme (quorum and pool of splits) for the role, domain, or vector. See "M of N Split Secrets (Quorum)" on page 85 for more information. If you do not want to use M of N (authentication by one iKey), enter a value of **1** for both M and N.

For each iKey in the quorum, proceed to "Stage 3: Setting a PIN" below.

### Stage 3: Setting a PIN

If you are creating a new iKey, 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 "iKey PINs" on page 85 for more information.

> **CAUTION!** If you forget your PIN, it is the same as losing the iKey entirely; you cannot authenticate the role. See "Consequences of Losing iKeys" on page 90.

You now have the opportunity to create a duplicate of the new iKey in "Stage 4: Duplicating New iKey" below. If you decline to create a duplicate now, repeat this stage for each new iKey in the quorum.

### Stage 4: Duplicating New iKey

You now have the option to create duplicates of your newly-created iKey(s) in case of key loss or theft.

## Authenticating a Role Using Luna USB HSM 7

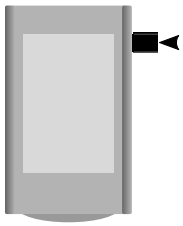
When connected, the Luna USB HSM 7 responds to authentication commands in LunaCM. Commands that require authentication include:

- Role login commands (blue, black, gray, or white iKeys)
- Backup/restore commands (red iKeys)
- Remote PED connection commands (orange iKey)

When you issue a command that requires authentication, the interface returns a message like the following:

```
lunacm:>role login -name po

        Please attend to the PED.
```

Whenever the Luna USB HSM 7 prompts you to insert a iKey, use the USB port on the right side of the Luna USB HSM 7:



> **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" on page 127 or Logging In to the Application Partition.

## To perform multifactor quorum authentication

1. The touchscreen prompts for the corresponding iKey. Insert the iKey (or the first M of N split-secret key) and follow the instructions on the touchscreen.

   ```
   lunacm:>role login -name po

           Please attend to the PED.
   ```

   - 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 USB HSM 7 returns control to the command interface.

     ```
     Command Result : No Error
     ```

2. If a PIN is associated with the iKey, the touchscreen prompts for the PIN.
   - If the key you inserted is an M of N split, continue to step 3.
   - Otherwise, authentication is complete and the Luna USB HSM 7 returns control to the command interface.

     ```
     Command Result : No Error
     ```

3. The touchscreen prompts for the next M of N split-secret key. Insert the next iKey and 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. At this point, authentication is complete and the Luna USB HSM 7 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 iKey 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 iKeys have been presented.

## Consequences of Losing iKeys

iKeys are the only means of authenticating roles, domains, and RPVs on the multifactor quorum-authenticated Luna USB HSM 7. Losing an iKey effectively locks the user out of that role. Always keep secure backups of your iKeys, including M of N split secrets. Forgetting the PIN associated with an iKey is equivalent to losing the iKey entirely. Losing a split-secret iKey is less serious, unless enough splits are lost so that M cannot be satisfied.

If an iKey is lost or stolen, log in with one of your backup keys and change the existing role secret immediately, to prevent unauthorized HSM access.

The consequences of a lost iKey with no backup vary depending on the type of secret:


> "Blue HSM SO iKey" below
> "Red HSM Domain iKey" below
> "Blue Partition SO iKey" on the next page
> "Red Partition Domain iKey" on the next page
> "Black Crypto Officer iKey" on the next page
> "Gray Crypto User iKey" on page 92
> "White Audit User iKey" on page 92


### Blue HSM SO iKey

If the HSM SO secret is lost, you can no longer perform administrative tasks on the HSM, including partition creation and client assignment. The contents of the HSM Admin partition are unrecoverable and you can no longer configure the HSM. Take the following steps:

1. Contact the Crypto Officer and have them immediately make a backup of their existing partition.
2. When all important cryptographic material is backed up, execute a factory reset of the HSM.
3. Initialize the HSM and create a new HSM SO secret.
4. Recreate the application partition.
5. The Partition SO must initialize the new partition using their original blue and red iKey(s), and initialize the Crypto Officer role (and Activation secret, if applicable). Supply the new black CO iKey to the Crypto Officer.
6. The Crypto Officer must change the login credentials from the new black CO iKey to their original black iKeys (and reset the Activation secret password, if applicable).
7. The Crypto Officer can now restore all partition contents from backup.
8. If you are using Remote PED, you must recreate the Remote PED Vector (RPV). You can re-use the original orange iKey.

### Red HSM Domain iKey

If the HSM Key Cloning Vector is lost, you can no longer perform backup/restore operations on the HSM Admin partition. 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.

### Blue Partition SO iKey

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 iKey

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 iKey

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 iKey**
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 iKey**
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 an iKey Secret Using Luna USB HSM 7

You can use this procedure to identify the type of secret (role, domain, or RPV) stored on an unidentified iKey. 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 USB HSM 7 in Admin Mode

> the key you want to identify

**To identify the type of secret stored on the iKey**

1. Insert the iKey you want to identify.
2. Tap the **ADMIN** tab on the touchscreen to enter Admin mode.

   The role secret type is identified on-screen.

## Duplicating an Existing iKey Using Luna USB HSM 7

During the key creation process, you have the option to create multiple copies of iKeys. If you want to make backups of your keys later, you can use this procedure to copy iKeys. You require:

> Luna USB HSM 7 in Admin Mode

> Enough blank or rewritable keys to make your copies

The iKey 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 an 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 M of N keyset. See "M of N Split Secrets (Quorum)" on page 85.

**To duplicate an existing iKey**

1. Insert the iKey you want to duplicate. Have a blank or rewritable iKey ready.
2. Tap the **ADMIN** tab on the touchscreen to enter Admin mode.
3. Tap **Duplicate this iKey** and follow the instructions on the touchscreen.

## Changing an iKey Credential

It may be necessary to change the iKey secret associated with a role. Reasons for changing credentials include:

- Regular credential rotation as part of your organization's security policy
- Compromise of a role due to loss or theft of a iKey
- 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 iKey credential depends on the type of key. Procedures for each type are provided below.

> **CAUTION!** If you are changing an iKey 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 iKey credentials, you must always present the old keyset first; do not overwrite your old iKeys until you have no further need for them.
>
> If you overwrite the original iKey with a new credential and the operation fails, it is possible for the iKey credential to be overwritten while the role remains tied to the old credential. If this happens, all login attempts with the overwritten iKey will fail. Ensure that you keep at least one backup copy of the old iKey credential until the role is successfuly set to a new credential.


- "Blue HSM SO iKey" on page 90
- "Red HSM Domain iKey" on page 90
- "Orange Remote PED Vector iKey" on the next page
- "Blue Partition SO iKey" on page 91
- "Red Partition Domain iKey" on page 91
- "Black Crypto Officer iKey" on page 91
- "Gray Crypto User iKey" on the previous page
- "White Audit User iKey" on the previous page


### Blue HSM SO iKey

The HSM SO can use this procedure to change the HSM SO credential.

**To change the blue HSM SO iKey credential**

1. In LunaCM, set the active slot to the Admin partition and log in as HSM SO.

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

2. Initiate the iKey change.

   lunacm:> **role changepw -name so**

3. You are prompted to present the original blue key(s) and then to create a new HSM SO keyset. See "Creating iKey Using Luna USB HSM 7" on page 86.

### Red HSM Domain iKey

It is not possible to change an HSM's cloning domain without performing a factory reset of 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 iKey

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 log in as HSM SO.

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

2. Initialize the RPV.

   lunacm:> **ped vector init**

   You are prompted to create a new Remote iKey.

3. Distribute a copy of the new orange key to the administrator of each Remote PED server.

### Blue Partition SO iKey

The Partition SO can use this procedure to change the Partition SO credential.

#### To change a blue Partition SO iKey credential

1. In LunaCM, log in as Partition SO.

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

2. Initiate the iKey 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.

### Red Partition Domain iKey

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.

### Black Crypto Officer iKey

The Crypto Officer can use this procedure to change the Crypto Officer credential.

### To change a black Crypto Officer iKey credential

1. In LunaCM, log in as Crypto Officer.

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

2. Initiate the iKey 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.

**Gray Crypto User iKey**

The Crypto User can use this procedure to change the Crypto User credential.

### To change a gray Crypto User iKey credential

1. In LunaCM, log in as Crypto User.

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

2. Initiate the iKey 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.

**White Audit User Key**

The Audit User can use this procedure to change the Audit User credential.

### To change the white Audit User iKey credential

1. In LunaCM, set the active slot to the Admin partition and log in as Auditor.

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

2. Initiate the iKey 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.

# CHAPTER 5: Audit Logging

Each event that occurs on the HSM can be recorded in the HSM event log, allowing you to audit your HSM usage. The HSM event log is viewable and configurable only by the **audit** user role. This **audit** role is disabled by default and must be explicitly enabled.

This chapter describes how to use audit logging to provide security audits of HSM activity. It contains the following sections:



## Audit Logging Features

The following list summarizes the functionality of the audit logging feature:

> Log entries originate from the Luna USB HSM 7 (cryptographic module - the feature is implemented via HSM firmware (rather than in the library), for maximum security.

> Log origin is assured.

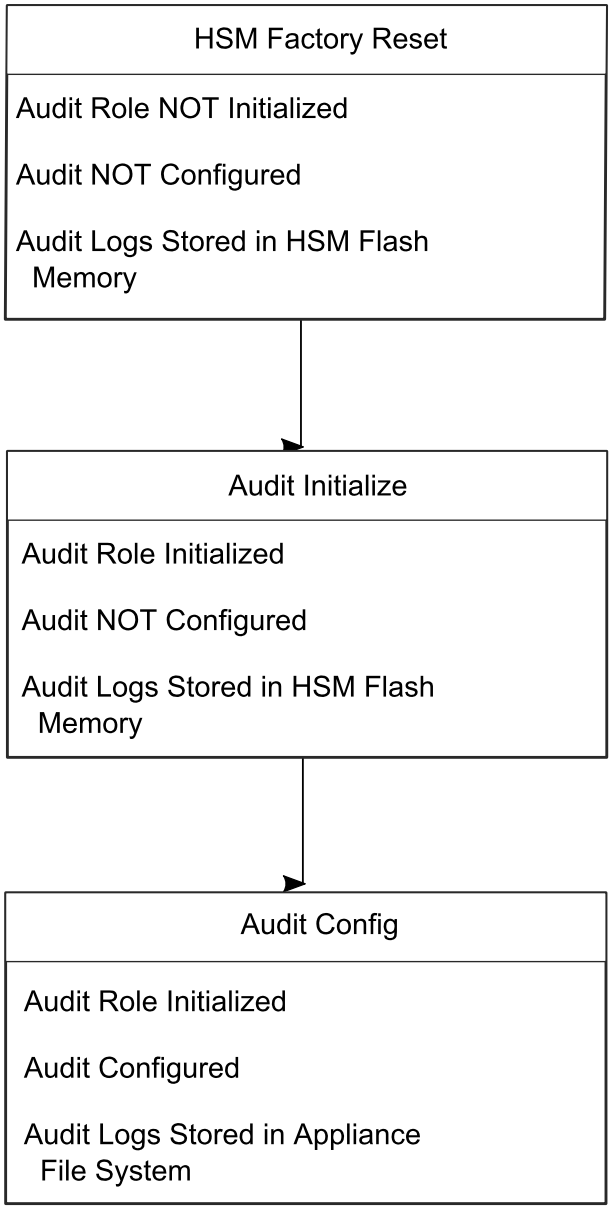
> Logs and individual records can be validated by any Luna USB HSM 7 that is a member of the same domain.

> Audit Logging can be performed on password-authenticated and multifactor quorum-authenticated (both FIPS 140-3 level 3) configurations, but these configurations may not validate each other's logs - see the "same domain" requirement, above.

> **NOTE** The "same domain" requirement still applies, but with the introduction of Extended Domain Management [ see Universal Cloning and Domain Planning ] (Partition Policy 44) in firmware version 7.8.0, you can change/add domains, such that the verifying HSM could be given the same domain as the original logging HSM.
>
> Thus, from Luna HSM firmware version 7.8.0 onward, it is possible
>
> - for a Multifactor Quorum HSM log to be validated by a Password-authenticated HSM or
> - for a Password-authenticated HSM log to be validated by a Multifactor Quorum HSM.

> Each entry includes the following:
>
> - When the event occurred
> - Who initiated the event (the authenticated entity)
> - What the event was
> - The result of the logging event (success, error, etc.)

- Multiple categories of audit logging are supported, configured by the audit role.
- Audit management is a separate role - the role creation does not require the presence or co-operation of the Luna USB HSM 7 SO.
- The category of audit logging is configurable by (and only by) the audit role.
- Audit log integrity is ensured against the following:
  - Truncation - erasing part of a log record
  - Modification - modifying a log record
  - Deletion - erasing of the entire log record
  - Addition - writing of a fake log record
- The following critical events are logged unconditionally, regardless of the state of the audit role (initialized or not):
  - Tamper
  - Decommission
  - Zeroization
  - SO creation
  - Audit role creation




**Note:**

Logs are exported from the HSM's memory to the appliance's hard drive. Only an authenticated Auditor role is allowed to configure or initiate the export function. Therefore, an HSM in the Factory Reset state is ***not*** allowed to export log files from HSM memory to the appliance file system.

**Note:**

"audit log clear" clears logs only from the appliance file system. It does ***not*** affect logs stored in the HSM memory.
Logs move out of HSM memory to the host file system, only when audit log rotation has been configured by the Auditor - so initialize and configure early to avoid log-entry build-up on the HSM.

### Types of events included in the logs

The events that are included in the log is configurable by the audit role. The types of events that can be logged include the following:

- log access attempts (logins)
- log HSM management (init/reset/etc)
- key management events (key create/delete)
- asymmetric key usage (sig/ver)
- first asymmetric key usage only (sig/ver)

- symmetric key usage (enc/dec)
- first symmetric key usage only (enc/dec)
- log messages from CA_LogExternal
- log events relating to log configuration

Each of these events can be logged if they fail, succeed, or both.

### Event log storage

When the HSM logs an event, the log is stored on the HSM. The audit user cannot view these log entries. Before a log can be viewed, it must be rotated. Log rotation saves the log entries on the HSM to the local file system, where they can be viewed. Log records are HMACed using an audit log secret to ensure their authenticity. The audit log secret is unique to the HSM where the log was created, and is required to view the HSM event logs. The secret can be exported, allowing you to view and verify the logs on another HSM.

**TIP** Log entries are stored in the cryptographic module (HSM) until they are rotated off. Log entries are not rotated out of the cryptographic module *until* the audit user is initialized and audit logging is configured. By default, even if there is no audit user or configuration, the cryptographic module logs unconditional events within its own memory, like:

> zeroize
> decommission
> hardware tamper
> card removal
> etc.

If the crypto module internal space ever fills completely with log records,

> whether slowly from unconditional logs, or
> quickly from more voluble high-volume event recording,

...the HSM / cryptographic module would *stop all operations* that were notrole init **-name au** and audit config. The HSM would resume providing service only after the audit user cleared the logs.

To avoid that ever happening, configure audit logging to organize log parameters and handling, being sure to set sufficient frequency of rotation for the volume of record generation that you enable.

**Best practice** is to:

> initialize the audit role as soon as the HSM is first powered on for production role init **-name au**
> configure the log storage path on the external file system, along with the types of events to log, the rotation interval, etc. audit config
> then, initialize the HSM Security Officer (this helps ensure that all messages, demanded by your auditing authority, are captured) hsm init
> then, proceed with partition initialization and usage with your application(s)
> then, *revisit* audit log configuration at regular intervals to tune the balance between
  - desired message types,
  - volume of audited actions normally performed (*),
  - and so on
> when you change behavior of the crypto module or change the types of events to audit, be sure to *revisit also* the rotation interval.

[* Example, you might always want to record the generation of keys, but if usage of those keys is very high-volume (like in some signature use-cases), and thus would generate a high volume of log entries, it might be permissible, and prudent, to log only first-use of any key. Check with the relevant authority.]

### Event logging impacts HSM performance

Each audit log record generated requires HSM resources. Configuring event logging to record most, or all, events may have an impact on HSM performance. You may need to adjust your logging configuration to provide adequate logging without significantly affecting performance. By default, only critical events are logged, imposing virtually no load on the HSM.

## Audit limitations and Controlled tamper recovery state

The following conditions apply when HSM Policy "48: Do controlled tamper recovery" is enabled (default setting).

- Auditor (the Audit role) cannot verify the integrity of audit logs until after recovery from tamper.
- Auditor cannot be initialized when the HSM is in controlled tamper recovery state.
- Existing Audit role can login when in controlled tamper recovery state.
- Existing Audit role cannot make audit config changes when in controlled tamper recovery state.
- Existing Audit role cannot export the audit secret when in controlled tamper recovery state.

## The Audit Role

A Luna USB HSM 7 Audit role allows complete separation of Audit responsibilities from the HSM Security Officer (HSM SO), the Crypto Officer(or User), and other HSM roles. If the Audit role is initialized, the HSM and Partition SOs are prevented from working with the log files, and auditors are unable to perform administrative tasks on the HSM. As a general rule, the Audit role should be created before the HSM Security Officer role, to ensure that all important HSM operations (including those that occur during initialization), are captured.

### Password-authenticated HSMs

For Luna USB HSM 7s with Password Authentication, the auditor role logs into the HSM to perform their activities using a password. After initializing the Audit role on a password-authenticated HSM, log in as the Auditor and set the domain (see role setdomain). This step is required before setting logging parameters or the log filepath, or importing/exporting audit logs.

### Multifactor Quorum-authenticated HSMs

For Luna USB HSM 7s with multifactor quorum authentication, the auditor role logs into the HSM to perform their activities using the Audit (white) iKey.

### Role Initialization

Creating the Audit role (and imprinting the white iKey for multifactor quorum-authenticated HSMs) does not require the presence or cooperation of the HSM SO.

### Audit Role Available Commands

In LunaCM, all commands are visible to the person who launches the utility, and some can be used without specific authentication to the HSM, such as view/show/list commands, which might be classified as "monitoring" functions. Attempts to run operational or administrative commands that need role-specific authentication, without that authentication, result in an error message. The Audit role has a limited set of operations available to it, on the HSM, which constitutes any of the generally accessible monitoring commands, plus everything under the "audit" heading.

```
lunacm:>audit


  The following sub commands are available:

  Command         Short    Description
  ------------------------------------

  verify          v        Verify a block of log messages
```

```
  config          c        Configure audit parameters
  export          e        Read the wrapped log secret from the HSM
  import          m        Import the wrapped log secret to the HSM
  time            t        Sync HSM time to host, or get HSM time
  status          s        Show status of logging subsystem
  logmsg          logm     Write a message to the HSM's log

  Syntax: audit <sub command>


Command Result : No Error
```

Anyone accessing the computer and running LunaCM can see the above commands, but cannot run them if they do not have the "audit" role authentication (password or PED key, as appropriate).

What is important is not the role you can access on the computer (a named user, admin, operator), but the role you can access within the HSM.

## Audit Log Secret

The HSM creates a log secret unique to the HSM, computed during the first initialization after manufacture. The log secret resides in flash memory (permanent, non-volatile memory), and is used to create log records that are sent to a log file. Later, the log secret is used to prove that a log record originated from a legitimate HSM and has not been tampered with.

### Log Secret and Log Verification

The 256-bit log secret which is used to compute the HMACs is stored in the parameter area on the HSM. It is set the first time an event is logged. It can be exported from one HSM to another so that a particular sequence of log messages can be verified by the other HSM. Conversely, it can be imported from other HSMs for verification purpose.

To accomplish cross-HSM verification, the HSM generates a key-cloning vector (KCV, a.k.a. the Domain key) for the audit role when it is initialized. The KCV can then be used to encrypt the log secret for export to the HOST.

To verify a log that was generated on another HSM, assuming it is in the same domain, we simply import the wrapped secret, which the HSM subsequently decrypts; any records that are submitted to the host for verification will use this secret thereafter.

When the HSM exports the secret, it calculates a 32-bit checksum which is appended to the secret before it is encrypted with the KCV.

When the HSM imports the wrapped secret, it is decrypted, and the 32-bit checksum is calculated over the decrypted secret. If this doesn’t match the decrypted checksum, then the secret that the HSM is trying to import comes from a system on a different domain, and an error is returned.

To verify a log generated on another HSM, in the same domain, the host passes to the target HSM the wrapped secret, which the target HSM subsequently decrypts; any records submitted to the target HSM for verification use this secret thereafter.

Importing a log secret from another HSM does not overwrite the target log secret because the operation writes the foreign log secret only to a separate parameter area for the wrapped log secret.

> **CAUTION!** Once an HSM has imported a wrapped log secret from another HSM, it must export and then re-import its own log secret in order to verify its own logs again.

## Audit Log Records

A log record consists of two fields – the log message and the HMAC for the previous record. When the HSM creates a log record, it uses the log secret to compute the SHA256-HMAC of all data contained in that log message, plus the HMAC of the previous log entry. The HMAC is stored in HSM flash memory. The log message is then transmitted, along with the HMAC of the previous record, to the host. The host has a logging daemon to receive and store the log data on the host hard drive.

