A Secure Password Wallet based on the SEcube™ framework

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Why are hardware-based approaches more reliable?

To authenticate, Master password + Device are required

Outline

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1. Introduction
2. Technologies used
   - Software libraries
   - The SEcube™ Framework
3. Design and implementation
   - Basic SEcube™ Operation
   - General Architecture
   - Implementation details
4. Demos
5. Conclusions
6. Future Work

Introduction

Exploit the capabilities of the SEcube™ (Secure Environment cube) hardware and software framework to store and protect a set of passwords (Wallet).

The desktop application, named **SEcubeWallet**, was written in C/C++and Qt, and it interacts with a SEcube™ device, requesting services like authentication and encryption/decryption of data.

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Dictionaries, keyboard patterns, sequences, years

The SEcube™ Open Security Platform

Hardware

Software

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Developed by the Blu5 Group

Software

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- SEcube™ DevKit
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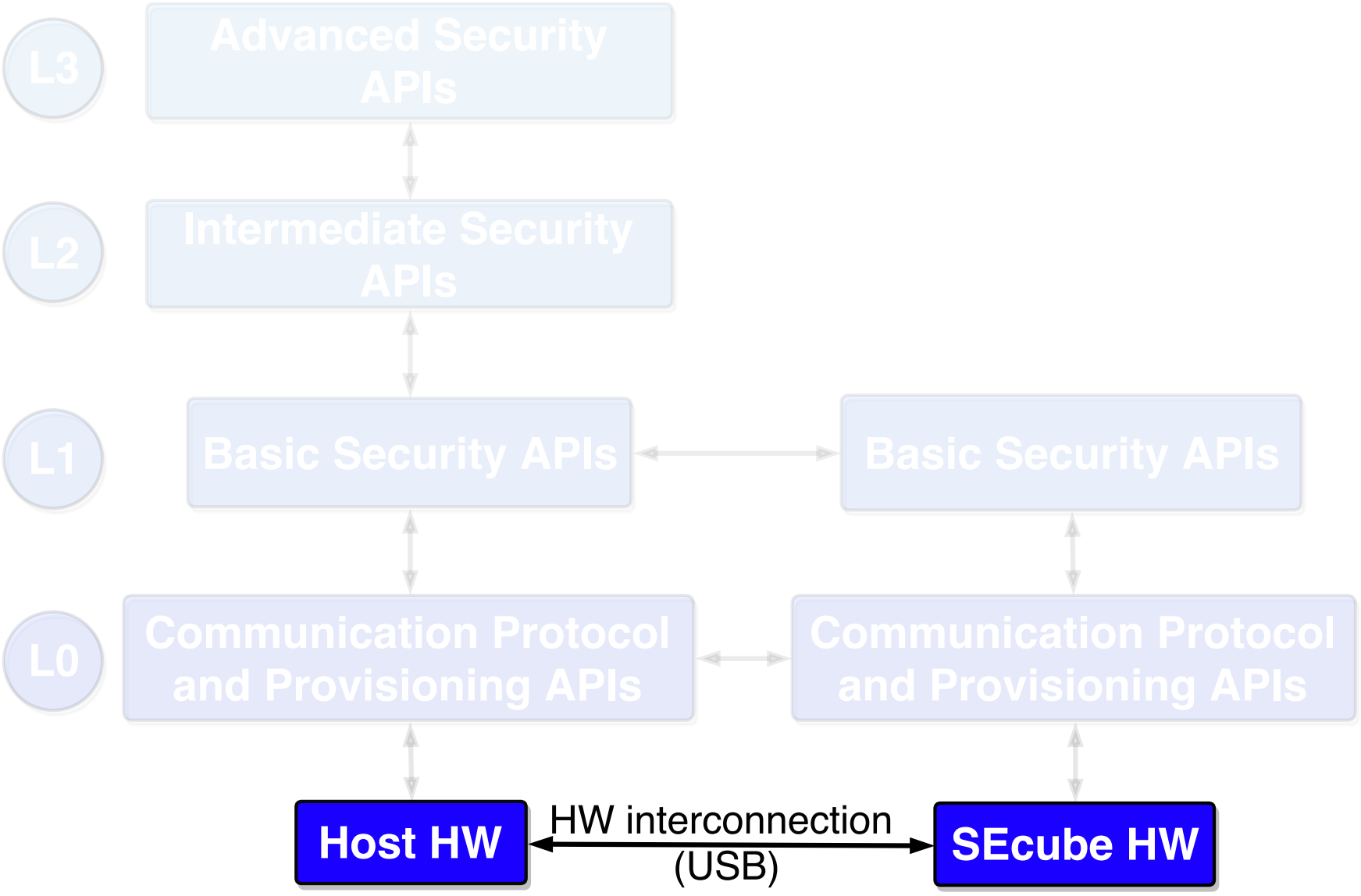
Host libraries: Allow to experience the platform as a high-security black box.

SEcube™ APIs hierarchy



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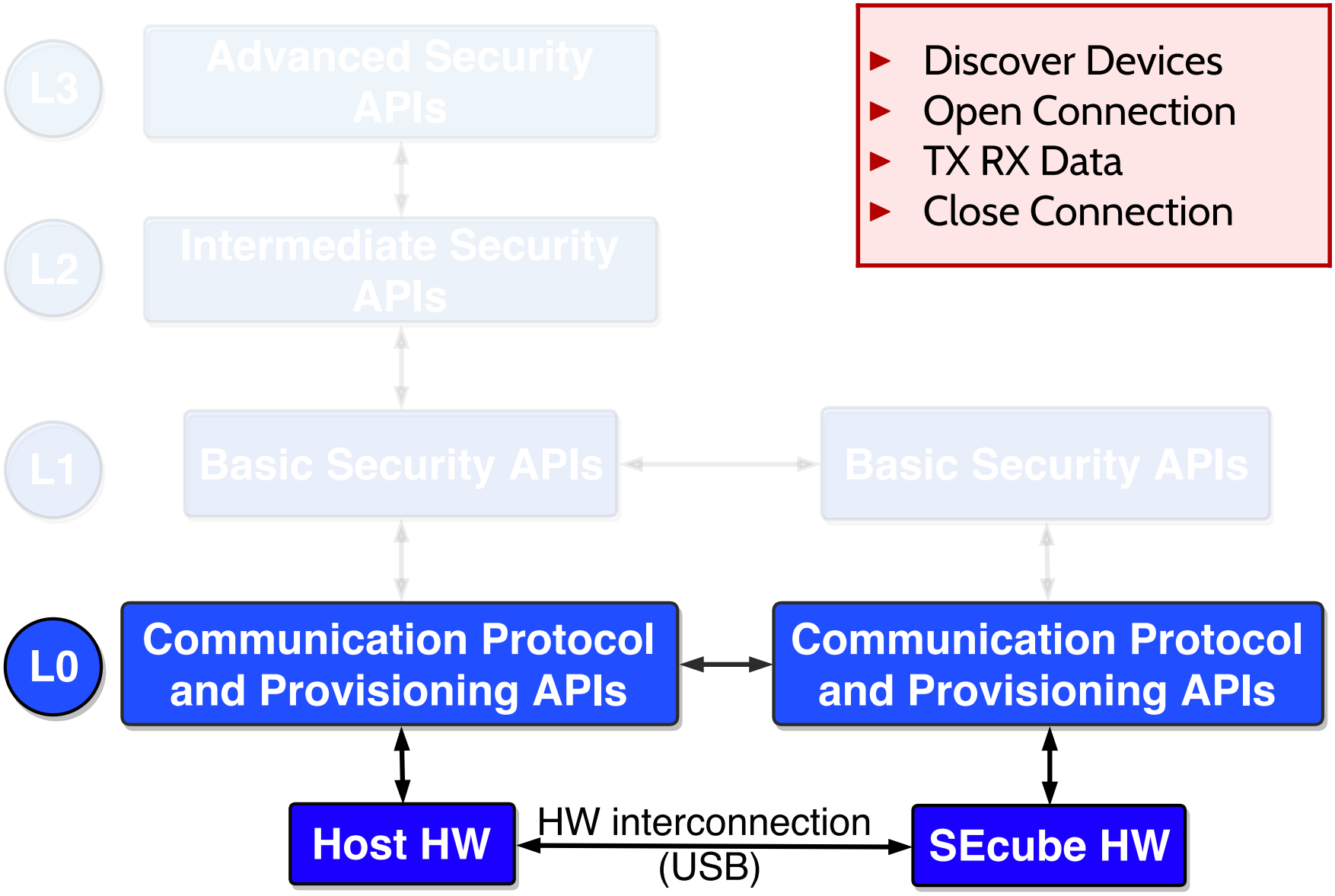

