Hardware Wallets:
Secure Storage of Bitcoins

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Goals

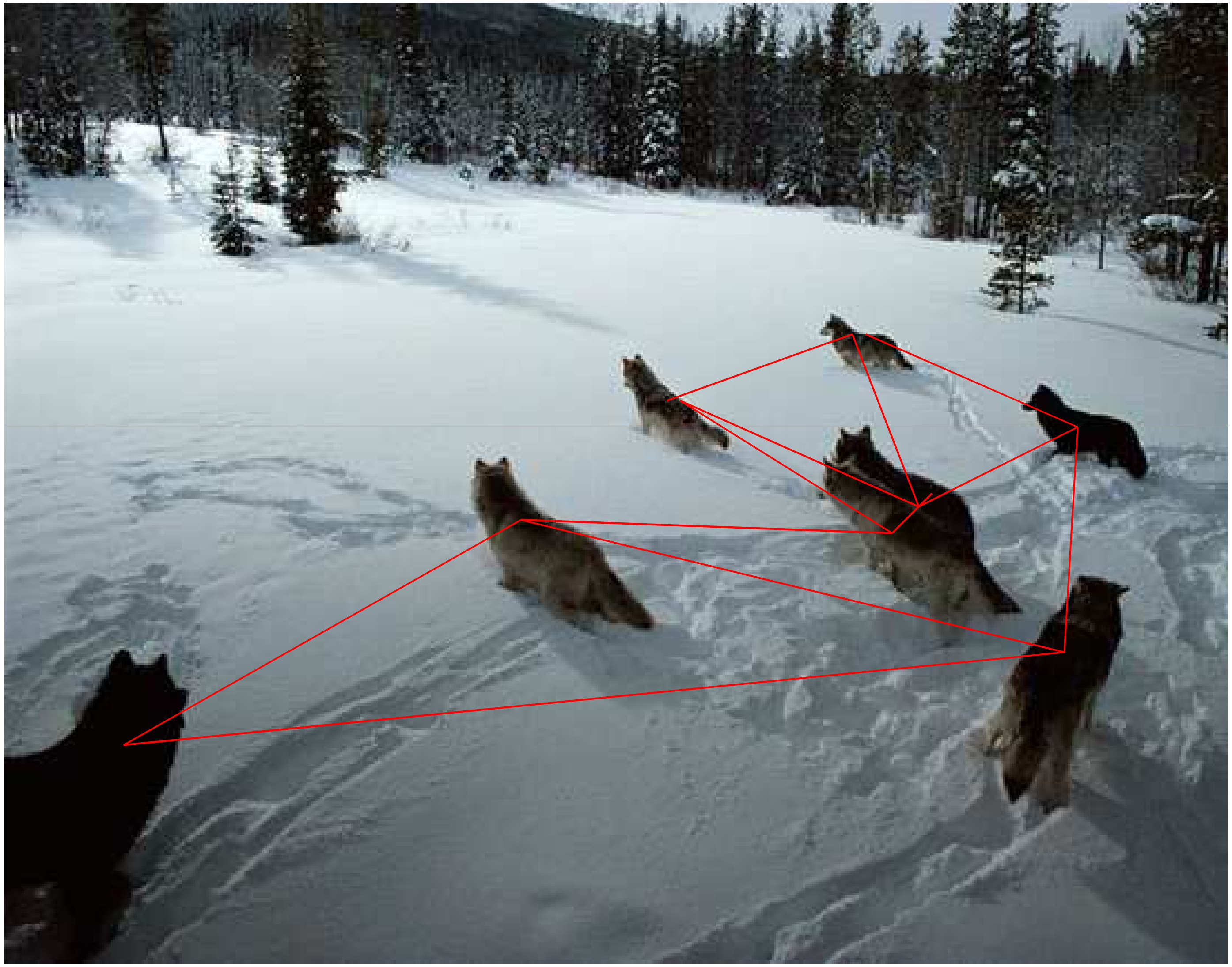
Prevent your bitcoins from being stolen.

Expert advice, yet practical.

