

## Thales Luna PCIe HSM 7.7.0

### PRODUCT OVERVIEW



# Document Information

---

<b>Last Updated</b>	2021-09-23 10:46:56 GMT-04:00
---------------------	-------------------------------

---

## **Trademarks, Copyrights, and Third-Party Software**

Copyright 2001-2021 Thales Group. All rights reserved. Thales and the Thales logo are trademarks and service marks of Thales and/or its subsidiaries and are registered in certain countries. All other trademarks and service marks, whether registered or not in specific countries, are the property of their respective owners.

## **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.

All intellectual property is protected by copyright. All trademarks and product names used or referred to are the copyright of their respective owners. No part of this document may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, mechanical, chemical, photocopy, recording or otherwise without the prior written permission of Thales Group.

## **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

Document Information .....	2
<b>Preface: About the Product Overview .....</b>	<b>7</b>
Customer Release Notes .....	7
Audience .....	7
Document Conventions .....	8
Support Contacts .....	10
<b>Chapter 1: Luna Hardware Security Modules .....</b>	<b>11</b>
Luna Network HSM .....	11
Ethernet-attached .....	11
Integrated Cryptographic Engine .....	12
Partitions .....	12
Dedicated Clients .....	12
Employ the HSM as a Service .....	12
Sample Deployment Architecture .....	12
Luna PCIe HSM .....	13
Single-partition .....	14
Cost Effective .....	14
Sample Deployment Architecture .....	14
Luna Backup HSM .....	15
Comparing the Luna Network HSM Appliance and PCIe HSM .....	15
Luna HSM Models .....	15
Luna A (Password-authenticated, FIPS Level 3) Models .....	16
Luna S (PED-authenticated, FIPS Level 3) Models .....	16
Backup HSM Models .....	17
Luna HSM Features .....	17
<b>Chapter 2: New Features and Enhancements .....</b>	<b>19</b>
Luna PCIe HSM Release 7.7.0 .....	19
Scalable Key Storage (requires firmware 7.7.0) .....	19
Per-Key Authorization (requires firmware 7.7.0) .....	20
Luna Backup HSM (G5) and (G7) .....	20
Initialize the Orange RPV Key Remotely .....	20
Luna HSM Client 10.2.0 .....	20
New Luna HSM Client Operating System Support .....	20
Support for New Mechanisms in Luna HSM Firmware 7.4.2 .....	20
Luna HSM Firmware 7.4.2 .....	21
3GPP Cryptography for 5G Mobile Networks .....	21
SM2/SM4 Support .....	21
SHA-3 Function Support .....	21

Luna HSM Client 10.1.0 .....	21
Luna HSM Client 10.1 Supports Both Luna HSMs and Luna Cloud HSM Services From Data .....	
Protection on Demand .....	22
Luna G7 Backup HSM .....	22
Remote PED Support on Linux .....	23
Windows Secure Boot Support .....	23
Luna PCIe HSM Release 7.4 .....	23
Functionality Modules .....	23
View Utilization Metrics by Partition .....	23
Ed25519ph Curve .....	24
Luna PCIe HSM Release 7.3 .....	24
BIP32 Algorithm .....	24
JavaSP support for ECC Curve 25519 .....	24
Luna PCIe HSM Release 7.2 .....	24
Improved Luna HSM Client .....	24
Relabel Partitions .....	25
Crypto User Can Clone Public Objects .....	25
Auto-Enabled HA Logging .....	25
SCP03 Encoding .....	25
Luna PCIe HSM Release 7.1 .....	25
Policy Templates .....	25
Configurable Policies for Export of Private Keys .....	25
Curve 25519 Available in FIPS Mode .....	26
Luna PCIe HSM Release 7.0 .....	26
Low-Profile Card .....	26
Partition Security Officer .....	26
Best-in-Class Performance .....	26
Industry-Leading Security .....	26
Improved Random Number Generation .....	26
New Cryptographic Mechanism Support .....	27
Increased Key Storage Capacity .....	27
Secure Transport Mode Redesigned .....	27
Version Dependencies by Feature .....	27
<b>Chapter 3: Security .....</b>	<b>31</b>
Layered Encryption .....	31
Scalable Key Storage (SKS) .....	33
Tamper Protection .....	34
Certification .....	35
<b>Chapter 4: Redundancy and Reliability .....</b>	<b>36</b>
High-Availability Groups .....	36
<b>Chapter 5: User Access Control .....</b>	<b>39</b>
<b>Chapter 6: Authentication .....</b>	<b>41</b>
Password Authentication .....	41

---

Multi-factor (PED) Authentication .....	43
Remote PED .....	45
Chapter 7: Capabilities and Policies .....	48
Chapter 8: Flexible Backups .....	50
Chapter 9: Logging and Reporting .....	53
Chapter 10: Functionality Modules .....	54

# PREFACE: About the Product Overview

For an overview of new features in this release, see ["New Features and Enhancements" on page 19](#).

This document provides an overview of the Luna HSM suite of products. It contains the following chapters:

- > ["New Features and Enhancements" on page 19](#)
- > ["Luna Hardware Security Modules" on page 11](#)
- > ["Security" on page 31](#)
- > ["Redundancy and Reliability" on page 36](#)
- > ["User Access Control" on page 39](#)
- > ["Authentication" on page 41](#)
- > ["Capabilities and Policies" on page 48](#)
- > ["Flexible Backups" on page 50](#)
- > ["Logging and Reporting" on page 53](#)

The preface includes the following information about this document:

- > [Customer Release Notes](#)
- > ["Audience" below](#)
- > ["Document Conventions" on the next page](#)
- > ["Support Contacts" on page 10](#)

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 this release that is not included in the customer documentation. Read the CRN to fully understand the capabilities, limitations, and known issues for this release. You can view or download the latest version of the CRN from the Technical Support Customer Portal at <https://supportportal.thalesgroup.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
<b>bold</b>	<p>The bold attribute is used to indicate the following:</p> <ul style="list-style-type: none"> <li>&gt; Command-line commands and options (Type <b>dir /p</b>.)</li> <li>&gt; Button names (Click <b>Save As</b>.)</li> <li>&gt; Check box and radio button names (Select the <b>Print Duplex</b> check box.)</li> <li>&gt; Dialog box titles (On the <b>Protect Document</b> dialog box, click <b>Yes</b>.)</li> <li>&gt; Field names (<b>User Name</b>: Enter the name of the user.)</li> <li>&gt; Menu names (On the <b>File</b> menu, click <b>Save</b>.) (Click <b>Menu &gt; Go To &gt; Folders</b>.)</li> <li>&gt; User input (In the <b>Date</b> box, type <b>April 1</b>.)</li> </ul>



Format	Convention
<i>italics</i>	In type, the italic attribute is used for emphasis or to indicate a related document. (See the <i>Installation Guide</i> for more information.)
<variable>	In command descriptions, angle brackets represent variables. You must substitute a value for command line arguments that are enclosed in angle brackets.
[optional] [<optional>]	Represent optional <b>keywords</b> or <variables> in a command line description. Optionally enter the keyword or <variable> that is enclosed in square brackets, if it is necessary or desirable to complete the task.
{a b c} {<a> <b> <c>}	Represent required alternate <b>keywords</b> or <variables> in a command line description. You must choose one command line argument enclosed within the braces. Choices are separated by vertical (OR) bars.
[a b c] [<a> <b> <c>]	Represent optional alternate keywords or variables in a command line description. Choose one command line argument enclosed within the braces, if desired. Choices are separated by vertical (OR) bars.

## Support Contacts

---

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

### Customer Support Portal

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

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

### Telephone

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

# CHAPTER 1: Luna Hardware Security Modules

Hardware Security Modules (HSMs) are dedicated systems that physically and logically secure cryptographic keys and cryptographic processing. The purpose of an HSM is to protect sensitive data from being stolen by providing a highly secure operation structure. HSMs are fully contained and complete solutions for cryptographic processing, key generation, and key storage. They are purpose-built appliances that automatically include the hardware and firmware (i.e., software) necessary for these functions in an integrated package.

An HSM manages cryptographic keys used to lock and unlock access to digitized information over their life-cycle. This includes generation, distribution, rotation, storage, termination, and archival functions. An HSM also engages in cryptographic processing, which produces the dual benefits of isolation and offloading cryptographic processing from application servers.

HSMs are available in the following forms:

- > Standalone network-attached appliances, as described in ["Luna Network HSM" below](#).
- > Hardware cards that plug into existing network-attached systems, as described in ["Luna PCIe HSM" on page 13](#).
- > USB-connected backup HSMs, as described in ["Luna Backup HSM" on page 15](#)

See the following topics for a comparison of the PCIe and Network HSMs, and for a description of the available HSM models:

- > ["Comparing the Luna Network HSM Appliance and PCIe HSM" on page 15](#)
- > ["Luna HSM Models" on page 15](#)

For a high level overview of the distinctive features of the Luna Network HSM and Luna PCIe HSM, see ["Luna HSM Features" on page 17](#).

## Luna Network HSM

---

Luna Network HSM stores, protects, and manages sensitive cryptographic keys in a centralized, high-assurance appliance, providing a root of trust for sensitive cryptographic data transactions. Deployed in more public cloud environments than any other HSM, Luna Network HSM works seamlessly across your on-premises, private, public, hybrid, and multi-cloud environments. Luna Network HSM is the most trusted general purpose HSM on the market, and with market leading performance, true hardware-based security, and the broadest ecosystem available, Luna Network HSM is at the forefront of HSM innovation.

### Ethernet-attached

An Ethernet-attached HSM, Luna Network HSM is designed to protect critical cryptographic keys and accelerate sensitive cryptographic operations across a wide range of security applications. It includes many features that increase security connectivity and ease-of-administration in dedicated and shared security

applications.

## Integrated Cryptographic Engine

The Luna Network HSM can be shared between multiple applications or clients connected to it through a network. In the same way that mail and web servers provide email or web pages to authenticated clients, the Luna Network HSM offers powerful key management and high-performance cryptographic processing to clients on the network. To achieve this, the Luna Network HSM includes an integrated FIPS 140-2- validated HSM and the Cryptographic Engine, which offers the same high level of security as traditional HSMs. Additionally, the Luna Network HSM adds a secure service layer that allows the Cryptographic Engine to be shared between network clients.

## Partitions

The Luna Network HSM also introduces the concept of HSM partitions, a feature that allows the Luna Network HSM's single physical HSM to be divided into several logical HSM partitions, each with independent data, access controls, and administrative policies. HSM partitions can be thought of as 'safety deposit boxes' that reside within the Cryptographic Engine's 'vault'. The vault itself offers an extremely high level of security for all the contents inside, while the safety deposit boxes protect their specific contents from people who have access to the vault. HSM partitions allow separate data storage and administration policies to be maintained by multiple applications sharing one HSM without fear of compromise from other partitions residing on it. Each HSM partition has a special access control role who manages it. Depending on the configuration, each Luna Network HSM can contain up to 100 partitions.

## Dedicated Clients

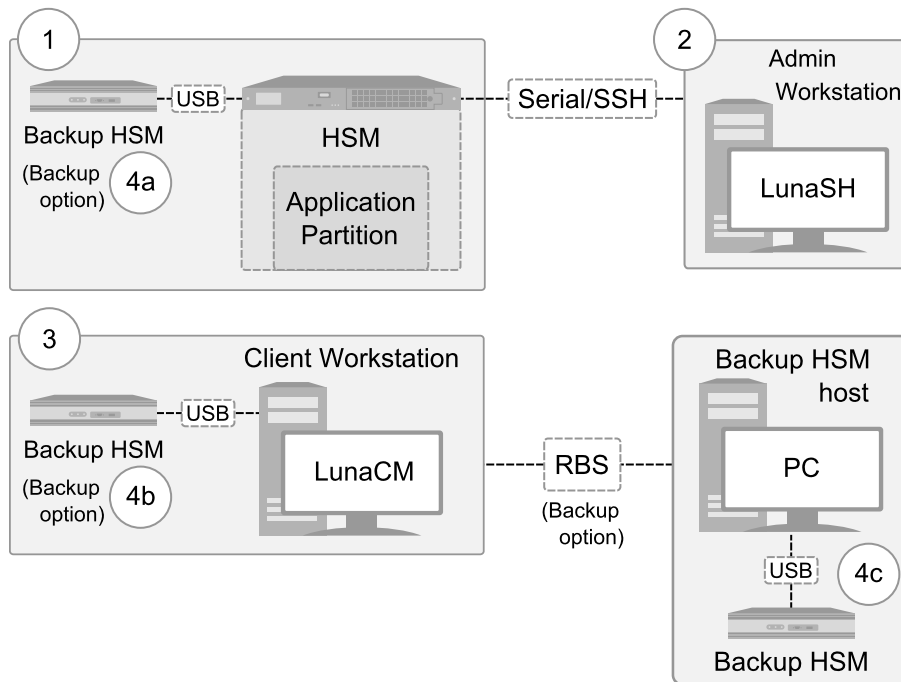
HSM partitions can be dedicated to a single Client, or multiple Clients that share access to a single HSM partition. Clients are applications, or application servers, that connect to the Luna Network HSM. Examples of possible clients are an encrypted database, a secure web server, or a Certificate Authority (CA); all these applications require the storage of sensitive cryptographic data or can benefit from the increased security and cryptographic performance offered by the Luna Network HSM. Each Client is assigned to one or more specific HSM partitions. Clients authenticate to the Luna Network HSM with a digital certificate and unique HSM partition challenge.