- Discover Devices
- Open Connection
- TX RX Data
- Close Connection

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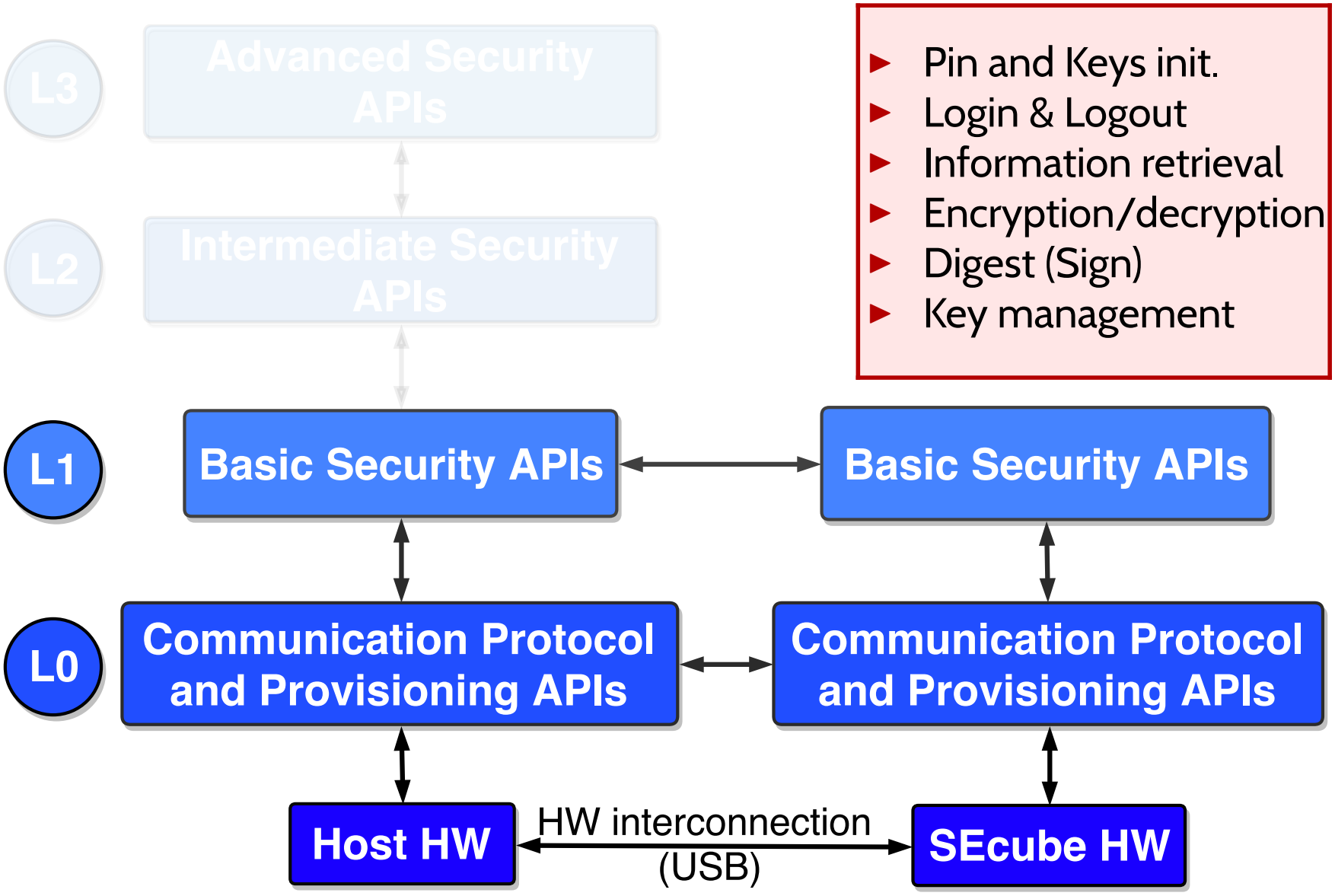

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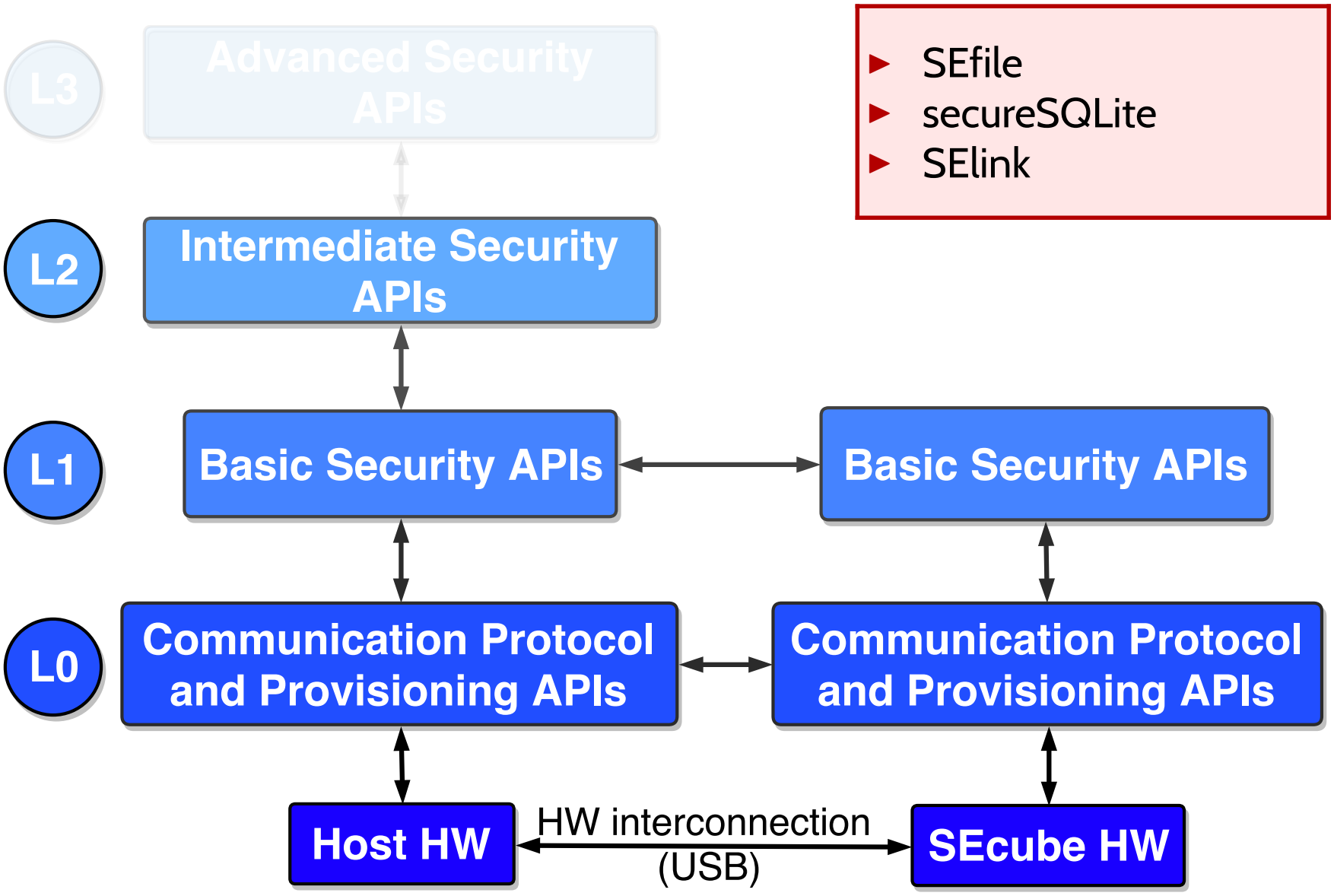

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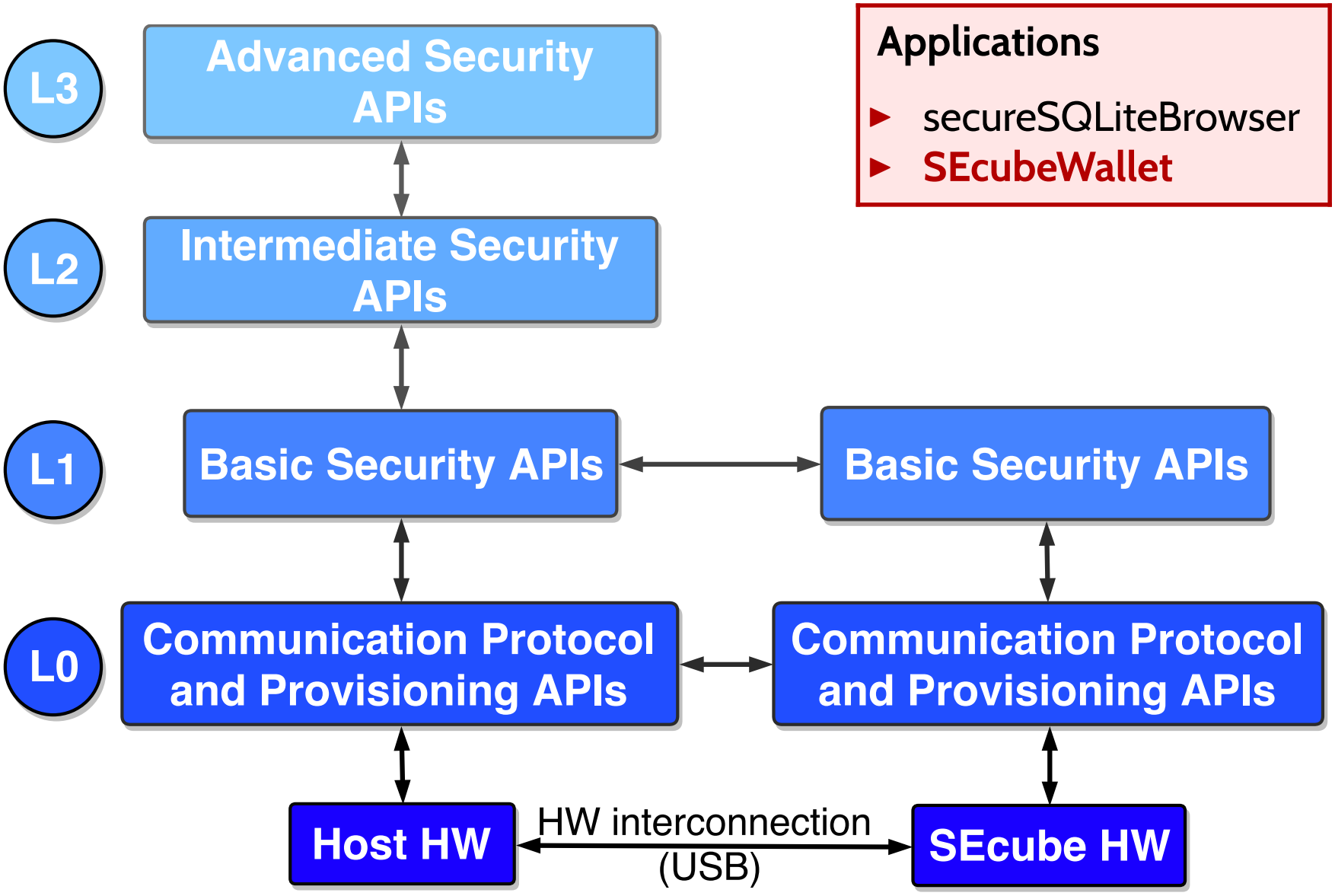