For the first log message ever returned from the HSM to the host there is no previous record and, therefore, no HMAC in flash. In this case, the previous HMAC is set to zero and the first HMAC is computed over the first log message concatenated with 32 zero-bytes. The first record in the log file then consists of the first log message plus 32 zero-bytes. The second record consists of the second message plus HMAC1 = HMAC (message1 || 0x0000). This results in the organization shown below.

| | |
|---|---|
| MSG 1 | HMAC 0 |
| | . . . |
| MSG n-1 | HMAC n-2 |
| MSG n | HMAC n-1 |
| . . . | |
| MSG n+m | HMAC n+m-1 |
| MSG n+m+1 | HMAC n+m |
| . . . | |
| MSG end | HMAC n+m-1 |

| | |
|---|---|
| Recent HMAC in NVRAM | HMAC end |

To verify a sequence of *m* log records which is a subset of the complete log, starting at index *n*, the host must submit the data illustrated above. The HSM calculates the HMAC for each record the same way as it did when the record was originally generated, and compares this HMAC to the value it received. If all of the calculated HMACs match the received HMACs, then the entire sequence verifies. If an HMAC doesn't match, then the associated record and all following records can be considered suspect. Because the HMAC of each message depends on the HMAC of the previous one, inserting or altering messages would cause the calculated HMAC to be invalid.

The HSM always stores the HMAC of the most-recently generated log message in flash memory. When checking truncation, the host would send the newest record in its log to the HSM; and, the HSM would compute the HMAC and compare it to the one in flash. If it does not match, then truncation has occurred.

## Audit Log Message Format

Each message is a fixed-length, comma delimited, and newline-terminated string. The table below shows the width and meaning of the fields in a message.

| Offset | Length (Chars) | Description |
|---|---|---|
| 0 | 10 | Sequence number |
| 10 | 1 | Comma |
| 11 | 17 | Timestamp |
| 28 | 1 | Comma |
| 29 | 256 | Message text, interpreted from raw data |
| 285 | 1 | Comma |
| 286 | 64 | HMAC of previous record as ASCII-HEX |
| 350 | 1 | Comma |
| 351 | 96 | Data for this record as ASCII-HEX (raw data) |
| 447 | 1 | Newline '\n' |

The raw data for the message is stored in ASCII-HEX form, along with a human-readable version. Although this format makes the messages larger, it simplifies the verification process, as the HSM expects to receive raw data records.

### Example

The following example shows a sample log record. It is separated into multiple lines for readability even though it is a single record. Some white spaces are also omitted.

```
38,12/08/13 15:30:50,session 1 Access 2147483651:22621 operation LUNA_CREATE_CONTAINER
returned LUNA_RET_SM_UNKNOWN_TOSM_STATE(0x00300014) (using PIN (entry=LUNA_ENTRY_DATA_AREA)),
29C51014B6F131EC67CF48734101BBE301335C25F43EDF8828745C40755ABE25,
2600001003600B00EA552950140030005D5800000300008001000000000000000000000000000000000000
```

The sequence number is “`38`”. The time is “`12/08/13 15:30:50`”.

The log message is “`session 1 Access 2147483651:22621 operation LUNA_CREATE_CONTAINER returned LUNA_RET_SM_UNKNOWN_TOSM_STATE(0x00300014) (using PIN (entry=LUNA_ENTRY_DATA_AREA))`”.

In the message text, the “who” is the session identified by “`session 1 Access 2147483651:22621`” (the application is identified by the access ID major = 2147483651, minor = 22621).

The “what” is “`LUNA_CREATE_CONTAINER`”.

The operation status is “`LUNA_RET_SM_UNKNOWN_TOSM_STATE(0x00300014)`”.

The HMAC of previous record is “`29C51014B6F131EC67CF48734101BBE301335C25F43EDF8828745C40755ABE25`”.

The remainder is the raw data for this record as ASCII-HEX.

- The “who” is LunaSH session “session 1 Access 2147483651:22621” (identified by the lunash access ID major = 2147483651, minor = 22621).
- The “what” is “LUNA_CREATE_CONTAINER”.
- The operation status is “LUNA_RET_SM_UNKNOWN_TOSM_STATE(0x00300014)”.

## Timestamping

The HSM has an internal real-time clock (RTC). The RTC does not have a relevant time value until it is synchronized with the HOST system time. Because the HSM and the host time could drift apart over time, periodic re-synchronization is necessary. Only an authenticated Auditor is allowed to synchronize the time.

### Time Reported in Log

When you perform **audit time get**, you might see a variance of a few seconds between the reported HSM time and the Host time. Any difference up to five seconds should be considered normal, as the HSM reads new values from its internal clock on a five-second interval. So, typically, Host time would show as slightly ahead.

## Log Capacity

The normal function of Audit logging is to export log entries constantly to the host file system. Short-term, within-the-HSM log storage capacity becomes important only in the rare situations where the HSM remains functioning but the file system is unreachable from the HSM.

### LOG FULL condition

If you receive CKR_LOG_FULL, the log capacity has been reached, and all HSM operations will stop. This is to prevent the HSM from performing unlogged operations. In this condition, most HSM commands will not work; only commands that allow the Auditor to log in, clear the log storage, set the logging configuration, or reset the HSM to factory conditions are permitted.

See the later steps in "Configuring Audit Logging" on page 109 for the procedure.

## Configuration Persists Unless Factory Reset is Performed

Audit logging configuration is not removed or reset upon HSM re-initialization or a tamper event. Factory reset or HSM decommission will remove the Audit user and configuration. Logs must be cleared by specific command. Therefore, if your security regime requires decommission at end-of-life, or prior to shipping an HSM, then explicit clearing of HSM logs should be part of that procedure.

This is by design, as part of separation of roles in the HSM. When the Audit role exists, the HSM SO cannot modify the logging configuration, and therefore cannot hide any activity from auditors.

# Audit Logging General Advice and Recommendations

The Security Audit Logging feature can produce a significant volume of data. It is expected, however, that Audit Officers will configure it properly for their specific operating environments. The data produced when the feature has been properly configured might be used for a number of reasons, such as:

- Reconstructing a particular action or set of actions (forensics)
- Tracing the actions of an application or individual user (accounting)
- Holding a specific individual accountable for their actions (non-repudiation)

That last point represents the ultimate conclusion of any audit trail – to establish an irrefutable record of the chain of events leading up to a particular incident for the purpose of identifying and holding accountable the individual responsible. Not every organization will want to use security audit to meet the strict requirements of establishing such a chain of events. However, all security audit users will want to have an accurate representation of a particular sequence of events. To ensure that the audit log does contain an accurate representation of events and that it can be readily interpreted when it is reviewed, these basic guidelines should be followed after the audit logging feature has been properly configured:

- Use a shell script to execute the lunacm:> **audit time sync** command at least once every 24 hours, provided the host has maintained its connection(s) to its configured NTP server(s).
  For newer firmware versions, that have HSM Policy **57 - Allow sync with host time**, you can initialize the time on the HSM, then set the policy on, to automatically sync the HSM with the local host every 24 hours.
- Do not allow synchronization with the host's clock if the host has lost connectivity to NTP. This ensures that the HSM's internal clock is not set to a less accurate time than it has maintained internally. In general, the HSM's RTC will drift much less than the host's RTC and will, therefore, be significantly more accurate than the host in the absence of NTP.
- Review logs at least daily and adjust configuration settings if necessary. It is important that any anomalies be identified as soon as possible and that the logging configuration that has been set is effective.
- The audit log records are comma-delimited. We recommend that full use be made of the CSV formatting to import records into a database system or spreadsheet tool for analysis, if an SIEM system is not available.
- The ASCII hex data representing the command and returned values and error code should be examined if an anomaly is detected in log review/analysis. It may be possible to match this data to the HSM's dual-port data. The dual-port, if it is available, will contain additional data that could be helpful in establishing the context surrounding the anomalous event. For example, if an unexpected error occurs it could be possible to identify the trace through the firmware subsystems associated with the error condition. This information would be needed to help in determining if the error was unexpected but legitimate or if it was forced in an attempt to exploit a potential weakness.

An important element of the security audit logging feature is the 'Log External' function. See Audit Logging for more information. For applications that cannot add this function call, it is possible to use lunacm:> **audit logmsg** within a startup script to insert a text record at the time the application is started.

> **NOTE** Audit log and syslog entries are timestamped in UTC format.

## Disk Full

In the event that all the audit disk space is used up, audit logs are written to the HSM's small persistent memory. When the HSM's persistent memory is full, normal crypto commands will fail with "disk full" error.

To resolve that situation, the audit user must:

1. Archive the audit logs on the host side.
2. Move the audit logs to some other location for safe storage.
3. Clear the audit log directory.

4. Restart the logger daemon (**PEDclient**).

   > **pedclient mode stop**

   > **pedclient mode start**

To prevent the "disk full" situation, we recommend that the audit user routinely archive the audit logs and clear the audit log directory.

**TIP** Log entries are stored in the cryptographic module (HSM) until they are rotated off. Log entries are not rotated out of the cryptographic module *until* the audit user is initialized and audit logging is configured. By default, even if there is no audit user or configuration, the cryptographic module logs unconditional events within its own memory, like:

> zeroize
> decommission
> hardware tamper
> card removal
> etc.

If the crypto module internal space ever fills completely with log records,

> whether slowly from unconditional logs, or
> quickly from more voluble high-volume event recording,

...the HSM / cryptographic module would *stop all operations* that were notrole init **-name au** and audit config. The HSM would resume providing service only after the audit user cleared the logs.

To avoid that ever happening, configure audit logging to organize log parameters and handling, being sure to set sufficient frequency of rotation for the volume of record generation that you enable.

**Best practice** is to:

> initialize the audit role as soon as the HSM is first powered on for production role init **-name au**
> configure the log storage path on the external file system, along with the types of events to log, the rotation interval, etc. audit config
> then, initialize the HSM Security Officer (this helps ensure that all messages, demanded by your auditing authority, are captured) hsm init
> then, proceed with partition initialization and usage with your application(s)
> then, *revisit* audit log configuration at regular intervals to tune the balance between
  - desired message types,
  - volume of audited actions normally performed (*),
  - and so on
> when you change behavior of the crypto module or change the types of events to audit, be sure to *revisit also* the rotation interval.

[* Example, you might always want to record the generation of keys, but if usage of those keys is very high-volume (like in some signature use-cases), and thus would generate a high volume of log entries, it might be permissible, and prudent, to log only first-use of any key. Check with the relevant authority.]

# Configuring and Using Audit Logging

This section describes the procedures required to enable audit logging, configure it to specify what is logged and how often the logs are rotated, and how to copy, verify and read the audit logs. It contains the following information:

> "Configuring Audit Logging" below
> "Exporting the Audit Logging Secret and Importing to a Verifying HSM" on the next page
> "Audit Role Authentication Considerations" on page 112

## Configuring Audit Logging

Configure audit logging using the LunaCM **audit** commands.

**To configure audit logging:**

1. Configure the Luna USB HSM 7 host computer to use network time protocol (NTP).
2. Set the slot focus to the HSM administrative partition of the desired HSM:

   lunacm:> **slot set -slot** <slotnum>
3. Initialize the Auditor role (you can also use the shortcut **au**). Specify a password if the HSM will be initialized to use password authentication. If you do not specify a password, multifactor quorum authentication will be used:

   lunacm:> **role init -name Auditor** [**-password** <password>]

   If you chose multifactor quorum authentication, you are referred to the touchscreen, which prompts for a white iKey.
4. Now that the Auditor role exists on the HSM, the auditing function must be configured. However, before you can configure you must log in as the Auditor user (you can also use the shortcut **au**):

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

   - On password-authenticated HSMs, you are prompted to enter the password for the Auditor user.
   - On multifactor quorum-authenticated HSMs, you are referred to the touchscreen, which prompts for the white iKey for the Auditor user.
5. Set the domain for the Audit role:

   lunacm:> **role setdomain**
6. Synchronize the HSM's clock with the host time (which should also be synchronized with the NTP server) so that all subsequent log records will have a valid and accurate timestamp.

   lunacm:> **audit time sync**
7. Set the filepath where log files are to be saved. You must complete this step before you can start event logging.

   lunacm:> **audit config path** <filepath>

   If you previously configured logging on the HSM and then made changes to your configuration that made that path invalid (such as deleting the path outside of LunaCM or reinstalling the HSM in a different host system), set a valid log path by running **audit config path** before restarting event logging. If the log path is set incorrectly, logs will be stored in the HSM's limited memory and not exported to the file system. Event logs may be lost if the HSM's memory runs out.
8. Configure audit logging to specify what you want to log. You can specify the level of audit appropriate for needs of the organization's policy and the nature of the application(s) using the HSM:

   lunacm:> **audit config evmask** <event_value>

> **NOTE** Before you configure audit logging, we suggest using **audit config ?** to see all the available options in the configuration process.

Security audits can generate a very large amount of data, which consumes HSM processing resources, host storage resources, and makes the job of the Auditor quite difficult when it comes time to review the logs. For this reason, ensure that you configure audit logging such that you capture only relevant data, and no more.

For example, the **First Symmetric Key Usage Only** or **First Asymmetric Key Usage Only** category is intended to assist Auditors to capture the relevant data in a space-efficient manner for high processing volume applications. On the other hand, a top-level Certificate Authority would likely be required, by policy, to capture all operations performed on the HSM but, since it is typically not an application that would see high volumes, configuring the HSM to audit all events would not impose a significant space and/or performance premium in that situation.

As a further example, the command **audit config evmask all** will log everything the HSM does. This might be useful in some circumstances, but will quickly fill up log files.

9. Configure audit logging to specify how often you want to rotate the logs. Log entries are made within the HSM, and are written to the currently active log file. When a log file reaches the rotation trigger, it is closed, and a new file gets the next log entry. The number of log files grows according to the logging settings and the rotation schedule that you configured. At any time, you can copy files to a remote computer and then clear the originals from the HSM, if you wish to free the space.

   a. Specify the rotation interval. You can rotate the logs hourly, daily, weekly, monthly, or never.

      lunacm:> **audit config interval** <value>

   b. Specify the maximum log file size. When the log reaches the maximum size, it is automatically rotated, regardless of rotation interval:

      lunacm:> **audit config size** <size>

   For example, the commands **audit config interval daily** and **audit config size 4m** would rotate the logs every day, unless they reached a size of 4 Mb first, in which case they would be rotated automatically. The daily rotation would still occur.

   > **CAUTION!** This step is very important. If you do not configure the log rotation correctly, logs are stored on the HSM and have nowhere to go. If the logs fill up all available space on the HSM, most operations will fail with CKR_LOG_FULL, and cryptographic services will be interrupted.

   See **audit config** for additional examples.

## Exporting the Audit Logging Secret and Importing to a Verifying HSM

You can export the audit log secret from one HSM and import it to another to allow the first HSM's logs to be viewed and verified on the second. The HSMs must share the same authentication method and Audit cloning domain (password string or red iKey). You can verify logs from a Luna PCIe HSM 7 using a Luna Network HSM 7, and vice-versa.

### To export the Audit Logging secret from the HSM and import to the verifying HSM

1. Export the audit logging secret to the user local directory. The file is written to the subdirectory specified by a previous **audit config path** command.

   lunacm:> **audit export file** <filename>

2. Exit LunaCM and list the contents of the **lunalogs** directory to see the filename of the wrapped log secret:

| | |
|---|---|
| **Linux** | **ls** <client_install_dir>**/lunalog**<br>`123456 7001347 123456.lws` |
| **Windows** | **dir** <client_install_dir>**\lunalog**<br>`04/12/2017 03:56 PM <DIR> 123456`<br>`04/05/2017 02:35 PM <DIR> 7001347`<br>`04/05/2017 02:35 PM 48 123456.lws` |

3. Transfer the logging secret to the HSM that will verify the logs. If you are verifying the logs with another locally-installed Luna USB HSM 7, skip this step.

   - If you are planning to verify logs with a Luna USB HSM 7, use **pscp** or **sftp** to transfer the logging secret to the appliance. Provide the audit user's credentials when prompted.

     <client_install_dir>:>**pscp** <log_secret_file> **audit@**<hostname_or_IP>**: .**

   - If you are planning to verify logs with a Luna USB HSM 7 installed in a different host computer, you can use **sftp**, **pscp**, or other secure means to transfer the logging secret.

     <client_install_dir>:>**pscp** <log_secret_file> <user>**@**<hostname_or_IP>**: .**

4. Log in to the verifying HSM appliance as the **audit** user. For this example, we will assume that you have already initialized the HSM audit user role, using the same domain/secret as is associated with the source HSM.

   - If you are using a Luna Network HSM 7, connect via SSH and log in to LunaSH as the **audit** user:

     lunash:> **audit login**

   - If you are using a Luna PCIe HSM 7 or Luna USB HSM 7, open LunaCM and log in using the Auditor role:

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

5. Import the audit logging secret to the HSM.

   - Luna Network HSM 7 (LunaSH):

     lunash:> **audit secret import -serialtarget** <target_HSM_SN> **-serialsource** <source_HSM_SN> **-file** <log_secret_file>

   - Luna PCIe HSM 7 or Luna USB HSM 7 (LunaCM):

     lunacm:> **audit import file** <log_secret_file>

6. You can now verify audit log files from the source HSM.

   - Luna Network HSM 7 (LunaSH):

     lunash:> **audit log verify -file** <audit_log_filename>**.log**

   - Luna PCIe HSM 7 or Luna USB HSM 7 (LunaCM):

     lunacm:> **audit verify file** <audit_log_filename>**.log**

     You might need to provide the full path to the file, depending upon your current environment settings.

> **NOTE** Linux users, if you notice that audit log messages are going to more than one location on your file system, you can edit the /etc/rsyslog.conf file to prevent reporting local3.info messages in /var/log/messages as follows:
>
> ```
> //Log anything (except local3 and mail) of level info or higher.
> *.info;local3.none;mail.none;authpriv.none;cron.none /var/log/messages
> ```
>
> The portion highlighted in red stops the duplication of output. This change is optional.

## Audit Role Authentication Considerations

> The audit role iKey or password is a critical property to manage the audit logs. If that authentication secret is lost, the HSM must be factory reset (that is, zeroize the HSM) in order to initialize the audit role again.

> Multiple bad logins produce different results for the HSM SO and for the audit role, as follows:

- After 3 bad SO logins, the LUNA_RET_SO_LOGIN_FAILURE_THRESHOLD error is returned and the HSM is zeroized.
- After 3 bad audit logins, the LUNA_RET_AUDIT_LOGIN_FAILURE_THRESHOLD error is returned, but the HSM is unaffected. If a subsequent login attempt is executed within 30 seconds, the LUNA_RET_AUDIT_LOGIN_TIMEOUT_IN_PROGRESS error is returned. If you wait for more than 30 seconds and try login again with the correct password, the login is successful.

# Logging In as Auditor

Before you can change the audit logging configuration, archive audit logs, or verify audit logs from another HSM, you must log in to the Luna USB HSM 7's Admin partition as Auditor (AU), or relevant commands will fail.

**To log in as Auditor**

1. Launch LunaCM on the Luna USB HSM 7 host workstation.
2. Set the active slot to the HSM Admin partition.

   lunacm:> **slot set -slot** <slotnum>
3. Log in as Auditor.

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

   You are prompted for the Auditor credential.

## Failed Auditor Login Attempts

If you fail three (3) consecutive Auditor login attempts, the Auditor role is locked out for ten minutes.

> **NOTE** The system must actually receive some erroneous/false information before it logs a failed attempt; if you merely forget to insert the iKey, or insert the wrong color key, that is not counted as a failed attempt. You must insert an incorrect iKey of the correct type, or enter an incorrect PIN or challenge secret, to fail a login attempt.

# Audit Log Categories and HSM Events

This section provides a summary of the audit log categories and their associated HSM events.