## Employ the HSM as a Service

Luna Network HSM empowers organizations to take a best practices approach to cryptographic key security by offloading cryptographic processes to a centralized, high-assurance key vault that can be deployed as a service. Only the Luna Network HSM is able to provide trusted key ownership and control, with full multi-tenancy across on-premises, private, public, hybrid, and multi-cloud environments.

## Sample Deployment Architecture

The following sample architecture illustrates potential connections between your Luna HSM(s), server(s), and workstation(s). Some of the elements are optional configuration items, and might not be present in your system.

**Figure 1: Network HSM Connections**

1. Within your Luna appliance lies an HSM. That HSM holds one or more application partitions (independent virtual HSMs) that different users or clients can access.
2. Initial setup of your HSM requires you to connect directly to it via serial cable. Post-setup, you can use SSH to remotely access your HSM. Both of these connections use LunaSH, the command-line interface or shell for appliance and HSM configuration and management.
3. To perform cryptographic operations with your HSM or Partition, you must login remotely through the Luna HSM Client at your workstation. The client uses LunaCM for the configuration and administration of your Partition, and uses cryptographic APIs such as PKCS#11, Java, JCPROV, CSP, and KSP to perform significant cryptographic operations.
4. Backup HSMs are used exclusively to securely backup sensitive material from Luna HSMs, and to restore backed-up material to Luna HSMs. The Luna Backup HSM can be connected using any of the following methods:
  - To the appliance containing the primary HSM or
  - To a client workstation that can access the HSM
  - Via Remote Backup Service (RBS) to a separate Backup HSM host, which allows you to further remove your backup to a more remote location.

## Luna PCIe HSM

Luna PCIe HSM stores, protects, and manages sensitive cryptographic keys in a small form factor PCIe card, providing a root of trust for sensitive cryptographic data transactions. With Luna PCIe HSM cryptographic processes are offloaded to a high-performance cryptographic processor. Luna PCIe HSM easily embeds in

servers and security appliances for an easy-to-integrate and cost-efficient solution for FIPS 140-2 validated key security. Luna PCIe HSM benefits from a diverse feature set that enables greater centralized control through secure remote management, transport, and backup.

## Single-partition

The Luna PCIe HSM is a single-partition HSM card that you can embed in a pre-existing network-attached system. Access to the partition is managed by a special access control role. The Luna PCIe HSM offers hardware accelerated ECC algorithms that can be used in the development of solutions for resource constrained environments (devices like smart phones, tablets, etc.), without the need to purchase additional licenses. ECC offers high key strength at a greatly reduced key length compared to RSA keys; higher security with fewer resources.

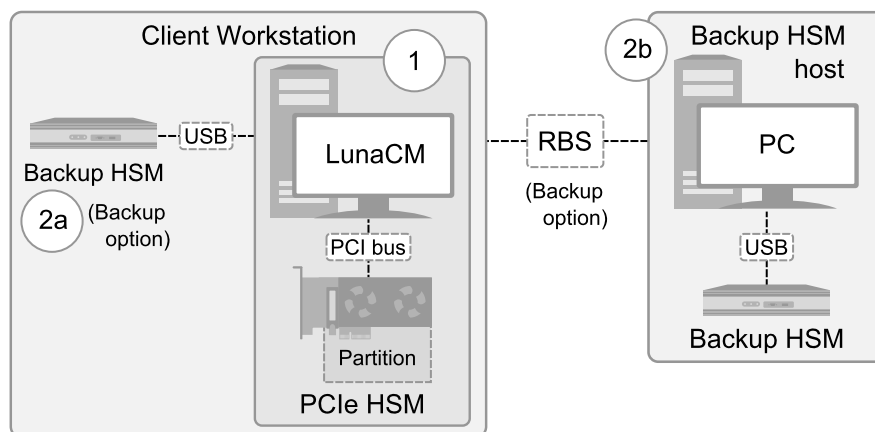
## Cost Effective

Like in the Luna Network HSM, the Luna PCIe HSM securely stores cryptographic keys in its hardware; sensitive information never leaves the HSM protection. The Luna PCIe HSM provides PKCS#11-compliant cryptographic services for applications running on the server in a secure and tamper-proof hardware package. Leveraging a Luna PCIe HSM in your appliance or service represents a cost effective way to bring FIPS 140-2 and Common Criteria validated solutions to market.

Luna PCIe HSM empowers organizations to take a best practices approach to cryptographic key security by offloading cryptographic processes to a dedicated small form factor cryptographic processor. Luna PCIe HSM is the highest performing embedded HSM on the market.

## Sample Deployment Architecture

The following sample architecture illustrates potential connections between your Luna HSM(s), server(s), and workstation(s). Some of the elements are optional configuration items, and might not be present in your system.



1. The PCIe HSM is a small card that fits in your system's connector slots, and it is accessed directly through the Luna HSM Client at your workstation. The client uses LunaCM for the configuration and administration of your PCIe HSM, and uses cryptographic APIs to perform cryptographic operations requested by your applications.

2. Backup HSMs are used exclusively to securely backup sensitive material from Luna HSMs, and to restore backed-up material to Luna HSMs. The Luna Backup HSM can be connected using any of the following methods:
- To the client host containing the primary HSM
  - Via Remote Backup Service (RBS) to a separate Backup HSM host, which allows you to further remove your backup to a more remote location.

## Luna Backup HSM

The Luna Backup HSM allows you to backup the objects in your Network or PCIe user partitions and store the object archive in a secure HSM. Backup HSMs are able to store objects only. They do not provide the ability to access the objects to perform cryptographic operations. See ["Flexible Backups" on page 50](#) for more information.

Two versions are available, as detailed in ["Backup HSM Models" on page 17](#).

## Comparing the Luna Network HSM Appliance and PCIe HSM

Luna Network HSM Appliance	Luna PCIe HSM
<ul style="list-style-type: none"> <li>&gt; Field-upgradable to 100 partitions</li> <li>&gt; Includes hardened OS</li> <li>&gt; High security, stable networking, and environmental protection via built-in chassis</li> <li>&gt; Routine firmware and software updates</li> <li>&gt; Automatic system logging</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Limited to 1 partition</li> <li>&gt; Compatible with external OS: Windows, Linux</li> <li>&gt; Allows custom and flexible chassis intrusion security</li> <li>&gt; Routine firmware updates</li> <li>&gt; Light and low-cost</li> </ul>

A database server using an HSM would require one HSM, while a secure website using SSL on the same network would require a second, separate HSM. As the number of secure applications requiring an HSM grows, so does the number of ordinary HSMs deployed. The Luna Network HSM bypasses this limitation by implementing multiple virtual HSMs, or HSM Partitions on a single HSM server. A PCIe HSM is useful for cases that need limited, but highly secure, data protection. A Network HSM and its appliance are useful for cases that require a more complex security infrastructure, like cloud computing.

## Luna HSM Models

Both the Luna Network HSM and the Luna PCIe HSM come in different models with different performance capabilities. Which one you choose to use will depend on your organization's security needs.

**NOTE** The FIPS levels below indicate the standard to which the product is designed. Always confirm the HSM certification status before deploying an HSM in a regulated environment.

## Luna A (Password-authenticated, FIPS Level 3) Models

Luna A models offer secure storage of your cryptographic information in a controlled and easy-to-manage environment. Luna A models protect your proprietary information by using password authentication. Depending on your needs, Luna A models are available at several performance levels, as follows:

Model	Luna Network HSM	Luna PCIe HSM
<b>Luna A700</b>	<ul style="list-style-type: none"> <li>&gt; Standard performance</li> <li>&gt; 2MB memory</li> <li>&gt; Password-based authentication</li> <li>&gt; 5 partitions</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Standard performance</li> <li>&gt; 2MB memory</li> <li>&gt; Password-based authentication</li> </ul>
<b>Luna A750</b>	<ul style="list-style-type: none"> <li>&gt; Enterprise-level performance</li> <li>&gt; 16MB memory</li> <li>&gt; Password-based authentication</li> <li>&gt; 5 partitions, upgradable to 20</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Enterprise-level performance</li> <li>&gt; 16MB memory</li> <li>&gt; Password-based authentication</li> </ul>
<b>Luna A790</b>	<ul style="list-style-type: none"> <li>&gt; Maximum performance</li> <li>&gt; 32MB memory</li> <li>&gt; Password-based authentication</li> <li>&gt; 10 partitions, upgradable to 100</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Maximum performance</li> <li>&gt; 32MB memory</li> <li>&gt; Password-based authentication</li> </ul>

## Luna S (PED-authenticated, FIPS Level 3) Models

Luna S models offer secure storage of your cryptographic information in a controlled and highly secure environment. Luna S models protect your proprietary information by using multifactor (PED) authentication. Depending on your needs, Luna S models are available at several performance levels, as follows:

Model	Luna Network HSM	Luna PCIe HSM
<b>Luna S700</b>	<ul style="list-style-type: none"> <li>&gt; Standard performance</li> <li>&gt; 2MB memory</li> <li>&gt; Multifactor authentication</li> <li>&gt; 5 partitions</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Standard performance</li> <li>&gt; 2MB memory</li> <li>&gt; Multifactor authentication</li> </ul>
<b>Luna S750</b>	<ul style="list-style-type: none"> <li>&gt; Enterprise-level performance</li> <li>&gt; 16MB memory</li> <li>&gt; Multifactor authentication</li> <li>&gt; 5 partitions, upgradable to 20</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Enterprise-level performance</li> <li>&gt; 16MB memory</li> <li>&gt; Multifactor authentication</li> </ul>
<b>Luna S790</b>	<ul style="list-style-type: none"> <li>&gt; Maximum performance</li> <li>&gt; 32MB memory</li> <li>&gt; Multifactor authentication</li> <li>&gt; 10 partitions, upgradable to 100</li> </ul>	<ul style="list-style-type: none"> <li>&gt; Maximum performance</li> <li>&gt; 32MB memory</li> <li>&gt; Multifactor authentication</li> </ul>



## Backup HSM Models

Backup HSMs offer secure backups of your Luna HSM user partitions. They can be initialized in either PED-authenticated or password-authenticated mode:

- > PED-authenticated backup HSMs can backup PED-authenticated partitions.
- > Password-authenticated backup HSMs can backup password-authenticated partitions.

Two versions are available:

- > the G5-based desktop model.
- > the G7-based hand-held model is available in the following models. Each model allows you to backup up to 100 partitions. In-field storage upgrades are not available.

<b>B700</b>	32 MB storage, up to 100 partitions of the same authentication type
<b>B750</b>	128 MB storage, up to 100 partitions of the same authentication type
<b>B790</b>	256 MB storage, up to 100 partitions of the same authentication type

## Luna HSM Features

Luna HSMs have a variety of features that distinguish them, as summarized below:

<b>Security</b>	Luna HSMs are designed and manufactured to high security standards, to comply with FIPS Level 3 and Common Criteria certifications, and updated validations are sought whenever major changes/improvements are introduced. Luna HSMs protect your data from unwanted tampering with secure anti-intrusion and vulnerability detection mechanisms. See " <a href="#">Security</a> " on page 31 for details.
<b>Redundancy</b>	Luna HSMs are equipped with physical features and configurations that enable auto-recovery of your HSMs. See " <a href="#">Redundancy and Reliability</a> " on page 36 for details.
<b>Access control</b>	Luna HSM products offer multiple identities, some mandatory and some optional, that you can invoke in different ways to map to roles and functions in your organization. See " <a href="#">User Access Control</a> " on page 39 for details.
<b>Authentication</b>	Luna HSMs are factory configured to be either <ul style="list-style-type: none"> <li>&gt; password-authenticated (single-factor authentication) or</li> <li>&gt; PED-authenticated (multi-factor authentication with option for quorum authentication), depending on the level of security and oversight with which you wish to protect your data.</li> </ul> See " <a href="#">Authentication</a> " on page 41 for details.
<b>Capabilities and policies</b>	Luna HSMs, and partitions within them, are characterized by capabilities that are set at the factory or added by means of capability updates, and that are adjusted by means of settable policies that correspond to some of them. See " <a href="#">Capabilities and Policies</a> " on page 48 for details.