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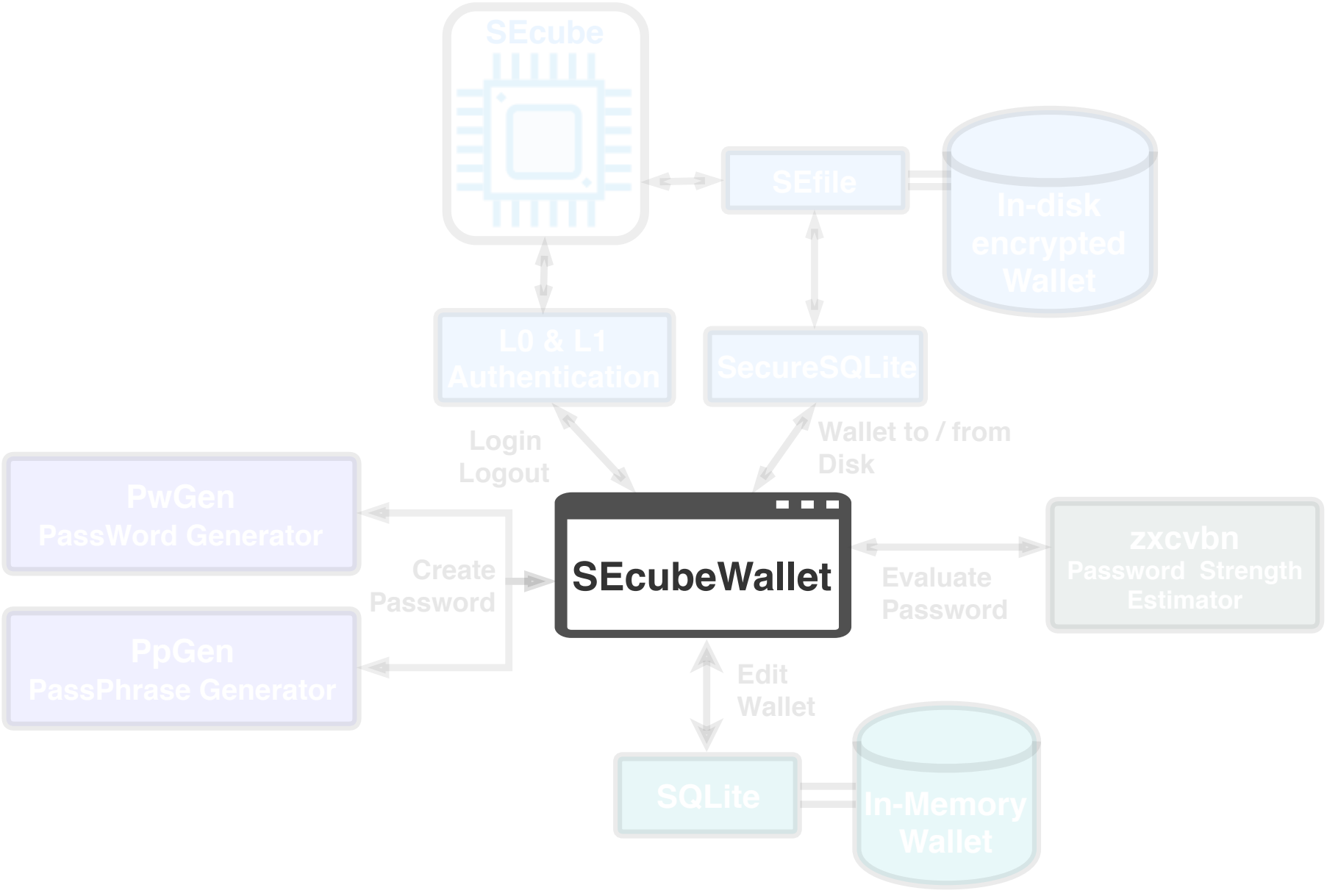
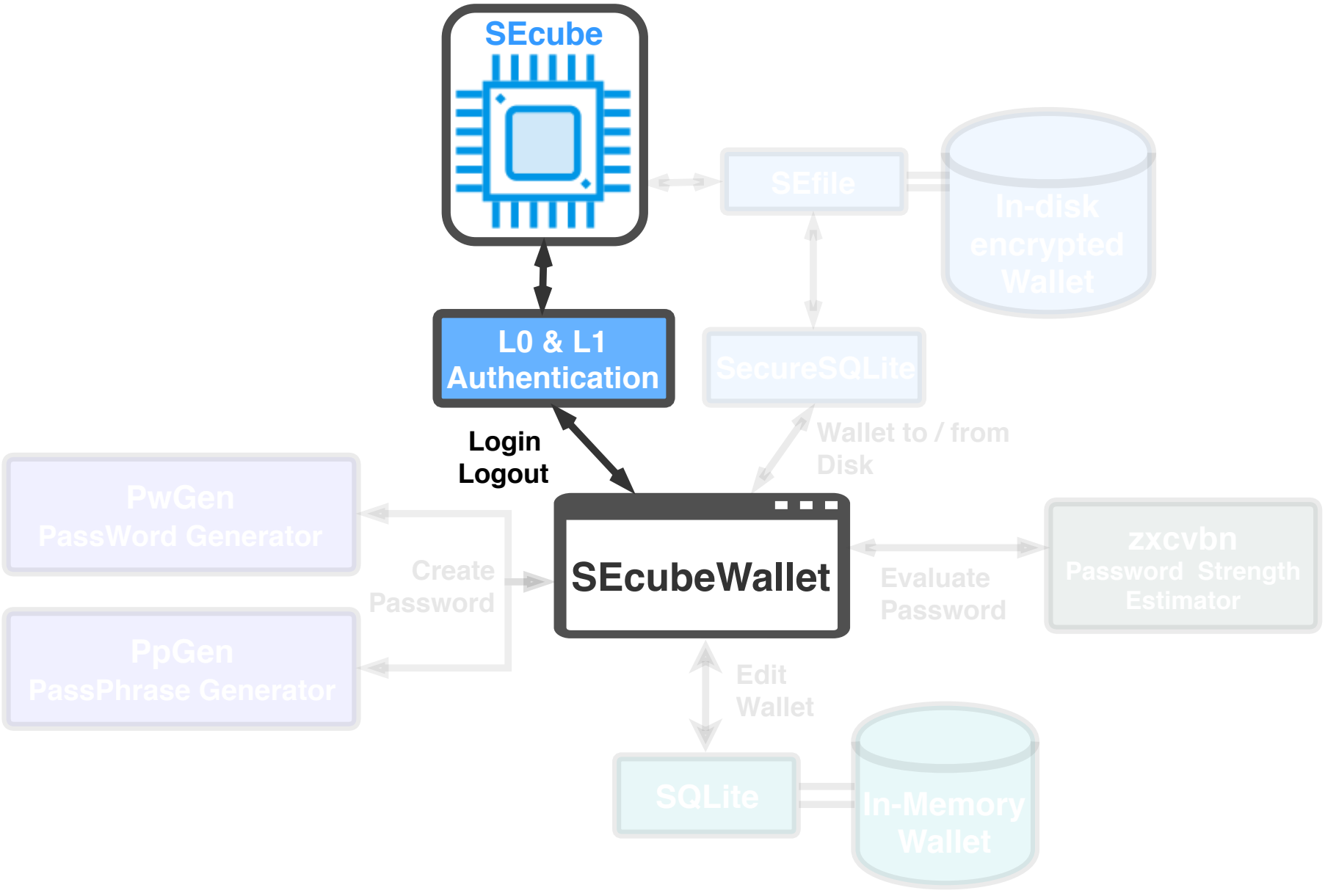
The data (passwords) can only be accessed if:

- SEcube™ device is connected
- Login pin is the correct one
- Key inside the device is the correct one.