We failed to protect our DATA

We failed to protect our MONEY

Solution = Decentralized P2P



Goals

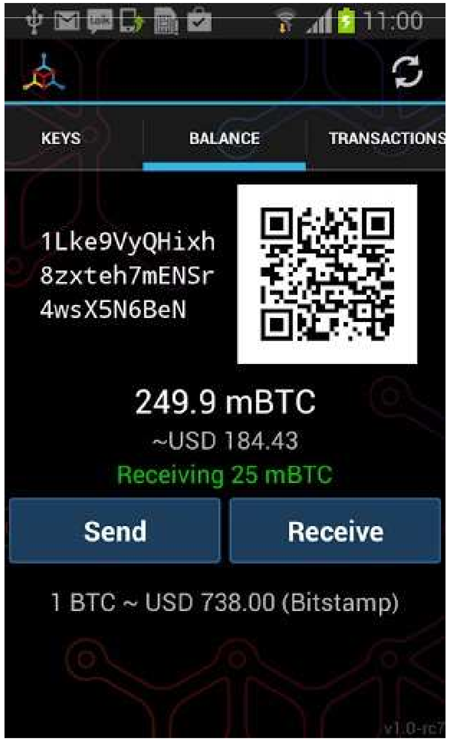
Prevent your bitcoins from being stolen.

How to Manage Keys in Practice?

Not easy, many pitfalls, see our paper:

Nicolas T. Courtois, Pinar Emirdag and Filippo Valsorda: Private Key Recovery Combination Attacks: On Extreme Fragility of Popular Bitcoin Key Management, Wallet and Cold Storage Solutions in Presence of Poor RNG Events, 16 Oct 2014, http://eprint.iacr.org/2014/848

Wallets



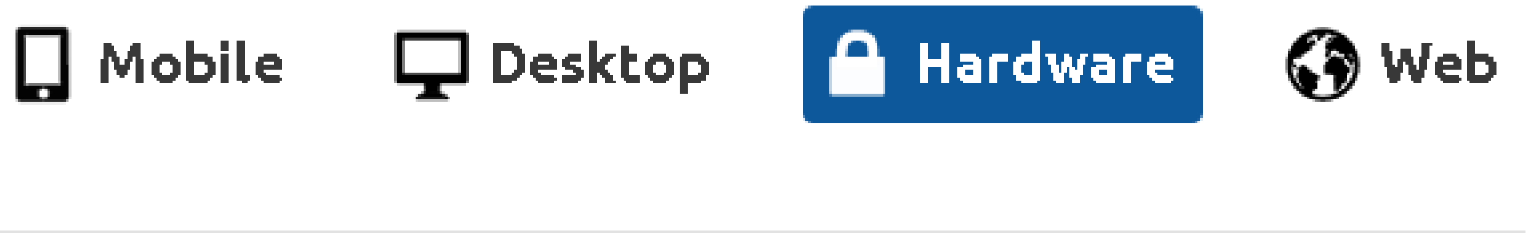
1Lke9VyQHixh8zxteh7mENSr4wsX5N6BeN

249.9 mBTC
~USD 184.43
Receiving 25 mBTC

1 BTC ~ USD 738.00 (Bitstamp)

Wallets - Hardware

https://bitcoin.org/en/choose-your-wallet



Mobile Desktop **Hardware** Web

TREZOR

HW.1

…

Bottom Line

Main Functionality:

-Private Key Generation

-Export public key

-ECDSA sign

BTChip HW1
hardwarewallet.com

Ledger
ledgerwallet.com

-optional:

sign full BTC transactions

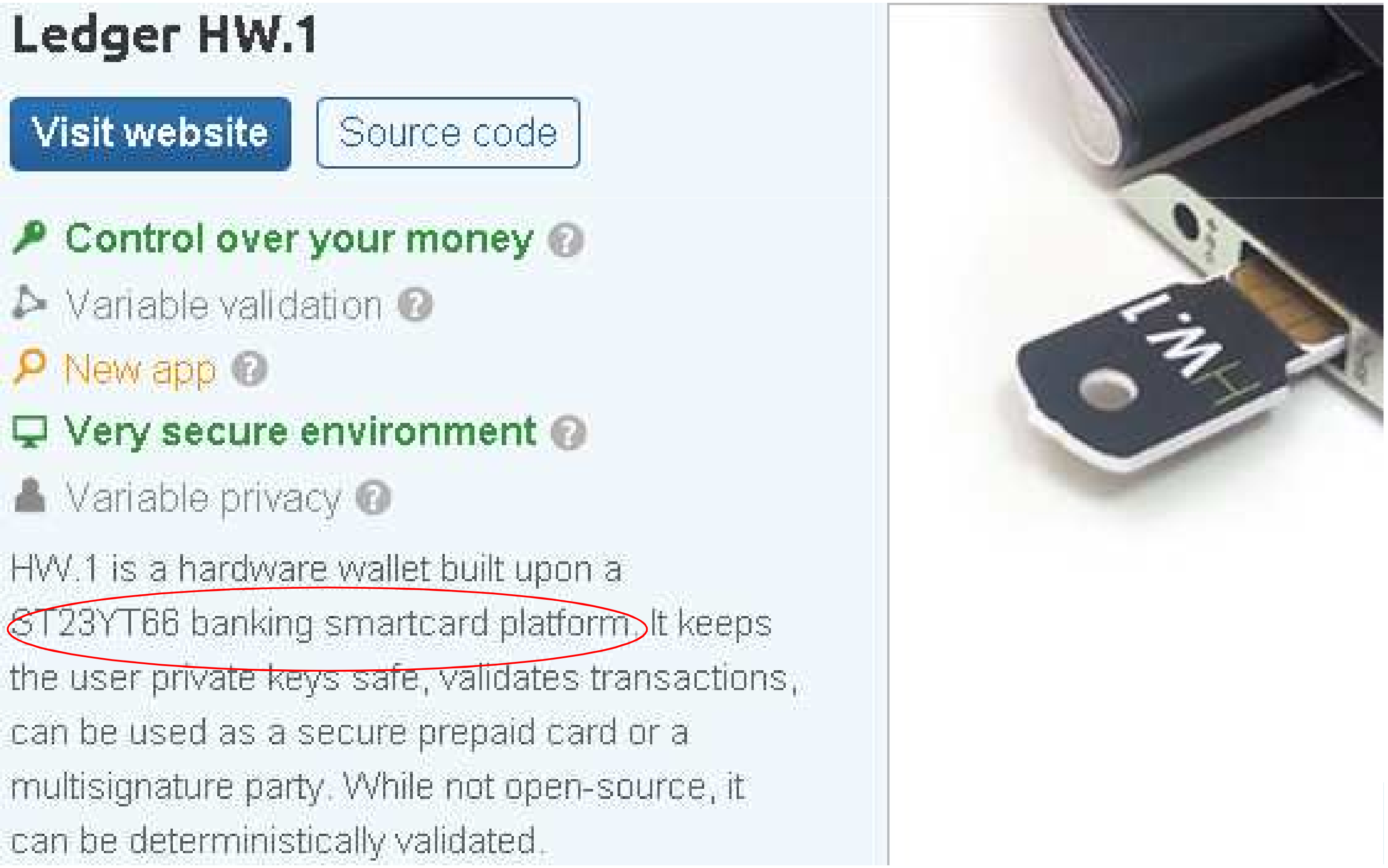
and confirm recipient on the screen

(huge classical pb with all smart cards and digital signature devices,
Ledger has a clever solution: regurgitates inputs on another device USB keyboa