## Partition Role IDs

If you are using a Luna USB HSM 7 with Luna HSM Firmware 7.7.0 or newer and Luna HSM Client 10.3.0 or newer, the HSM event log reports events with the following IDs assigned to each partition role:

### Administrative Partition Role IDs

| Partition Role | Role ID |
|---|---|
| Administrator | 0 |
| HSM Security Officer | 1 |
| Auditor | 8 |

### Application Partition Role IDs

| Partition Role | Role ID |
|---|---|
| Partition Security Officer | 1 |
| Crypto Officer | 0 |
| Limited Crypto Officer | 9 |
| Crypto User | 5 |

## HSM Access

| HSM Event | Description |
|---|---|
| LUNA_LOGIN | C_Login.<br>This event must be allowed to proceed even if the result should be logged but cannot (for example, due to a log full condition). |
| LUNA_LOGOUT | C_Logout.<br>This event must be allowed to proceed even if the result should be logged but cannot (for example, due to a log full condition). |

| HSM Event | Description |
|---|---|
| LUNA_LOGOUT_OTHER | C_LogoutOther.<br>This event must be allowed to proceed even if the result should be logged but cannot (for example, due to a log full condition). |
| LUNA_MODIFY_OBJECT | C_SetAttributeValue |
| LUNA_OPEN_SESSION | C_OpenSession.<br>This event must be allowed to proceed even if the result should be logged but cannot (for example, due to a log full condition). |
| LUNA_CLOSE_ALL_ SESSIONS | C_CloseAllSessions |
| LUNA_CLOSE_SESSION | C_CloseSession<br>This event must be allowed to proceed even if the result should be logged but cannot (for example, due to a log full condition). |
| LUNA_OPEN_ACCESS | CA_OpenApplicationID |
| LUNA_CLEAN_ACCESS | CA_Restart, CA_RestartForContainer |
| LUNA_CLOSE_ACCESS | CA_CloseApplicationID |
| LUNA_LOAD_CUSTOM_ MODULE | CA_LoadModule |
| LUNA_LOAD_ENCRYPTED_ CUSTOM_MODULE | CA_LoadEncryptedModule |
| LUNA_UNLOAD_CUSTOM_ MODULE | CA_UnloadModule |
| LUNA_EXECUTE_CUSTOM_ COMMAND | CA_PerformModuleCall |
| LUNA_HA_LOGIN | CA_HAGetLoginChallenge,<br>CA_HAAnswerLoginChallenge,<br>CA_HALogin,<br>CA_HAAnswerMofNChallenge,<br>HAActivateMofN |

## Log External

| HSM Event | Description |
|---|---|
| LUNA_LOG_EXTERNAL | CA_LogExternal |

## HSM Management

| HSM Event | Description |
|---|---|
| LUNA_ZEROIZE | CA_FactoryReset<br>This event is logged unconditionally. |
| LUNA_INIT_TOKEN | C_InitToken<br>This event is logged unconditionally. |
| LUNA_SET_PIN | C_SetPIN |
| LUNA_INIT_PIN | C_InitPIN |
| LUNA_CREATE_CONTAINER | CA_CreateContainer |
| LUNA_DELETE_CONTAINER | CA_DeleteContainer, CA_DeleteContainerWithHandle |
| LUNA_SEED_RANDOM | C_SeedRandom |
| LUNA_EXTRACT_CONTEXTS | C_GetOperationState |
| LUNA_INSERT_CONTEXTS | C_SetOperationState |
| LUNA_SELF_TEST | C_PerformSelfTest |
| LUNA_LOAD_CERT | CA_SetTokenCertificateSignature |
| LUNA_HA_INIT | CA_HAInit |
| LUNA_SET_HSM_POLICY | CA_SetHSMPolicy |
| LUNA_SET_DESTRUCTIVE_HSM_POLICY | CA_SetDestructiveHSMPolicy |
| LUNA_SET_CONTAINER_POLICY | CA_SetContainerPolicy |
| LUNA_SET_CAPABILITY | Internal, for capability update |
| LUNA_CREATE_LOGIN_CHALLENGE | CA_CreateLoginChallenge |

| HSM Event | Description |
|---|---|
| LUNA_REQUEST_CHALLENGE | CA_SIMInsert, CA_SIMMultiSign |
| LUNA_PED_INIT_RPV | CA_InitializeRemotePEDVector |
| LUNA_PED_DELETE_RPV | CA_DeleteRemotePEDVector |
| LUNA_MTK_LOCK | Internal, for manufacturing |
| LUNA_MTK_UNLOCK_CHALLENGE | Internal, for manufacturing |
| LUNA_MTK_UNLOCK_RESPONSE | Internal, for manufacturing |
| LUNA_MTK_RESTORE | CA_MTKRestore |
| LUNA_MTK_RESPLIT | CA_MTKResplit |
| LUNA_MTK_ZEROIZE | CA_MTKZeroize |
| LUNA_FW_UPGRADE_INIT | CA_FirmwareUpdate |
| LUNA_FW_UPGRADE_UPDATE | CA_FirmwareUpdate |
| LUNA_FW_UPGRADE_FINAL | CA_FirmwareUpdate |
| LUNA_FW_ROLLBACK | CA_FirmwareRollback |
| LUNA_MTK_SET_STORAGE | CA_MTKSetStorage |
| LUNA_SET_CONTAINER_SIZE | CA_SetContainerSize |

## Key Management

| HSM Event | Description |
|---|---|
| LUNA_CREATE_OBJECT | C_CreateObject |
| LUNA_COPY_OBJECT | C_CopyObject |
| LUNA_DESTROY_OBJECT | C_DestroyObject |
| LUNA_DESTROY_MULTIPLE_OBJECTS | CA_DestroyMultipleObjects |
| LUNA_GENERATE_KEY | C_GenerateKey |

| HSM Event | Description |
|---|---|
| LUNA_GENERATE_KEY_PAIR | C_GenerateKeyPair |
| LUNA_WRAP_KEY | C_WrapKey |
| LUNA_UNWRAP_KEY | C_UnwrapKey |
| LUNA_DERIVE_KEY | C_DeriveKey |
| LUNA_GET_RANDOM | C_GenerateRandom |
| LUNA_CLONE_AS_SOURCE, LUNA_REPLICATE_AS_SOURCE | CA_CloneAsSource |
| LUNA_CLONE_AS_TARGET_INIT, LUNA_REPLICATE_AS_TARGET_INIT | CA_CloneAsTargetInit |
| LUNA_CLONE_AS_TARGET, LUNA_REPLICATE_AS_TARGET | CA_CloneAsTarget |
| LUNA_GEN_TKN_KEYS | CA_GenerateTokenKeys |
| LUNA_GEN_KCV | CA_ManualKCV, C_InitPIN, C_InitToken, CA_InitAudit |
| LUNA_SET_LKCV | CA_SetLKCV |
| LUNA_M_OF_N_GENERATE | CA_GenerateMofN_Common, CA_GenerateMofN |
| LUNA_M_OF_N_ACTIVATE | CA_ActivateMofN |
| LUNA_M_OF_N_MODIFY | CA_ActivateMofN |
| LUNA_EXTRACT | CA_Extract |
| LUNA_INSERT | CA_Insert |
| LUNA_LKM_COMMAND | CA_LKMInitiatorChallenge, CA_LKMReceiverResponse, CA_LKMInitiatorComplete, CA_LKMReceiverComplete. |
| LUNA_MODIFY_USAGE_COUNT | CA_ModifyUsageCount |

## Key Usage and Key First Usage

| HSM Event | Description |
|---|---|
| LUNA_ENCRYPT_INIT | C_EncryptInit |
| LUNA_ENCRYPT | C_Encrypt |
| LUNA_ENCRYPT_END | C_EncryptFinal |
| LUNA_DECRYPT_INIT | C_DecryptInit |
| LUNA_DECRYPT | C_Decrypt |
| LUNA_DECRYPT_END | C_DecryptFinal |
| LUNA_DIGEST_INIT | C_DigestInit |
| LUNA_DIGEST | C_Digest |
| LUNA_DIGEST_KEY | C_DigestKey |
| LUNA_DIGEST_END | C_DigestFinal |
| LUNA_SIGN_INIT | C_SignInit |
| LUNA_SIGN | C_Sign |
| LUNA_SIGN_END | C_SignFinal |
| LUNA_VERIFY_INIT | C_VerifyInit |
| LUNA_VERIFY | C_Verify |
| LUNA_VERIFY_END | C_VerifyFinal |
| LUNA_SIGN_SINGLEPART | C_Sign |
| LUNA_VERIFY_SINGLEPART | C_Verify |
| LUNA_WRAP_CSP | CA_CloneMofN_Common |
| LUNA_M_OF_N_DUPLICATE | CA_DuplicateMofN |
| LUNA_ENCRYPT_SINGLEPART | C_Encrypt |
| LUNA_DECRYPT_SINGLEPART | C_Decrypt |

## Per-Key Authorization

| HSM Event | Description |
|---|---|
| LUNA_AUTHORIZE_KEY | CA_AuthorizeKey |
| LUNA_SET_AUTHORIZATION_DATA | CA_SetAuthorizationData |
| LUNA_RESET_AUTHORIZATION_DATA | CA_ResetAuthorizationData |
| LUNA_ASSIGN_KEY | CA_AssignKey |
| LUNA_INCREMENT_FAILED_AUTH_COUNT | CA_IncrementFailedAuthCount |

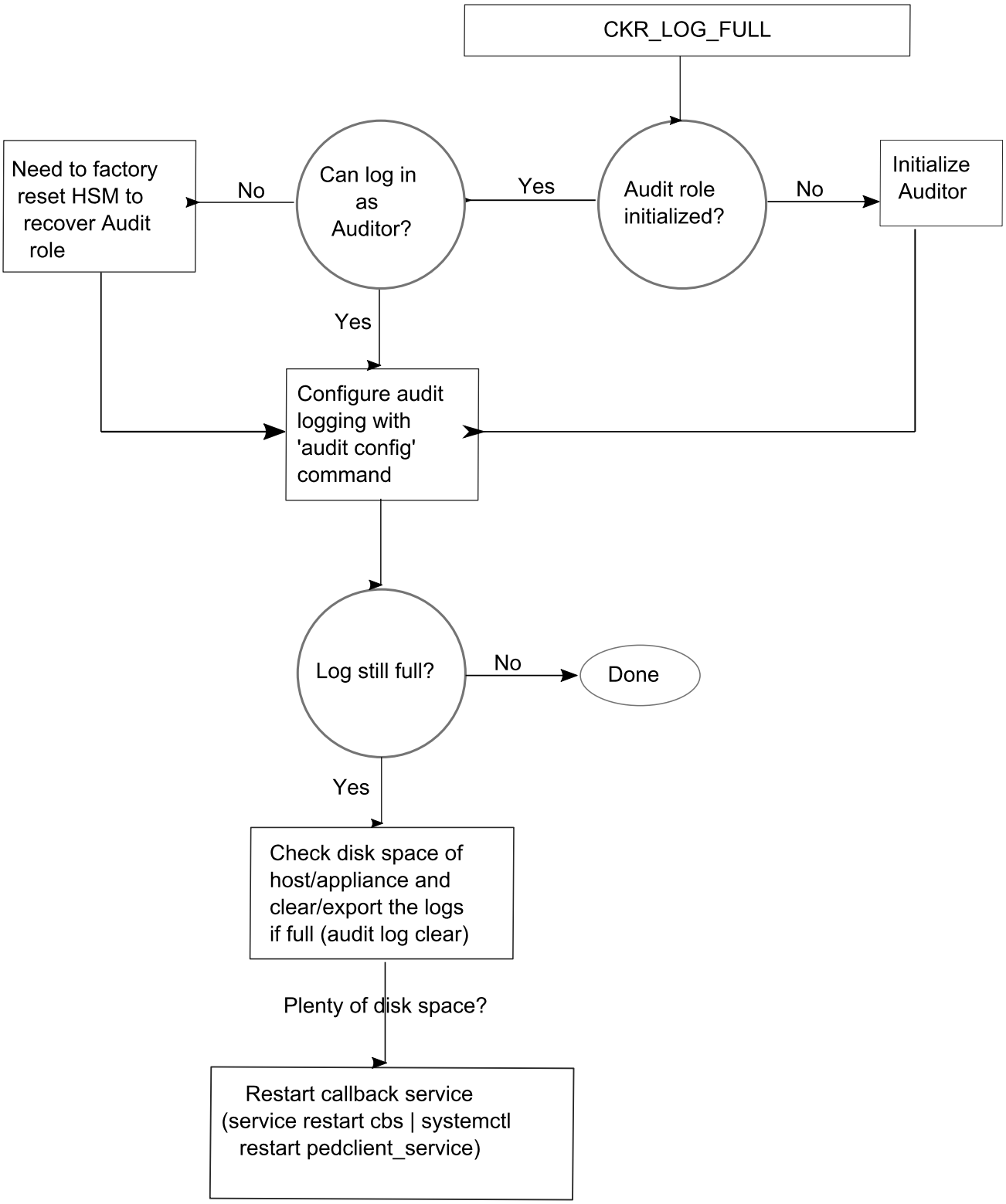
## Audit Log Management

| HSM Event | Description |
|---|---|
| LUNA_LOG_SET_TIME | CA_TimeSync |
| LUNA_LOG_GET_TIME | CA_GetTime |
| LUNA_LOG_SET_ CONFIG | CA_LogSetConfig<br>This event must be allowed to proceed even if the result should be logged but cannot (for example, due to a log full condition). |
| LUNA_LOG_GET_ CONFIG | CA_LogGetConfig<br>This event must be allowed to proceed even if the result should be logged but cannot (for example, due to a log full condition). |
| LUNA_LOG_VERIFY | CA_LogVerify |
| LUNA_CREATE_AUDIT_ CONTAINER ** | CA_ InitAudit<br>The event is logged unconditionally. |
| LUNA_LOG_IMPORT_ SECRET | CA_LogImportSecret |
| LUNA_LOG_EXPORT_ SECRET | CA_LogExportSecret |

# Audit Log Troubleshooting

The following sequence might help for problems with audit logging, like "log full."



## Cryptographic Operations Blocked During Remote PED Operations When Audit Logging Is Enabled

With audit logging enabled on the HSM, crypto operations are blocked on all application partitions during Remote PED operations. During this time, requests sent to HA member partitions on this HSM will not fail over to other members. When the Remote PED operation is complete, all crypto operations resume normally. If your application has its own timeout programmed, it may incorrectly conclude that the entire HA group has failed.

Using Luna HSM Client 10.7.2 or newer, you can configure the "ProbeTimeout" on page 62 setting in the **Chrystoki.conf/crystoki.ini** file to trigger an HA failover after a specified time. This allows operations to continue normally during Remote PED operations.

# CHAPTER 6: Initializing the Luna USB HSM 7

Initialization prepares a new Luna USB HSM 7 for use, or an existing HSM for reuse. You must initialize the HSM before you can generate and store objects, or perform cryptographic operations.

- On a new or factory-reset Luna USB HSM 7, initialization sets the HSM Security Officer credentials (password string or USB iKey), the HSM label, and the cloning domain (password string or USB iKey) of the HSM Admin partition. This is often referred to as a 'hard' initialization. See "Initializing a New or Factory-reset HSM" below.
- On an initialized HSM, re-initialization destroys all existing partitions and objects, but retains the HSM SO credentials and cloning domain (password strings or USB iKeys). You have the option to change or retain the existing label. This is sometimes referred to as a 'soft' initialization. See "Re-initializing the Luna USB HSM 7" on page 125.

> **NOTE** To ensure accurate auditing, perform initialization only after you have set the system time parameters (time, date, time zone, use of Network Time Protocol). You can use the **-authtimeconfig** option when initializing the HSM to require HSM SO authorization of any time-related changes once the HSM is initialized.

The following table summarizes the differences between a hard and soft initialization.

| Condition/Effect | Soft init | Hard init |
|---|---|---|
| HSM SO authentication required | Yes | No |
| Can set new HSM label | Yes | Yes |
| Creates new HSM SO identity | No | Yes |
| Creates new Domain | No | Yes |
| Destroys partitions | Yes | No (none exist to destroy) |
| Destroys objects | Yes | No (none exist to destroy) |

## Initializing a New or Factory-reset HSM

During the initialization procedure, you select password or multifactor quorum (iKey) authentication as your preferred authentication method. This cannot be changed later without destroying all cryptographic objects on the HSM. Ensure that you use the same method that the rest of your HSM deployment uses.

On a new, or factory-reset HSM (using **hsm factoryreset**), the following attributes are set during a hard initialization:

| | |
|---|---|
| **HSM Label** | The label is a string that uniquely identifies this HSM.<br>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:<br>`abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^&*()-_=+[]{}\|/;:'",.<>?`~`<br>Spaces are allowed; enclose the label in double quotes if it includes spaces. Including both spaces and quotation marks in a label may cause unexpected labeling behavior.<br>For more information, refer to "Name, Label, and Password Requirements" on page 128. |
| **HSM SO credentials** | If you select multifactor quorum authentication (**-iped** option), you create a new HSM SO (blue) iKey (set) or re-use an existing key(set) from an HSM you want to share credentials with. If you are using multifactor quorum authentication, ensure that you have an iKey strategy before beginning. See "Multifactor Quorum Authentication" on page 81.<br>If you select password authentication (**-ipwd** option), you specify the HSM SO password. Employ standard password-security practices.<br><br>**NOTE** To *change* the authentication type of a Luna USB HSM 7 between Password auth and Multifactor Quorum auth, or the reverse, (with the `-ipwd` option or the `-iped` option of the `hsm init command`) requires a factory reset first (hsm factoryreset).<br>The factory reset is *not* needed if you are initializing the HSM to the same mode of authentication as is currently configured.<br><br>Passwords and activation challenge secrets must be 8-255 characters in length. Spaces are allowed; to specify a password with spaces using command-line options, enclose the password in double quotation marks. The space character may not be used as the first character in a password.<br>The following characters are allowed:<br>`!#$%'()*+,-./0123456789:=? @ABCDEFGHIJKLMNOPQRSTUVWXYZ[]^_abcdefghijklmnopqrstuvwxyz{}~`<br>This character set is enforced when using Luna HSM Client 10.8.0 or newer, and recommended for all previous versions. Previously-set passwords and challenge secrets are unaffected, but the new character set is enforced when these passwords are changed. |

| | |
|---|---|
| **Cloning domain for the HSM Admin partition** | The cloning domain is a shared identifier that makes cloning possible among a group of HSM partitions. On the Luna 7 HSM Admin partition, it must be set, but has no practical function.<br>**NOTE** This is distinct from the domain on an application partition, which is a critical component required for key cloning, backup/restore, and high availability groups. Refer to Domain Planning for more information.<br>If you select multifactor quorum authentication (**-iped** option), you create a new Domain (red) iKey(set) or re-use an existing key(set) from an HSM you want to be able to clone with.<br>If you select password authentication (**-ipwd** option), you create a new domain string or re-use an existing string from an HSM you want to be able to clone with.<br>The domain string must be 1-128 characters in length. The following characters are allowed:<br>`abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789 !@#$%^*-_=+[]{}()/:',.~`<br>The following characters are problematic or invalid and must not be used in a domain string:<br>`"&;<>?\`\|`<br>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.<br>For password-authenticated HSMs, the domain string should match the complexity of the partition password. |

## Prerequisites

Before you begin, ensure that you are familiar with the concepts in the following sections

> "Multifactor Quorum Authentication" on page 81 (if you plan to use this authentication method)

> "HSM Roles" on page 126

### To initialize a new or factory-reset HSM

1. Open a LunaCM session and set the active slot to the HSM Admin partition.
2. If Secure Transport Mode is set, you must unlock the HSM before proceeding. New Luna USB HSM 7s are shipped from the factory in Secure Transport Mode (STM). STM allows you to verify that an HSM has not been tampered while out of your possession, such as when it is shipped to another location, or placed into storage. See "Secure Transport Mode" on page 77 for more information.

   To recover your HSM from Secure Transport Mode, follow the procedure in "Recovering an HSM From Secure Transport Mode" on page 78.
3. If you are initializing the HSM to use multifactor quorum authentication, ensure that you have sufficient iKeys available.
4. Initialize the HSM, specifying a label for your Luna USB HSM 7 and your preferred method of authentication, password (**-ipwd**) or multifactor quorum (**-iped**):

   lunacm:> **hsm init -label** <label> { **-ipwd** | **-iped** }
5. Respond to the prompts to complete the initialization process:
   - If you selected password authentication, you are prompted to set the HSM SO password and the HSM Admin partition cloning domain string.

- If you selected multifactor quorum authentication, you receive the prompt "**Attend to the PED**". These operations are completed using the Luna USB HSM 7 touchscreen. Follow the instructions on the touchscreen to complete the initialization procedure. You can create MofN quorum keysets and duplicate keys as required. See "Creating iKey Using Luna USB HSM 7" on page 86 for more information.

# Re-initializing the Luna USB HSM 7

On an initialized Luna USB HSM 7, re-initialization clears all existing partitions and objects, but retains the HSM SO credentials and cloning domain. You have the option to change or retain the existing label. Re-initialization is also referred to as a soft initialization. If you do not want to do a soft init, and also change the SO credentials and cloning domain, you reset the HSM to factory conditions using **hsm factoryreset**, and then perform the procedure described in "Initializing a New or Factory-reset HSM" on page 122.

> **CAUTION!** Ensure you have backups for any partitions and objects you want to keep, before re-initializing the HSM.

### To re-initialize the HSM (soft init)

1. Open a LunaCM session and set the slot to the HSM Admin partition.
2. Log in as the HSM SO.
3. If Secure Transport Mode is set, you must unlock the HSM before proceeding. See "Recovering an HSM From Secure Transport Mode" on page 78.
4. If you are initializing a multifactor quorum-authenticated HSM, have the appropriate iKeys ready.
5. Re-initialize the HSM, specifying a label for your Luna USB HSM 7:

   lunacm:> **hsm init -label** <label>

# CHAPTER 7: HSM 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 client 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.

Luna USB HSM 7 divides roles on the HSM according to an enhanced version of the PKCS#11 standard. Configuration, administration, and auditing of the HSM itself is the responsibility of the roles described below. Cryptographic functions take place on the application partition, which has a different set of independent roles (see Partition Roles).

Personnel holding the HSM roles described below access HSM functions by logging in to the Admin partition on the HSM using LunaCM. They must therefore have the appropriate Administrator access to the workstation hosting the Luna USB HSM 7.

The HSM-level roles are as follows:

## HSM Security Officer (SO)

The HSM SO handles all administrative and configuration tasks on the HSM, including:

- Initializing the HSM and setting the SO credential (see "Initializing the Luna USB HSM 7" on page 122)
- Setting and changing global HSM policies (see "HSM Capabilities and Policies" on page 130)
- Creating/deleting the application partition (see "Application Partitions" on page 140)

**Managing the HSM Security Officer Role**

Refer also to the following procedures to manage the HSM SO role:

- "Logging In as HSM Security Officer" on the next page

## Auditor (AU)

The Auditor is responsible for managing HSM audit logging. These responsibilities have been separated from the other roles on the HSM and application partition so that the Auditor can provide independent oversight of all HSM processes, and no other user, including the HSM SO, can clear those logs. The Auditor's tasks include:

- Initializing the Auditor role
- Setting up audit logging on the HSM
- Configuring the maximum size of audit log files and the time interval for log rotation
- Archiving the audit logs

**Managing the Auditor Role**

Refer to "Configuring and Using Audit Logging" on page 108 for procedures involving the Auditor role. See also:

> "Logging In as Auditor" on page 112

> "Changing a Role Credential" below

### Administrator (AD)

The HSM Administrator is a deprecated role on the Admin partition whose functions are now served by the application partition roles (see Partition Roles). Initializing this role is not recommended.

## Logging In as HSM Security Officer

Before you can create an application partition or perform other administrative functions on the HSM, you must log in to the Luna USB HSM 7's Admin partition as HSM Security Officer (SO), or administrative commands will fail.

**To log in as HSM SO**

1. Launch LunaCM on the Luna USB HSM 7 client workstation.
2. Set the active slot to the HSM Admin partition.

   lunacm:> **slot set -slot** <slotnum>
3. Log in as HSM SO.