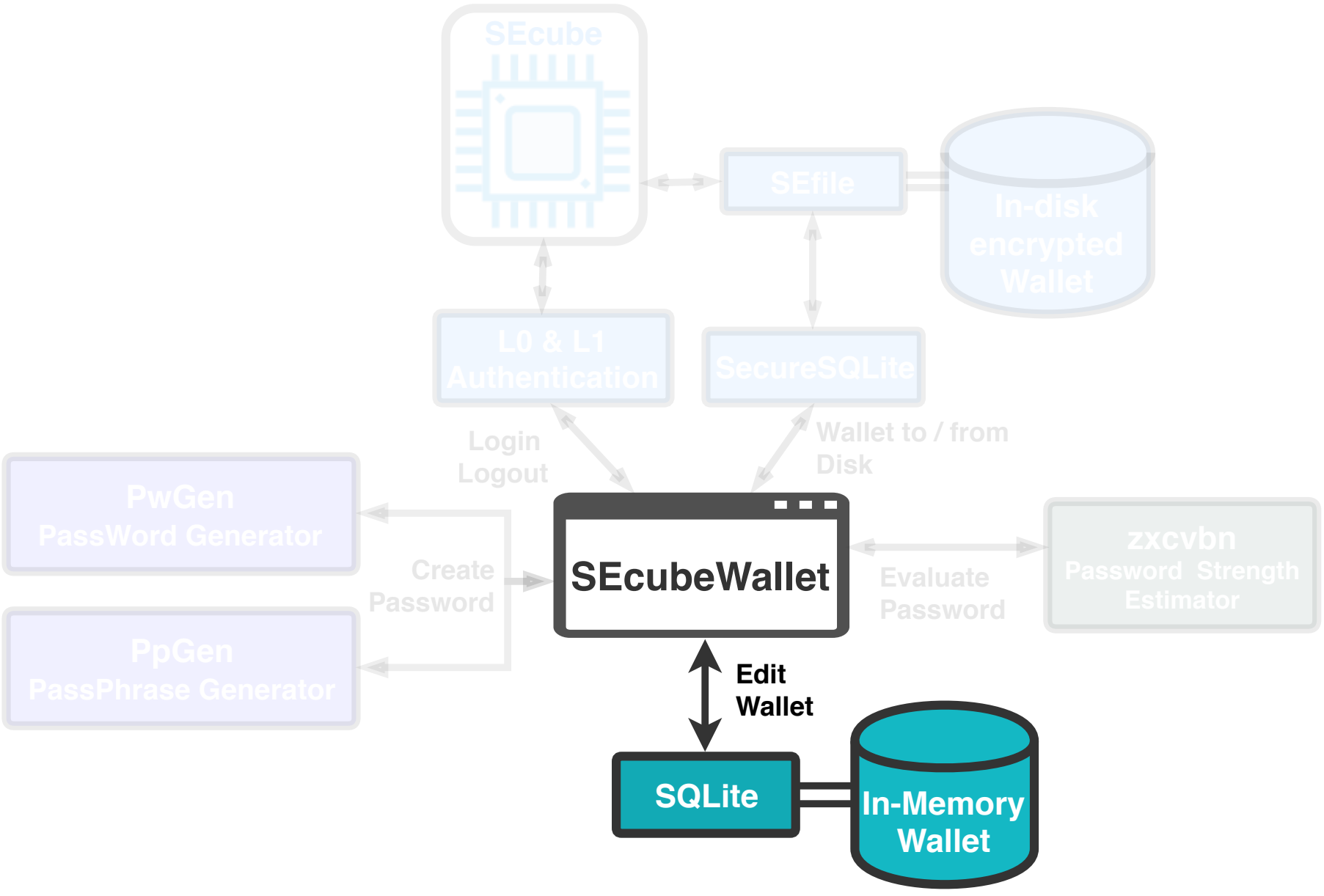
SEcubeWallet Application



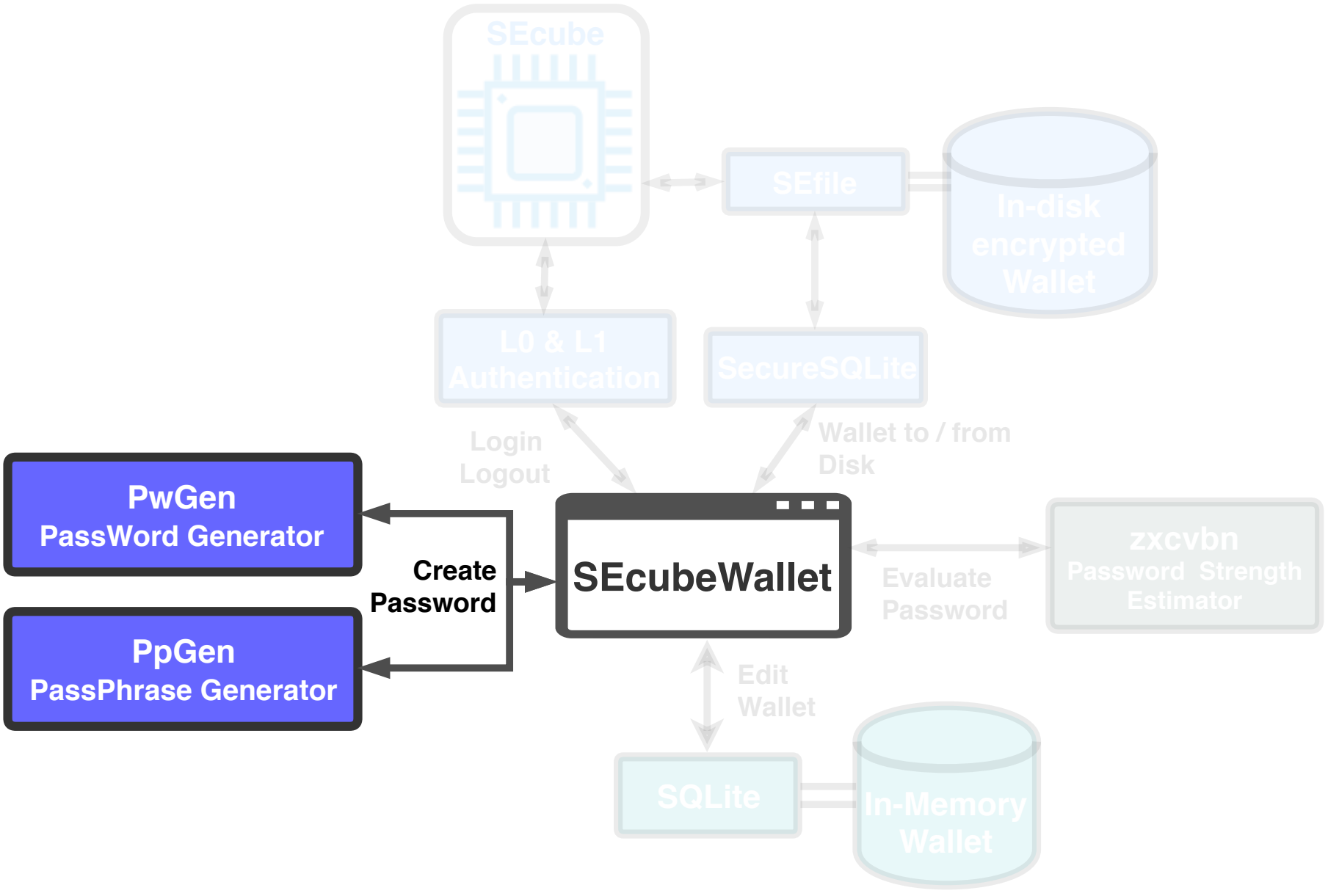
Open device and authenticate



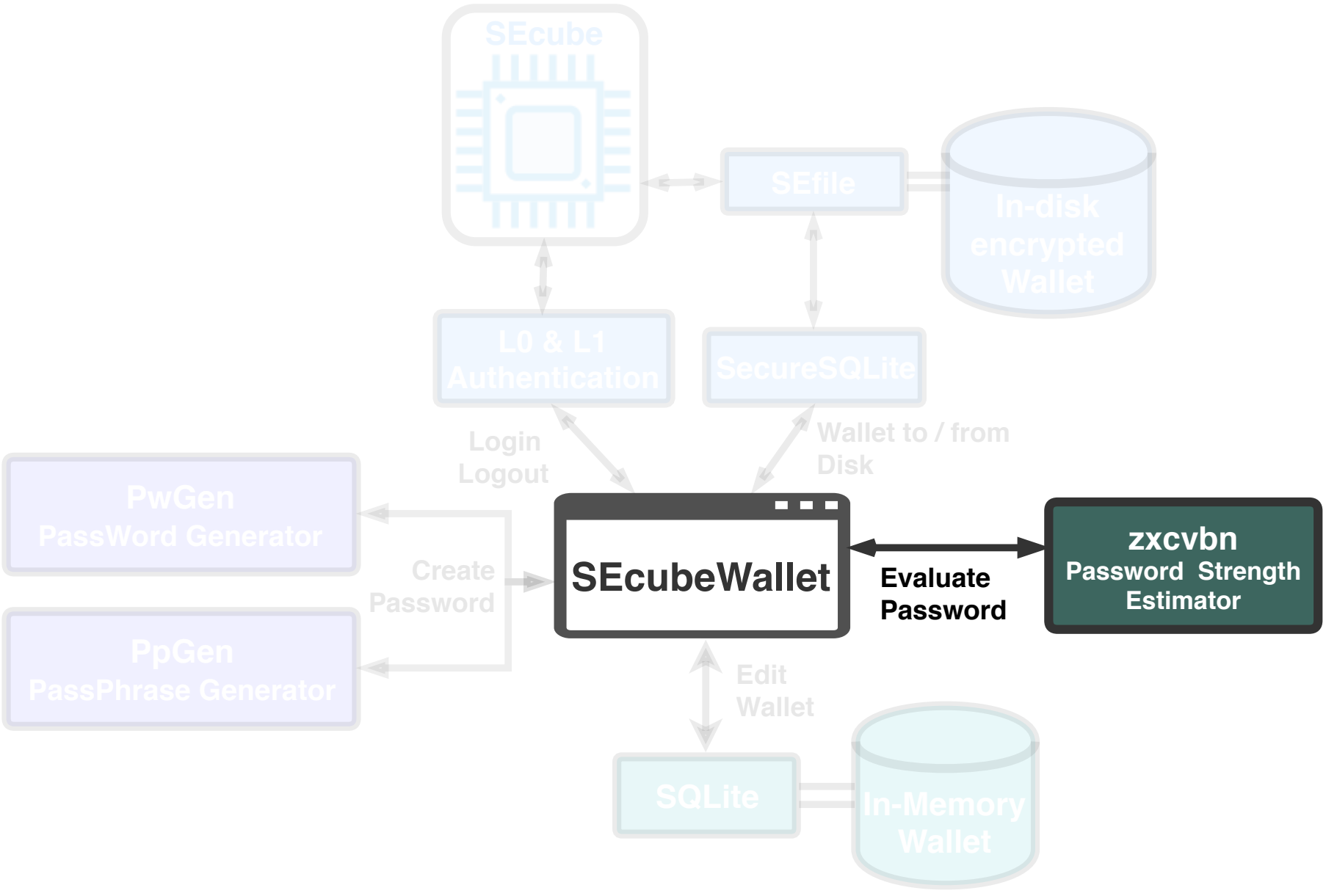
Create In-memory Wallet



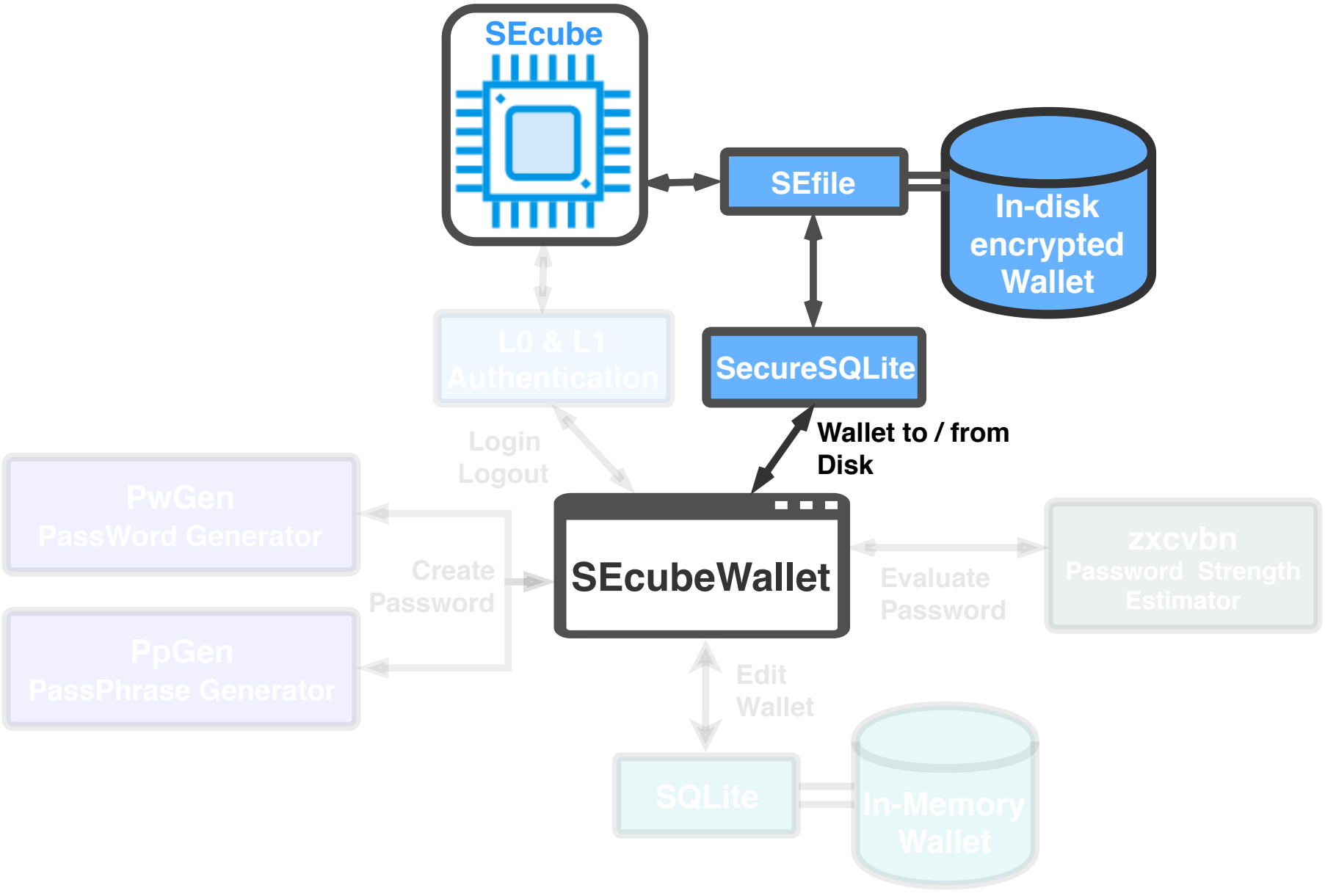
Generate Password/Passphrase



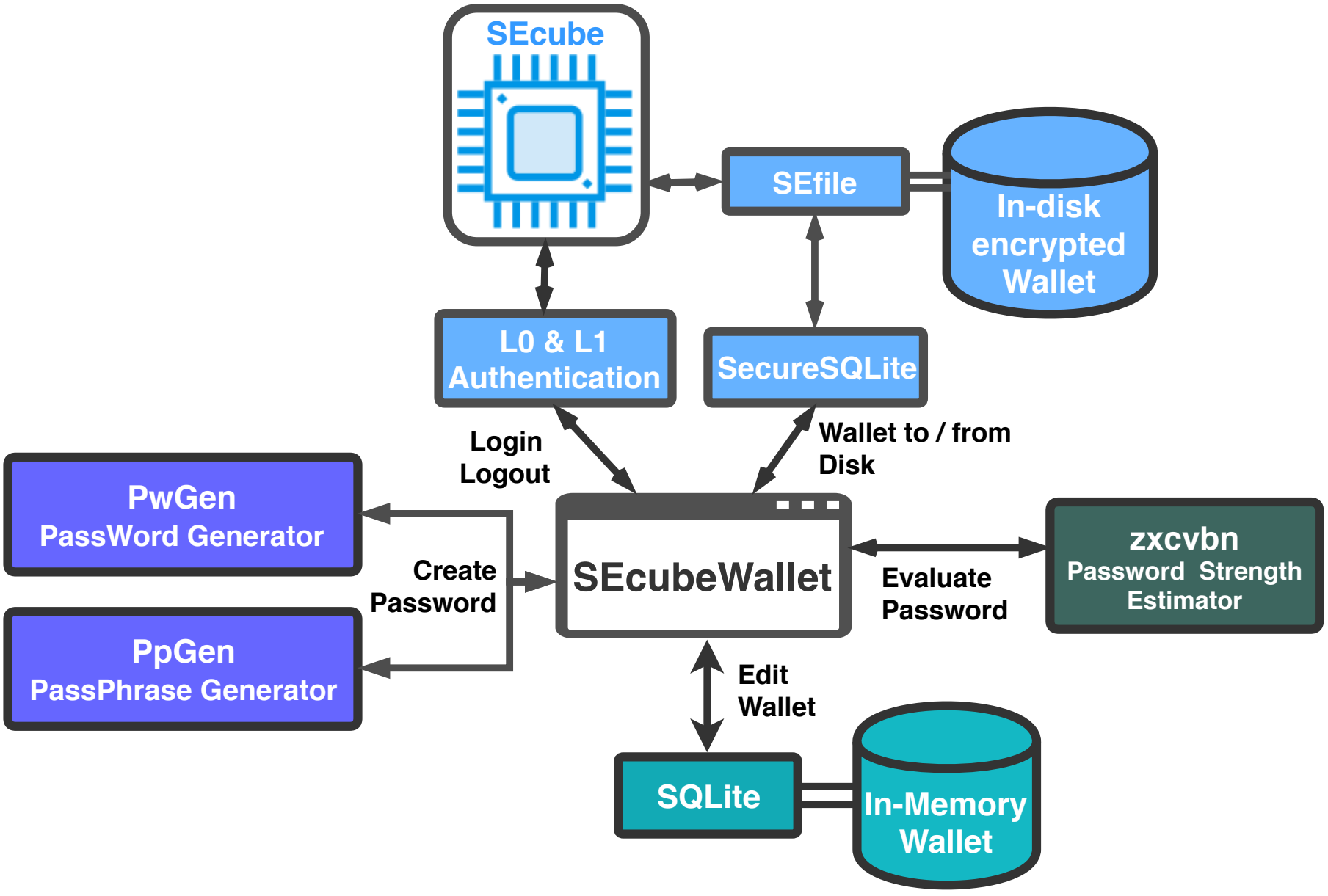
Evaluate Strength



Encrypt and Save Wallet to disk