<b>Backups</b>	Luna HSMs contain sensitive material that, if lost, could be detrimental. The Luna Backup HSM and RBS securely back up and store such information that can be restored in case of failures in primary HSM functioning. See " <a href="#">Flexible Backups</a> " on page 50 for details.
<b>Logging and reporting</b>	Luna HSMs are equipped with performance monitoring and audit logging features to monitor security and provide audits of HSM activity. See " <a href="#">Logging and Reporting</a> " on page 53 for details.

# CHAPTER 2: New Features and Enhancements

Thales has introduced many new features and enhancements to Luna PCIe HSM 7 since the initial release, as described below.

- > ["Luna PCIe HSM Release 7.7.0" below](#)
- > ["Luna HSM Client 10.2.0" on the next page](#)
- > ["Luna HSM Firmware 7.4.2" on page 21](#)
- > ["Luna HSM Client 10.1.0" on page 21](#)
- > ["Luna PCIe HSM Release 7.4" on page 23](#)
- > ["Luna PCIe HSM Release 7.3" on page 24](#)
- > ["Luna PCIe HSM Release 7.2" on page 24](#)
- > ["Luna PCIe HSM Release 7.1" on page 25](#)
- > ["Luna PCIe HSM Release 7.0" on page 26](#)

## Luna PCIe HSM Release 7.7.0

---

This release consists of:

- > Luna HSM Client 10.3.0
- > Luna HSM firmware 7.7.0
- > Luna G7 Backup HSM B790 model
- > Luna Backup HSM (G7) firmware 7.7.1
- > Luna Backup HSM (G5) firmware 6.28.0
- > Luna PED firmware 2.7.4 and 2.9.0

### Scalable Key Storage (requires firmware 7.7.0)

Scalable Key Storage (SKS) is an optional feature that allows off-board storage of keys and objects in quantities greater than the capacity of an HSM - virtually unlimited storage, for use with your RSS (Remote Signing and Sealing) and other applications that require thousands or millions of keys. An SKS Master Key (SMK, which never leaves the HSM) securely encrypts extracted keys and objects, such that they remain within the HSM's security envelope, and can be reinserted (decrypted inside the HSM) for immediate use by your application.

Preserves key attributes through the life-cycle of a key.

Provides the option of new SKS function, or classic Luna "keys always in hardware" operation, on a partition-by-partition basis.

See ["Scalable Key Storage \(SKS\)"](#) on page 1.

## Per-Key Authorization (requires firmware 7.7.0)

PKA Allows granular control of key material for applications requiring high assurance by providing authorization on a per-key basis.

See ["Per-Key Authorization \(PKA\)"](#) on page 1.

## Luna Backup HSM (G5) and (G7)

Thales has previously introduced Luna Backup HSM (G7) models B700 and B750, and now introduces the new model B790 model, which includes 256 MB of storage and up to 100 backup partitions (model versions/sizes must be decided when purchasing, and are not field-installable upgrades of each other). Local backup is supported with Luna HSM 7.7.0 and later.

Luna Backup HSM (G5) at firmware 6.28.0 is supported with Luna HSM 7.7.0.

See ["Backup and Restore Using a Luna Backup HSM \(G7\)"](#) on page 1.

## Initialize the Orange RPV Key Remotely

You can now initialize the Luna PCIe HSM's Remote PED Vector (orange key) using a Luna PED connected to a remote workstation running PEDserver. A one-time numeric password is used to authenticate the Remote PED to the HSM before initializing the RPV. This optional method is useful if the HSM SO only has remote SSH access to the appliance. The HSM must be in a zeroized state (uninitialized), for security. Your firewall settings must allow an HSM-initiated Remote PED connection.

See [Initializing the Remote PED Vector \(RPV\) and Creating an Orange Remote PED Key \(RPK\)](#).

---

# Luna HSM Client 10.2.0

---

## New Luna HSM Client Operating System Support

Luna HSM Client 10.2.0 can be installed on the following new operating systems:

- > Windows Server Core 2016/2019
- > Red Hat Enterprise Linux 8 (including variants like CentOS 8)

See [Supported Luna HSM Client Operating Systems](#).

## Support for New Mechanisms in Luna HSM Firmware 7.4.2

Luna HSM Client 10.2.0 includes support for Luna HSM firmware 7.4.2 mechanisms.

- > [3GPP Mechanisms for 5G Mobile Networks](#)
- > [SM2/SM4 Mechanisms](#)
- > [SHA-3 Mechanisms](#)

## Luna HSM Firmware 7.4.2

---

This release adds support for 3GPP, SM2/SM4, and SHA-3 cryptographic functions to Luna PCIe HSMs. It consists of:

- > Luna HSM firmware 7.4.2
- > Luna HSM Client 7.4.0 software patch

### 3GPP Cryptography for 5G Mobile Networks

The new 3GPP crypto functions support the authentication and re-synchronization of a mobile device to the back-end authentication center (AUC). Milenage, Tuak and Comp128 algorithms are available and are relevant to 2/2.5G, 3G, 4G(LTE) and newer 5G mobile networks. The primary benefit of using the Luna HSM ensures that the subscribers key (Ki) is never exposed in the clear outside the security perimeter of a hardware security device. Optionally the Operators Variant string (OP) may also be encrypted under a storage key only found inside the HSM.

See [3GPP Mechanisms for 5G Mobile Networks](#).

### SM2/SM4 Support

SM2 is comparable to Elliptic Curve (EC) in terms of key structure though the signing algorithm is different. SM2 is required for sign/verify. There is a new key type CKK\_SM2. SM4 is comparable to Advanced Encryption Standard (AES-128) in terms of key size though the encryption algorithm is different. SM4 is required for encrypt/decrypt (modes ECB, CBC, CBC-PAD). There is a new key type CKK\_SM4.

See [SM2/SM4 Mechanisms](#).

### SHA-3 Function Support

This provides a guide to using the SHA-3 crypto functions in the Luna HSM. The SHA-3 implementation conforms to the NIST publication FIPS PUB 202. The SHA-3 hash algorithm has been implemented in the K7 FW. This provides the ability to send message data to the Luna HSM in order to receive the SHA-3 digest of the data. The algorithm is implemented for digest bit lengths of 224, 256, 384 and 512 similar to the SHA-2 family of hash algorithms. Other mechanisms that make use of a digest include support for SHA-3 by either specifying the mechanism type or specifying mechanism parameters.

See [SHA-3 Mechanisms](#).

---

## Luna HSM Client 10.1.0

---

This release consists of:

- > Luna HSM Client 10.1.0

## Luna HSM Client 10.1 Supports Both Luna HSMs and Luna Cloud HSM Services From Data Protection on Demand

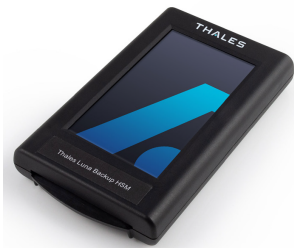
Luna HSM Client can now be used with Luna Cloud HSM services provided by Thales Data Protection on Demand. This allows you to migrate keys from a password-authenticated Luna HSM partition to a Luna Cloud HSM service or vice-versa, set up High-Availability (HA) groups that include both password-authenticated Luna partitions and Luna Cloud HSM services, and operate your local (Luna PCIe), remote (Luna Network), and cloud HSM solutions on the same client workstation.

Luna Cloud HSM client compatibility is limited to Windows and Red Hat Enterprise Linux 7-based operating systems in this release.

Refer to the following sections:

- > [Adding a DPoD HSM on Demand Service](#)
- > [Cloning Keys Between Luna 6, Luna 7, and HSM on Demand](#)

## Luna G7 Backup HSM



Thales is pleased to announce the availability of the Luna G7 Backup HSM – a full-featured, hand-held, USB-attached backup HSM that includes an informational full-color display.

You can use the Luna G7 Backup HSM to backup your Luna HSM 5.x, 6.x, and 7.x user partitions.

The Luna G7 Backup HSM connects easily to a client workstation using the included USB 3.0 Type C cable, and includes a universal 5V external power supply, which may be required to power the device in some instances.

**NOTE** The smart card slot located at the bottom front of the unit is reserved for future use and has been disabled in this release.

For detailed usage instructions, see [Backing Up Partition Objects to a G7-based Backup HSM](#).

### Models

The Luna G7 Backup HSM is available in the following models. All models can be initialized in PED or password-authenticated mode for backing up either PED or password authenticated partitions. In-field storage upgrades are not available.

<b>B700</b>	32 MB storage, up to 100 partitions of the same authentication type
<b>B750</b>	128 MB storage, up to 100 partitions of the same authentication type
<b>B790</b>	256 MB storage, up to 100 partitions of the same authentication type

To use the Luna G7 Backup HSM, you must upgrade to Luna HSM Client 10.1, a client-only field update for Linux and Windows. Luna HSM Client 10.1 provides the drivers and software updates you need to use the Luna G7 Backup HSM.

## Remote PED Support on Linux

You can now host Remote PED services on a Linux workstation.

See [Remote PED Setup](#).

## Windows Secure Boot Support

The drivers included with the Luna HSM Client software for Luna PCIe HSMs, Luna Backup HSMs, Luna USB HSMs, and Luna PEDs now support Windows Secure Boot.

---

## Luna PCIe HSM Release 7.4

---

This release consists of:

- > Luna HSM Client 7.4.0
- > Luna HSM firmware 7.4.0

### Functionality Modules

Luna PCIe HSM 7.4 introduces Functionality Modules (FMs). FMs consist of your own custom-developed code, loaded and operating within the logical and physical security of a Luna PCIe HSM as part of the HSM firmware. FMs allow you to customize your Luna PCIe HSM's functionality to suit the needs of your organization. Custom functionality provided by your own FMs can include:

- > new cryptographic algorithms, including Quantum algorithms
- > security-sensitive code, isolated from the rest of the HSM environment
- > keys and critical parameters managed by the FM, independent from standard PKCS#11 objects, held in tamper-protected persistent storage

To create FMs, you will need the Functionality Module Software Development Kit (SDK), which is included with the Luna HSM Client software. Applications that use FM functions are supported on Windows and Linux.

**CAUTION!** Enabling FMs (**HSM policy 50**) introduces changes to Luna HSM functionality, some of which are permanent; they cannot be removed by disabling the policy. FM-enabled status is **not** reversible by Factory Reset. Refer to ["FM Deployment Constraints" on page 1](#) for details before enabling.

See ["About the FM SDK Programming Guide" on page 1](#) and ["Functionality Modules" on page 1](#) for details and procedures.

### View Utilization Metrics by Partition

Release 7.4 allows you to view utilization metrics for an individual partition or a specified list of partitions.

See ["Partition Utilization Metrics" on page 1](#) for details.

## Ed25519ph Curve

Luna PCIe HSM firmware version 7.4.0 includes support for the ed25519ph curve variant.

See "[CKM\\_EDDSA](#)" on page 1 for details.

---

## Luna PCIe HSM Release 7.3

---

This release consists of:

- > Luna HSM Client 7.3.0
- > Luna HSM firmware 7.3.0

### BIP32 Algorithm

Luna PCIe HSM 7.3 includes new mechanisms that use the BIP32 cryptographic algorithm. This allows Luna PCIe HSM to support applications that use Hierarchical Deterministic Wallets, used in Bitcoin and blockchain transactions (requires firmware 7.3.0).

### JavaSP support for ECC Curve 25519

The Luna Java Provider now includes support for mechanisms using ECC Curve 25519.

---

## Luna PCIe HSM Release 7.2

---

This release consists of:

- > Luna HSM Client 7.2.0
- > Luna HSM firmware 7.2.0

### Improved Luna HSM Client

Release 7.2 adds improvements to the Luna HSM Client software:

- > **Enhanced Version Compatibility for Luna HSM Client** — Version 7.2 and newer Luna HSM Client can be used with HSMs running Luna 6.2.1 or higher, or any Luna 7 version, without conflict. Luna HSM Client 7.2 and newer versions can coexist in large deployments. You can schedule client roll-outs at your convenience, without need to match versions across your organization. Future HSM features that do not have client-version dependencies will function without issue.
- > **Improved Client Installer with User-Defined Install Paths (Windows)** — Luna HSM Client can be installed at user-selected locations (file paths with sufficient space), and installed Client software can be modified without uninstalling and reinstalling.
- > **User-Defined Client Install Paths (Linux)** — Linux root-level users can install the Luna HSM Client software to an installation directory of their choice.