Trezor
bitcointrezor.com

BTChip HW.1

since Jan 2013



Ledger HW.1

Control over your money

Variable validation

New app

Very secure environment

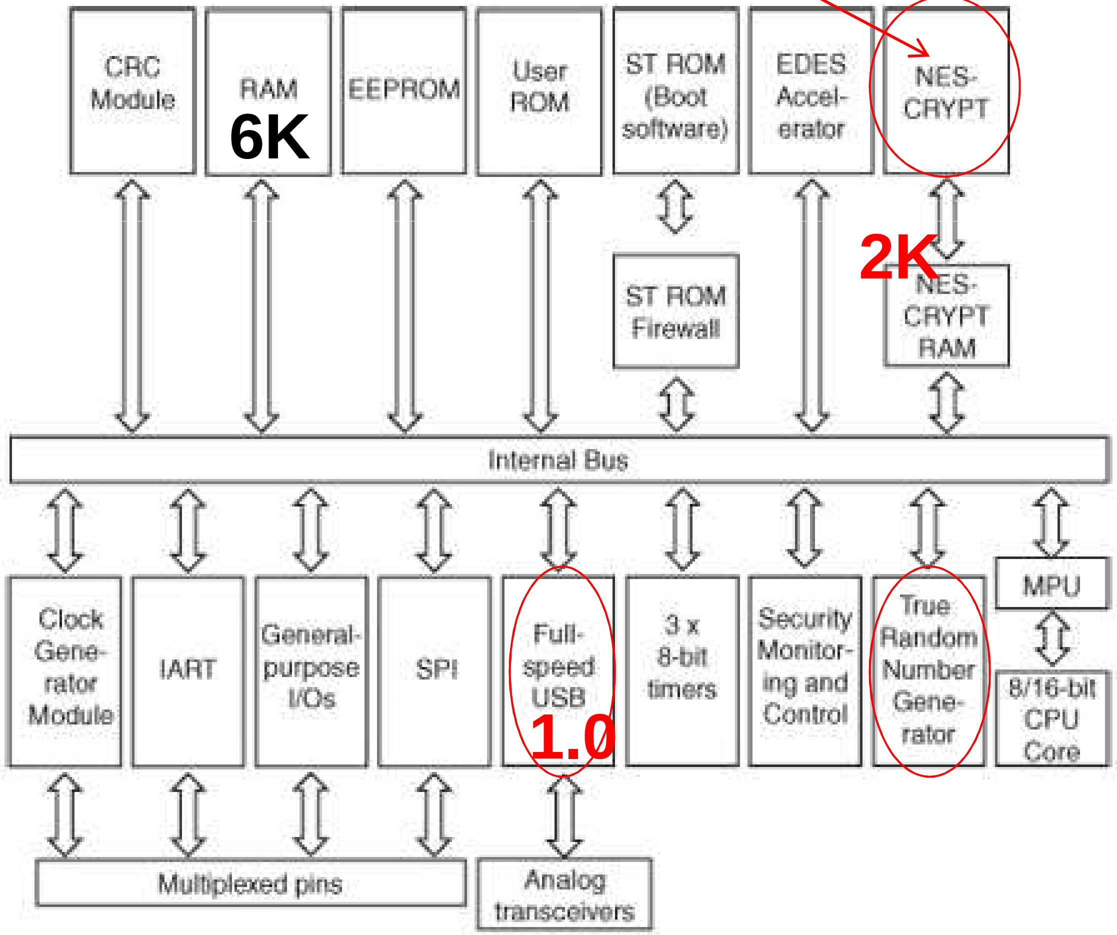
Variable privacy

HW.1 is a hardware wallet built upon a ST23YT66 banking smartcard platform. It keeps the user private keys safe, validates transactions, can be used as a secure prepaid card or a multisignature party. While not open-source, it can be deterministically validated.

*Features of USB card ST23YT66

NESCRYPT crypto-processor for PK crypto

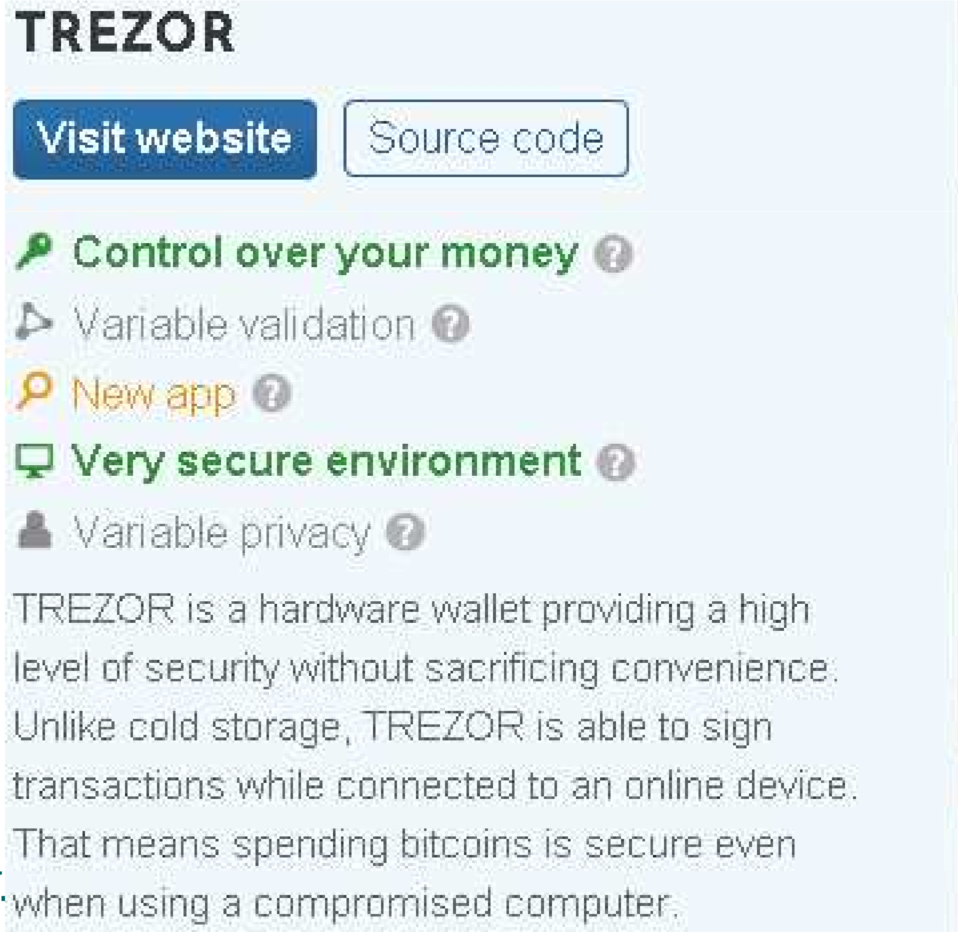
- 900 ms for 1 ECDSA signature
- 900 ms for key gen
- encrypts private keys on the card (‘content’ key) 3DES CBC
  - content key can be protected with “a GlobalPlatform Secure Channel” authentication mechanism