General Architecture



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- **Delete Wallet:** Both the In-memory DB and the In-disk encrypted file are deleted.

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  - **Table View:** for displaying the wallet entries

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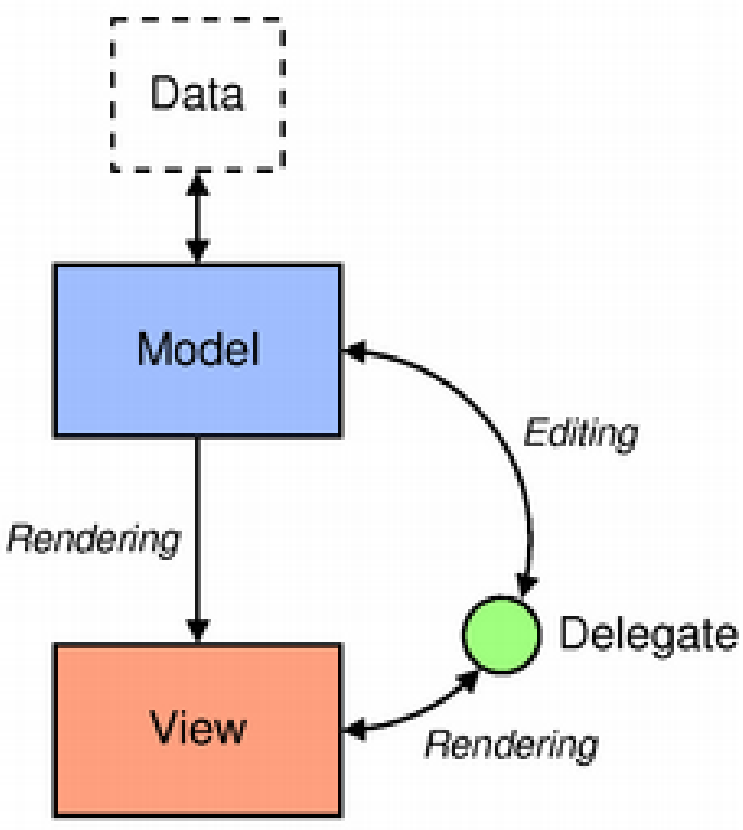