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

   You are prompted for the HSM SO credential.

### Failed HSM SO Login Attempts

If you fail three (3) consecutive HSM SO login attempts, application partitions are destroyed, the HSM is zeroized and all of its contents are rendered unrecoverable. The number is not adjustable. As soon as you authenticate successfully, the counter is reset to zero.

> **NOTE** The system must actually receive some erroneous/false information before it logs a failed attempt; if you merely forget to insert the iKey, or insert the wrong color key, that is not counted as a failed attempt. You must insert an incorrect iKey of the correct type, or enter an incorrect PIN or challenge secret, to fail a login attempt.

## Changing a Role Credential

From time to time, you may need to change the credential for a role. The credential might have been compromised, or your organization's security policy may mandate password changes after a specific time interval. The following procedure allows you to change the credential for a role (HSM SO, Auditor, Partition SO, Crypto Officer, Crypto User). You must first log in using the role's current credential.

> **NOTE** If **partition policy 21: Force user PIN change after set/reset** is set to **1** (default), this procedure is required after initializing or resetting the CO or CU role and/or creating a challenge secret.

**To change a role credential**

1. In LunaCM, log in using the role's current credential (see Logging In to the Application Partition).

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

2. Change the credential for the logged-in role. If you are using a password-authenticated HSM, specify a new password. If you are using a multifactor quorum-authenticated HSM, ensure that you have a blank or rewritable iKey available. Refer to "Creating iKey Using Luna USB HSM 7" on page 86.

   Passwords and activation challenge secrets must be 8-255 characters in length. Spaces are allowed; to specify a password with spaces using command-line options, enclose the password in double quotation marks. The space character may not be used as the first character in a password.The following characters are allowed:
   `!#$%'()*+,-./0123456789:=? @ABCDEFGHIJKLMNOPQRSTUVWXYZ[]^_abcdefghijklmnopqrstuvwxyz{}~`
   This character set is enforced when using Luna HSM Client 10.8.0 or newer, and recommended for all previous versions. Previously-set passwords and challenge secrets are unaffected, but the new character set is enforced when these passwords are changed.

   lunacm:> **role changepw -name** <role>

3. To change the CO or CU challenge secret for an activated multifactor quorum-authenticated partition, specify the **-oldpw** and/or **-newpw** options.

   lunacm:> **role changepw -name** <role> **-oldpw** <oldpassword> **-newpw** <newpassword>

# Name, Label, and Password Requirements

This page describes length and character requirements for setting labels, domains, passwords, and challenge secrets on the Luna USB 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

Passwords and activation challenge secrets must be 8-255 characters in length. Spaces are allowed; to specify a password with spaces using command-line options, enclose the password in double quotation marks. The space character may not be used as the first character in a password.

The following characters are allowed:

```
!#$%'()*+,-./0123456789:=? @ABCDEFGHIJKLMNOPQRSTUVWXYZ[]^_abcdefghijklmnopqrstuvwxyz{}~
```

This character set is enforced when using Luna HSM Client 10.8.0 or newer, and recommended for all previous versions. Previously-set passwords and challenge secrets are unaffected, but the new character set is enforced when these passwords are changed.

# CHAPTER 8: HSM Capabilities and Policies

The Luna USB HSM 7 can be configured to suit the cryptographic needs of your organization. Configurable functions are governed by the following settings:

- **HSM Capabilities** are features of HSM functionality, set at time of manufacture. Some capabilities have corresponding modifiable HSM policies.
- **HSM Policies** are configurable settings that allow the HSM Security Officer to modify the function of their corresponding capabilities. Some policies affect HSM-wide functionality, and others allow further customization of application partitions by the Partition Security Officer.

The table below describes all Luna USB HSM 7 capabilities, their corresponding policies, and the results of changing their settings. This section contains the following procedures:

- "Setting HSM Policies Manually" on page 137
- "Setting HSM Policies Using a Template" on page 137

To zeroize the HSM and revert policies to their default values, see "Zeroizing or Resetting the HSM to Factory Conditions" on page 182.

To zeroize the HSM and keep the existing policy settings, use lunacm:> **hsm zeroize**.

## Destructive Policies

Some policies affect the security of the HSM. As a security measure, changing these policies results in application partitions or the entire HSM being zeroized. These policies are listed below as **destructive**.

| # | HSM Capability | HSM Policy |
|---|---|---|
| **0** | **Enable PIN-based authentication**<br>Always **1**. The HSM can authenticate users with keyboard-entered passwords. | **PIN-based authentication**<br>Displays **1** if you chose password authentication at the time of HSM initialization. |
| **1** | **Enable PED-based authentication**<br>Always **1**. The HSM can authenticate users with secrets stored on physical iKeys (multifactor quorum authentication) inserted into the Luna USB HSM 7. The Crypto Officer and Crypto User roles may also be configured with a secondary, keyboard-entered challenge secret. | **PED-based authentication**<br>Displays **1** if you chose multifactor quorum authentication at the time of HSM initialization. |
| **2** | **Performance level**<br>This value is standard on all Luna USB HSM 7s. | N/A |

| # | HSM Capability | HSM Policy |
|---|---|---|
| 4 | **Enable domestic mechanisms & key sizes**<br>Always **1**. All Luna USB HSM 7s are capable of full-strength cryptography with no US export restrictions. | N/A |
| 6 | **Enable masking**<br>Always **1**. | **Allow Masking** |
| 7 | **Enable cloning**<br>Always **1**. All current Luna USB HSM 7s have the ability to clone cryptographic objects from one partition to another. | **Allow cloning**<br>*Destructive*<br>> **1** (default): The HSM may clone cryptographic objects from one partition to another sharing the same cloning domain. This is required to back up partitions. The Partition SO can enable/disable cloning on individual partitions.<br>> **0**: The application partition may not clone cryptographic objects. The Partition SO cannot change this. |
| 9 | **Enable full (non-backup) functionality**<br>Always **1**. The Luna USB HSM 7 is capable of full cryptographic functions. | N/A |
| 12 | **Enable non-FIPS algorithms**<br>Always **1**. The HSM can use all cryptographic algorithms described in Supported Mechanisms. | **Allow non-FIPS algorithms**<br>*Destructive*<br>> **1** (default): The HSM may use all available cryptographic algorithms, meaning all the FIPS-approved algorithms as well as non-FIPS algorithms.<br>> **0**: Only algorithms sanctioned by the FIPS 140 standard are permitted. Some of these algorithms will have certain operations restricted; refer to your firmware version in Supported Mechanisms for more information. |

| # | HSM Capability | HSM Policy |
|---|---|---|
| 15 | **Enable SO reset of partition PIN**<br>Always **1**. This capability enables:<br>> the Partition SO to reset the password or iKey secret of the Crypto Officer.<br>> the Crypto Officer to reset the password or iKey secret of the Crypto User. | **SO can reset partition PIN**<br>*Destructive*<br>> **1**: Partition SO may reset the password or iKey secret of a Crypto Officer who has been locked out after too many failed login attempts.<br>> **0** (default): The CO lockout is permanent and the partition contents are no longer accessible. The partition must be re-initialized, and key material restored from a backup device.<br>See Resetting the Crypto Officer or Crypto User Credential. |
| 16 | **Enable network replication**<br>Always **1**. This capability enables cloning of cryptographic objects over a network. This is required for partition backup to a remote Luna Backup HSM. | **Allow network replication**<br>> **1** (default): Cloning of cryptographic objects is permitted over a network. Remote backup is allowed.<br>> **0**: Cloning over a network is not permitted. Partition backup is possible to a locally-connected Luna Backup HSM only. |
| 17 | **Enable Korean Algorithms**<br>Always **0**. The Korea-specific algorithm set is not currently available for Luna USB HSM 7. | N/A |
| 19 | **Manufacturing Token**<br>Always **0**. For Thales internal use only. | N/A |
| 21 | **Enable forcing user PIN change**<br>Always **1**. This capability forces the Crypto Officer or Crypto User to change the initial role credential created by the Partition SO. | **Force user PIN change after set/reset**<br>> **1** (default): After the Partition SO initializes or resets the Crypto Officer credential, the CO must change the credential before any other actions are permitted. This also applies when the CO initializes/resets the Crypto User role. This policy is intended to enforce the separation of roles on the partition.<br>> **0**: The CO/CU may continue to use the credential assigned by the Partition SO.<br>See "Changing a Role Credential" on page 127. |

| # | HSM Capability | HSM Policy |
|---|---|---|
| **22** | **Enable offboard storage**<br>Always **1**. | **Allow offboard storage**<br>*Destructive*<br>Deprecated policy. On previous HSMs, this policy allowed or disallowed the use of the portable SIM key.<br>Default: **1** |
| **23** | **Enable partition groups**<br>Always **0** - deprecated capability. | N/A |
| **25** | **Enable Remote PED usage**<br>Always **1**. | **Allow Remote PED usage**<br>> **1** (default): When initialized for multifactor quorum authentication, the HSM may authenticate roles using a remotely-located Luna PED server.<br>> **0**: The HSM can authenticate roles by connecting iKeys directly to the Luna USB HSM 7 only. |
| **27** | **HSM non-volatile storage space**<br>Displays the maximum non-volatile storage space (in bytes) on the HSM. | N/A |
| **30** | **Enable Unmasking**<br>Always **1**. This capability enables migration from legacy Luna HSMs that used SIM. | **Allow unmasking**<br>> **1** (default): Cryptographic objects may be migrated from legacy Luna HSMs that used SIM.<br>> **0**: Migration from legacy HSMs using SIM is not possible. |
| **33** | **Maximum number of partitions**<br>Always **1**. Displays the maximum number of application partitions that can be created on the Luna USB HSM 7. | **Current maximum number of partitions**<br>N/A |
| **35** | **Enable Single Domain**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |
| **36** | **Enable Unified PED Key**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |

| # | HSM Capability | HSM Policy |
|---|---|---|
| 37 | **Enable MofN**<br>Always **1**. | **Allow MofN**<br>> **1** (default): During iKey creation, you have the option to require a quorum to authenticate the role, by splitting the role secret among multiple iKeys. See "M of N Split Secrets (Quorum)" on page 85.<br>> **0**: Users do not have the option to split role secrets (M and N are automatically set to **1**). |
| 38 | **Enable small form factor backup/restore**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |
| 40 | **Enable decommission on tamper**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |
| 42 | **Enable partition re-initialize**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |
| 43 | **Enable low level math acceleration**<br>Always **1**. This capability enables acceleration of cryptographic functionality for maximum HSM performance. | N/A |
| 46 | **Allow Disabling Decommission**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |
| 48 | **Enable Controlled Tamper Recovery**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |
| 49 | **Enable Partition Utilization Metrics**<br>Always **1**. This capability enables the HSM SO to view (or export to a named file) counters that record how many times specific cryptographic operations have been performed in the application partition since the last counter-reset event. | **Allow Partition Utilization Metrics**<br>> **1**: The HSM SO can view Partition Utilization Metrics.<br>> **0** (default): Partition Utilization Metrics are not available.<br>See "Partition Utilization Metrics" on page 152 for more information. |
| 50 | **Enable Functionality Modules**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |
| 51 | **Enable SMFS Auto Activation**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |

| # | HSM Capability | HSM Policy |
|---|---|---|
| **52** | **Allow Restricting FM Privilege Level**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |
| **53** | **Allow Encrypting of Keys from FM to HSM**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |
| **55** | **Enable Restricted Restore**<br>Always **0**. Not applicable to Luna USB HSM 7. | N/A |

| # | HSM Capability | HSM Policy |
|---|---|---|
| 56 | **Enable User Defined ECC Curves**<br>Always **1**. This capability allows the HSM SO to restrict or allow the use of user-defined ECC curves.<br>The state of the associated policy is preserved through firmware update.<br>Requires Luna USB HSM 7 Firmware 7.7.3 or newer. | **Allow User Defined ECC Curves**<br>*Destructive*<br>> : User-defined ECC curves can be used, without restriction.<br>> (default): Named curves (that we have verified) can still be used, as can user-defined ECC curves where the named-curve parameters are provided. User-defined ECC curves that cannot map to built-in named curves during key-pair generation, public key creation, private key unwrapping, cloning or SKS, and key derivation, return the error ECC_CURVE_NOT_ALLOWED.<br>Named-curve samples are provided when you include the SDK option while installing the Client. The files must be unmodified.<br>/usr/safenet/lunaclient/samples/ecc_examples<br>> bpP160r1.txt<br>> bpP512t1.txt<br>> x962_char2_163v1.txt<br>> bpP192r1.txt<br>> secp384r1.txt<br>> x962_char2_359V1.txt<br>> bpP224r1.txt<br>> bpP384R1.txt<br>> sm2p256v1.txt<br>**NOTE** For FIPS compliance, NIST requires us to make security claims with respect to the curves that we support.<br>It is impossible to test and report on all possible user-defined ECC curves. Therefore, commonly-used, named curves are explicitly tested, documented to comply with FIPS requirements, and allowed in FIPS 140 approved configuration. |

# Setting HSM Policies Manually

The HSM SO can change available policies to customize HSM functionality. Some policies apply to all partitions on the HSM; others enable the Partition SO to customize functionality at the partition level. Refer to "HSM Capabilities and Policies" on page 130 for a complete list of HSM policies and their effects.

In most cases, HSM policies are either enabled (**1**) or disabled (**0**), but some allow a range of values.

To change multiple policy settings during HSM initialization, see "Setting HSM Policies Using a Template" below.

### Prerequisites

> The HSM must be initialized (see "Initializing the Luna USB HSM 7" on page 122).

> If you are changing a destructive policy and you have partitions existing on the HSM, back up any important cryptographic objects (see Partition Backup and Restore).

### To manually set or change an HSM policy

1. Launch LunaCM and set the active slot to the HSM Admin partition.

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

2. [Optional] Display the existing HSM policy settings.

   lunacm:> **hsm showpolicies**

3. Log in as HSM SO (see "Logging In as HSM Security Officer" on page 127).

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

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).

   lunacm:> **hsm changehsmpolicy -policy** <policy_ID> **-value** <value>

   If you are changing a destructive policy, you are prompted to enter **proceed** to continue the operation.

# Setting HSM Policies Using a Template

An HSM policy template is a file containing a set of preferred HSM policy settings, used to initialize HSMs with those settings. You can use the same file to initialize multiple HSMs, rather than changing policies manually after initialization. This can save time and effort when initializing multiple HSMs that are to function together (such as in 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.

See also Setting Partition Policies Using a Template.

You can create a policy template file from an initialized or uninitialized HSM, and edit it using a standard text editor.

HSM policy templates cannot be used to alter settings for an initialized HSM. Once an HSM has been initialized, the SO must change individual policy values manually (see "Setting HSM Policies Manually" above).

To zeroize the HSM and revert policies to their default values, see "Zeroizing or Resetting the HSM to Factory Conditions" on page 182.

To zeroize the HSM and keep the existing policy settings, use lunacm:> **hsm zeroize**.

This section provides instructions for the following procedures, and some general guidelines and restrictions:

> "Creating an HSM Policy Template" below

> "Editing an HSM Policy Template" below

> "Applying an HSM Policy Template" on the next page

## Creating an HSM Policy Template

The following procedures describe how to generate an HSM policy template from the HSM. This can be done optionally at two points in the HSM setup process:

> before the HSM is initialized: this produces a template file containing the default policy settings, which can then be edited

> after initializing and setting the HSM policies manually: this produces a template file with the current HSM policy settings, which can then be used to initialize other HSMs with the same settings. The HSM SO must complete the procedure.

### To create an HSM policy template

1. Launch LunaCM and set the active slot to the Admin partition. If you are creating a template from an initialized HSM, you must log in as HSM SO.

   lunacm:> **slot set slot** <admin_slotnum>

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

2. Create the HSM policy template file with an original filename. Specify the path to the location where you wish to save the template. No file extension is required. If a template file with the same name exists in the specified directory, it is overwritten.

   lunacm:> **hsm showpolicies -exporttemplate** <filepath/filename>

   ```
   lunacm:>hsm showpolicies -exporttemplate /usr/safenet/lunaclient/templates/HSMPT

   HSM policies for HSM: myPCIeHSM written to /usr/safenet/lunaclient/templates/HSMPT

   Command Result : No Error
   ```

3. Customize the template file with a standard text editor (see "Editing an HSM Policy Template" below).

## Editing an HSM Policy Template

Use a standard text editor to manually edit HSM policy templates for custom configurations. This section provides template examples and customization guidelines.

### HSM Policy Template Example

This example shows the contents of an HSM policy template created using the factory default policy settings. Use a standard text editor to change the policy values (0=OFF, 1=ON, or the desired value 0-255). You cannot edit the destructiveness of HSM policies. See "HSM Capabilities and Policies" on page 130 for more information.

If you export a policy template from an uninitialized HSM, the **Sourced from HSM** 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.

```
# HSM Policy template FW Version 7.7.2
# Sourced from HSM: myLunaUSB, SN: 556677
# Field format - Policy ID:Policy Description:Policy Value


6:"Allow masking":1
7:"Allow cloning":1
12:"Allow non-FIPS algorithms":1
15:"SO can reset partition PIN":0
16:"Allow network replication":1
21:"Force user PIN change after set/reset":1
22:"Allow offboard storage":1
25:"Allow remote PED usage":1
30:"Allow unmasking":1
33:"Current maximum number of partitions":1
37:"Allow MofN":1
43:"Allow low level math acceleration":1
49:"Allow Partition Utilization Metrics":0
56:"Allow User Defined ECC Curves":1
```

### Editing Guidelines and Restrictions

When creating or editing 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 HSM will use the default value for that policy.
- You may not use invalid policy values (outside the acceptable range), or values that conflict with your HSM's capabilities. For example, **HSM capability 35: Enable Single Domain** is always **Disallowed**, so you cannot set the corresponding HSM policy to **1**. If you attempt to initialize an HSM with a template containing invalid policy values, an error is returned and initialization fails.

## Applying an HSM Policy Template

The following procedure describes how to initialize the HSM using a policy template.

### To apply a policy template to a new HSM

1. Ensure that the template file is saved on the workstation hosting the destination HSM.
2. Launch LunaCM and initialize the destination HSM using the policy template file. If the template file is not in the same directory as LunaCM, include the correct filepath.

   lunacm:> **hsm init -label** <label> **-applytemplate** <filepath/filename>
3. Verify that the template has been applied correctly by checking the partition's policy settings.

   lunacm:> **hsm showpolicies**

# CHAPTER 9: Application Partitions

The Luna USB HSM 7 has two partitions:

- one administrative partition, created when you initialize the HSM. The administrative partition is owned by the HSM Security Officer (SO). This partition is used by the HSM SO and the Auditor, and is not used to store cryptographic objects.
- one application partition, created by the HSM SO. The application partition is owned by its Partition Security Officer (PO), and has its own access controls and security policies independent from the administrative partition. Its function is to store cryptographic objects used by your applications.

An application partition is like a safe deposit box that resides within a bank's vault. The HSM (vault) itself offers an extremely high level of security for its contents. An application partition (safe deposit box) on the HSM has its own security and access controls, so that even though the HSM SO has access to the vault, they still cannot access the contents of the individual partitions. Only the Partition Security Officer holds the partition's administrative credentials.

## Creating the Application Partition

The HSM Security Officer (SO) is responsible for creating the application partition.

### Prerequisites

- The HSM must be initialized (see "Initializing the Luna USB HSM 7" on page 122).
- You require the HSM SO credential (password or blue iKey).

**To create the application partition on the Luna USB HSM 7**

1. Log in as HSM SO (see "Logging In as HSM Security Officer" on page 127).

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

2. Create the application partition, specifying a slot number to associate with it. You can optionally specify a V1 partition using the **-version** option, or a V0 partition is created by default. You can also convert V0 to V1 after initialization (see V0 and V1 Partitions).

   lunacm:> **partition create -slot** <slotnum> [**-version 1**]

3. [Optional] Confirm that the partition was created.

   lunacm:> **slot list**

## Deleting the Application Partition

The HSM SO can delete the partition at any time, destroying all partition roles and stored cryptographic objects.

### To delete the application partition

1. Log in as HSM SO (see "Logging In as HSM Security Officer" on page 127).

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

2. Delete the application partition by specifying the slot number.

   lunacm:> **partition delete -slot** <slot>

# CHAPTER 10: Security in Operation

This section addresses actions and settings with security-related implications.



Refer also to Security of Your Partition Challenge.

## Physical Security and Tamper Events

The Luna USB HSM 7 (the cryptographic module) contains a single battery to keep the time clock up to date.

By design, that battery will last longer than the life expectancy of the device. The following notes pertain:

> Should the battery fail, then the time must be set before using the device.
> The presence or absence of a working battery has no impact on the key materials.
> Key materials are accessible only when
  - the HSM is powered on -- there is no way to extract key material from a powered-off Luna USB HSM 7,
  - the user has been successfully authenticated -- there is no way to extract key material from a Luna USB HSM 7 without the appropriate user authentication (either by password or by multi-factor quorum [PED] ).
> Tamper detection is enabled when the unit is powered on.
> Physical intrusion is prevented by an epoxy layer applied on components where the key materials reside.
> Both temperature and voltage are monitored, and the cryptographic module shuts down while any environmental conditions are outside of normal allowed operating ranges:
  - Temperature -- Environmental Failure Protection (EFP) temperature events are detected by an internal temperature sensor.

| Under Temperature | Over Temperature |
|---|---|
| **Soft Tamper** | **Soft Tamper** |
| 0°C ± 2°C | +70°C ± 2°C |

  - Voltage -- the module monitors the 5V power rail

| Under Voltage | Over Voltage |
|---|---|
| **Halt** | **Soft Tamper** |
| 3.9V ± 0.11V | 5.71V ± 0.145V |

# Tamper Events

Luna USB HSM 7 detects hardware anomalies (such as card over-temperature) and registers them as tamper events.

| Tamper event | Response |
|---|---|
| Over/under temperature | Halt the HSM. Deactivate activated partitions.<br>Decommission the HSM if **policy 40: Decommission on Tamper** is enabled.<br>Warnings are logged for mild over/under temperature events. Warnings are self-clearing if the condition is resolved. |
| Over/under voltage | Halt the HSM. Deactivate activated partitions.<br>Decommission the HSM if **policy 40: Decommission on Tamper** is enabled.<br>Warnings are logged for mild over/under voltage events. Warnings are self-clearing if the condition is resolved. |

## Recovering from a Tamper Event

If you are using activation on your multifactor quorum-authenticated partitions, it is disabled when a tamper is detected, or if any uncleared tamper conditions are detected on reboot. See Activation on Multifactor Quorum-Authenticated Partitions and Partition Capabilities and Policies for more information.