## Relabel Partitions

The Partition SO can now change the label of an initialized partition. This allows partitions to be created ahead of time and renamed to something more suitable later, when they are allocated for a particular purpose (Requires firmware 7.2.0).

## Crypto User Can Clone Public Objects

The Crypto User (CU) role has always been able to create public objects, but not clone them. In HA mode, this would cause the replication and subsequent object creation operations to fail. Firmware 7.2.0 allows the CU to clone public objects, and therefore to perform operations on HA groups without Crypto Officer authentication (Requires firmware 7.2.0).

## Auto-Enabled HA Logging

Luna HSM Client now automatically enables HA logging, either when you create the first HA group, or when you update the Luna HSM Client to 7.2.0 and it detects a previously-configured HA group. If you manually turn HA logging off, logging is not auto-enabled for new HA groups.

## SCP03 Encoding

The SCP03 encoding scheme, as defined in [NIST SP 800-108](#), is now supported for Global Platform.

---

# Luna PCIe HSM Release 7.1

---

This release consists of:

- > Luna HSM Client 7.1.0
- > Luna HSM firmware 7.1.0

## Policy Templates

The HSM or Partition SO can save a copy of their organization's preferred HSM or partition policy settings to a template. They can then use this template to configure policy settings when initializing other HSMs or partitions.

This can save time and effort when deploying multiple HSMs or partitions. It also ensures consistency across your HSMs and partitions, which helps to simplify future audit and compliance requirements.

See [Setting HSM Policies Using a Template](#) and [Setting Partition Policies Using a Template](#).

## Configurable Policies for Export of Private Keys

The Partition SO can use partition policies to control whether or not the private keys in a given partition can be exported off the HSM. The ability to export private keys is particularly useful in use cases such as smart card & identity issuance, secure manufacturing, etc.

This gives organizations the ability to support a wider variety of use cases with their HSM, and also provides Partition SOs with more flexibility overall.

See [Configuring the Partition for Cloning or Export of Private Keys](#).

## Curve 25519 Available in FIPS Mode

Curve 25519 is now available for use in FIPS mode.

---

## Luna PCIe HSM Release 7.0

---

This release consists of:

- > New Luna PCIe HSM adapter
- > Luna HSM Client 7.0.0
- > Luna HSM firmware 7.0.1

### Low-Profile Card

The Luna PCIe HSM 7 is smaller than its predecessors and can be installed in a half-height PCIe slot.

See [Luna PCIe HSM Required Items](#).

### Partition Security Officer

All application partitions now have a Partition Security Officer (PO) role that is completely distinct from the HSM Security Officer (HSM SO) role. In this security model, the HSM SO is responsible only for initializing the HSM, setting HSM-level security policies, and creating and deleting partitions. After creating the partitions, the HSM SO has no access to the contents of the partitions. Partitions are owned by the PO, who is responsible for initializing the partition, setting the partition-level security policies and initializing the cryptographic roles on the partition. This model permits a complete separation of roles on the HSM.

See [Partition Roles](#).

### Best-in-Class Performance

Luna PCIe HSM 7 provides cryptographic performance that is 10x faster than the release 5.x and 6.x Luna HSMs.

### Industry-Leading Security

Luna PCIe HSM 7 provides enhanced environmental failure protection and tamper resistance.

### Improved Random Number Generation

The performance of Luna PCIe HSM 7's AES-256 CTR DRBG random number generation is significantly increased from previous versions. The RNG is fully compliant with the latest entropy standards:

- > SP800-90B
- > SP800-90C
- > BSI DRG.4

## New Cryptographic Mechanism Support

Luna PCIe HSM 7 adds support for the following cryptographic algorithms:

- > SP800-108 HMAC (RSA & ECC)
- > SP800-38F (KWP)
- > Curve 25519
- > AES-XTS - disk encryption standard

## Increased Key Storage Capacity

Luna PCIe HSM 7 provides up to 32 MB of cryptographic object storage (depending on the model).

## Secure Transport Mode Redesigned

Secure Transport Mode (STM) in Luna PCIe HSM 7 provides a simple, secure method for shipping an HSM to a new location and verifying its integrity upon receipt. When the HSM SO enables STM, it locks the HSM and its contents, and records the current configuration as a pair of unique strings. When the HSM is recovered from STM, the unique strings are redisplayed. If the strings match, the HSM has not been tampered or modified during transport.

See [Secure Transport Mode](#).

## Version Dependencies by Feature

Some of the Luna PCIe HSM functionality described in the documentation has been introduced in updates since the initial product release. For your own reasons, you may wish to apply some aspects of a product update and not others. For example:

- > you may choose to update client software while keeping an earlier, FIPS-certified firmware version
- > if you are maintaining a large number of client workstations, it may be cumbersome to apply software updates to all of them

The following table outlines the Luna PCIe HSM functions that depend on a certain software/firmware version, or have other requirements you must consider.

Function	Minimum Version Requirements	Notes
<b>V0 and V1 partitions</b> > <a href="#">What are "pre-firmware 7.7.0", and V0, and V1 partitions?</a>	<b>Client:</b> 10.3.0 <b>Appliance:</b> 7.7 <b>Firmware:</b> 7.7.0	This new cloning protocol is a necessary underpinning for some of the features that ensure eIDAS compatibility. It affects backup and restore operations, High Availability, Scalable Key Storage. Migration from earlier cloning-version HSMs is one-way V0/V1 HSMs/partitions can accept and decrypt older objects, but can encrypt and export only V0/V1 objects.

Function	Minimum Version Requirements	Notes
<b>Scalable Key Storage</b> > <a href="#">Scalable Key Storage (SKS)</a>	<b>Client:</b> 10.3.0 <b>Appliance:</b> 7.7 <b>Firmware:</b> 7.7.0	SKS allows off-boarding of objects and keys as encrypted blobs, for handling of much greater numbers of objects than can be contained within the HSM. With firmware 7.7.0, backup and restore and HA are implemented using SKS blobs, while the latest cloning protocol is used for replicating or archiving the SKS Master Key (that encrypts and decrypts the blobs). Migration from the earlier version of SKS in firmware 6.x is supported, but the reverse direction is not.
<b>Per-Key Authorization (PKA)</b> > <a href="#">Per-Key Authorization (PKA)</a>	<b>Client:</b> 10.3.0 <b>Appliance:</b> 7.7 <b>Firmware:</b> 7.7.0	PKA meets a requirement of PP 419-221.5, and allows each key in a partition to have its own authorization and rules governing its use, including integration with a SAM. and sole control of keys. The resulting overhead increases the size of partition headers, affecting the size and number of objects that can be stored, which invokes new considerations for backup and restore. Existing applications (with no PKA awareness) can still work if the new Client Cryptoki library is installed. Existing partitions become "backward compatible" when the HSM is upgraded to f/w 7.7.0. New partitions can be backward compatible or PP 419-221.5-compatible by setting an option at creation time.
<b>Luna G7 Backup HSM Firmware 7.7.1</b> > <a href="#">Updating the Luna G7 Backup HSM Firmware</a> > <a href="#">Rolling Back the Luna G7 Backup HSM Firmware</a>	<b>Client:</b> 10.3.0 <b>Appliance:</b> 7.7.0	The Luna G7 Backup HSM requires minimum firmware 7.7.1 to back up and restore Luna 7.7.x partitions, or to migrate keys from Luna HSMs using older firmware. You require, at minimum, Luna HSM Client 10.3.0 to upgrade the Luna G7 Backup HSM firmware.
<b>Initialize the orange RPV key remotely</b> > <a href="#">"Remote RPV Initialization" on page 1</a>	<b>Firmware:</b> 7.7.0 <b>Client:</b> 10.3.0	

Function	Minimum Version Requirements	Notes
<b>Support for 3GPP, SM2/SM4, and SHA-3 Cryptographic Algorithms</b> <ul style="list-style-type: none"> <li>&gt; <a href="#">3GPP Mechanisms for 5G Mobile Networks</a></li> <li>&gt; <a href="#">SM2/SM4 Mechanisms</a></li> <li>&gt; <a href="#">SHA-3 Mechanisms</a></li> </ul>	<b>Firmware:</b> 7.4.2 <b>Client:</b> 10.2 (or patched 7.4)	Refer also to Firmware 7.4.2 Mechanisms for descriptions of the applicable mechanisms. Refer to the <i>Luna HSM Firmware 7.4.2 Technical Note</i> for installation instructions.
<b>DPoD Luna Cloud HSM Support</b> <ul style="list-style-type: none"> <li>&gt; <a href="#">"Adding a Luna Cloud HSM Service" on page 1</a></li> </ul>	<b>Client:</b> 10.1	Refer to <a href="#">"Cloning Keys Between Luna 6, Luna 7, and Luna Cloud HSM" on page 1</a> for more information on using a Luna Cloud HSM service with Luna HSMs.
<b>Remote PED Server Support on Linux Clients</b> <ul style="list-style-type: none"> <li>&gt; <a href="#">Remote PED Setup</a></li> </ul>	<b>Client:</b> 10.1	
<b>Luna Backup HSM (G7 model) Support</b> <ul style="list-style-type: none"> <li>&gt; <a href="#">Backing Up Partition Objects to a G7-based Backup HSM</a></li> </ul>	<b>Client:</b> 10.1	
<b>Functionality Modules</b> <ul style="list-style-type: none"> <li>&gt; <a href="#">Functionality Modules</a></li> <li>&gt; <a href="#">About the FM SDK Guide</a></li> </ul>	<b>Hardware:</b> FM-Ready <b>Firmware:</b> 7.4.0 <b>Client:</b> 7.4	Refer to <a href="#">Preparing the Luna PCIe HSM to Use FMs</a> for an overview of hardware/software/firmware requirements.
<b>Support for BIP32 Cryptographic Algorithms</b> <ul style="list-style-type: none"> <li>&gt; <a href="#">BIP32 Mechanism Support and Implementation</a></li> </ul>	<b>Firmware:</b> 7.3.0 <b>Client:</b> 7.3.0	Refer also to Firmware 7.3.0 Mechanism Summary for descriptions of the applicable mechanisms.
<b>Partition Utilization Metrics</b> <ul style="list-style-type: none"> <li>&gt; <a href="#">Partition Utilization Metrics</a></li> </ul>	<b>Firmware:</b> 7.3.0 <b>Client:</b> 7.3	

Function	Minimum Version Requirements	Notes
<p><b>Improved Luna HSM Client</b></p> <ul style="list-style-type: none"> <li>&gt; Version-Compatible Luna HSM Client (Luna HSMs version 6.2.1 and higher)</li> <li>&gt; <a href="#">Modifying the Installed Windows Luna HSM Client Software</a></li> <li>&gt; User-Defined Luna HSM Client install paths</li> </ul>	<p><b>Client:</b> 7.2</p>	<ul style="list-style-type: none"> <li>&gt; Luna HSM Client 10.1 or higher is required to use Luna partitions with DPoD Luna Cloud HSM services</li> <li>&gt; The <b>PE1756Enabled</b> setting on Luna 6.x HSMs is not supported for use with the Version-Compatible Luna HSM Client</li> <li>&gt; Minimum OS requirements for Luna HSM Client 7.2 must be met (Refer to the CRN for details)</li> </ul>
<p><b>Re-label partitions</b></p> <ul style="list-style-type: none"> <li>&gt; <a href="#">partition changelabel</a></li> </ul>	<p><b>Firmware:</b> 7.2.0 <b>Client:</b> 7.2</p>	
<p><b>Crypto User can clone public objects</b></p>	<p><b>Firmware:</b> 7.2.0</p>	<p>The Crypto User (CU) role has always been able to create public objects, but not clone them. In HA mode, this would cause the replication and subsequent object creation operations to fail. Firmware 7.2.0 allows the CU to clone public objects, and therefore to perform operations on HA groups without Crypto Officer authentication.</p>
<p><b>Configure partition policies for export of private keys</b></p> <ul style="list-style-type: none"> <li>&gt; <a href="#">Configuring the Partition for Cloning or Export of Private Keys</a></li> </ul>	<p><b>Firmware:</b> 7.1.0</p>	<p>You can configure partition policies for Cloning or Key Export Mode manually, as long as you have updated the HSM firmware. To set these modes using Policy Templates, you must meet the Policy Template requirements.</p>
<p><b>Policy Templates</b></p> <ul style="list-style-type: none"> <li>&gt; <a href="#">Setting HSM Policies Using a Template</a></li> <li>&gt; <a href="#">Setting Partition Policies Using a Template</a></li> </ul>	<p><b>Firmware:</b> 7.1.0 <b>Client:</b> 7.1</p>	

# CHAPTER 3: Security

Luna HSMs ensure the highest quality of protection of your cryptographic material with the following security measures:

- > ["Layered Encryption" below](#)
- > ["Tamper Protection" on page 34](#)
- > ["Certification" on page 35](#)

## Layered Encryption

---

Luna HSMs do not keep any objects in the clear. All objects are encrypted by multiple layers, and are fully decrypted in temporary (volatile) memory only when needed.