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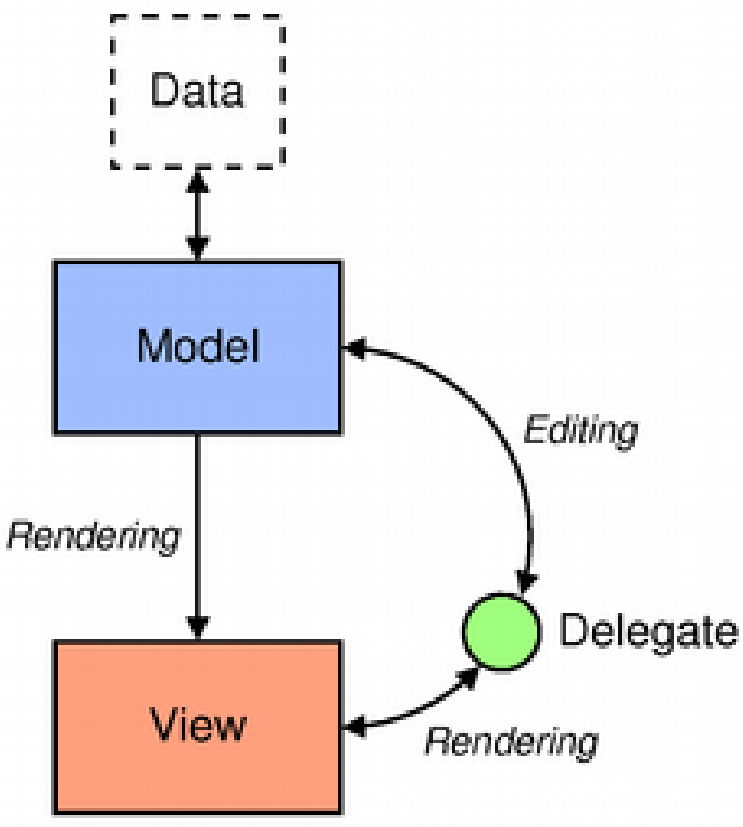

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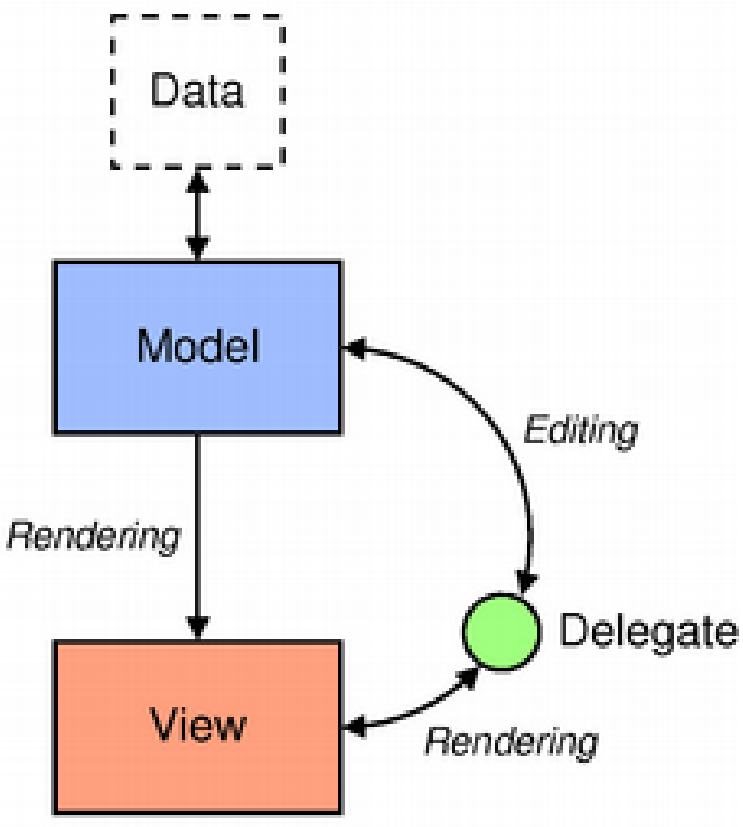

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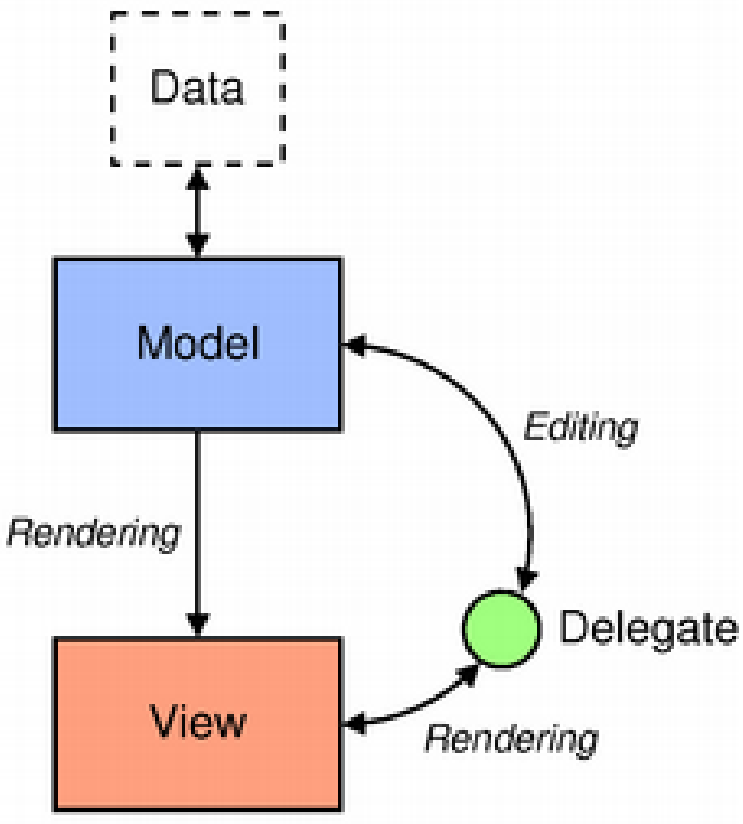

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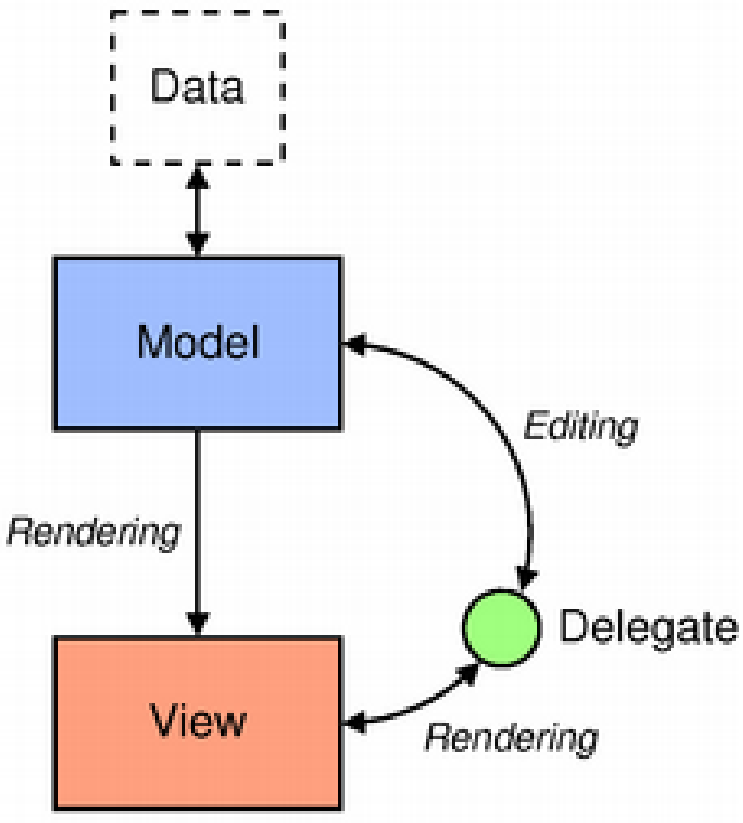

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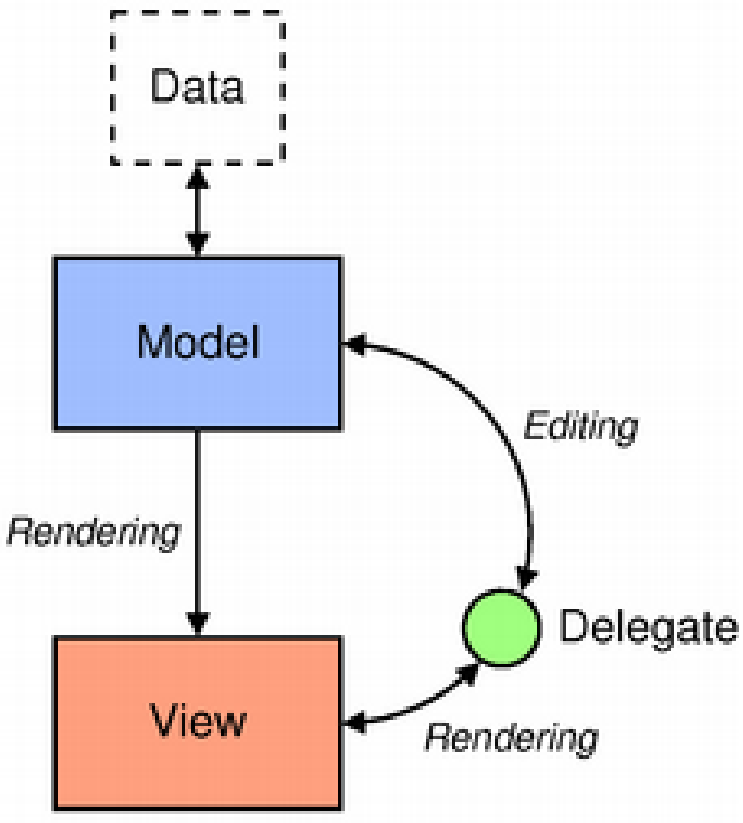

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- **Delegate**: Used to Show/Hide the passwords.