released March 2014 Trezor **by Satoshi Labs Prague, CZ**

+ display: know to whom you send the money!

+- has open source firmware: https://github.com/trezor/trezor-mcu

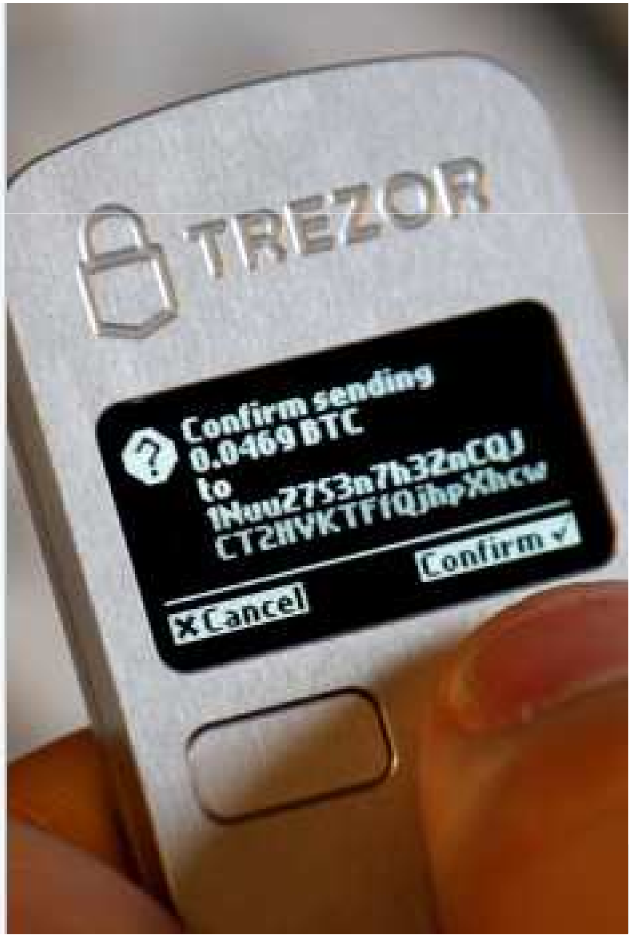


TREZOR

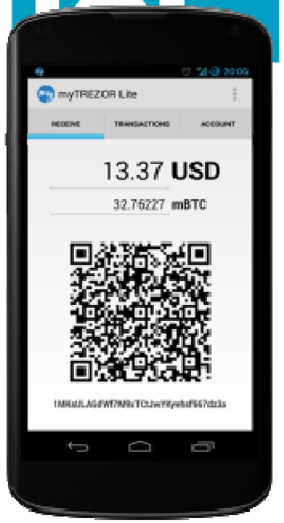
Visit website | Source code

- Control over your money ?
- Variable validation ?
- New app ?
- Very secure environment ?
- Variable privacy ?

TREZOR is a hardware wallet providing a high level of security without sacrificing convenience. Unlike cold storage, TREZOR is able to sign transactions while connected to an online device. That means spending bitcoins is secure even when using a compromised computer.