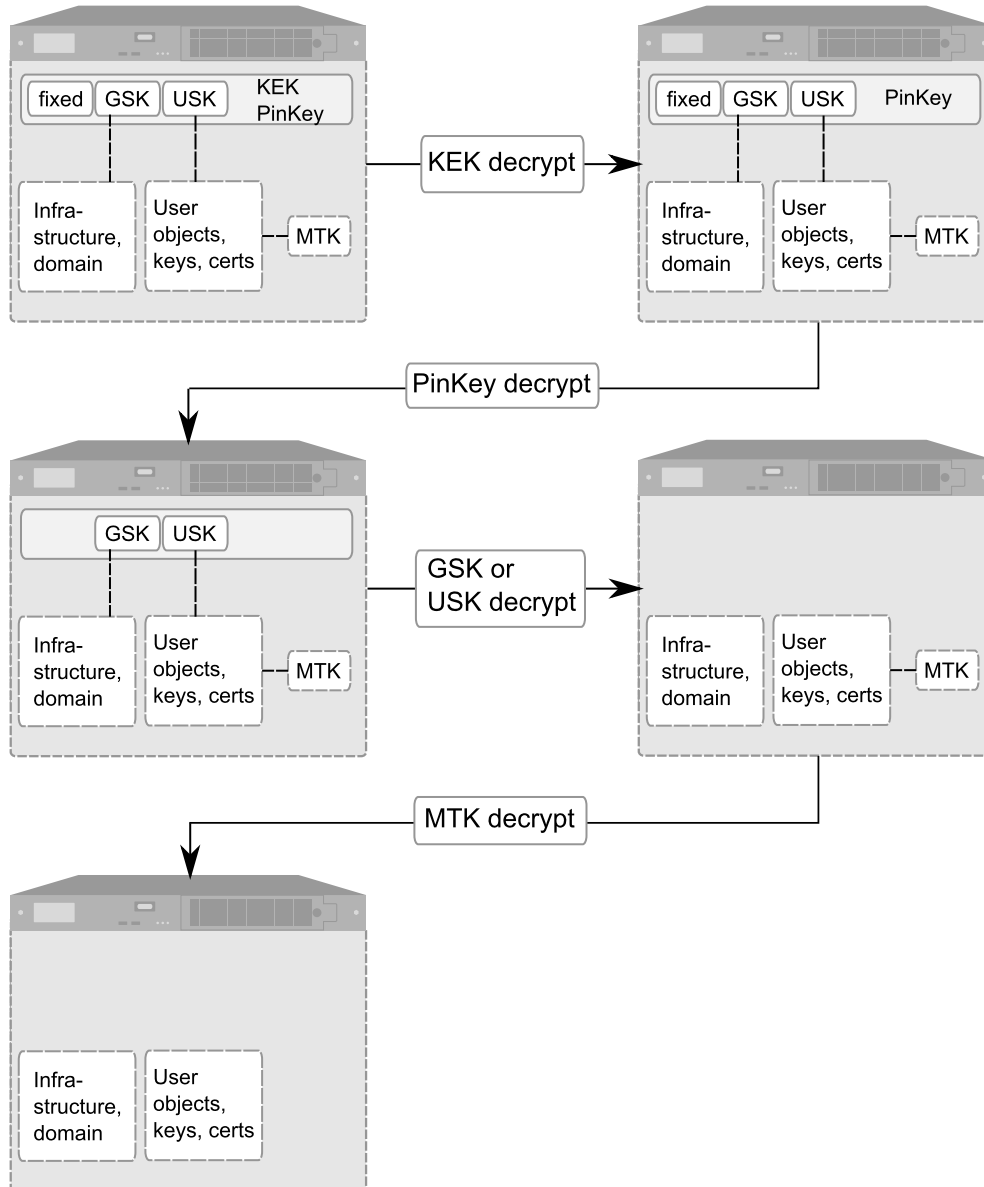
### Hierarchy of Protection

One general storage key (GSK), for the HSM, protects general storage objects that might be needed by various roles. A separate user storage key (USK) for each role, protects the contents of the partition accessed by that role. The hierarchy of protection, depicted in ["HSM Layered Encryption" on the next page](#), applies to each individual role. The USK for each role on the HSM encrypts objects that are owned by that role, ensuring that each person sees and touches only what belongs to them. Every Luna HSM has a master tamper key (MTK) that strongly encrypts each object generated and stored within the HSM.

The key encryption key (KEK) further encrypts every key being used to ensure that your keys are never shown in plaintext.

## Three-Layer Authentication Model

Figure 2: HSM Layered Encryption



When the HSM is powered on, all stored objects are still tightly encrypted. When an object is decrypted for use, the decrypted version exists in volatile memory, only while being used, and only while the HSM has power.

1. KEK is unique to each HSM, and encrypts everything that is encrypted by the PinKey.
2. During login, KEK and PinKey decryptions are performed.
  - For password-authenticated HSMs, the PinKey is the HSM SO password (or Partition SO, or CO or CU or Auditor, depending on who is logging in).
  - For PED-authenticated HSMs, the PinKey is the secret retrieved from the correct blue SO PED key (or black or gray or white, depending on who is logging in).

At this point, objects are partially decrypted, but still under further levels of encryption (see next steps).



3. GSK encrypts all general-storage objects, while USK encrypts all security and user objects for the role logged into the HSM. Objects are decrypted (into volatile memory) individually when needed.
4. At the lowest level, MTK encrypts all objects.
5. Some objects are fully decrypted in volatile memory only when in use. Others, including ECDSA with NIST Prime curves, AES, DES3, and RSA keys remain MTK-encrypted. Once decrypted and accessible, objects inside the HSM can be used. If power is lost or a tamper occurs, all temporarily decrypted objects instantly evaporate, and stored objects remain tightly encrypted as always.

The in-depth application of multiple layers of security at all levels of the interface to Luna HSMs and their internal HSMs provides a high degree of confidence that cryptographic material within the HSM will not be compromised. Customers with extremely demanding security requirements can enhance the already strong security of Luna HSMs by choosing appropriate installation, HSM configuration, and policy options.

## Cloning Domain or Security Domain

Every HSM or partition is part of a security domain, set at initialization time. This is also called a cloning domain, because objects under such a domain can be securely copied (cloned) only to other HSMs or partitions that share that exact domain.

Multiple HSMs or partitions can be set to be part of the same cloning domain or different ones. Key material cannot leave its cloning domain, so if an attacker were to try to copy your cryptographic material to a device that does not share a cloning domain with your HSM or partition, they would be unsuccessful. Using cloning domains ensures that key material can travel only between trusted and authorized devices. This adds a strong layer of defense against attackers.

**NOTE** The security or cloning domain is not the lowest encryption level, so a cloning operation does not provide access to Crypto material. Operations that use cloning are limited to backup, restore and synchronizing the HSMs in HA groups ( among HSMs that share the same domain). Only the backup operation imposes a source-partition domain on the target partition within the Backup HSM; the restore operation and the HA synchronization both require that the source and target HSMs or partitions must already have matching domains.

## Scalable Key Storage (SKS)

Beginning at firmware 7.7.0, the concept and feature of Scalable Key Storage is introduced. Where, prior to 7.7.0 all application partitions were of one type, now partitions are either:

- > version zero (V0) partitions that continue to support the cloning model described above (also referred to as "Keys in Hardware"), and
- > version one (V1) partitions that support cloning only for the SKS Master Key (SMK), while all other backup/restore and HA operations involve keys and objects being exported and imported as encrypted binary large objects (blobs), while otherwise remaining securely encrypted in external storage.

The SMK secures all stored keys and objects within the security envelope of the HSM, even when they reside in offboard storage because,

- > the keys and objects are securely encrypted with the SMK, when not in use inside the HSM, and

- > the SMK is secured by the traditional "keys in hardware" cloning/security domain, and can be copied only to another HSM or partition that shares the specific cloning/security domain.

The cloning (or security) domain is set by the partition SO and does not change for the life of the partition.

The choice of partition type:

- V0 (traditional cloning for protected movement of keys and objects), or
- V1 (enables PKA and SKS features and uses cloning only for the SMK)

is made by the HSM SO at partition creation.

HA replication and synchronization, that traditionally used cloning, transparently use a combination of SMK cloning and SKS extract/insert operations when V1 partitions are involved.

## Tamper Protection

### Physical Security

Luna HSMs are equipped with intrusion-resistant, tamper-evident hardware, and use the strongest cryptographic algorithms to ensure that your data is secure. If a security breach is detected, a tamper event occurs and the HSM becomes locked until the tamper is cleared by the appropriate authority or the HSM is reset.

#### Luna PCIe HSM

The Luna PCIe HSM, or cryptographic module, is a multi-chip standalone module as defined by FIPS PUB 140–2 section 4.5. This means that:

- > The module is enclosed in a strong enclosure that provides tamper-evidence. Any tampering that might compromise the module's security is detectable by visual inspection of the physical integrity of the module. In addition, any attempts to physically tamper with the token would likely result in the destruction of its circuitry and components, thus ensuring that your keys and sensitive objects are safe from an attacker.
- > The module's physical design also resists visual inspection of the device design, physical probing of the device and attempts to access sensitive data on individual components of the device.

If an attacker with unlimited resources were to simply steal the appliance, and apply the resources of a well-equipped engineering lab, it might be possible to breach the physical security. However, without the password (password-authenticated HSMs) or the PED keys (PED-authenticated HSMs), such an attacker would be unable to decipher any signal or data that they manage to extract.

With that said, it is your responsibility to ensure the physical security of the unit to prevent such theft, and it is your responsibility to enforce procedural security to prevent an attacker ever having possession of (or unsupervised access to) both the HSM and its authentication secrets.

### Surrounding Environment

The data sheets provided for individual products show the environmental limits that the device is designed to withstand. It is your responsibility to ensure that the unit is protected throughout its working lifetime from extremes of temperature, humidity, dust, vibration/shock that exceed the stated limits.

We do not normally specify operational tolerances for vibration and shock, as the Luna HSM is intended for installation and use in an office or data center environment. We perform qualification testing on all our products to ensure that they will survive extremes encountered in shipping, which we assume to be more demanding than the intended operational environment.

It is also your responsibility to ensure that the HSM appliance is installed in a secure location, safe from vandalism, theft, and other attacks. In summary, this usually means a clean, temperature-, humidity-, and access-controlled facility. We also strongly recommend power conditioning and surge suppression to prevent electrical damage, much as you would do for any important electronic equipment.

## Authentication Data Security

It is your responsibility to protect passwords and/or PED keys from disclosure or theft and to ensure that personnel who might need to input passwords do not allow themselves to be watched while doing so, and that they do not use a computer or terminal with keystroke logging software installed.

## Certification

---

### FIPS

At any given time, a FIPS-validated version of the HSM is available, and a newer not-yet-validated version might also be available for newly introduced products that have not had time to go through the long evaluation and validation process. The usual practice is to ship units pre-loaded with the firmware and software at the FIPS-validated level by default, while providing the option to update the Client software, Appliance software, and HSM firmware to the newer version. This allows customers who need FIPS validation to have that configuration from the factory, and customers who need newer features (and do not need FIPS validation) to upgrade by simply installing the newer software and following the upgrade procedure. To check the progress of HSM versions that are submitted for FIPS 140-2 validation visit the NIST site at <http://csrc.nist.gov/groups/STM/cmvp/validation.html>.

### Common Criteria

Some versions of the product are submitted for Common Criteria EAL evaluation.

You can check with Thales Customer Support to inquire about the certification status of Luna HSM products. If FIPS validation or CC EAL certification are not requirements for you, then the newest version is normally the preferred option.