### To recover from a tamper

1. View the output of lunacm:> **slot list** (displayed by default on login). The reason for the tamper is indicated by the **HSM Status** field. You can also use lunacm:> hsm tampershow to display the last tamper event.

   > **NOTE** The **slot list** and hsm tampershow commands only show the last tamper event, even if several tampers have occurred.

2. Resolve the issue(s) that caused the tamper event.
3. If the tamper message indicates that a reset is required, exit LunaCM and use the **lunareset** utility to reset the HSM.

   **lunareset** <device>
4. Verify that all tampers have been cleared:

   lunacm:> hsm tampershow

5. If the **Policy 22: Allow Activation** and/or **Policy 23: Allow AutoActivation** are enabled on your multifactor quorum-authenticated partitions, the CO and CU (if enabled) must log in to reactivate those roles:

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

# Security Effects of Administrative Actions

Actions that you take, in the course of administering your Luna HSM, can have effects, including destruction, on the roles, the spaces, and the contents of your HSM and its application partition(s). It is important to be aware of such consequences before taking action.

## Overt Security Actions

Some actions in the administration of the HSM, or of an application partition, are explicitly intended to adjust specific security aspects of the HSM or partition. Examples are:

- Changing a password
- Modifying a policy to make a password or other attribute more stringent than the original setting

Those are discussed in their own sections.

## Actions with Security- and Content-Affecting Outcomes

Other administrative events have security repercussions as included effects of the primary action, which could have other intent. Some examples are:

- HSM factory reset
- HSM zeroization
- Change of a destructive policy
- HSM initialization
- Application partition initialization

This table lists some major administrative actions that can be performed on the HSM, and compares relevant security-related effects. Use the information in this table to help decide if your contemplated action is appropriate in current circumstances, or if additional preparation (such as backup of partition content, collection of audit data) would be prudent before continuing.

### Factory Reset HSM

| | |
|---|---|
| **Domain** | Destroyed |
| **HSM SO Role** | Destroyed |
| **Partition SO Role** | Destroyed |
| **Auditor Role** | Destroyed |
| **Partition Roles** | Destroyed |

| | |
|---|---|
| **HSM or Partition/Contents** | HSM/Destroyed |
| **HSM Policies** | Reset |
| **RPV** | Destroyed |
| **Messaging** | You are about to factory reset the HSM. All contents of the HSM will be destroyed. HSM policies will be reset and the remote PED vector will be erased. |

### Zeroize HSM

| | |
|---|---|
| **Domain** | Destroyed |
| **HSM SO Role** | Destroyed |
| **Partition SO Role** | Destroyed |
| **Auditor Role** | Unchanged |
| **Partition Roles** | Destroyed |
| **HSM or Partition/Contents** | HSM/Destroyed |
| **HSM Policies** | Unchanged |
| **RPV** | Unchanged |
| **Messaging** | You are about to zeroize the HSM. All contents of the HSM will be destroyed. HSM policies, remote PED vector and Auditor left unchanged. |

### Change Destructive HSM Policy

| | |
|---|---|
| **Domain** | Unchanged |
| **HSM SO Role** | Unchanged |
| **Partition SO Role** | Destroyed |
| **Auditor Role** | Unchanged |
| **Partition Roles** | Destroyed |
| **HSM or Partition/Contents** | HSM/Destroyed |
| **HSM Policies** | Unchanged except for new policy |
| **RPV** | Unchanged |

| | |
|---|---|
| **Messaging** | You are about to change a destructive HSM policy. All partitions of the HSM will be destroyed. |

### HSM Initialize When Zeroized (hard init)

| | |
|---|---|
| **Domain** | Destroyed |
| **HSM SO Role** | Destroyed |
| **Partition SO Role** | Destroyed |
| **Auditor Role** | Unchanged |
| **Partition Roles** | Destroyed |
| **HSM or Partition/Contents** | HSM/Destroyed |
| **HSM Policies** | Unchanged |
| **RPV** | Unchanged |
| **Messaging** | You are about to initialize the HSM. All contents of the HSM will be destroyed. |

### HSM Initialize From Non-Zeroized State (soft init)

| | |
|---|---|
| **Domain** | Unchanged |
| **HSM SO Role** | Unchanged |
| **Partition SO Role** | Destroyed |
| **Auditor Role** | Unchanged |
| **Partition Roles** | Destroyed |
| **HSM or Partition/Contents** | HSM/Destroyed |
| **HSM Policies** | Unchanged |
| **RPV** | Unchanged |
| **Messaging** | You are about to initialize the HSM that is already initialized. All partitions of the HSM will be destroyed. You are required to provide the current SO password. |

### Partition Initialize When Zeroized (hard init)

| | |
|---|---|
| **Domain** | Unchanged |
| **HSM SO Role** | Unchanged |
| **Partition SO Role** | Destroyed |
| **Auditor Role** | Unchanged |
| **Partition Roles** | Destroyed |
| **HSM or Partition/Contents** | Partition/Destroyed |
| **HSM Policies** | Unchanged |
| **RPV** | Unchanged |
| **Messaging** | You are about to initialize the partition. All contents of the partition will be destroyed. |

### Partition Initialize From Non-Zeroized State (soft init)

| | |
|---|---|
| **Domain** | Unchanged |
| **HSM SO Role** | Unchanged |
| **Partition SO Role** | Destroyed |
| **Auditor Role** | Unchanged |
| **Partition Roles** | Destroyed |
| **HSM or Partition/Contents** | Partition/Destroyed |
| **HSM Policies** | Unchanged |
| **RPV** | Unchanged |
| **Messaging** | You are about to initialize the partition that is already initialized. All contents of the partition will be destroyed. You are required to provide the current Partition SO password. |

## Elsewhere

Certain other actions can sometimes cause collateral changes to the HSM, like firmware update. They usually do not affect contents, unless a partition is full and the action changes the size of partitions or changes the amount of space-per-partition that is taken by overhead/infrastructure. These are discussed elsewhere.

# CHAPTER 11: Monitoring the HSM

Thales provides different methods of monitoring activity on the HSM. This chapter contains the following sections:



## HSM Status Values

Each HSM administrative slot shown in a LunaCM slot listing includes an HSM status. Here are the possible values and what they mean, and what is required to recover from each one.

| Indicated Status of HSM | Meaning | Recovery |
|---|---|---|
| OK | The HSM is in a good state, working properly. | n/a |
| Zeroized | The HSM is in zeroized state. All objects and roles are unusable. | HSM initialization is required before the HSM can be used again. "Hard init" - HSM SO and domain are gone, no authentication required. (see Note1) |
| Decommissioned | The HSM has been decommissioned. | HSM initialization is required before the HSM can be used again. "Hard init" - HSM SO and domain are gone, no authentication required. (see Note1) |
| Transport Mode | The HSM is in Secure Transport Mode. | STM must be disabled before the HSM can be used. |
| Transport Mode, zeroized | The HSM is in Secure Transport Mode, and is also zeroized. | STM must be disabled, and then HSM initialization is required before the HSM can be used. |

| Indicated Status of HSM | Meaning | Recovery |
|---|---|---|
| Transport Mode, Decommissioned | The HSM is in Secure Transport Mode, and has been decommissioned. | STM must be disabled, and then HSM initialization is required before the HSM can be used. |
| Hardware Tamper | The HSM has been tampered. (MTK is destroyed and must be rebuilt from recovery vectors.) | Reboot the host or restart the HSM. The event is logged |
| Hardware Tamper, Zeroized | The HSM has been tampered. (MTK is destroyed and must be rebuilt from recovery vectors.) The HSM is also in zeroized state. All objects and roles are unusable. | Reboot the host or restart the HSM. The event is logged.<br>HSM initialization is required before the HSM can be used again. HSM SO and domain are gone, no authentication required. (see Note1) |
| HSM Tamper, Decommissioned | The HSM has been tampered. (MTK is destroyed and must be rebuilt from recovery vectors.) The HSM has also been decommissioned. | Reboot the host or restart the HSM. The event is logged.<br>HSM initialization is required before the HSM can be used again. HSM SO and domain are gone, no authentication required. (see Note1) |

**NOTE1:** A condition, not reported above, preserves the HSM SO and the associated Domain, while SO objects and all application partitions and contents are destroyed. In this case, HSM SO login is required to perform a "soft init". See "Initializing the Luna USB HSM 7" on page 122 for more information.

# System Operational and Error Messages

## Extra slots that say "token not present"

This happens for two reasons:

- PKCS#11 originated in a world of software cryptography, which only later acknowledged the existence of Hardware Security Modules, so initially it did not have the concept of physically removable crypto slots. PKCS#11 requires a static list of slots when an application starts. The cryptographic "token" can be inserted into, or removed from a slot dynamically (by a user), for the duration of the application.
- When the token is inserted, the running application must be able to detect that token. When the token is removed, the running application gets "token not present". Because we allow for the possibility of backup, we routinely declare 'place-holder' slots that might later be filled by a physical Luna USB HSM 7 or a Luna Backup HSM.

In the Chrystoki.conf file (or the Windows crystoki.ini file), for Luna USB HSM 7, you can remove the empty slots by modifying the CardReader entry, like this:

```
CardReader = {
 LunaG5Slots=0;
}
```

For Luna Network HSM 7, which has its configuration file internal to the appliance, and not directly accessible for modification, you cannot change the default cryptographic slot allotments.

## Error: 'hsm update firmware' failed. (10A0B : LUNA_RET_OPERATION_RESTRICTED) when attempting to perform hsm update firmware

You must ensure that STM is disabled before you run the firmware update.

Also, as with any update, you should backup any important HSM contents before proceeding.

## LUNA_RET_OPERATION_RESTRICTED when attempting to perform a restore operation

Did you perform the backup before Functionality Modules (FMs) were enabled on the HSM? Enabling FMs allows injection of software into the HSM, which makes it inherently less secure than an HSM that has never had FMs enabled. The cloning operation (used to perform backup and restore) recognizes the state of the source and target devices, and can refuse to transfer objects from a more secure device to a less-secure device.

In general, to ensure that you will be able to backup and restore (with partition archive commands) or clone directly with clone commands or include partitions in HA groups (which also uses cloning), ensure that partition policies are set the same on the involved partitions.

## KR_ECC_POINT_INVALID Error when decrypting a file encrypted from BSAFE through ECIES using ECC key with any of the curves from the x9_t2 section

As indicated on the BSAFE web site, they support only the NIST-approved curves (prime, Binary, and Koblitz). That includes most/all the curves from test items 0 through 37 in CK Demo: the "secp", "X9_62_prime", and "sect" curves.

The X9.62 curves that are failing in this task are X9.62 binary/char2 curves which do not appear to be supported by BSAFE. So, you appear to be encountering a BSAFE limitation and not a Luna HSM problem.

## Slow/interrupted response from the HSM, and the "hsm show" command shows LUNA_RET_SM_SESSION_REALLOC_ERROR

```
   Appliance Details:
   ==================
   Software Version:                7.0.0
Error:  'hsm show' failed. (310102 : LUNA_RET_SM_SESSION_REALLOC_ERROR)

Command Result : 65535 (Luna Shell execution)
```

The error LUNA_RET_SM_SESSION_REALLOC_ERROR means the HSM cannot expand the session table.

The HSM maintains a table for all of the open sessions. For performance reasons, the table is quite small initially. As sessions are opened (and not closed) the table fills up. When the table gets full, the HSM tries to expand the table. If there is not enough available RAM to grow the table, this error is returned.

RAM can be used up by an application that creates and does not delete a large number of session objects, as well as by an application that opens and fails to close a large number of sessions.

The obvious solution is proper housekeeping. Your applications must clean up after themselves, by closing sessions that are no longer in use - this deletes session objects associated with those sessions. If your application practice is to have long-lived sessions, and to open many objects in a given session, then your application should explicitly delete those session objects as soon as each one is no longer necessary.

By far, we see more of the former problem - abandoned sessions - and very often in conjunction with Java-based applications. Proper garbage collection includes deleting session objects when they are no longer useful, or simply closing sessions as soon as they are not required. Formally closing a session (or stopping/restarting the HSM) deletes all session objects within each affected session. These actions keep the session table small, so it uses the least possible HSM volatile memory.

# Performance Monitoring

An HSM administrator might find it helpful to know how busy the HSM is and at what percentage of its capacity it has been running.

The HSM Information Monitor is a use counter that provides an indication of momentary and cumulative resource usage on the HSM, in the form of a percentage. The HSM firmware tracks the overall time elapsed since the last reset (Up-Time), and the overall time during which the processor was not performing useful work (Idle-Time).

On request, the HSM calculates "Busy-time" over an interval, by subtracting Idle-time for that interval from Up-time for the interval. Then, the load on the processor is calculated as the Busy-time divided by the Up-time, and expressed as a percentage.

You can use the available commands for a single, one-off query, which actually takes an initial reading and then another, five seconds later (the default setting), in order to calculate and show the one-time difference.

You can specify a sampling interval (five seconds is the shortest) and a number of repetitions for an extended view of processor activity/resource usage. The resulting records, showing the time of each measurement, the percentage value at that time, and the difference from the previous measurement, can be output to a file that you import into other tools to analyze and graph the trends.

By watching trends and correlating with what your application is doing, you can:

- Determine the kinds of loads you are placing on the HSM.
- Seek efficiencies in how your applications are coded and configured.
- Plan for expansion or upgrades of your existing HSM infrastructure.
- Plan for upgrades of electrical capacity and HVAC capacity.

## Notes about Monitor/Counter Behavior

When performing certain operations the HSM reaches its maximum performance capability before the counter reaches 100%. This occurs because the counter measures the load on the HSM’s CPU and the CPU is able to saturate the asymmetric engines and still have capacity to perform other actions.

Also, symmetric cryptographic operations cause the counter to quickly rise to 90% even though there is significant remaining capacity. This behavior occurs because, as the HSM receives more concurrent symmetric commands, its CPU is able to handle them more efficiently (by performing them in bulk) – thus achieving more throughput from the same number of CPU cycles.

See lunacm:> **hsm monitor**.

# Partition Utilization Metrics

In order to ensure the quality of service (QoS) that you provide to applications that make use of HSM partitions, it is first necessary to know how the users and applications are making use of the HSM resources - that is, the distribution of demand.

For an HSM with a single application partition, it can be helpful to know what type of load is being imposed on the HSM and the enumeration and categorization of operations that are being performed. Application developers might have a good idea of the expected ratio of operations, but the operations team managing the application servers would like to know the real-world utilization, for their planning and management purposes.

> **NOTE**
>
> - Utilization metrics are based on *utilization counters* that track operations by category. This is not to be confused with *usage counters*, that track and limit the number of times a key or certificate is allowed to be used.
> - Using and Luna HSM Firmware 7.8.9 or newer, you can now choose whether "Partition Utilization Metrics" above can be viewed/exported and reset without needing login to the HSM. For continuity, the option defaults to requiring SO login, but that can be changed with a single command, to suit your security and auditing regimes. The existing QoS commands function as previously; only access to them is affected. This option is set using **HSM Policy 58:** Allow Unrestricted Metrics Access.

## Rules of acquisition

Utilization Metrics count these operations within category "bins", per partition:

- Sign
- Verify
- Encrypt
- Decrypt
- Key generate
- Key derive

Operations not in that list do not increment any counter. That is, an operation request to the HSM increments counters in 0 (zero) or more bins. The list might expand in future releases. Each bin has a single counter that counts how many requests have been received from the host, since the last counter-reset order or power cycle. Counters for a partition can be read and reset as a single operation, or as two separate operations.

The utilization counters count *requests* to the HSM, because, while successful requests are expected and are counted, unsuccessful requests also consume resources and therefore need to be counted as well. Any request that fails on the host - meaning it does not reach the HSM - is not counted, because it did not use any HSM resources.

Utilization counters are volatile, and therefore are lost in the event of a power failure. If they are valued, they should be polled regularly and the results kept in non-volatile storage on the host.

## Availability of Partition Utilization Metrics

Utilization metrics are supported using HSM-level policy **49: Allow Partition Utilization Metrics**. That policy is off (value 0) by default, as it is not required in all use-cases, and is most useful where multiple applications use the HSM.

> **NOTE** The Utilization Metrics feature allows the HSM SO to know which operations are being performed on the HSM. This information is normally available only to the Auditor when audit logging is turned on. However, while the SO can see a record of cryptographic operations, there is no visibility as to which keys are being used.

Setting the policy on (value 1) enables utilization metrics for all partitions including the Admin partition. Changing the policy is not destructive in either direction (off-to-on or on-to-off).

The **hsm showUtilization** command allows you to view the current utilization counter values for all partitions, and overall counts for the entire HSM, without resetting the counters.

The **hsm resetUtilization** command allows you to reset to zero the current utilization counter values for all partitions.

### To access the Partition Utilization Metrics feature

1. Log in as HSM SO (see "Logging In as HSM Security Officer" on page 127).

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

2. Enable HSM policy **49: Allow Partition Utilization Metrics**.

   lunacm:> **hsm changehsmpolicy -policy 49 -value 1**

### To view or save Partition Utilization Metrics without resetting

lunacm:> **hsm showUtilization -serial** <partition_SN)

### To reset the Partition Utilization Metrics counters to zero

Metrics are reset whenever power is lost to the HSM or the HSM is reset, or the HSM is initialized. These events do not save the metrics.

To display the metrics since the last reset (making them available to be captured manually or by script) and then immediately reset the metrics:

lunacm:> **hsm resetUtilization**

# Cryptographic Module and Token Return Codes

The following table summarizes HSM error codes:

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_OK | 0x00000000 | CKR_OK |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_CANCEL | 0x00010000 | CKR_CANCEL |
| LUNA_RET_FLAGS_INVALID | 0x00040000 | CKR_FLAGS_INVALID, removed from v2.0 |
| LUNA_RET_TOKEN_NOT_PRESENT | 0x00E00000 | CKR_TOKEN_NOT_PRESENT |
| LUNA_RET_FORMER_INVALID_ENTRY_TYPE | 0x00300130 | CKR_DEVICE_ERROR |
| LUNA_RET_SP_TX_ERROR | 0x00300131 | CKR_DEVICE_ERROR |
| LUNA_RET_SP_RX_ERROR | 0x00300132 | CKR_DEVICE_ERROR |
| LUNA_RET_PED_ID_INVALID | 0x00300140 | CKR_DEVICE_ERROR |
| LUNA_RET_PED_UNSUPPORTED_PROTOCOL | 0x00300141 | CKR_DEVICE_ERROR |
| LUNA_RET_PED_UNPLUGGED | 0x00300142 | CKR_PED_UNPLUGGED |
| LUNA_RET_PED_ERROR | 0x00300144 | CKR_DEVICE_ERROR |
| LUNA_RET_PED_UNSUPPORTED_CRYPTO_ PROTOCOL | 0x00300145 | CKR_DEVICE_ERROR |
| LUNA_RET_PED_DEK_INVALID | 0x00300146 | CKR_DEVICE_ERROR |
| LUNA_RET_PED_CLIENT_NOT_RUNNING | 0x00300147 | CKR_PED_CLIENT_NOT_RUNNING |
| LUNA_RET_CL_ALIGNMENT_ERROR | 0x00300200 | CKR_DEVICE_ERROR |
| LUNA_RET_CL_QUEUE_LOCATION_ERROR | 0x00300201 | CKR_DEVICE_ERROR |
| LUNA_RET_CL_QUEUE_OVERLAP_ERROR | 0x00300202 | CKR_DEVICE_ERROR |
| LUNA_RET_CL_TRANSMISSION_ERROR | 0x00300203 | CKR_DEVICE_ERROR |
| LUNA_RET_CL_NO_TRANSMISSION | 0x00300204 | CKR_DEVICE_ERROR |
| LUNA_RET_CL_COMMAND_MALFORMED | 0x00300205 | CKR_DEVICE_ERROR |
| LUNA_RET_CL_MAILBOXES_NOT_AVAILABLE | 0x00300206 | CKR_DEVICE_ERROR |
| LUNA_RET_MM_NOT_ENOUGH_MEMORY | 0x00310000 | CKR_DEVICE_MEMORY † |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_MM_INVALID_HANDLE | 0x00310001 | CKR_DEVICE_MEMORY † |
| LUNA_RET_MM_USAGE_ALREADY_SET | 0x00310002 | CKR_DEVICE_MEMORY † |
| LUNA_RET_MM_ACCESS_OUTSIDE_ALLOCATION_ RANGE | 0x00310003 | CKR_DEVICE_MEMORY † |
| LUNA_RET_MM_INVALID_USAGE | 0x00310004 | CKR_DEVICE_MEMORY † |
| LUNA_RET_MM_ITERATOR_PAST_END | 0x00310005 | CKR_DEVICE_MEMORY † |
| LUNA_RET_MM_FATAL_ERROR | 0x00310006 | CKR_DEVICE_MEMORY † |
| LUNA_RET_MEMORY_ALLOCATION_FAILED | 0x00310007 | CKR_DEVICE_MEMORY † |
| LUNA_RET_TEMPLATE_INCOMPLETE | 0x00D00000 | CKR_TEMPLATE_INCOMPLETE |
| LUNA_RET_TEMPLATE_INCONSISTENT | 0x00D10000 | CKR_TEMPLATE_INCONSISTENT* |
| LUNA_RET_ATTRIBUTE_TYPE_INVALID | 0x00120000 | CKR_ATTRIBUTE_TYPE_INVALID |
| LUNA_RET_ATTRIBUTE_VALUE_INVALID | 0x00130000 | CKR_ATTRIBUTE_VALUE_INVALID |
| LUNA_RET_ATTRIBUTE_READ_ONLY | 0x00100000 | CKR_ATTRIBUTE_READ_ONLY |
| LUNA_RET_ATTRIBUTE_SENSITIVE | 0x00110000 | CKR_ATTRIBUTE_SENSITIVE |
| LUNA_RET_OBJECT_HANDLE_INVALID | 0x00820000 | CKR_OBJECT_HANDLE_INVALID |
| LUNA_RET_MAX_OBJECT_COUNT | 0x00820001 | CKR_MAX_OBJECT_COUNT_ EXCEEDED |
| LUNA_RET_ATTRIBUTE_NOT_FOUND | 0x00120010 | CKR_ATTRIBUTE_TYPE_INVALID |
| LUNA_RET_CAN_NOT_CREATE_SECRET_KEY | 0x00D10011 | CKR_TEMPLATE_INCONSISTENT |
| LUNA_RET_CAN_NOT_CREATE_PRIVATE_KEY | 0x00D10012 | CKR_TEMPLATE_INCONSISTENT |
| LUNA_RET_SECRET_KEY_MUST_BE_SENSITIVE | 0x00130013 | CKR_ATTRIBUTE_VALUE_INVALID |
| LUNA_RET_SECRET_KEY_MUST_HAVE_SENSITIVE_ ATTRIBUTE | 0x00D00014 | CKR_TEMPLATE_INCOMPLETE |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_PRIVATE_KEY_MUST_BE_SENSITIVE | 0x00130015 | CKR_ATTRIBUTE_VALUE_INVALID |
| LUNA_RET_PRIVATE_KEY_MUST_HAVE_SENSITIVE_ ATTRIBUTE | 0x00D00016 | CKR_TEMPLATE_INCOMPLETE |
| LUNA_RET_SIGNING_KEY_MUST_BE_LOCAL | 0x00680001 | CKR_KEY_FUNCTION_NOT_ PERMITTED |
| LUNA_RET_MULTI_FUNCTION_KEYS_NOT_ALLOWED | 0x00D10018 | CKR_TEMPLATE_INCONSISTENT |
| LUNA_RET_CAN_NOT_CHANGE_KEY_FUNCTION | 0x00100019 | CKR_ATTRIBUTE_READ_ONLY |
| LUNA_RET_KEY_SIZE_RANGE | 0x00620000 | CKR_KEY_SIZE_RANGE |
| LUNA_RET_KEY_TYPE_INCONSISTENT | 0x00630000 | CKR_KEY_TYPE_INCONSISTENT |
| LUNA_RET_KEY_INVALID_FOR_OPERATION | 0x00630001 | CKR_KEY_TYPE_INCONSISTENT |
| LUNA_RET_KEY_PARITY | 0x00630002 | CKR_KEY_TYPE_INCONSISTENT |
| LUNA_RET_KEY_UNEXTRACTABLE | 0x006a0000 | CKR_KEY_UNEXTRACTABLE |
| LUNA_RET_KEY_EXTRACTABLE | 0x006a0001 | KR_KEY_UNEXTRACTABLE |
| LUNA_RET_KEY_INDIGESTIBLE | 0x00670000 | CKR_KEY_INDIGESTIBLE |
| LUNA_RET_KEY_NOT_WRAPPABLE | 0x00690000 | CKR_KEY_NOT_WRAPPABLE |
| LUNA_RET_KEY_NOT_UNWRAPPABLE | 0x00690001 | CKR_KEY_NOT_WRAPPABLE |
| LUNA_RET_ARGUMENTS_BAD | 0x00070000 | CKR_ARGUMENTS_BAD |
| LUNA_RET_INVALID_ENTRY_TYPE | 0x00070001 | CKR_INVALID_ENTRY_TYPE |
| LUNA_RET_DATA_INVALID | 0x00200000 | CKR_DATA_INVALID |
| LUNA_RET_SM_DATA_INVALID | 0x00200002 | CKR_DATA_INVALID |
| LUNA_RET_NO_RNG_SEED | 0x00200015 | CKR_DATA_INVALID |
| LUNA_RET_FUNCTION_NOT_SUPPORTED | 0x00540000 | CKR_FUNCTION_NOT_SUPPORTED |
| LUNA_RET_NO_OFFBOARD_STORAGE | 0x00540001 | CKR_FUNCTION_NOT_SUPPORTED |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_CL_COMMAND_NON_BACKUP | 0x00540002 | CKR_FUNCTION_NOT_SUPPORTED |
| LUNA_RET_BUFFER_TOO_SMALL | 0x01500000 | CKR_BUFFER_TOO_SMALL |
| LUNA_RET_DATA_LEN_RANGE | 0x00210000 | CKR_DATA_LEN_RANGE |
| LUNA_RET_GENERAL_ERROR | 0x00050000 | CKR_GENERAL_ERROR |
| LUNA_RET_DEVICE_ERROR | 0x00300000 | CKR_DEVICE_ERROR |
| LUNA_RET_UNKNOWN_COMMAND | 0x00300001 | CKR_FUNCTION_NOT_SUPPORTED |
| LUNA_RET_TOKEN_LOCKED_OUT | 0x00300002 | CKR_PIN_LOCKED |
| LUNA_RET_RNG_ERROR | 0x00300003 | CKR_DEVICE_ERROR |
| LUNA_RET_DES_SELF_TEST_FAILURE | 0x00300004 | CKR_DEVICE_ERROR |
| LUNA_RET_CAST_SELF_TEST_FAILURE | 0x00300005 | CKR_DEVICE_ERROR |
| LUNA_RET_CAST3_SELF_TEST_FAILURE | 0x00300006 | CKR_DEVICE_ERROR |
| LUNA_RET_CAST5_SELF_TEST_FAILURE | 0x00300007 | CKR_DEVICE_ERROR |
| LUNA_RET_MD2_SELF_TEST_FAILURE | 0x00300008 | CKR_DEVICE_ERROR |
| LUNA_RET_MD5_SELF_TEST_FAILURE | 0x00300009 | CKR_DEVICE_ERROR |
| LUNA_RET_SHA_SELF_TEST_FAILURE | 0x0030000a | CKR_DEVICE_ERROR |
| LUNA_RET_RSA_SELF_TEST_FAILURE | 0x0030000b | CKR_DEVICE_ERROR |
| LUNA_RET_RC2_SELF_TEST_FAILURE | 0x0030000c | CKR_DEVICE_ERROR |
| LUNA_RET_RC4_SELF_TEST_FAILURE | 0x0030000d | CKR_DEVICE_ERROR |
| LUNA_RET_RC5_SELF_TEST_FAILURE | 0x0030000e | CKR_DEVICE_ERROR |
| LUNA_RET_SO_LOGIN_FAILURE_THRESHOLD | 0x0030000f | CKR_SO_LOGIN_FAILURE_ THRESHOLD |
| LUNA_RET_RNG_SELF_TEST_FAILURE | 0x00300010 | CKR_DEVICE_ERROR |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_SM_UNKNOWN_COMMAND | 0x00300011 | CKR_DEVICE_ERROR |
| LUNA_RET_UM_TSN_MISSING | 0x00300012 | CKR_DEVICE_ERROR |
| LUNA_RET_SM_TSV_MISSING | 0x00300013 | CKR_DEVICE_ERROR |
| LUNA_RET_SM_UNKNOWN_TOSM_STATE | 0x00300014 | CKR_DEVICE_ERROR |
| LUNA_RET_DSA_PARAM_GEN_FAILURE | 0x00300015 | CKR_DEVICE_ERROR |
| LUNA_RET_DSA_SELF_TEST_FAILURE | 0x00300016 | CKR_DEVICE_ERROR |
| LUNA_RET_SEED_SELF_TEST_FAILURE | 0x00300017 | CKR_DEVICE_ERROR |
| LUNA_RET_AES_SELF_TEST_FAILURE | 0x00300018 | CKR_DEVICE_ERROR |
| LUNA_RET_FUNCTION_NOT_SUPPORTED_BY_ HARDWARE | 0x00300019 | CKR_DEVICE_ERROR |
| LUNA_RET_HAS160_SELF_TEST_FAILURE | 0x0030001a | CKR_DEVICE_ERROR |
| LUNA_RET_KCDSA_PARAM_GEN_FAILURE | 0x0030001b | CKR_DEVICE_ERROR |
| LUNA_RET_KCDSA_SELF_TEST_FAILURE | 0x0030001c | CKR_DEVICE_ERROR |
| LUNA_RET_HSM_INTERNAL_BUFFER_TOO_SMALL | 0x0030001d | CKR_DEVICE_ERROR |
| LUNA_RET_COUNTER_WRAPAROUND | 0x0030001e | CKR_DEVICE_ERROR |
| LUNA_RET_TIMEOUT | 0x0030001f | CKR_TIMEOUT |
| LUNA_RET_NOT_READY | 0x00300020 | CKR_DEVICE_ERROR |
| LUNA_RET_RETRY | 0x00300021 | CKR_DEVICE_ERROR |
| LUNA_RET_SHA1_RSA_SELF_TEST_FAILURE | 0x00300022 | CKR_DEVICE_ERROR |
| LUNA_RET_SELF_TEST_FAILURE | 0x00300023 | CKR_DEVICE_ERROR |
| LUNA_RET_INCOMPATIBLE | 0x00300024 | CKR_DEVICE_ERROR |
| LUNA_RET_RIPEMD160_SELF_TEST_FAILURE | 0x00300034 | CKR_DEVICE_ERROR |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_TOKEN_LOCKED_OUT_CL | 0x00300100 | CKR_DEVICE_ERROR |
| LUNA_RET_TOKEN_LOCKED_OUT_MM | 0x00300101 | CKR_DEVICE_ERROR |
| LUNA_RET_TOKEN_LOCKED_OUT_UM | 0x00300102 | CKR_DEVICE_ERROR |
| LUNA_RET_TOKEN_LOCKED_OUT_SM | 0x00300103 | CKR_DEVICE_ERROR |
| LUNA_RET_TOKEN_LOCKED_OUT_RN | 0x00300104 | CKR_DEVICE_ERROR |
| LUNA_RET_TOKEN_LOCKED_OUT_CA | 0x00300105 | CKR_DEVICE_ERROR |
| LUNA_RET_TOKEN_LOCKED_OUT_PM | 0x00300106 | CKR_DEVICE_ERROR |
| LUNA_RET_TOKEN_LOCKED_OUT_OH | 0x00300107 | CKR_DEVICE_ERROR |
| LUNA_RET_TOKEN_LOCKED_OUT_CCM | 0x00300108 | CKR_DEVICE_ERROR |
| LUNA_RET_TOKEN_LOCKED_OUT_SHA_DIGEST | 0x00300109 | CKR_DEVICE_ERROR |
| LUNA_RET_SM_ACCESS_REALLOC_ERROR | 0x00310101 | CKR_DEVICE_ERROR |
| LUNA_RET_SM_SESSION_REALLOC_ERROR | 0x00310102 | CKR_DEVICE_ERROR |
| LUNA_RET_SM_MEMORY_ALLOCATION_ERROR | 0x00310103 | CKR_DEVICE_ERROR |
| LUNA_RET_ENCRYPTED_DATA_INVALID | 0x00400000 | CKR_ENCRYPTED_DATA_INVALID |
| LUNA_RET_ENCRYPTED_DATA_LEN_RANGE | 0x00410000 | CKR_ENCRYPTED_DATA_LEN_RANGE |
| LUNA_RET_FUNCTION_CANCELED | 0x00500000 | CKR_FUNCTION_CANCELED |
| LUNA_RET_KEY_HANDLE_INVALID | 0x00600000 | CKR_KEY_HANDLE_INVALID |
| LUNA_RET_MECHANISM_INVALID | 0x00700000 | CKR_MECHANISM_INVALID |
| LUNA_RET_MECHANISM_PARAM_INVALID | 0x00710000 | CKR_MECHANISM_PARAM_INVALID |
| LUNA_RET_OPERATION_ACTIVE | 0x00900000 | CKR_OPERATION_ACTIVE |
| LUNA_RET_OPERATION_NOT_INITIALIZED | 0x00910000 | CKR_OPERATION_NOT_INITIALIZED |
| LUNA_RET_UM_PIN_INCORRECT | 0x00a00000 | CKR_PIN_INCORRECT |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_UM_PIN_INCORRECT_CONTAINER_ ZEROIZED | 0x00a00001 | CKR_PIN_INCORRECT |
| LUNA_RET_UM_PIN_INCORRECT_CONTAINER_ LOCKED | 0x00a00002 | CKR_PIN_INCORRECT |
| LUNA_RET_UM_PIN_LEN_RANGE | 0x00a20000 | CKR_PIN_LEN_RANGE |
| LUNA_RET_SM_PIN_EXPIRED | 0x00a30000 | CKR_PIN_EXPIRED |
| LUNA_RET_SM_EXCLUSIVE_SESSION_EXISTS | 0x00b20000 | CKR_SESSION_EXCLUSIVE_EXISTS |
| LUNA_RET_SM_SESSION_HANDLE_INVALID | 0x00b30000 | CKR_SESSION_HANDLE_INVALID |
| LUNA_RET_SIGNATURE_INVALID | 0x00c00000 | CKR_SIGNATURE_INVALID |
| LUNA_RET_SIGNATURE_LEN_RANGE | 0x00c10000 | CKR_SIGNATURE_LEN_RANGE |
| LUNA_RET_UNWRAPPING_KEY_HANDLE_INVALID | 0x00f00000 | CKR_UNWRAPPING_KEY_HANDLE_ INVALID |
| LUNA_RET_UNWRAPPING_KEY_SIZE_RANGE | 0x00f10000 | CKR_UNWRAPPING_KEY_SIZE_RANGE |
| LUNA_RET_UNWRAPPING_KEY_TYPE_INCONSISTENT | 0x00f20000 | CKR_UNWRAPPING_KEY_TYPE_ INCONSISTENT |
| LUNA_RET_USER_ALREADY_LOGGED_IN | 0x01000000 | CKR_USER_ALREADY_LOGGED_IN |
| LUNA_RET_SM_OTHER_USER_LOGGED_IN | 0x01000001 | CKR_USER_ALREADY_LOGGED_IN |
| LUNA_RET_USER_NOT_LOGGED_IN | 0x01010000 | CKR_USER_NOT_LOGGED_IN |
| LUNA_RET_SM_NOT_LOGGED_IN | 0x01010001 | CKR_USER_NOT_LOGGED_IN |
| LUNA_RET_USER_PIN_NOT_INITIALIZED | 0x01020000 | CKR_USER_PIN_NOT_INITIALIZED |
| LUNA_RET_USER_TYPE_INVALID | 0x01030000 | CKR_USER_TYPE_INVALID |
| LUNA_RET_WRAPPED_KEY_INVALID | 0x01100000 | CKR_WRAPPED_KEY_INVALID |
| LUNA_RET_WRAPPED_KEY_LEN_RANGE | 0x01120000 | CKR_WRAPPED_KEY_LEN_RANGE |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_WRAPPING_KEY_HANDLE_INVALID | 0x01130000 | CKR_WRAPPING_KEY_HANDLE_ INVALID |
| LUNA_RET_WRAPPING_KEY_SIZE_RANGE | 0x01140000 | CKR_WRAPPING_KEY_SIZE_RANGE |
| LUNA_RET_WRAPPING_KEY_TYPE_INCONSISTENT | 0x01150000 | CKR_WRAPPING_KEY_TYPE_ INCONSISTENT |
| LUNA_RET_CERT_VERSION_NOT_SUPPORTED | 0x00300300 | CKR_DEVICE_ERROR |
| LUNA_RET_SIM_AUTHFORM_INVALID | 0x0020011e | CKR_SIM_AUTHFORM_INVALID |
| LUNA_RET_CCM_TOO_LARGE | 0x00210001 | CKR_DATA_LEN_RANGE |
| LUNA_RET_TEST_VS_BSAFE_FAILED | 0x00300820 | CKR_DEVICE_ERROR |
| LUNA_RET_SFNT3120_ERROR | 0x00300821 | CKR_DEVICE_ERROR |
| LUNA_RET_SFNT3120_SELFTEST_FAILED | 0x00300822 | CKR_DEVICE_ERROR |
| LUNA_RET_SFNT3120_CRC | 0x00300823 | CKR_DEVICE_ERROR |
| LUNA_RET_SFNT3120_ALG_NO_SOFTWARE_ SUPPORT | 0x00300824 | CKR_DEVICE_ERROR |
| LUNA_RET_ISES_ERROR | 0x00300880 | CKR_DEVICE_ERROR |
| LUNA_RET_ISES_INIT_FAILED | 0x00300881 | CKR_DEVICE_ERROR |
| LUNA_RET_ISES_LNAU_TEST_FAILED | 0x00300882 | CKR_DEVICE_ERROR |
| LUNA_RET_ISES_RNG_TEST_FAILED | 0x00300883 | CKR_DEVICE_ERROR |
| LUNA_RET_ISES_CMD_FAILED | 0x00300884 | CKR_DEVICE_ERROR |
| LUNA_RET_ISES_CMD_PARAMETER_INVALID | 0x00300885 | CKR_DEVICE_ERROR |
| LUNA_RET_ISES_TEST_VS_BSAFE_FAILED | 0x00300886 | CKR_DEVICE_ERROR |
| LUNA_RET_RM_ELEMENT_VALUE_INVALID | 0x00200a00 | CKR_DATA_INVALID |
| LUNA_RET_RM_ELEMENT_ID_INVALID | 0x00200a01 | CKR_DATA_INVALID |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_RM_NO_MEMORY | 0x00310a02 | CKR_DEVICE_MEMORY |
| LUNA_RET_RM_BAD_HSM_PARAMS | 0x00300a03 | CKR_DEVICE_ERROR |
| LUNA_RET_RM_POLICY_ELEMENT_DESTRUCTIVE | 0x00200a04 | CKR_DATA_INVALID |
| LUNA_RET_RM_POLICY_ELEMENT_NOT_ DESTRUCTIVE | 0x00200a05 | CKR_DATA_INVALID |
| LUNA_RET_RM_CONFIG_CHANGE_ILLEGAL | 0x00010a06 | CKR_CANCEL |
| LUNA_RET_RM_CONFIG_CHANGE_FAILS_ DEPENDENCIES | 0x00010a07 | CKR_CANCEL |
| LUNA_RET_LICENSE_ID_UNKNOWN | 0x00200a08 | CKR_DATA_INVALID |
| LUNA_RET_LICENSE_CAPACITY_EXCEEDED | 0x00010a09 | CKR_LICENSE_CAPACITY_EXCEEDED |
| LUNA_RET_RM_POLICY_WRITE_RESTRICTED | 0x00010a0a | CKR_CANCEL |
| LUNA_RET_OPERATION_RESTRICTED | 0x00010a0b | CKR_OPERATION_NOT_ALLOWED |
| LUNA_RET_CANNOT_PERFORM_OPERATION_TWICE | 0x00010a0c | CKR_CANCEL |
| LUNA_RET_BAD_PPID | 0x00200a0d | CKR_DATA_INVALID |
| LUNA_RET_BAD_FW_VERSION | 0x00200a0e | CKR_DATA_INVALID |
| LUNA_RET_OPERATION_SHOULD_BE_DESTRUCTIVE | 0x00200a0f | CKR_DATA_INVALID |
| LUNA_RET_RM_CONFIG_ILLEGAL | 0x00200a10 | CKR_DATA_INVALID |
| LUNA_RET_BAD_SN | 0x00200a11 | CKR_DATA_INVALID |
| LUNA_RET_CHALLENGE_TYPE_INVALID | 0x00200b00 | CKR_DATA_INVALID |
| LUNA_RET_CHALLENGE_REQUIRES_PED | 0x00010b01 | CKR_CANCEL |
| LUNA_RET_CHALLENGE_NOT_REQUIRED | 0x00010b02 | CKR_CANCEL |
| LUNA_RET_CHALLENGE_RESPONSE_INCORRECT | 0x00a00b03 | CKR_PIN_INCORRECT |
| LUNA_RET_OH_OBJECT_VERSION_INVALID | 0x00300c00 | CKR_DEVICE_ERROR |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_OH_OBJECT_TYPE_INVALID | 0x00300c01 | CKR_DEVICE_ERROR |
| LUNA_RET_OH_OBJECT_ALREADY_EXISTS | 0x00010c02 | CKR_CANCEL |
| LUNA_RET_OH_OBJECT_OWNER_DOES_NOT_EXIST | 0x00200c03 | CKR_DATA_INVALID |
| LUNA_RET_STORAGE_TYPE_INCONSISTENT | 0x00200c04 | CKR_DATA_INVALID |
| LUNA_RET_CONTAINER_CAN_NOT_HAVE_MEMBERS | 0x00200c05 | CKR_DATA_INVALID |
| LUNA_RET_SAVED_STATE_INVALID | 0x01600000 | CKR_SAVED_STATE_INVALID |
| LUNA_RET_STATE_UNSAVEABLE | 0x01800000 | CKR_STATE_UNSAVEABLE |
| LUNA_RET_ERROR | 0x80000000 | CKR_GENERAL_ERROR |
| LUNA_RET_CONTAINER_HANDLE_INVALID | 0x80000001 | CKR_CONTAINER_HANDLE_INVALID |
| LUNA_RET_INVALID_PADDING_TYPE | 0x80000002 | CKR_DATA_INVALID |
| LUNA_RET_NOT_FOUND | 0x80000007 | CKR_FUNCTION_FAILED |
| LUNA_RET_TOO_MANY_CONTAINERS | 0x80000008 | CKR_TOO_MANY_CONTAINERS |
| LUNA_RET_CONTAINER_LOCKED | 0x80000009 | CKR_PIN_LOCKED |
| LUNA_RET_CONTAINER_IS_DISABLED | 0x8000000a | CKR_PARTITION_DISABLED |
| LUNA_RET_SECURITY_PARAMETER_MISSING | 0x8000000b | CKR_SECURITY_PARAMETER_ MISSING |
| LUNA_RET_DEVICE_TIMEOUT | 0x8000000c | CKR_DEVICE_TIMEOUT |
| LUNA_RET_OBJECT_DELETED | 0x8000000d | HSM Internal ONLY |
| LUNA_RET_INVALID_FUF_TARGET | 0x8000000e | CKR_INVALID_FUF_TARGET |
| LUNA_RET_INVALID_FUF_HEADER | 0x8000000f | CKR_INVALID_FUF_HEADER |
| LUNA_RET_INVALID_FUF_VERSION | 0x80000010 | CKR_INVALID_FUF_VERSION |
| LUNA_RET_KCV_PARAMETER_ALREADY_EXISTS | 0x80000100 | CKR_CLONING_PARAMETER_ ALREADY_EXISTS |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_KCV_PARAMETER_COULD_NOT_BE_ADDED | 0x80000101 | CKR_DEVICE_MEMORY |
| LUNA_RET_INVALID_CERTIFICATE_DATA | 0x80000102 | CKR_CERTIFICATE_DATA_INVALID |
| LUNA_RET_INVALID_CERTIFICATE_TYPE | 0x80000103 | CKR_CERTIFICATE_DATA_INVALID |
| LUNA_RET_INVALID_CERTIFICATE_VERSION | 0x80000104 | CKR_CERTIFICATE_DATA_INVALID |
| LUNA_RET_INVALID_MODULUS_SIZE | 0x80000105 | CKR_ATTRIBUTE_VALUE_INVALID |
| LUNA_RET_WRAPPING_ERROR | 0x80000107 | CKR_WRAPPING_ERROR |
| LUNA_RET_UNWRAPPING_ERROR | 0x80000108 | CKR_UNWRAPPING_ERROR |
| LUNA_RET_INVALID_PRIVATE_KEY_TYPE | 0x80000109 | CKR_DATA_INVALID |
| LUNA_RET_TSN_MISMATCH | 0x8000010a | CKR_DATA_INVALID |
| LUNA_RET_KCV_PARAMETER_MISSING | 0x8000010b | CKR_CLONING_PARAMETER_MISSING |
| LUNA_RET_TWC_PARAMETER_MISSING | 0x8000010c | CKR_CERTIFICATE_DATA_MISSING |
| LUNA_RET_TUK_PARAMETER_MISSING | 0x8000010d | CKR_CERTIFICATE_DATA_MISSING |
| LUNA_RET_CPK_PARAMETER_MISSING | 0x8000010e | CKR_KEY_NEEDED |
| LUNA_RET_MASKING_NOT_SUPPORTED | 0x8000010f | CKR_FUNCTION_NOT_SUPPORTED |
| LUNA_RET_INVALID_ACCESS_LEVEL | 0x80000110 | CKR_ARGUMENTS_BAD |
| LUNA_RET_MAC_MISSING | 0x80000111 | CKR_MAC_MISSING |
| LUNA_RET_DAC_POLICY_PID_MISMATCH | 0x80000112 | CKR_DAC_POLICY_PID_MISMATCH |
| LUNA_RET_DAC_MISSING | 0x80000113 | CKR_DAC_MISSING |
| LUNA_RET_BAD_DAC | 0x80000114 | CKR_BAD_DAC |
| LUNA_RET_SSK_MISSING | 0x80000115 | CKR_SSK_MISSING |
| LUNA_RET_BAD_MAC | 0x80000116 | CKR_BAD_MAC |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_DAK_MISSING | 0x80000117 | CKR_DAK_MISSING |
| LUNA_RET_BAD_DAK | 0x80000118 | CKR_BAD_DAK |
| LUNA_RET_HOK_MISSING | 0x80000119 | CKR_CERTIFICATE_DATA_MISSING |
| LUNA_RET_CITS_DAK_MISSING | 0x8000011a | CKR_CITS_DAK_MISSING |
| LUNA_RET_SIM_AUTHORIZATION_FAILED | 0x8000011b | CKR_SIM_AUTHORIZATION_FAILED |
| LUNA_RET_SIM_VERSION_UNSUPPORTED | 0x8000011c | CKR_SIM_VERSION_UNSUPPORTED |
| LUNA_RET_SIM_CORRUPT_DATA | 0x8000011d | CKR_SIM_CORRUPT_DATA |
| LUNA_RET_ECC_MIC_MISSING | 0x8000011e | CKR_CERTIFICATE_DATA_MISSING |
| LUNA_RET_ECC_HOK_MISSING | 0x8000011f | CKR_CERTIFICATE_DATA_MISSING |
| LUNA_RET_ECC_HOC_MISSING | 0x80000120 | CKR_CERTIFICATE_DATA_MISSING |
| LUNA_RET_ECC_DAK_MISSING | 0x80000121 | CKR_CERTIFICATE_DATA_MISSING |
| LUNA_RET_ECC_DAC_MISSING | 0x80000122 | CKR_CERTIFICATE_DATA_MISSING |
| LUNA_RET_ROOT_CERT_MISSING | 0x80000123 | CKR_CERTIFICATE_DATA_MISSING |
| LUNA_RET_HOC_MISSING | 0x80000124 | CKR_CERTIFICATE_DATA_MISSING |
| LUNA_RET_INVALID_CERTIFICATE_FUNCTION | 0x80000125 | CKR_CERTIFICATE_DATA_INVALID |
| LUNA_RET_N_TOO_LARGE | 0x80000200 | CKR_ARGUMENTS_BAD |
| LUNA_RET_N_TOO_SMALL | 0x80000201 | CKR_ARGUMENTS_BAD |
| LUNA_RET_M_TOO_LARGE | 0x80000202 | CKR_ARGUMENTS_BAD |
| LUNA_RET_M_TOO_SMALL | 0x80000203 | CKR_ARGUMENTS_BAD |
| LUNA_RET_WEIGHT_TOO_LARGE | 0x80000204 | CKR_ARGUMENTS_BAD |
| LUNA_RET_WEIGHT_TOO_SMALL | 0x80000205 | CKR_ARGUMENTS_BAD |
| LUNA_RET_TOTAL_WEIGHT_INVALID | 0x80000206 | CKR_ARGUMENTS_BAD |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_MISSING_SPLITS | 0x80000207 | CKR_ARGUMENTS_BAD |
| LUNA_RET_SPLIT_DATA_INVALID | 0x80000208 | CKR_ARGUMENTS_BAD |
| LUNA_RET_SPLIT_ID_INVALID | 0x80000209 | CKR_ARGUMENTS_BAD |
| LUNA_RET_M_OF_N_PARAMETER_NOT_AVAILABLE | 0x8000020a | CKR_OPERATION_NOT_INITIALIZED |
| LUNA_RET_M_OF_N_ACTIVATION_REQUIRED | 0x8000020b | CKR_OPERATION_NOT_INITIALIZED |
| LUNA_RET_TOO_MANY_WEIGHTS | 0x8000020e | CKR_ARGUMENTS_BAD |
| LUNA_RET_MISSING_WEIGHT_VALUE | 0x8000020f | CKR_ARGUMENTS_BAD |
| LUNA_RET_MISSING_VALUE_FOR_M | 0x80000210 | CKR_ARGUMENTS_BAD |
| LUNA_RET_MISSING_VALUE_FOR_N | 0x80000211 | CKR_ARGUMENTS_BAD |
| LUNA_RET_MISSING_NUMBER_OF_VECTORS | 0x80000212 | CKR_ARGUMENTS_BAD |
| LUNA_RET_MISSING_VECTOR | 0x80000213 | CKR_ARGUMENTS_BAD |
| LUNA_RET_VECTOR_TOO_LARGE | 0x80000214 | CKR_ARGUMENTS_BAD |
| LUNA_RET_VECTOR_TOO_SMALL | 0x80000215 | CKR_ARGUMENTS_BAD |
| LUNA_RET_TOO_MANY_VECTORS_PROVIDED | 0x80000216 | CKR_ARGUMENTS_BAD |
| LUNA_RET_INVALID_VECTOR_SIZE | 0x80000217 | CKR_ARGUMENTS_BAD |
| LUNA_RET_M_OF_N_PARAMETER_EXIST | 0x80000218 | CKR_FUNCTION_FAILED |
| LUNA_RET_VECTOR_VERSION_INVALID | 0x80000219 | CKR_DATA_INVALID |
| LUNA_RET_VECTOR_OF_DIFFERENT_SET | 0x8000021a | CKR_ARGUMENTS_BAD |
| LUNA_RET_VECTOR_DUPLICATE | 0x8000021b | CKR_ARGUMENTS_BAD |
| LUNA_RET_VECTOR_TYPE_INVALID | 0x8000021c | CKR_ARGUMENTS_BAD |
| LUNA_RET_MISSING_COMMAND_PARAMETER | 0x8000021d | CKR_ARGUMENTS_BAD |
| LUNA_RET_M_OF_N_CLONING_IS_NOT_ALLOWED | 0x8000021e | CKR_FUNCTION_NOT_SUPPORTED |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_M_OF_N_IS_NOT_REQUIRED | 0x8000021f | CKR_OPERATION_NOT_INITIALIZED |
| LUNA_RET_M_OF_N_IS_NOT_INITIALZED | 0x80000220 | CKR_OPERATION_NOT_INITIALIZED |
| LUNA_RET_M_OF_N_SECRET_INVALID | 0x80000221 | CKR_GENERAL_ERROR |
| LUNA_RET_CCM_NOT_PRESENT | 0x80000300 | CKR_FUNCTION_NOT_SUPPORTED |
| LUNA_RET_CCM_NOT_SUPPORTED | 0x80000301 | CKR_FUNCTION_NOT_SUPPORTED |
| LUNA_RET_CCM_UNREMOVABLE | 0x80000302 | CKR_DATA_INVALID |
| LUNA_RET_CCM_CERT_INVALID | 0x80000303 | CKR_DATA_INVALID |
| LUNA_RET_CCM_SIGN_INVALID | 0x80000304 | CKR_DATA_INVALID |
| LUNA_RET_CCM_UPDATE_DENIED | 0x80000305 | CKR_DATA_INVALID |
| LUNA_RET_CCM_FWUPDATE_DENIED | 0x80000306 | CKR_DATA_INVALID |
| LUNA_RET_SM_ACCESS_ID_INVALID | 0x80000400 | CKR_DATA_INVALID |
| LUNA_RET_SM_ACCESS_ALREADY_EXISTS | 0x80000401 | CKR_DATA_INVALID |
| LUNA_RET_SM_MULTIPLE_ACCESS_DISABLED | 0x80000402 | CKR_FUNCTION_NOT_SUPPORTED |
| LUNA_RET_SM_UNKNOWN_ACCESS_TYPE | 0x80000403 | CKR_ARGUMENTS_BAD |
| LUNA_RET_SM_BAD_ACCESS_HANDLE | 0x80000404 | CKR_DATA_INVALID |
| LUNA_RET_SM_BAD_CONTEXT_NUMBER | 0x80000405 | CKR_DATA_INVALID |
| LUNA_RET_SM_UNKNOWN_SESSION_TYPE | 0x80000406 | CKR_DATA_INVALID |
| LUNA_RET_SM_CONTEXT_ALREADY_ALLOCATED | 0x80000407 | CKR_DATA_INVALID |
| LUNA_RET_SM_CONTEXT_NOT_ALLOCATED | 0x80000408 | CKR_DEVICE_MEMORY |
| LUNA_RET_SM_CONTEXT_BUFFER_OVERFLOW | 0x80000409 | CKR_DEVICE_MEMORY |
| LUNA_RET_SM_TOSM_DOES_NOT_VALIDATE | 0x8000040A | CKR_USER_NOT_LOGGED_IN |
| LUNA_RET_SM_ACCESS_DOES_NOT_VALIDATE | 0x8000040B | CKR_USER_NOT_AUTHORIZED |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_MTK_ZEROIZED | 0x80000531 | CKR_MTK_ZEROIZED |
| LUNA_RET_MTK_STATE_INVALID | 0x80000532 | CKR_MTK_STATE_INVALID |
| LUNA_RET_MTK_SPLIT_INVALID | 0x80000533 | CKR_MTK_SPLIT_INVALID |
| LUNA_RET_INVALID_IP_PACKET | 0x80000600 | CKR_DEVICE_ERROR |
| LUNA_RET_INVALID_BOARD_TYPE | 0x80000700 | CKR_DEVICE_ERROR |
| LUNA_RET_ECC_NOT_SUPPORTED | 0x80000601 | CKR_FUNCTION_NOT_SUPPORTED |
| LUNA_RET_ECC_BUFFER_OVERFLOW | 0x80000602 | CKR_DEVICE_ERROR |
| LUNA_RET_ECC_POINT_INVALID | 0x80000603 | CKR_ECC_POINT_INVALID** |
| LUNA_RET_ECC_SELF_TEST_FAILURE | 0x80000604 | CKR_DEVICE_ERROR |
| LUNA_RET_ECC_UNKNOWN_CURVE | 0x80000605 | CKR_ECC_UNKNOWN_CURVE |
| LUNA_RET_HA_NOT_SUPPORTED | 0x80000900 | CKR_FUNCTION_NOT_SUPPORTED |
| LUNA_RET_HA_USER_NOT_INITIALIZED | 0x80000901 | CKR_OPERATION_NOT_INITIALIZED |
| LUNA_RET_HSM_STORAGE_FULL | 0x80000902 | CKR_HSM_STORAGE_FULL |
| LUNA_RET_CONTAINER_OBJECT_STORAGE_FULL | 0x80000903 | CKR_CONTAINER_OBJECT_STORAGE_FULL |
| LUNA_RET_KEY_NOT_ACTIVE | 0x80000904 | CKR_KEY_NOT_ACTIVE |
| LUNA_RET_CB_NOT_SUPPORTED | 0x80000a01 | CKR_FUNCTION_NOT_SUPPORTED |
| LUNA_RET_CB_PARAM_INVALID | 0x80000a02 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_NO_MEMORY | 0x80000a03 | CKR_DEVICE_MEMORY |
| LUNA_RET_CB_TIMEOUT | 0x80000a04 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_RETRY | 0x80000a05 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_ABORTED | 0x80000a06 | CKR_CALLBACK_ERROR |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_CB_SYS_ERROR | 0x80000a07 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_HIOS_HANDLE_INVALID | 0x80000a10 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_HIOS_ID_INVALID | 0x80000a11 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_HIOS_CLOSED | 0x80000a12 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_HIOS_CANCELED | 0x80000a13 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_HIOS_IO_ERROR | 0x80000a14 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_HIOS_SEND_TIMEOUT | 0x80000a15 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_HIOS_RECV_TIMEOUT | 0x80000a16 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_HIOS_STATE_INVALID | 0x80000a17 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_HIOS_OUTPUT_BUFFER_TOO_SMALL | 0x80000a18 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_HIOS_INPUT_BUFFER_TOO_SMALL | 0x80000a19 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_HANDLE_INVALID | 0x80000a20 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_ID_INVALID | 0x80000a21 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_REMOTE_ABORT | 0x80000a22 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_REMOTE_CLOSED | 0x80000a23 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_REMOTE_ABANDONED | 0x80000a24 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_MUST_READ | 0x80000a25 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_MUST_WRITE | 0x80000a26 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_INVALID_CALL_FOR_THE_STATE | 0x80000a27 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_SYNC_ERROR | 0x80000a28 | CKR_CALLBACK_ERROR |
| LUNA_RET_CB_PROT_DATA_INVALID | 0x80000a29 | CKR_CALLBACK_ERROR |
| LUNA_RET_LOG_FILE_NOT_OPEN | 0x80000d00 | CKR_LOG_FILE_NOT_OPEN |