+ Trezor Lite App

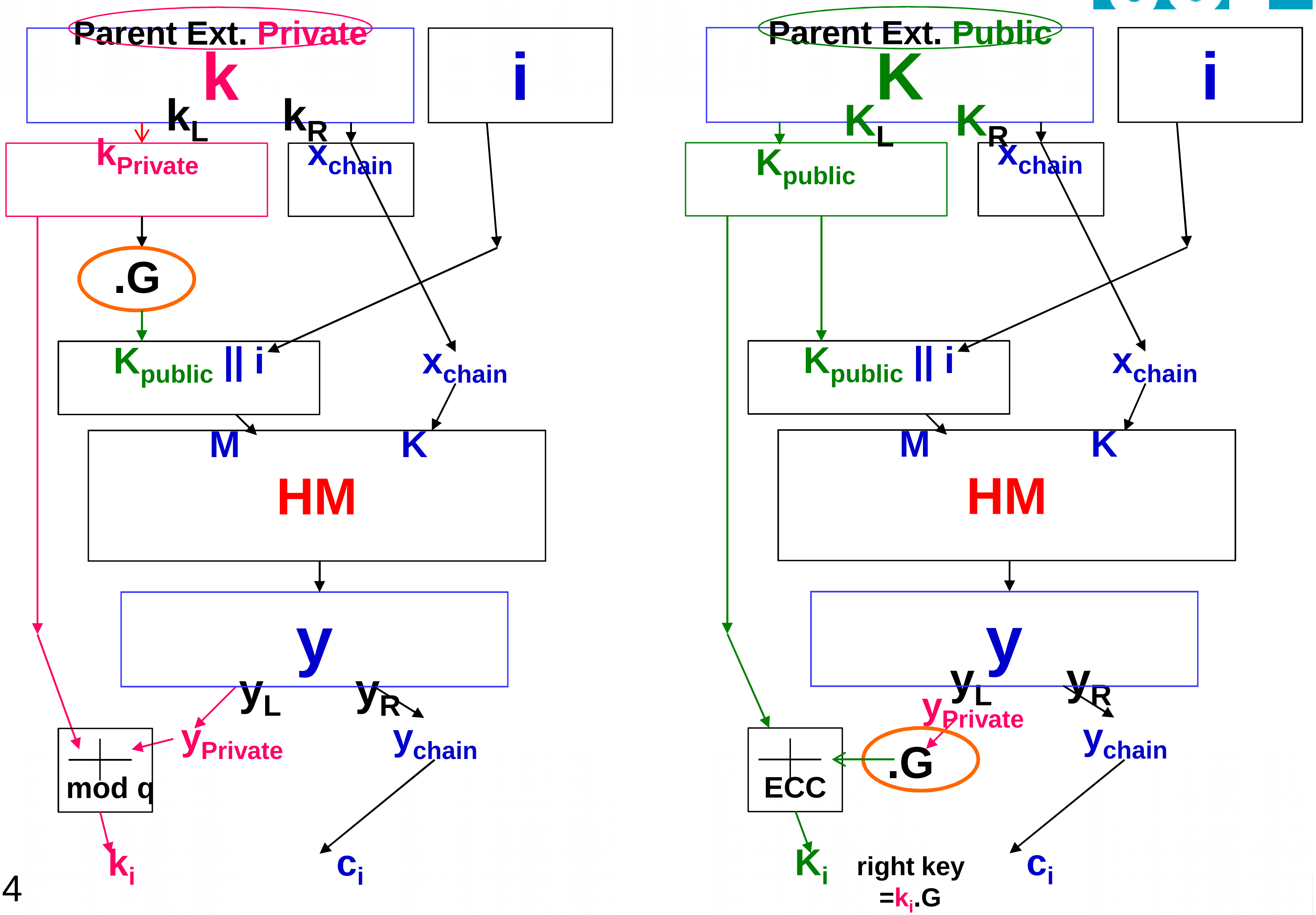


Allows to see your money
when you don’t have your device with you!

Based on BIP032 audit capability
=> quite dangerous: see

Nicolas T. Courtois, Pinar Emirdag and Filippo Valsorda: Private Key Recovery Combination Attacks: On Extreme Fragility of Popular Bitcoin Key Management, Wallet and Cold Storage Solutions in Presence of Poor RNG Events, 16 Oct 2014, http://eprint.iacr.org/2014/848

BIP032


Parent Ext. Private
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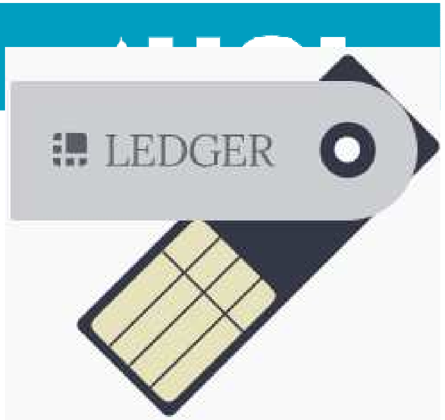
K_i
right key
$=k_i.G$
c_i