# CHAPTER 4: Redundancy and Reliability

Luna HSMs are reliable in the case of unexpected events like power failures in the following ways:

- > They have hot-swappable power supplies that can be replaced without turning off your system.
- > They have dual fans to ensure that your HSM remains at a constant temperature and does not overheat and fail should one fan fail. This allows you to continue using your HSM while you replace the defective fan.

Luna HSMs can also be grouped in a High Availability (HA) configuration for auto-recovery of your data in case an HSM fails. See "[High-Availability Groups](#)" below for an overview of this scheme.

## High-Availability Groups

Luna HSMs can provide scalability and redundancy for cryptographic applications that are critical to your organization. For applications that require continuous, uninterrupted uptime, the Luna HSM Client allows you to combine application partitions on multiple HSMs into a single logical group, known as a High-Availability (HA) group.

An HA group allows your client application to access cryptographic services as long as one member HSM is functional and network-connected. This allows you to perform maintenance on any individual member without ever pausing your application, and provides redundancy in the case of individual failures. Cryptographic requests are distributed across all active group members, enabling a performance gain for each member added. Cryptographic objects are replicated across the entire group, so HA can also be used to keep a current, automatic, remote backup of the group contents.

HA functionality is handled by the Luna HSM Client software. The individual partitions have no way to know they are configured in an HA group, so you can configure HA on a per-application basis. The way you group your HSMs depends on your circumstances and desired performance.

### Performance

For repetitive operations (for example, many signings using the same key), an HA group provides linear performance gains as group members are added. The best approach is to maintain an HA group at a size that best balances application server capability and the expected loads, with an additional unit providing capacity for bursts of traffic.

### Load Balancing

Cryptographic requests sent to the HA group's virtual slot are load-balanced across all active members of the HA group. The load-balancing algorithm sends requests for cryptographic operations to the least busy partition in the HA group. This scheme accounts for operations of variable length, ensuring that queues are balanced even when some partitions are assigned very long operations. When an application requests a repeated set of operations, this method works. When the pattern is interrupted, however, the request type becomes relevant, as follows:

- > Single-part (stateless) cryptographic operations are load-balanced.

- > Multi-part (stateful) cryptographic operations are load-balanced.
- > Multi-part (stateful) information retrieval requests are not load-balanced. In this case, the cost of distributing the requests to different HA group members is generally greater than the benefit. For this reason, multi-part information retrieval requests are all targeted at one member.
- > Key management requests are not load-balanced. Operations affecting the state of stored keys (creation, deletion) are performed on a single HA member, and the result is then replicated to the rest of the HA group.

## Key Replication

When an application creates a key on the virtual HA slot, the HA library automatically replicates the key across all group members before reporting back to the application. Keys are created on one member partition and replicated to the other members. If a member fails during this process, the HA group reattempts key replication to that member until it recovers, or failover attempts time out. Once the key exists on all active members of the HA group, a success code is returned to the application.

**Key replication, for pre-firmware-7.7.0 HSM partitions and for V0 partitions**, uses the Luna cloning protocol, which provides mutual authentication, confidentiality, and integrity for each object that is copied from one partition to another. Therefore, all HA group member partitions must be initialized with the same cloning domain.

**Key replication for V1 partitions** uses the Luna cloning protocol to ensure that all HA group members have the same SMK, and uses SKS to export a key originating at one member and to import and decrypt that key (using the common SMK) on each other member in the group. Again, all HA group member partitions must be initialized with the same cloning domain in order that the common SMK can be available on every member.

## Failover

When any active HA group member fails, a failover event occurs – the affected partition is dropped from the list of available HA group members, and all operations that were pending on the failed partition are transparently rescheduled on the remaining member partitions. The Luna HSM Client continuously monitors the health of member partitions at two levels:

- > network connectivity – disruption of the network connection causes a failover event after a 20-second timeout.
- > command completion – any command that is not executed within 20 seconds causes a failover event.

As long as one HA group member remains functional, cryptographic service is maintained to an application no matter how many other group members fail.

## Recovery

Recovery of a failed HA group member is designed to be automatic in as many cases as possible. You can configure your auto-recovery settings to require as much manual intervention as is convenient for you and your organization. In either an automated or manual recovery process, there is no need to restart your application.

As part of the recovery process:

- > Any cryptographic objects created while the member was offline are automatically replicated to the recovered partition.
- > The recovered partition becomes available for its share of load-balanced cryptographic operations.

### **Automatic Recovery**

With automatic recovery, the client library automatically performs periodic recovery attempts while a member is failed. The frequency of these checks is adjustable. Most customers enable auto-recovery in all configurations.

### **Manual Recovery**

Simply run the client recovery command and the recovery logic inside the client makes a recovery attempt the next time the application uses the HSM. As part of recovery, any key material created while the member was offline is automatically replicated to the recovered unit.

Even if a manual recovery process is selected, the application does not need to be restarted.

### **Permanent Failure**

Sometimes a failure of a device is permanent (for example, if the HSM is re-initialized). In this event, you only need to remove the failed unit and deploy a new member to the group. The running clients automatically resynchronize keys to the new member and start scheduling operations to it.

### **Standby Members**

After you add member partitions to an HA group, you can designate some as standby members. Cryptographic objects are replicated on all members of the HA group, including standby members, but standby members do not perform any cryptographic operations unless all the active members go offline. In this event, all standby members are immediately promoted to active service, and operations are load-balanced across them. This provides an extra layer of assurance against a service blackout for your application.

# CHAPTER 5: User Access Control

The security of an HSM and its cryptographic contents depends on well-controlled access to that HSM. A controlled access policy is defined by:

- > the set of users with valid login credentials for the host system, the HSM and the application partition
- > the actions each user is allowed to perform when logged in (the user's role)

For example, an access policy that adheres to the PKCS#11 standard requires two roles: the security officer (SO), who administers the user account(s), and the standard user, who performs cryptographic operations. When a user logs in to the HSM, they can perform only those functions that are permitted for their role.

Access to Luna PCIe HSM is controlled through an enhanced version of the PKCS#11 hierarchy of roles, assigned to different users in your organization. Each role allows its user to execute a different set of commands to perform specialized tasks at one of the following levels:

## HSM-Level Roles

HSM roles are responsible for administration, configuration, and auditing of the HSM. These roles log in to the Luna PCIe HSM Admin partition using LunaCM. HSM-level roles cannot perform cryptographic operations on the application partition.

**Table 1: HSM Roles**

<b>HSM Security Officer (SO)</b> <b>PED Key: Blue</b>	<ul style="list-style-type: none"><li>&gt; Initializes the HSM, creating the SO credential</li><li>&gt; Creates/deletes the application partition</li><li>&gt; Configures global HSM policies</li><li>&gt; Performs updates of the HSM firmware</li></ul>
<b>Auditor (AU)</b> <b>PED Key: White</b>	<ul style="list-style-type: none"><li>&gt; Manages HSM audit logging</li></ul>

## Partition-Level Roles

Partition-level roles are responsible for administration and configuration of the application partition, and using the partition to perform cryptographic functions. Partition roles log in using LunaCM, or supply their credentials via crypto applications.

**Table 2: Partition Roles**

<b>Partition Security Officer (PO)</b> <b>PED Key: Blue</b>	<ul style="list-style-type: none"><li>&gt; Initializes the partition, creating the PO credential and setting the cloning domain</li><li>&gt; Initializes the Crypto Officer role and can reset the CO credential (if permitted by HSM policy)</li><li>&gt; Configures partition policies</li></ul>
--	--

<b>Crypto Officer (CO)</b> <b>PED Key: Black</b>	<ul style="list-style-type: none"><li>&gt; Creates and modifies cryptographic objects on the partition</li><li>&gt; Manages backup and restore operations for the partition</li><li>&gt; Performs cryptographic functions via user applications</li><li>&gt; Initializes the Crypto User role and can reset the CU credential</li></ul>
<b>Crypto User (CU)</b> <b>PED Key: Gray</b>	<ul style="list-style-type: none"><li>&gt; Performs cryptographic functions via user applications (optional read-only role)</li><li>&gt; Can create public objects only</li><li>&gt; Can perform backup/restore of public objects on the partition</li></ul>



# CHAPTER 6: Authentication

Each Luna HSM comes in one of two authentication types – Password authenticated or Multi-factor-authenticated (also called PED-authenticated). PED stands for PIN Entry Device. The authentication type is configured at the factory and cannot be modified in the field.

For an outline of the key differences between password and PED authentication, see "[Authentication Types](#)" below.

**Table 1: Authentication Types**

<b>Password Authentication (single factor)</b>	<b>PED Authentication (multi-factor)</b>
Two-factor authentication is not available; relies on "something you know".	Two-factor authentication is available by way of physical PED Key per role and optional PED PIN per key; that is, can require "something you know" in addition to "something you have" for authentication
Authentication can be input locally or from a remote terminal.	Authentication requires physical local connection or pre-configured Remote PED link.
Knowledge of partition password is sufficient for accessing cryptographic keys.	Access to cryptographic keys is restricted to CO (read/write) and CU (read only); possession of appropriate PED key(s) and potentially also their PED PINs is required.
Dual or multi-person access control is not available.	Dual or multi-person (quorum) access control is available by way of MofN (split-knowledge secret sharing); physical PED Keys, each containing a portion of the role-authentication secret, can be held by separate people who must cooperate to perform authentication.
Key-custodian responsibility and role separation are linked to password knowledge only.	Key-custodian responsibility and role separation are linked to partition password knowledge <i>and</i> PED key(s) ownership / physical possession.

For more detailed information on each authentication type, see:

- > "[Password Authentication](#)" below
- > "[Multi-factor \(PED\) Authentication](#)" on page 43

## Password Authentication

In general, there are two paths to access the Luna appliance and its HSM:

- > The administrative path, via SSH or via local serial link, which uses the LunaSH command-line interface
- > The client path, via SSL, by which client applications use the Luna Network HSM API to perform cryptographic functions within pre-assigned virtual HSMs (called partitions) on the Luna system

For Luna HSMs with Password Authentication, the various, layered roles are protected by passwords.

### HSM Admin

To access the HSM to perform HSM-specific administration tasks (set HSM-wide policies, update firmware and capabilities, backup and restore the HSM, create and remove HSM Partitions, etc.), you must be logged in to LunaSH as admin, then you must further be logged in as HSM Admin (of which there can be only one per Luna HSM). Good security practices suggest that the HSM Admin password should be different from the appliance admin password. However, your corporate policies may differ. As the HSM Admin, you can connect locally, via a serial terminal, or remotely via SSH – you must first be logged in as admin to have access to LunaSH commands.

### Partition Owner

To access HSM Partitions, in order to perform partition-specific administration tasks (set partition-specific policies, assign Partition to Clients, revoke Clients, etc.), you must be logged in to LunaSH as admin, then you must further be logged in as Partition Owner (of which there can be several - one for each partition in the HSM) , using the Partition Password. Good security practices suggest that the Partition Password should be different from the appliance admin password, different than the HSM Admin password, and different than other Partition Passwords (for other partitions). However, your corporate policies may differ. As the Partition Owner, you can connect locally, via a serial terminal, or remotely via SSH – you must first be logged in as admin to have access to LunaSH commands.

### Client

To access HSM Partitions with an application to perform cryptographic operations on data, you must connect remotely via SSL (called NTLS in our implementation) as a Client (one that has been registered by certificate exchange and assigned by the Partition Owner to this partition), then pass a User-type (this is done invisibly by your client application), and present the Partition Password (also done automatically by your application). The password used by a Client is the same Partition Password that is used by the Partition Owner for the particular partition. What limits the scope of operations that a registered, authenticated Client can perform on a partition is the fact that partition administrative commands can be issued only via LunaSH. Thus, for security, Clients must not be allowed to learn the appliance admin password that gives access to LunaSH.

## Authentication

Objects on the HSM are encrypted by the owner of the HSM Admin space or of the User space (partition), and can be decrypted and accessed only by means of the specific secret (password) imparted by the HSM Admin or the partition User respectively.

If you cannot present the secret (the password) that encrypted the objects, then the HSM is just a secure storage device to which you have no access, and those objects might as well not exist.

**NOTE** The administrative role secret is also the application-authentication secret: one plain-text secret used for two purposes. On a Password-authenticated HSM, once the administrator (Crypto Officer or Crypto User) has distributed the secret to the application(s), the only way to restrict access by applications (or personnel) that have come into possession of that secret is to change the password - which also changes the authentication for the associated administrative role.