| HSM Error | Hex Code | PKCS#11 or SFNT Defined CKR Error |
|---|---|---|
| LUNA_RET_LOG_FILE_WRITE_ERROR | 0x80000d01 | CKR_LOG_FILE_WRITE_ERROR |
| LUNA_RET_LOG_BAD_FILE_NAME | 0x80000d02 | CKR_LOG_BAD_FILE_NAME |
| LUNA_RET_LOG_FULL | 0x80000d03 | CKR_LOG_FULL |
| LUNA_RET_LOG_NO_KCV | 0x80000d04 | CKR_LOG_NO_KCV |
| LUNA_RET_LOG_BAD_RECORD_HMAC | 0x80000d05 | CKR_LOG_BAD_RECORD_HMAC |
| LUNA_RET_LOG_BAD_TIME | 0x80000d06 | CKR_LOG_BAD_TIME |
| LUNA_RET_LOG_AUDIT_NOT_INITIALIZED | 0x80000d07 | CKR_LOG_AUDIT_NOT_INITIALIZED |
| LUNA_RET_LOG_RESYNC_NEEDED | 0x80000d08 | CKR_LOG_RESYNC_NEEDED |
| LUNA_RET_AUDIT_LOGIN_TIMEOUT_IN_PROGRESS | 0x80000d09 | CKR_AUDIT_LOGIN_TIMEOUT_IN_PROGRESS |
| LUNA_RET_AUDIT_LOGIN_FAILURE_THRESHOLD | 0x80000d0a | CKR_AUDIT_LOGIN_FAILURE_THRESHOLD |
| LUNA_RET_XTC_ERROR | 0x80001600 | CKR_XTC_ERROR |
| LUNA_RET_CONTEXT_INVALID | 0x80001601 | CKR_CONTEXT_INVALID |
| LUNA_RET_SESSION_COUNT | 0x80001603 | CKR_MAX_SESSION_COUNT |
| LUNA_RET_BUSY | 0x80001604 | CKR_BUSY |

* This error (CKR_TEMPLATE_INCONSISTENT) might be encountered when using CKDemo in a new client with firmware older than version 6.22.0. Try CKDemo option 98, sub-option 16. If it is set to "enhanced roles", try selecting it to set it to "legacy Luna roles". The setting is a toggle, and flips every time you select it.

** This error, or "unable to read public key", might be encountered when using BSAFE to encrypt data with ECC public key using curves from the Brainpool suite. As indicated on the BSAFE website (May 2012) they do not appear to support Brainpool curves. Therefore, your own applications should not attempt that combination, and you should avoid attempting to specify Brainpool curves with BSAFE ECC when using the Luna CKDemo utility.

† These errors (0x00310000 through 0x00310007) are all considered as the same generic CKR_DEVICE_MEMORY error *by a host application*. They are visible using Luna HSM Firmware 7.8.1 or newer. Your application is responsible for closing crypto sessions and releasing resources when they are no longer being used. Failure to do so allows accumulating orphan sessions to eventually consume all available HSM memory. The HSM has no way to know that any given session is no longer needed, unless your application explicitly closes the session. If a solution/application mixes Java and C/C++ operations, those might not agree on when sessions are to close.

**Workaround:** If you are seeing device memory errors in the logs, consider:

1. Stopping your application (so that it does not continue attempting cryptographic operations against the HSM)
2. Restarting the HSM to clear any orphan sessions or processes (use hsm restart to restart the HSM)
3. Restarting your application.

> **NOTE** This is a temporary measure to clear the effects of application behavior that should be corrected, or the problem can recur. Contact your application vendor to report the memory issue.