Ledger



- have their own operating system!
  - closed source, their Chrom front-end is open source
  - due to the current JavaCard limitiation:
    - cannot implement deterministic ECDSA (RFC6979)
- bitcoin tx processing implemented inside (unlike HW.1)
  - claimed to be a “more secure” evolution of HW.1
- communicates with Google Chrome directly, no middleware
- data retention: 30 years
- open: no NDA for any wallet to support this

It Implements:

- Standard Multisig, P2SH style (BIP016)
- BIP032 : HD Wallets

  ⇒danger, see our paper…

  ⇒Solution: implements RFC 6979, deterministic signatures
- BIP039: seed mnemonic (list of words in English)
- BIP044: specific wallet structure

Security

- master backup
  - printed card with master private seed

  + long passhrase to be written on paper (used only to recover)
  - recovery also possibly if the hardware is lost
    - standard method BIP39, no lock-in, can be recovered on 3rd party soft/hard
  - enter wrong PIN 3 times=>all data are claimed to be erased
  - claimed totally anonymous
    - except browser IP address will be revealed when you send Tx to the network
- each device is paired with a printed card A=>3, to be kept with the wallet,
  - this card=second factor authn. (malware cannot use the device)
  - duo edition has the same card: can create 2 identical hardware wallets
  - Pb: PIN code is entered on a PC: BUT
    - to sign a transaction, need to enter correspondance codes A=>3
      "based on a random sampling of the payment address"

Pi Wallet

- Fully Open source
- OS+Electrum,
- no WiFi,
- can remove/swap SD cards and move them to a safe

BitStash

- Not released yet,
- a large hardware box
  +standard USB key (encrypted)
    - so similar capabilities like Raspberry Pi solution…
    - move SD Card/USB to a safe!

- Main advantages:
  – works through Bluetooth
    - [connection is claimed to be hardned],
  – can be connected to a laptop/tablet

Combined Solution [Sept 2014]