## Advantages

Using password authentication, as opposed to PED authentication, has the following advantages:

- > Convenience: changing passwords and authentication secrets is easy in the case of personnel changes or suspected compromise
- > Direct mapping to organizational policies: password change policies already existing in an organization are easy to map onto a password authenticated framework

## Disadvantages

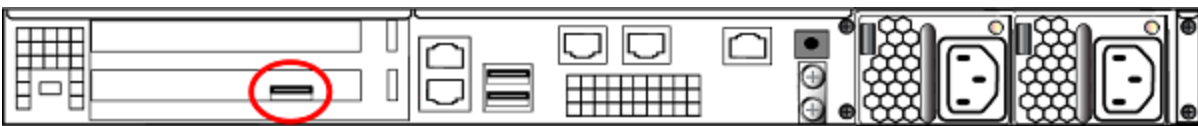
Passwords are less secure than the two-factor authentication provided by the PED, and thus have the following disadvantages:

- > Vulnerability to observation: passwords being typed can be easily observed in person, through a camera, or with mal-ware like keystroke loggers
- > Record-keeping: secure passwords are obscure and must be written, with its record securely stored
- > Accountability: it is difficult to know who might have seen or been told a password

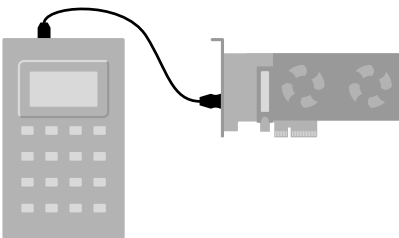
## Multi-factor (PED) Authentication

The connection between the Luna PED and the Luna HSM is a secure trusted path.

- > For the Luna Network HSM, the PED connection is on the appliance rear panel.



- > For the Luna PCIe HSM, the PED connection is a slot-edge connector, directly on the HSM card, accessible at the exterior of a tower or server computer (not through the host computer).



For Local PED, the connection is a secure physical link, directly to the HSM, bypassing the computer memory and bus.

For Remote PED, the PED Key information is made available from the PED location by a PedServer instance, and is received at the HSM location by a PedClient instance there. Two connection options are available:

- > standard, or client-initiated Remote PED involves the PedClient reaching out to a PedServer; while the path is clear, the PED Key data is encrypted and secured at both ends by the Remote PED Vector (on an orange PED Key and in the HSM)
- > peer-to-peer, or server-initiated Remote PED involves the PedServer instance reaching out to the PedClient instance, in order to satisfy HSM location behind a firewall that forbids outgoing initiation of

connections; the PED Key data is secured at both ends by the Remote PED Vector (on an orange PED Key and in the HSM), and the network connection is secured by a TLS link, using previously exchanged certificates.

At no time does an authentication secret exist in-clear, anywhere in computer memory or on any computer bus.

In general, there are three paths to access the Luna HSM:

- > The administrative path, via SSH or via local serial link, which uses the LunaSH command-line interface
- > The Client path, via TLS (our implementation is called NTLS), by which client applications use the Luna HSM API to perform cryptographic functions within pre-assigned virtual HSMs (called Partitions) on the HSM
- > The Trusted Path, used for authentication data passed from the PED and PED keys - this path ensures that HSM authentication data does not pass unencrypted through a host or terminal computer, where it might be subject to attack. This applies only to PED-authenticated (multi-factor) HSMs.

For Luna HSMs with PED Authentication, the various layered roles are protected by a combination of PED keys and passwords.

### **HSM Admin (Security Officer)**

To access the HSM to perform HSM-specific administration tasks (set HSM-wide policies, update firmware and capabilities, backup and restore the HSM, create and remove HSM Partitions, etc.), you must first be authenticated as SO (Security Officer) or HSM Admin (of which there can be only one per Luna HSM). The authentication data for SO/HSM Admin is a secret carried on a blue PED key. For the SO to login and issue HSM commands, someone must be present at the connected local Luna PED, or at the configured Remote Luna PED, to insert the required blue PED key when prompted. Otherwise, HSM commands cannot be used.

### **Partition User (Crypto Officer)**

To access HSM Partitions to perform partition-specific administration tasks, such as setting partition policies, assigning partitions to clients, or revoking clients, you must be authenticated as Partition User. There can only be one Partition User per HSM on the Luna PCIe HSM, or there can be several on the Luna Network HSM - one for each partition. The authentication data for the CO (Crypto Officer) or Partition User is both a password and a secret carried on a black PED key. As the Partition User/CO, you can connect locally, via a serial terminal, or remotely via SSH. To perform partition administration on Luna Network HSM, you must first be logged in as admin to have access to LunaSH commands.

- > For the Luna PCIe HSM, you simply need access to the host computer, where you can use LunaCM commands. For the Partition User/CO to login and issue partition administration commands, someone must be present at the connected Luna PED (or the configured and validated Remote PED) to insert the required black PED key when prompted, or the partition must have been left in Activated state.
- > For the Luna Network HSM, good security practices suggest that the Partition Password be different than the appliance admin password, and different from other Partition Passwords.

If you have invoked the Crypto Officer/Crypto User distinction, there are two Partition Passwords, but only the Crypto Officer password allows you to run LunaSH or LunaCM commands to administer the partition. It is also recommended that the passwords for each of these roles differ.

## Client (Crypto User)

To access HSM Partitions with an application to perform cryptographic operations on data, you must pass a User-type (this is done invisibly by your client application), and present the Partition Password (also done automatically by your application).

- > For a standard "Client", the password is the same Partition Password that is used by the Partition User for the particular partition. What limits the scope of operations that a registered, authenticated Client can perform on a partition on a Luna Network HSM is the fact that partition administrative commands can be issued only via LunaSH. Thus, for security, Clients should not be allowed to learn the appliance admin password that gives access to LunaSH command line. For Luna PCIe HSM, the password or other authentication that gives access to the client application is often the same authentication that gives access to LunaCM for partition administration, so the ability to keep roles separate is more dependent on control of PED keys.
- > For a Crypto User client, the password is different from the Crypto Officer password, offering another layer of protection for the partition and its contents.

## Auditor

This role combines a special, limited-access appliance account and a special HSM role authenticated by the white PED key, for the purpose of managing HSM audit logs. The auditor is distinct and separate from other role on the appliance and the HSM, conforming to the requirements of auditing standards.

## Remote PED

By default, Luna PED is connected directly to the HSM via a USB cable, and powered by the included power block. However, Luna PED can also be used remotely from the HSM(s) for which it manages access control. When it is not convenient to be physically near the host computer that contains a Luna HSM you can operate remotely and securely.

The PED-Authenticated Luna HSM, and one or more orange PED keys are imprinted with a Remote PED Vector (RPV). This can occur at any time before the HSM is deployed, and requires a locally connected PED. All future PED and PED key interactions can then be accomplished distantly from the HSM, as follows:

1. One computer, running a supported OS, hosts the HSM. This could be:

- A server or tower containing a Luna PCIe HSM.
- A Luna Network HSM appliance.

The HSM host computer must be network attached. HSM administration commands can be input locally, or via remote connection, but the network connection is essential for Remote PED operation.

2. A second computer (laptop, workstation, server running a supported OS) has a Luna PED (Remote Capable) attached via USB, and powered via its included power block. The Remote PED host computer must be network attached. The administration of the distant HSM host does not have to come from this Remote PED host computer, but it is usually done that way, since the person handling the PED must coordinate with the person giving commands to the HSM. The Remote PED host computer and PED must have the orange Remote PED Key (RPK) available, along with:

- Either blue, black and red (optionally, white) PED keys that were imprinted with the HSM previously
- Or blank blue, black, and red (optionally, white) PED keys that are about to be imprinted along with the HSM

3. The HSM is told to look to a remote PED for its authentication requests.

4. The PED host computer has the LunaPED driver installed, and runs the pedserver utility.
5. The HSM host computer runs the pedclient utility, and the HSM is told to connect to the Remote PED.
6. The Remote PED (via the pedserver) receives the request and prompts for the orange PED Key.

The Remote PED and the HSM (via the pedclient/pedserver connection) must agree that the provided orange PED key contains the same Remote PED Vector as the one imprinted on the HSM, and only then is the secure Remote PED link established.

7. The HSM SO runs commands on the HSM (on the host computer) via remote desktop or SSH connection.

All future authentication for the HSM can be performed at the Remote PED, with no need for personnel to visit the HSM host, which could be locked away in a lights-off facility on the other side of the world.

## Authentication

Objects on the HSM are encrypted by the owner of the HSM Admin space (rarely) or of the User space (partition), and can be decrypted and accessed only by means of the specific secret injected from the blue PED key (HSM Admin) or the black PED key (User) respectively.

If you cannot present the secret (the PED key) that encrypted the objects, then the HSM is just a secure storage device to which you have no access, and those objects might as well not exist.

### Challenge Secrets

When the HSM is PED-authenticated:

- > The administrative role secret contained on a black or gray PED key is one secret, used only by administrative personnel.
- > The challenge-secret or password is a second secret (plain text, initially presented on the PED screen, but you can change it), which is the application-authentication secret, that allows the HSM verify that the presenting application is entitled to perform cryptographic operations on the particular application partition.

The application can submit its own authentication (that second secret) only after the PED key secret has "opened" the HSM partition for operation (by Activating it). That is, there are two levels of protection: one administrative, and the other operational, where the operational level is gated by the administrative level.

### Activation

By default, PED-authenticated partitions require that a PED key and challenge password be provided each time a user or application authenticates to the HSM. For some use cases, such as key vaulting, the need to provide a physical key to access the HSM may be desirable. For most application use cases, however, requiring a physical key each time the application accesses the HSM is impractical.

Activation allows registered users and applications to authenticate to the HSM without a PED key, using only a challenge secret. The PED key secret for the CO or CU role is copied the first time you perform an action that requires authentication, and it is cached on the HSM.

The ability to use activation is determined by its corresponding policy. Enabling this policy will allow you to use activation.

### Auto-Activation

In the event of a restart or short power outage, activated roles are deactivated and must re-authenticate with a PED key and challenge secret.

Auto-activation enables automatic re-activation of an activated role, so that users or applications do not have to provide a PED key again to reactivate their role.

The ability to use auto-activation is determined by its corresponding policy. Enabling this policy will allow you to use auto-activation.

## Advantages

Using PED authentication, as opposed to password authentication, has the following advantages:

- > Security: no written record of the secret or password exists, so it cannot be compromised
- > Tracking: access and handling of physical devices (PED keys) can be tracked and controlled
- > Duplication restrictions: duplication and promulgation can be prevented by physical security measures
- > Physical device: using the PED to input passwords and PEN PINs prevents key-logging exploits that typed passwords are vulnerable to

## Disadvantages

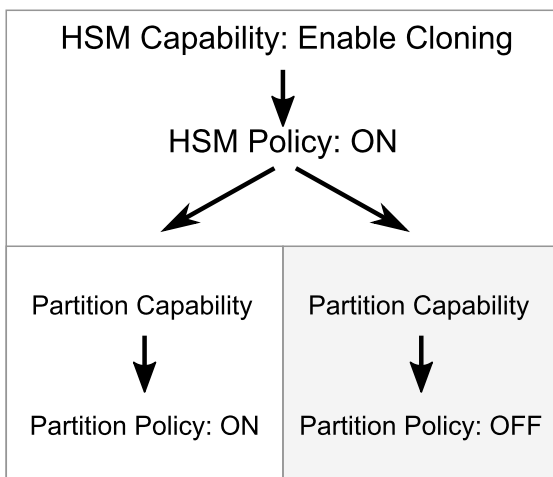
PED keys are physical items that can be lost or misplaced, unlike passwords, and thus have the following disadvantages:

- > Password change policies: scheduled or mandated password-change cycles in an organization can be logistically intensive when HSMs share PED key secrets
- > Inconvenience: handling of secrets requires hands-on, physical action by personnel to perform changes of authentication secrets in case of compromise

# CHAPTER 7: Capabilities and Policies

HSMs, and partitions within them, are characterized by capabilities that are set at the factory, or added by means of capability updates, and that are adjusted by means of settable policies that correspond to some of the capabilities. HSM capabilities, and the HSM policies that derive from them, apply HSM-wide. Application partition capabilities, and the application partition policies that derive from them, can be inherited from the HSM, or control characteristics that make sense only at the application partition level. "[Capability and Policy Inheritance](#)" below illustrates an example of how capabilities and policies can be inherited from the HSM-level to the partition-level on a Luna Network HSM.

**Figure 3: Capability and Policy Inheritance**



All policies have an equivalent capability, but not all capabilities are matched by a policy that allows adjustment of the capability. The HSM administrator is responsible for setting up the HSM with capabilities, but it is up to the Partition SO to enable their corresponding policies.