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PassPhrase Generator

- Implemented as a C++/Qt function.
- Works by extracting Random words from dictionaries.
- HorseBatteryShoeStudying

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- **Launch entry's domain**
  In default OS web browser

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Login and Open a Wallet

Generate and evaluate password

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- In any password manager it is important to suggest random passwords and to check their strength
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- The developed application still lacks some features in order to be considered a truly commercial product.

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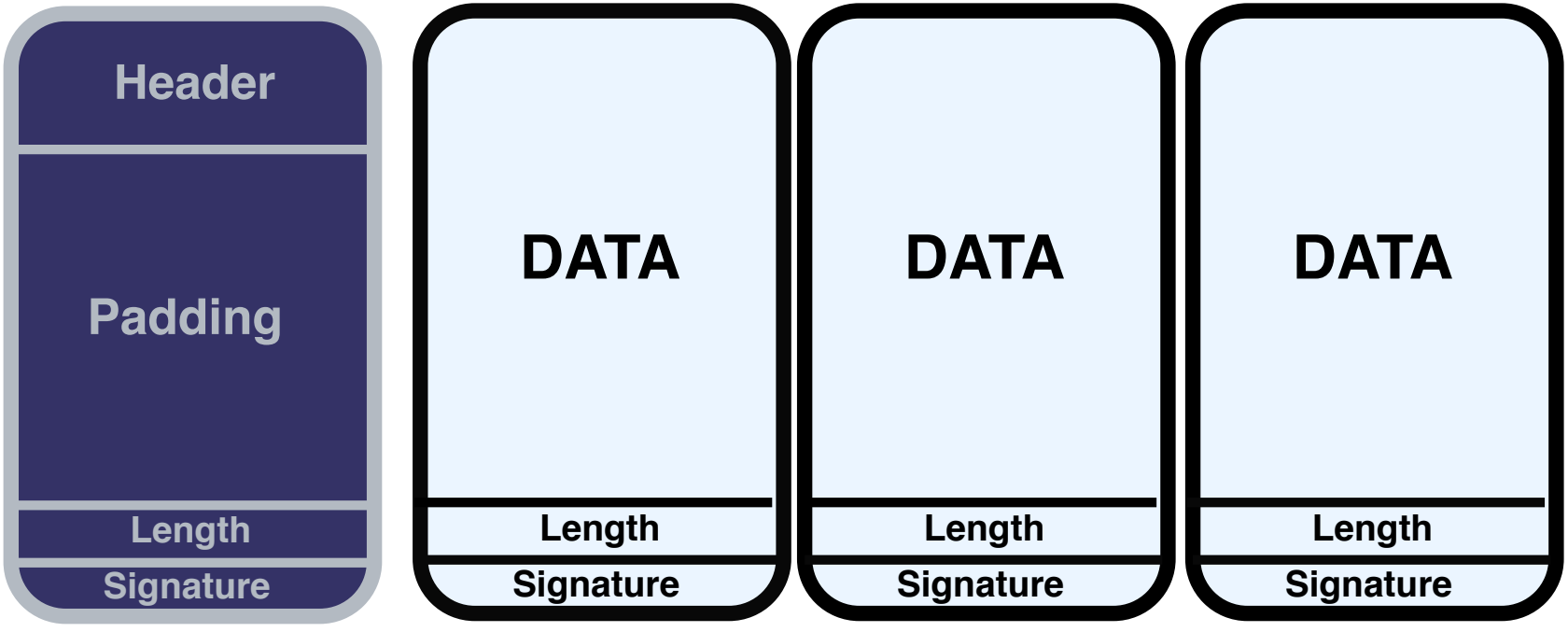
Android

- Use a SEcube™ phone device
- Port SEcube™ host-side libraries to android
- Port Qt application to android

SEfile

A secured file has the structure shown in figure. The data is divided in sectors, and each of them is encrypted and signed. The first sector (header) contains metadata. When a portion of the file wants to be read or written, it is not necessary to process the whole file. Only the required sectors are manipulated.



Algorithms

Encryption: Advanced Encryption Standard (AES), established by the U.S. National Institute of Standards and Technology (NIST). For each data sector AES-256-CTR is used, while the header sector is encrypted using AES-256-ECB.

Authentication Each sector, including the header, is signed using SHA-256-HMAC, meaning that the signature depends on both the data contained in the sector itself and on a chosen encryption key.

To use two different keys to encrypt data and to digest authentication. SEfile leverages on the pbkdf2()

secureSQLite

Based on the SQLite and SEfile, this API allows the user to create SEcube™ secured data bases.

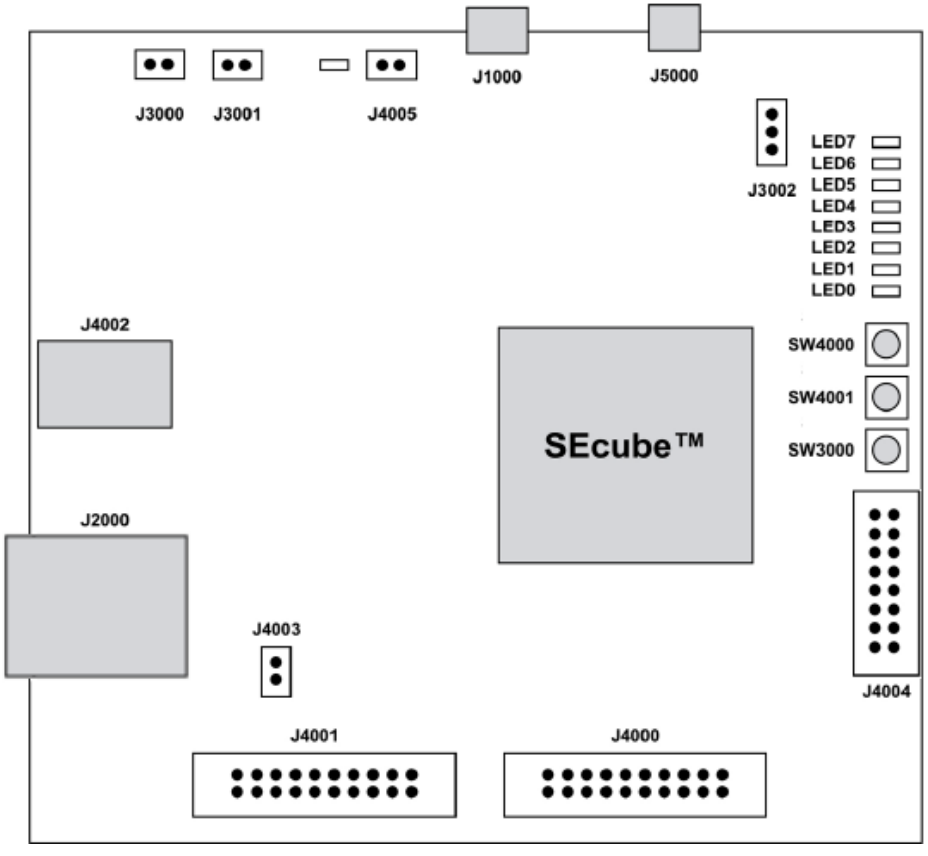
The SQLite system has been modified to use a wrapper based on SEfile, rather than using directly the OS calls. The development is based on a template for making a custom VFS interface distributed along with SQLite.

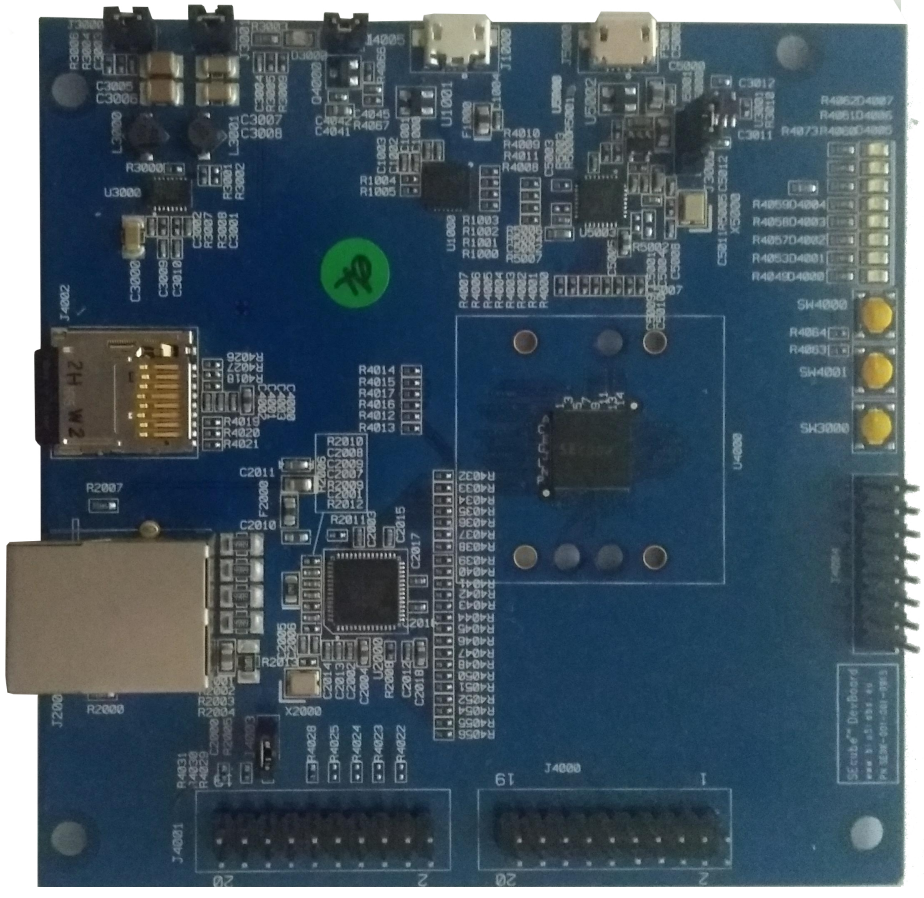
Every database created with secureSQLite is cyphered and signed, thus making it impossible to read the database contents without the SEcube™.