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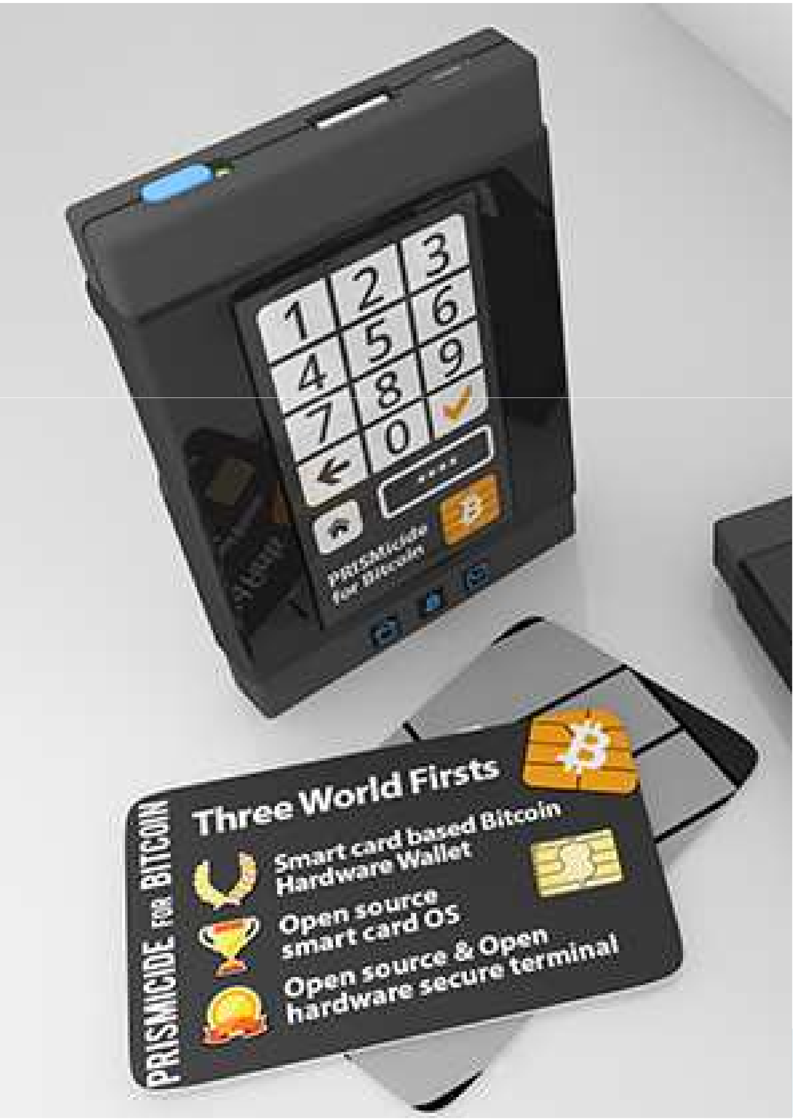
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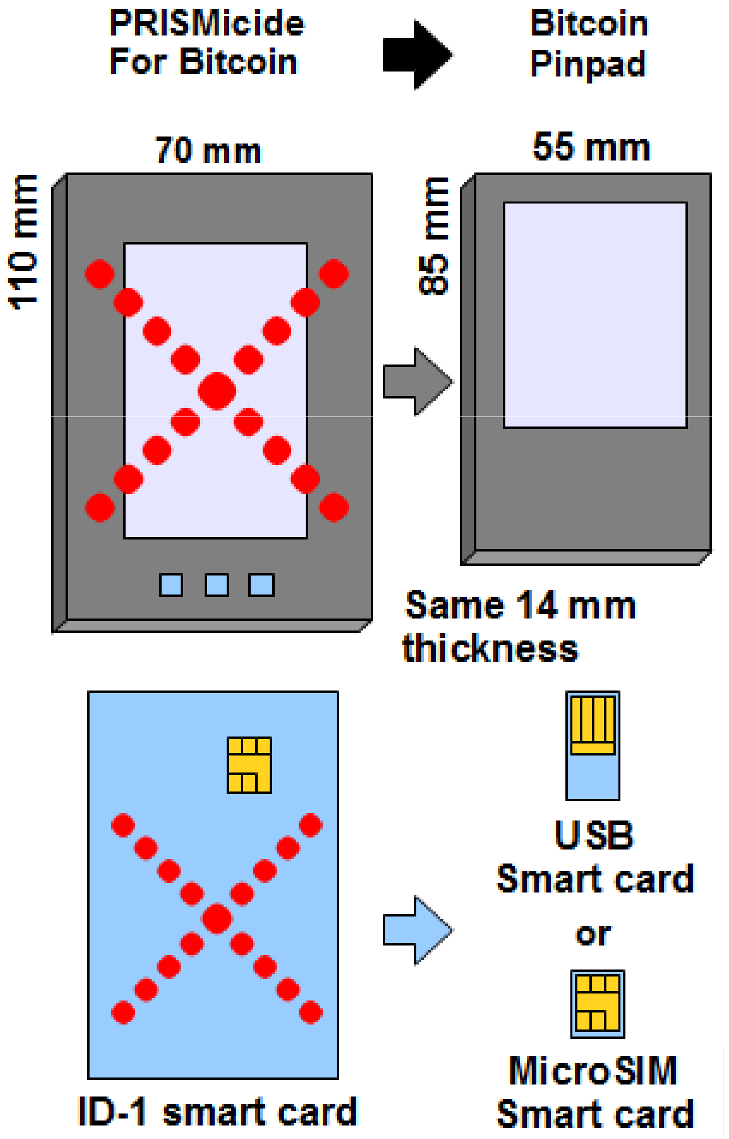
PRISMicide for Bitcoin
Three World Firsts
Smart card based Bitcoin Hardware Wallet
Open source smart card OS
Open source & Open hardware secure terminal
PRISMICIDE FOR BITCOIN

Combined Solution [Sept 2014]

- Next version: smaller



CoinKite

- card + terminal with HSM

+ supports multisig

Reading their security FAQ:

- they use HSMs at many places,
  - can be very secure
  - all private keys always stored inside HSMs
  - Everything happens on the bitcoin blockchain
    - no off-chain transacitons
- servers are hosted in Canada

CoinKite Security

- Pb 1.
  - “each new member receives a "welcome email" which contains the "xpubkey" (extended public key) for their deposits.”
  - super dangerous!
- Pb 2.
  - all private keys for all accounts are known to CoinKite
    - Except for “shared multi-sig accounts”
  - User receive an encrypted backup copy of the private extended key,
- Pb 3.