Some policy settings are numerical values that can be increased or decreased. Most policy settings are simply OFF/ON switches. Policy setting requires that the SO be logged in. For HSM-wide policies, that is the HSM SO. For partition-level policies, that is the Partition SO.

## Set Policies

Set policies with the **hsm changepolicy** command or the **partition changepolicy** command, as appropriate. The command requires that you identify the policy number that is to change, and the new value it is to hold. For OFF/ON policies, the value is set as zero or one, respectively.

For detailed lists of HSM and Partition capabilities, as well as their corresponding policy settings, see:

- > [HSM Capabilities and Policies](#)
- > [Partition Capabilities and Policies](#)



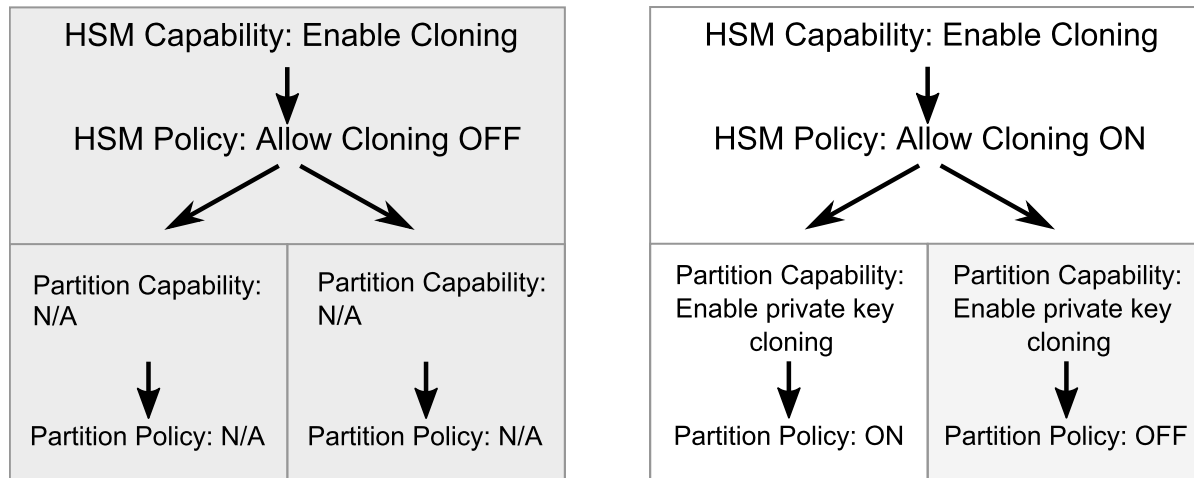
**Example: Cloning**

The cloning operation allows you to duplicate or copy the contents of your HSM or partition to other HSMs or partitions that share a cloning domain. The HSM capability that controls cloning on your HSM is Enable Cloning. The equivalent HSM Policy, Allow Cloning, is the modifiable switch that turns cloning on or off for your specific HSM.

**NOTE** Turning cloning ON or OFF is destructive, and resets your HSM. Ensure that you decide early on in your configuration whether or not you will be using this capability.

"Cloning Capability Inheritance" below shows how the cloning capability is inherited by partitions within your HSM, depending on whether you turn it on or off when you set its policy value.

**Figure 4: Cloning Capability Inheritance**



If cloning is not allowed HSM-wide, then no partition on the HSM will be able to use cloning.

If cloning is allowed HSM-wide, then each partition inherits that capability and can independently decide whether it wants to enable it.

# CHAPTER 8: Flexible Backups

While some applications might deal in ephemeral objects that are erased after their use, in many Luna HSM applications the keys and objects within the HSM and partition have value and are meant to persist. For such valuable data, any security regime requires that the data be backed up in secure fashion, and stored securely.

Backup and restore operations require access to the objects in your partition in order to copy them. As such, backup and restore operations are restricted to HSMs that share a cloning domain and partitions whose administrators allow access to.

**NOTE** This section describes the backup options G5-based Backup HSM. For a description of the G7-based Backup HSM, see [Backup and Restore Using a G7-Based Backup HSM](#).

## Backup

Backup operations copy the secure material on your HSM and store it on a separate Backup HSM. Backup is not performed continuously. The frequency of backup is dependent on your backup plan or strategy.

The Luna Backup HSM can be connected directly to the HSM to perform backup or restore operations on the spot. It is not able to perform cryptographic operations; it functions only in its secure backup/restore role. The Backup HSM takes on the authentication type of the primary HSM with which it is paired for backup - so it becomes a password-authenticated Backup HSM when backing up a password-authenticated primary HSM, and a PED-authenticated Backup HSM when backing up a PED-authenticated primary HSM.

The Backup HSM can also be connected to a host computer, located at a distance from the source HSM, and can perform backup and restore operations over secure network connection. This is normally the case when the source HSM is kept in a secure server room or a lights-out facility.

There are several ways to do backup with Luna HSMs. Depending on the type and number of HSMs and partitions you have, and how they are organized, different methods may be more suitable for your situation. The following sections describe these methods in more detail:

- > ["Local Backup" below](#)
- > ["Remote Backup" on the next page](#)
- > ["Comparing Local Versus Remote Backup" on page 52](#)

## Restore

Restore operations are only necessary if there is no hope of recovering your data on your HSM, and using your backup to restore the content is the only solution. The restore operation is identical to the backup operation, only in the opposite direction.

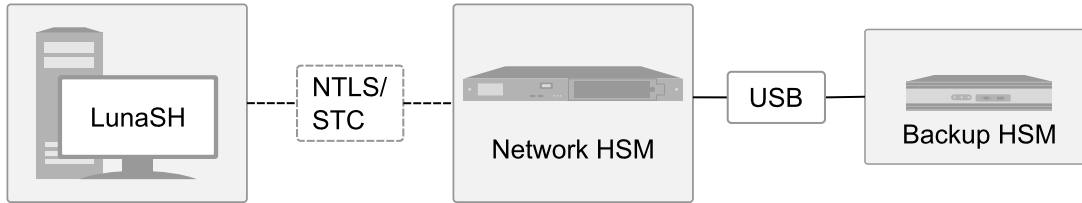
## Local Backup

Local backup requires a direct connection to the HSM to be successful. Backup can be done directly from the secure appliance housing the HSM or from a client workstation connected to the HSM.

### Centralized Local Backup

Centralized backup uses a direct connection between the HSM you wish to back up and the Backup HSM. "[Centralized Local Backup](#)" below outlines the basic setup required for simple local backup.

**Figure 5: Centralized Local Backup**

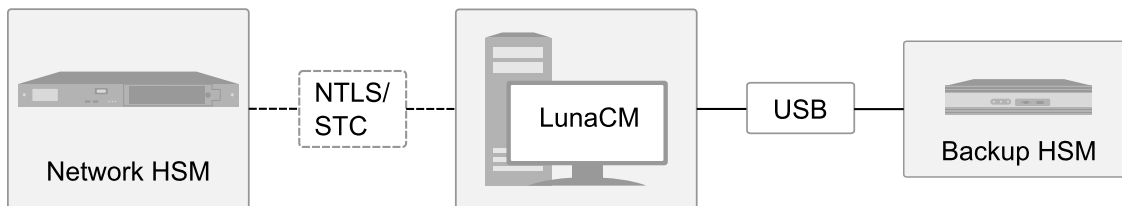


Connecting your Backup HSM directly to the HSM or secure appliance housing the HSM you wish to back up is a highly secure method of copying your keys. It requires you to have physical access to the HSM in addition to the HSM SO and Partition SO credentials for every partition needing backup. The backup operation is initiated from the LunaSH command line.

### Client-side Local Backup

Client-side backup connects to the HSM you wish to back up via your client workstation. The Backup HSM connects directly to the client workstation to perform backup. "[Client-side Local Backup](#)" below outlines the basic setup required for local backup via client workstation.

**Figure 6: Client-side Local Backup**

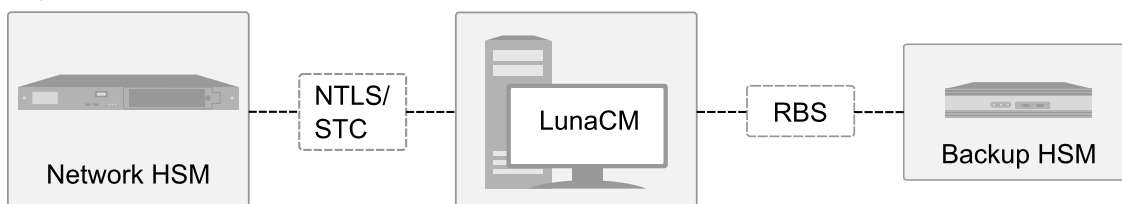


The backup operation in this case is still local, and thus requires a direct wired connection between your Backup HSM and client workstation. This method is highly secure, and allows for some flexibility in case the HSM you wish to back up is not easily available for direct connection. A PC running Luna HSM Client and LunaCM can connect to the HSM and, with the appropriate Partition SO credentials for every partition needing backup, can access and securely copy your cryptographic keys.

### Remote Backup

Remote backup allows you to securely back up your HSM from any location that is convenient. A secure network connection facilitated by RBS enables you to access your HSM or partition without needing to be physically near it. "[Remote Backup](#)" below outlines the basic setup required for remote backup.

**Figure 7: Remote Backup**



Remote Backup Service (RBS) runs on a system hosting a Luna Backup HSM, making the Backup HSM available to distant HSMs. This allows backup and restore operations to run from any location most convenient for the administrator. In this configuration, backup and restore operations are performed over secure network connection.

## Comparing Local Versus Remote Backup

Regardless of whether you use a local connection to backup and restore your HSM, or whether you use a remote one, backup and restore operations always require a Backup HSM. How you decide to connect it and organize your backup/restore infrastructure depends on what your organization needs.

Local backup is easier and faster to configure than remote, but the remote option allows more secure storage of your cryptographic material in case the entire environment in which your HSM resides collapses.

For detailed instructions on carrying out backup and restore operations, see [Backup and Restore Using a G5-Based Backup HSM](#) or [Backup and Restore Using a G7-Based Backup HSM](#).

# CHAPTER 9: Logging and Reporting

Luna PCIe HSM allows you to track and report all activity on your HSM to encourage responsibility, ensure accountability, and upkeep tight security.

Both Luna Network and PCIe HSMs come equipped with HSM-level audit logging via Audit role. See "[HSM-Level Audit Logging](#)" below.

## HSM-Level Audit Logging

Monitoring HSM activity is essential to maintaining a high level of security for the highly sensitive material on your HSM. Luna HSMs have logging and reporting abilities to support this. These features are implemented in the HSM firmware for maximum security.

### Logging

Secure logging is done at the whole HSM level. The HSM stores a record of past operations that is suitable for security audit review. Audit logging sends HSM log event records to a secure database on the local file system, with cryptographic safeguards ensuring verifiability, continuity, and reliability of HSM event log files.

Each log entry indicates what event occurred when, and who initiated it. Critical events are logged automatically.

### Audit Management

For circumstances that require more comprehensive review of events taking place on the HSM, an HSM-level Audit role (White PED key for PED-authenticated HSMs) can be used. Each HSM has a unique Audit role whose purpose is to manage audits and monitor HSM activity.

The Audit role is independent from the other roles on the HSM. Creating the Audit role does not require the presence of the HSM SO and if the Audit role is initialized, the HSM and partition administrators are prevented from working with the log files. Only the Auditor can add failures, successes, key usage, and other events to the HSM logging procedure.

Audit log integrity is ensured against altering log records. Separating logging and its role from other administrative roles protects critical information related to the operations of your HSM.

For detailed instructions on implementing audit logging, see [Audit Logging](#).

# CHAPTER 10: Functionality Modules

Functionality Modules (FMs) consist of your own custom-developed code, loaded into and operating within the logical and physical security of a Luna PCIe HSM as part of the HSM firmware. FMs allow you to customize your Luna PCIe HSM's functionality to suit the needs of your organization. Custom functionality provided by your own FMs can include the following:

- > new cryptographic algorithms, including Quantum algorithms
- > security-sensitive code, isolated from the rest of the HSM environment
- > keys and critical parameters managed by the FM, independent from standard PKCS#11 objects, held in tamper-protected persistent storage

To create FMs, you will need the Functionality Module Software Development Kit (SDK), which is included with the Luna HSM Client software.

See ["About the FM SDK Guide" on page 1](#) and ["Functionality Modules" on page 1](#) for details and procedures.

## NOTE

This feature has hardware dependencies described in [Preparing the Luna PCIe HSM to Use FMs](#).