## Library Codes

| Hex value | Decimal value | Return code/error description |
|---|---|---|
| 0 | 0 | OKAY, NO ERROR |
| 0xC0000000 | 3221225472 | PROGRAMMING ERROR: RETURN CODE |
| 0xC0000001 | 3221225473 | OUT OF MEMORY |
| 0xC0000002 | 3221225474 | NON-SPECIFIC ERROR |
| 0xC0000003 | 3221225475 | UNEXPECTED NULL POINTER |
| 0xC0000004 | 3221225476 | PROGRAMMING ERROR: LOGIC |
| 0xC0000005 | 3221225477 | OPERATION WOULD BLOCK IF ATTEMPTED |
| 0xC0000006 | 3221225478 | BUFFER IS TOO SMALL |
| 0xC0000100 | 3221225728 | OPERATION CANCEL |
| 0xC0000101 | 3221225729 | INVALID SLOT IDENTIFIER |
| 0xC0000102 | 3221225730 | INVALID DATA |
| 0xC0000103 | 3221225731 | INVALID PIN |
| 0xC0000104 | 3221225732 | NO TOKEN PRESENT |
| 0xC0000105 | 3221225733 | FUNCTION IS NOT SUPPORTED |
| 0xC0000106 | 3221225734 | NON-CRYPTOKI ELEMENT CLONE |
| 0xC0000107 | 3221225735 | INVALID BUFFER SIZE FOR CHALLENGE |

| Hex value | Decimal value | Return code/error description |
|---|---|---|
| 0xC0000108 | 3221225736 | PIN IS LOCKED |
| 0xC0000109 | 3221225737 | INVALID VERSION |
| 0xC000010a | 3221225738 | NEEDED KEY NOT PROVIDED |
| 0xC000010b | 3221225739 | USER NAME IS IN USE |
| 0xC0000200 | 3221225984 | INVALID DISTINGUISHED ENCODING RULES CLASS |
| 0xC0000303 | 3221226243 | OPERATION TIMED OUT |
| 0xC0000304 | 3221226244 | RESET FAILED |
| 0xC0000400 | 3221226496 | INVALID TOKEN STATE |
| 0xC0000401 | 3221226497 | DATA APPEARS CORRUPTED |
| 0xC0000402 | 3221226498 | INVALID FILENAME |
| 0xC0000403 | 3221226499 | FILE IS READ-ONLY |
| 0xC0000404 | 3221226500 | FILE ERROR |
| 0xC0000405 | 3221226501 | INVALID OBJECT IDENTIFIER |
| 0xC0000406 | 3221226502 | INVALID SOCKET ADDRESS |
| 0xC0000407 | 3221226503 | INVALID LISTEN SOCKET |
| 0xC0000408 | 3221226504 | CACHE IS NOT CURRENT |
| 0xC0000409 | 3221226505 | CACHE IS NOT MAPPED |
| 0xC000040a | 3221226506 | OBJECT IS NOT IN LIST |
| 0xC000040b | 3221226507 | INVALID INDEX |
| 0xC000040c | 3221226508 | OBJECT ALREADY EXISTS |
| 0xC000040d | 3221226509 | SEMAPHORE ERROR |
| 0xC000040e | 3221226510 | END OF LIST ENCOUNTERED |

| Hex value | Decimal value | Return code/error description |
|---|---|---|
| 0xC000040f | 3221226511 | WOULD ASSIGN SAME VALUE |
| 0xC0000410 | 3221226512 | INVALID GROUP NAME |
| 0xC0000411 | 3221226513 | NOT HSM BACKUP TOKEN |
| 0xC0000412 | 3221226514 | NOT PARTITION BACKUP TOKEN |
| 0xC0000413 | 3221226515 | SIM NOT SUPPORTED |
| 0xC0000500 | 3221226752 | SOCKET ERROR |
| 0xC0000501 | 3221226753 | SOCKET WRITE ERROR |
| 0xC0000502 | 3221226754 | SOCKET READ ERROR |
| 0xC0000503 | 3221226755 | CLIENT MESSAGE ERROR |
| 0xC0000504 | 3221226756 | SERVER DISCONNECTED |
| 0xC0000505 | 3221226757 | CLIENT DISCONNECTED |
| 0xC0000506 | 3221226758 | SOCKET WOULD BLOCK |
| 0xC0000507 | 3221226759 | SOCKET ADDRESS IS IN USE |
| 0xC0000508 | 3221226760 | SOCKET BAD FILE DESCRIPTOR |
| 0xC0000509 | 3221226761 | HOST RESOLUTION ERROR |
| 0xC000050a | 3221226762 | INVALID HOST CERTIFICATE |
| 0xC0000600 | 3221227008 | NO BUFFER AVAILABLE |
| 0xC0000601 | 3221227009 | INVALID ENUMERATION OPTION |
| 0xC0000700 | 3221227264 | SSL ERROR |
| 0xC0000701 | 3221227265 | SSL CTX ERROR |
| 0xC0000702 | 3221227266 | SSL CIPHER LIST ERROR |
| 0xC0000703 | 3221227267 | SSL CERT VERIFICATION LOCATION ERROR |

| Hex value | Decimal value | Return code/error description |
|---|---|---|
| 0xC0000704 | 3221227268 | SSL LOAD SERVER CERT ERROR |
| 0xC0000705 | 3221227269 | SSL LOAD SERVER PRIVATE KEY ERROR |
| 0xC0000706 | 3221227270 | SSL VALIDATE SERVER PRIVATE KEY ERROR |
| 0xC0000707 | 3221227271 | SSL CREATE SSL ERROR |
| 0xC0000708 | 3221227272 | SSL LOAD CLIENT CERT ERROR |
| 0xC0000709 | 3221227273 | SSL GET CERTIFICATE ERROR |
| 0xC000070a | 3221227274 | SSL INVALID CERT STRUCTURE |
| 0xC000070b | 3221227275 | SSL LOAD CLIENT PRIVATE KEY ERROR |
| 0xC000070c | 3221227276 | SSL GET PEER CERT ERROR |
| 0xC000070d | 3221227277 | SSL WANT READ ERROR |
| 0xC000070e | 3221227278 | SSL WANT WRITE ERROR |
| 0xC000070f | 3221227279 | SSL WANT X509 LOOKUP ERROR |
| 0xC0000710 | 3221227280 | SSL SYSCALL ERROR |
| 0xC0000711 | 3221227281 | SSL FAILED HANDSHAKE |
| 0xC0000800 | 3221227520 | INVALID CERTIFICATE TYPE |
| 0xC0000900 | 3221227776 | INVALID PORT |
| 0xC0000901 | 3221227777 | SESSION SCRIPT EXISTS |
| 0xC0001000 | 3221229568 | PARTITION LOCKED |
| 0xC0001001 | 3221229569 | PARTITION NOT ACTIVATED |
| 0xc0002000 | 3221233664 | FAILED TO CREATE THREAD |
| 0xc0002001 | 3221233665 | CALLBACK ERROR |
| 0xc0002002 | 3221233666 | UNKNOWN CALLBACK COMMAND |

| Hex value | Decimal value | Return code/error description |
|---|---|---|
| 0xc0002003 | 3221233667 | SHUTTING DOWN |
| 0xc0002004 | 3221233668 | REMOTE SIDE DISCONNECTED |
| 0xc0002005 | 3221233669 | SOCKET CLOSED |
| 0xC0002006 | 3221233670 | INVALID COMMAND |
| 0xC0002007 | 3221233671 | UNKNOWN COMMAND |
| 0xC0002008 | 3221233672 | UNKNOWN COMMAND VERSION |
| 0xC0002009 | 3221233673 | FILE LOCK FAILED |
| 0xC0002010 | 3221233680 | FILE LOCK ERROR |
| 0xc0002011 | 3221233681 | FAILED TO CREATE PROCESS |
| 0xc0002012 | 3221233682 | USB PED NOT FOUND |
| 0xc0002013 | 3221233683 | USB PED NOT RESPONDING |
| 0xc0002014 | 3221233684 | USB PED OPERATION CANCELLED |
| 0xc0002015 | 3221233685 | USB PED TOO MANY CONNECTED |
| 0xc0002016 | 3221233686 | USB PED OUT OF SYNC |
| 0xC0001100 | 3221229824 | UNABLE TO CONNECT |

## Vendor-Defined Return Codes

| Code | Name |
|---|---|
| 0x80000004 | CKR_RC_ERROR |
| 0x80000005 | CKR_CONTAINER_HANDLE_INVALID |
| 0x80000006 | CKR_TOO_MANY_CONTAINERS |

| Code | Name |
| --- | --- |
| 0x80000007 | CKR_USER_LOCKED_OUT |
| 0x80000008 | CKR_CLONING_PARAMETER_ALREADY_EXISTS |
| 0x80000009 | CKR_CLONING_PARAMETER_MISSING |
| 0x8000000a | CKR_CERTIFICATE_DATA_MISSING |
| 0x8000000b | CKR_CERTIFICATE_DATA_INVALID |
| 0x8000000c | CKR_ACCEL_DEVICE_ERROR |
| 0x8000000d | CKR_WRAPPING_ERROR |
| 0x8000000e | CKR_UNWRAPPING_ERROR |
| 0x8000000f | CKR_MAC_MISSING |
| 0x80000010 | CKR_DAC_POLICY_PID_MISMATCH |
| 0x80000011 | CKR_DAC_MISSING |
| 0x80000012 | CKR_BAD_DAC |
| 0x80000013 | CKR_SSK_MISSING |
| 0x80000014 | CKR_BAD_MAC |
| 0x80000015 | CKR_DAK_MISSING |
| 0x80000016 | CKR_BAD_DAK |
| 0x80000017 | CKR_SIM_AUTHORIZATION_FAILED |
| 0x80000018 | CKR_SIM_VERSION_UNSUPPORTED |
| 0x80000019 | CKR_SIM_CORRUPT_DATA |
| 0x8000001a | CKR_USER_NOT_AUTHORIZED |
| 0x8000001b | CKR_MAX_OBJECT_COUNT_EXCEEDED |
| 0x8000001c | CKR_SO_LOGIN_FAILURE_THRESHOLD |

| Code | Name |
| --- | --- |
| 0x8000001d | CKR_SIM_AUTHFORM_INVALID |
| 0x8000001e | CKR_CITS_DAK_MISSING |
| 0x8000001f | CKR_UNABLE_TO_CONNECT |
| 0x80000020 | CKR_PARTITION_DISABLED |
| 0x80000021 | CKR_CALLBACK_ERROR |
| 0x80000022 | CKR_SECURITY_PARAMETER_MISSING |
| 0x80000023 | CKR_SP_TIMEOUT |
| 0x80000024 | CKR_TIMEOUT |
| 0x80000025 | CKR_ECC_UNKNOWN_CURVE |
| 0x80000026 | CKR_MTK_ZEROIZED |
| 0x80000027 | CKR_MTK_STATE_INVALID |
| 0x80000028 | CKR_INVALID_ENTRY_TYPE |
| 0x80000029 | CKR_MTK_SPLIT_INVALID |
| 0x8000002a | CKR_HSM_STORAGE_FULL |
| 0x8000002b | CKR_DEVICE_TIMEOUT |
| 0x8000002c | CKR_CONTAINER_OBJECT_STORAGE_FULL |
| 0x8000002d | CKR_PED_CLIENT_NOT_RUNNING |
| 0x8000002e | CKR_PED_UNPLUGGED |
| 0x8000002f | CKR_ECC_POINT_INVALID |
| 0x80000030 | CKR_OPERATION_NOT_ALLOWED |
| 0x80000031 | CKR_LICENSE_CAPACITY_EXCEEDED |
| 0x80000032 | CKR_LOG_FILE_NOT_OPEN |

| Code | Name |
|---|---|
| 0x80000033 | CKR_LOG_FILE_WRITE_ERROR |
| 0x80000034 | CKR_LOG_BAD_FILE_NAME |
| 0x80000035 | CKR_LOG_FULL |
| 0x80000036 | CKR_LOG_NO_KCV |
| 0x80000037 | CKR_LOG_BAD_RECORD_HMAC |
| 0x80000038 | CKR_LOG_BAD_TIME |
| 0x80000039 | CKR_LOG_AUDIT_NOT_INITIALIZED |
| 0x8000003A | CKR_LOG_RESYNC_NEEDED |
| 0x8000003B | CKR_AUDIT_LOGIN_TIMEOUT_IN_PROGRESS |
| 0x8000003C | CKR_AUDIT_LOGIN_FAILURE_THRESHOLD |
| 0x8000003D | CKR_INVALID_FUF_TARGET |
| 0x8000003E | CKR_INVALID_FUF_HEADER |
| 0x8000003F | CKR_INVALID_FUF_VERSION |
| 0x80000040 | CKR_ECC_ECC_RESULT_AT_INF |
| 0x80000041 | CKR_AGAIN |
| 0x80000042 | CKR_TOKEN_COPIED |
| 0x80000043 | CKR_SLOT_NOT_EMPTY |
| 0x80000044 | CKR_USER_ALREADY_ACTIVATED |
| 0x80000045 | CKR_STC_NO_CONTEXT |
| 0x80000046 | CKR_STC_CLIENT_IDENTITY_NOT_CONFIGURED |
| 0x80000047 | CKR_STC_PARTITION_IDENTITY_NOT_CONFIGURED |
| 0x80000048 | CKR_STC_DH_KEYGEN_ERROR |

| Code | Name |
| --- | --- |
| 0x80000049 | CKR_STC_CIPHER_SUITE_REJECTED |
| 0x8000004a | CKR_STC_DH_KEY_NOT_FROM_SAME_GROUP |
| 0x8000004b | CKR_STC_COMPUTE_DH_KEY_ERROR |
| 0x8000004c | CKR_STC_FIRST_PHASE_KDF_ERROR |
| 0x8000004d | CKR_STC_SECOND_PHASE_KDF_ERROR |
| 0x8000004e | CKR_STC_KEY_CONFIRMATION_FAILED |
| 0x8000004f | CKR_STC_NO_SESSION_KEY |
| 0x80000050 | CKR_STC_RESPONSE_BAD_MAC |
| 0x80000051 | CKR_STC_NOT_ENABLED |
| 0x80000052 | CKR_STC_CLIENT_HANDLE_INVALID |
| 0x80000053 | CKR_STC_SESSION_INVALID |
| 0x80000054 | CKR_STC_CONTAINER_INVALID |
| 0x80000055 | CKR_STC_SEQUENCE_NUM_INVALID |
| 0x80000056 | CKR_STC_NO_CHANNEL |
| 0x80000057 | CKR_STC_RESPONSE_DECRYPT_ERROR |
| 0x80000058 | CKR_STC_RESPONSE_REPLAYED |
| 0x80000059 | CKR_STC_REKEY_CHANNEL_MISMATCH |
| 0x8000005a | CKR_STC_RSA_ENCRYPT_ERROR |
| 0x8000005b | CKR_STC_RSA_SIGN_ERROR |
| 0x8000005c | CKR_STC_RSA_DECRYPT_ERROR |
| 0x8000005d | CKR_STC_RESPONSE_UNEXPECTED_KEY |
| 0x8000005e | CKR_STC_UNEXPECTED_NONCE_PAYLOAD_SIZE |

| Code | Name |
|---|---|
| 0x8000005f | CKR_STC_UNEXPECTED_DH_DATA_SIZE |
| 0x80000060 | CKR_STC_OPEN_CIPHER_MISMATCH |
| 0x80000061 | CKR_STC_OPEN_DHNIST_PUBKEY_ERROR |
| 0x80000062 | CKR_STC_OPEN_KEY_MATERIAL_GEN_FAIL |
| 0x80000063 | CKR_STC_OPEN_RESP_GEN_FAIL |
| 0x80000064 | CKR_STC_ACTIVATE_MACTAG_U_VERIFY_FAIL |
| 0x80000065 | CKR_STC_ACTIVATE_MACTAG_V_GEN_FAIL |
| 0x80000066 | CKR_STC_ACTIVATE_RESP_GEN_FAIL |
| 0x80000067 | CKR_CHALLENGE_INCORRECT |
| 0x80000068 | CKR_ACCESS_ID_INVALID |
| 0x80000069 | CKR_ACCESS_ID_ALREADY_EXISTS |
| 0x8000006a | CKR_KEY_NOT_KEKABLE |
| 0x8000006b | CKR_MECHANISM_INVALID_FOR_FP |
| 0x8000006c | CKR_OPERATION_INVALID_FOR_FP |
| 0x8000006d | CKR_SESSION_HANDLE_INVALID_FOR_FP |
| 0x8000006e | CKR_CMD_NOT_ALLOWED_HSM_IN_TRANSPORT |
| 0x8000006f | CKR_OBJECT_ALREADY_EXISTS |
| 0x80000070 | CKR_PARTITION_ROLE_DESC_VERSION_INVALID |
| 0x80000071 | CKR_PARTITION_ROLE_POLICY_VERSION_INVALID |
| 0x80000072 | CKR_PARTITION_ROLE_POLICY_SET_VERSION_INVALID |
| 0x80000073 | CKR_REKEK_KEY |
| 0x80000074 | CKR_KEK_RETRY_FAILURE |

| Code | Name |
| --- | --- |
| 0x80000075 | CKR_RNG_RESEED_TOO_EARLY |
| 0x80000076 | CKR_HSM_TAMPERED |
| 0x80000077 | CKR_CONFIG_CHANGE_ILLEGAL |
| 0x80000078 | CKR_SESSION_CONTEXT_NOT_ALLOCATED |
| 0x80000079 | CKR_SESSION_CONTEXT_ALREADY_ALLOCATED |
| 0x8000007a | CKR_INVALID_BL_ITB_AUTH_HEADER |
| 0x80000114 | CKR_OBJECT_READ_ONLY |
| 0x80000136 | CKR_KEY_NOT_ACTIVE |
| 0x80000400 | CKR_ACCESS_ID_INVALID |
| 0x80001600 | CKR_XTC_ERROR |
| 0x80001601 | CKR_CONTEXT_INVALID |
| 0x80001603 | CKR_MAX_SESSION_COUNT |
| 0x80001604 | CKR_BUSY |
| 0x80001606 | CKR_SERVICE_UNAVAILABLE |

# CHAPTER 12: Zeroizing or Resetting the HSM to Factory Conditions

During the lifetime of a Luna HSM, you might have cause to take the HSM out of service, and wish to perform actions to ensure that no trace of your sensitive material remains. Those events might include:

- Placing the unit into storage, perhaps as a spare
- Shipping to another location or business unit in your organization
- Shipping the unit back to Thales for repair/re-manufacture
- Removing the HSM permanently from operational use, for disposal at end-of-life

This chapter describes the available options in the following sections:



## Comparing Zeroize and Factory Reset

You can clear the contents of your Luna HSM, or the HSM may be cleared in response to an event. How this affects the contents and configuration of your HSM depends on whether the user partitions were deleted or whether the HSM was zeroized or factory reset as detailed below:

| Action | Command/Event | Description |
|---|---|---|
| Erase User Partitions | > Enable or disable a destructive HSM policy | Destroy/erase the user partition, but do not zeroize the HSM. To bring the HSM back into service, you need to:<br>1. Recreate the partition<br>2. Reinitialize the partition roles |
| Zeroize | > Too many bad login attempts on the HSM SO account<br>> lunacm:> **hsm zeroize** | Deletes all partitions and their contents, but retains the HSM configuration (audit role and configuration, policy settings). To bring the HSM back into service, you need to:<br>1. Reinitialize the HSM<br>2. Recreate the partition<br>3. Reinitialize the partition roles |

| Action | Command/Event | Description |
|---|---|---|
| Factory Reset | lunacm:> **hsm factoryreset** | Deletes the application partition and its contents, and resets all roles and policy configurations to their factory default values. To bring the HSM back into service, you need to completely reconfigure the HSM as though it were new from the factory. |

# HSM Zeroization

In the context of HSMs in general, the term "zeroize" means to erase all plaintext keys. Some HSMs keep all keys in plaintext within the HSM boundary. Luna HSMs do not.

In the context of Luna HSMs, keys at rest (keys or objects that are stored in the HSM) are encrypted. Keys are decrypted into a volatile working memory space inside the HSM only while they are being used. Items in volatile memory disappear when power is removed. The action that we loosely call "zeroizing", or clearing, erases volatile memory as well as destroying the key that encrypts stored objects.

Any temporarily decrypted keys are destroyed, and all customer keys on the HSM are immediately rendered inaccessible and unrecoverable whenever you:

- perform **hsm factoryreset**
- make too many bad login attempts on the SO account
- set a "destructive" HSM policy

The KEK (key encryption key that encrypts all user objects, partition structure, cloning vectors, masking vectors, etc.) is destroyed by a zeroization (erasure) or decommission event. At that point, any objects or identities in the HSM become effectively random blobs of bits that can never be decoded.

> **NOTE** The next HSM power-up following a KEK zeroization automatically erases the contents of user storage, which were already an indecipherable blob without the original KEK. That is, any zeroizing event instantly makes encrypted objects unusable, and as soon as power is re-applied, the HSM immediately erases even the encrypted remains before it allows further use of the HSM.

The HSM must now be re-initialized in order to use it again, and initialization overwrites the HSM with new user parameters. Everything is further encrypted with a new KEK unique to that HSM.

Keys not encrypted by the KEK are those that require exemption and are not involved in user identities or user objects:

- The Master Tamper Key, which enables tamper handling
- The Remote PED Vector, to allow Remote PED-mediated recovery from tamper or from Secure Transport Mode
- The hardware origin key that certifies the HSM hardware as having been built by Thales

# Resetting the Luna USB HSM 7 to Factory Condition

These instructions will allow you to restore your Luna USB HSM 7 to its original factory configuration. The HSM is zeroized, all partitions erased, and HSM policies are returned to their default settings.

### To reset the HSM to factory condition

1. Set the active slot to the admin partition.

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

2. Reset the HSM to factory settings.

   lunacm:> **hsm factoryreset**

# Stored Data Integrity

Beginning with Luna HSM Firmware 7.7.0, a new eIDAS-supporting feature called SDI, Stored Data Integrity, has been added that checks the integrity of the stored data. The HSM firmware will halt if it detects that objects have been corrupted. An *hsmrecover* function has been introduced, as part of the **hsm factoryReset** command to clear the storage and recover the HSM from the halt state without requiring RMA of the appliance.

If the HSM firmware halts because data in the volatile memory is corrupted, restarting the HSM using lunacm:>**hsm restart** should recover the HSM without losing data in permanent storage.

If the HSM firmware halts because data in the permanent flash storage is corrupted, the HSM is recovered by using the newly enhanced **hsm factoryReset** command which deletes all the partitions, zeroizes all the objects, and resets the policies.

Since **hsm factoryReset** is destructive, it is important to keep a regular backup of HSM objects in case the HSM ever goes into a state that requires factory reset.

Running the **hsm factoryReset** command, while the HSM is in normal working state, has the same behavior as before Luna HSM Firmware 7.7.0.

Running the **hsm factoryReset** command, while the HSM is in a halt state (where the normal "factoryReset" fails), invokes the recovery process, which takes several minutes (6+ minutes) to complete. It is important to wait for the **hsm factoryReset** command to complete without interruption.

For an example of the output, see **hsm factoryreset**.