Development Board

J1000 USB 2.0 to UART
J2000 Ethernet 10/100
J4000 FPGA and CPU GPIOs
J4001 JTAG
J4002 microSD card

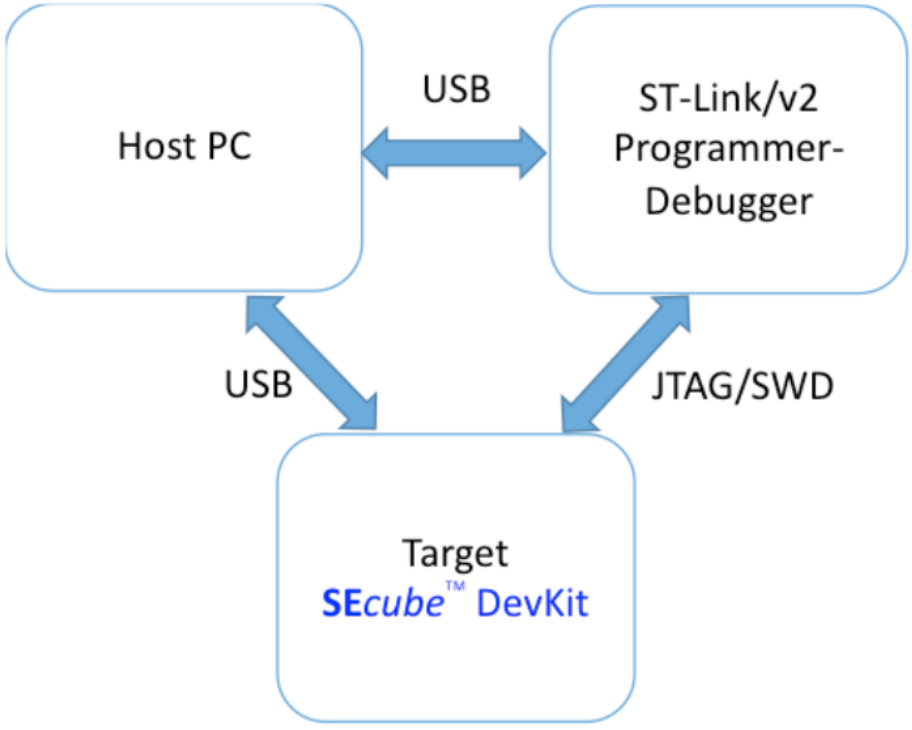
J4004 FPGA and CPU GPIOs
J5000 USB 2.0 High Speed
LEDx Leds
SWx00y Switches





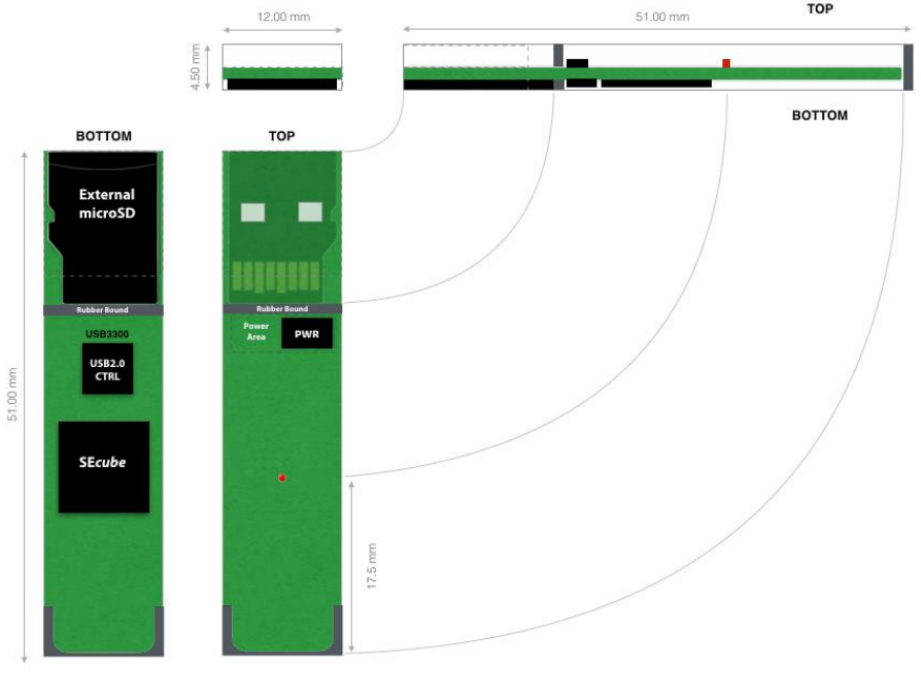
JTAG Connections

To program and debug the chip, we use an **ST-Link/V2** which communicates with the MCU using the JTAG/SWD connection in the DevKit board.



The USEcube™ Stick

- SEcube™ chip + USB 2.0 High-Speed + SDcard socket.
- Compatible with any Operating System, and no need for drivers.
- Separation of encrypted data from the encryptor/decryptor.
- microSD can be changed to adjust size and speed.
- Dust and water-resistant
- No JTAG interface. To inject firmware, secure bootloader.



YubiKey

Family of hardware authentication devices developed by Yubico

Unfortunately, not open source.

Supports Google Accounts, Facebook Accounts, GitHub, Dropbox

- Static Passwords
- Yubico One-Time Password (OTP)
- OATH – HOTP (EVENT)
- OATH – TOTP (TIME)
- Challenge and Response (HMAC-SHA1, Yubico OTP)
- PIV-Compatible Smart Card:
- OpenPGP
- FIDO U2F

Mooltipass: A Simple Offline Password Keeper

The Mooltipass emulates a standard USB keyboard, The Mooltipass has an internal flash in which the user encrypted credentials are stored, while a PIN-locked smartcard contains the AES-256bits key required for their decryption. Open software and open hardware, kickstarter campaign.

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- **ST662ACD-TR:** Power
- **ATMEGA32U4:** MCU
- **AT88SC102:** Smart Card
- **AT45DB011D-SSH-T:** Flash

PwGen Examples

`-s`: Random
`-y`: Symbols
`-v`: No vowels
`-B`: No ambiguous
`-A`: No capital
`-0`: No numerals

Password	Length	Options	Log Entropy
`iesohGhai3`	10	-	9.75 (Level 3)
`ees0cooLo2`	10	-	10.47 (Level 4)
`dX042wKqlW`	10	`-s`	17.86 (Level 4)
`@!,Q*l5}+H`	10	`-ys`	18.15 (Level 4)
`TBw4)9`	6	`-ys`	11.62 (Level 4)
`B7t34Lck`	8	`-v`	11.87 (Level 4)
`nofosootei`	10	`-BA0`	6.50 (Level 2)

PassPhrase Generator examples

PassPhrase	wor	len	uncom	Log Entr
Cocchio	1	-	-	4.27 (L1)
Legitimately	1	8	-	4.55 (L1)
Woodhaven	1	8	30%	4.94 (L1)
ShorelineCech	2	-	-	9.18 (L3)
MongoliaSimpsons	2	8	-	7.30 (L2)
McinnisPhaya	2	-	30%	9.14 (L3)
ZucchiniSalamandra	2	8	30%	9.19 (L3)
SacchettiVigevano	2	8	30%	9.11 (L3)
DrammaturgicoSbatacchiare	2	12	-	8.98 (L3)
MalformationsAstrophysical	2	12	-	9.60 (L3)
LatinaInterchangeFbo	3	-	-	13.5 (L4)
OsaAymanCantinflas	3	-	-	12.98 (L4)
ImmobileCwSites	3	-	-	11.43 (L4)
RimmelBragFaenza	3	-	30%	13.49 (L4)
RecliningCanberraEcuadorian	3	8	-	13.69 (L4)
InaspettatoRothschildsDisconcerting	3	8	30%	14.48 (L4)

Other contributions

Besides the application development, other results obtained during this work are:

- The implementation of an improved Login behaviour in the SEcube™ framework, that renders more usable SEcubeWallet and any other application that uses the SEcube™ authentication system.
- The discovery and fix of a bug in the SEfile library that did not allow to use the secureSQLite library in a FAT32 file system.

SEkey: key management for SEcube™

SEkey is a new library currently under development by Mateus Françani as his master thesis work. The library will sit next to SEfile and SElink.

Right now keys inside a SEcube™ chip can only be modified at factory reset. This is not very useful in a working environment, as the purpose of having multiple keys is to allow users to share information with selected people.

The job of the SEkey library will be to allow an admin to dynamically add and remove keys to SEcube™ devices.