

# Attacking and Defending Blockchains: From Horror Stories to Secure Wallets

JP Aumasson



<insert blockchain meme here>

# /me

- <https://aumasson.jp> | @veorq
- VP Technology @ Kudelski Security
- Did lots of security audits for major blockchain organizations
- Also founds bugs for fun, collected bug bounties
- Co-designed a cryptocurrency storage solution used by several Swiss financial institutions (Taurus)

# Flight plan

- PART I: Wallets
- PART II: Horror stories

# **Defending and Attacking Blockchains: Secure Wallets and Horror Stories**

JP Aumasson

# PART I: Wallets

# What's a wallet

A medium to **store the seeds/passphrases/keys** associated to digital assets accounts

- These secrets are required to generate the private keys used to sign transactions, i.e. to spend money
- Unlike real wallets, a crypto wallet does not directly include funds, only the key to spend them
- The public keys and address can be made public (but may compromise anonymity and linkability)



# Hot vs. Cold



## Hot wallets

- ≈ Checking accounts, readily available to spend
- Must be connected to internet
- Higher risk of theft, e.g. if OS compromised



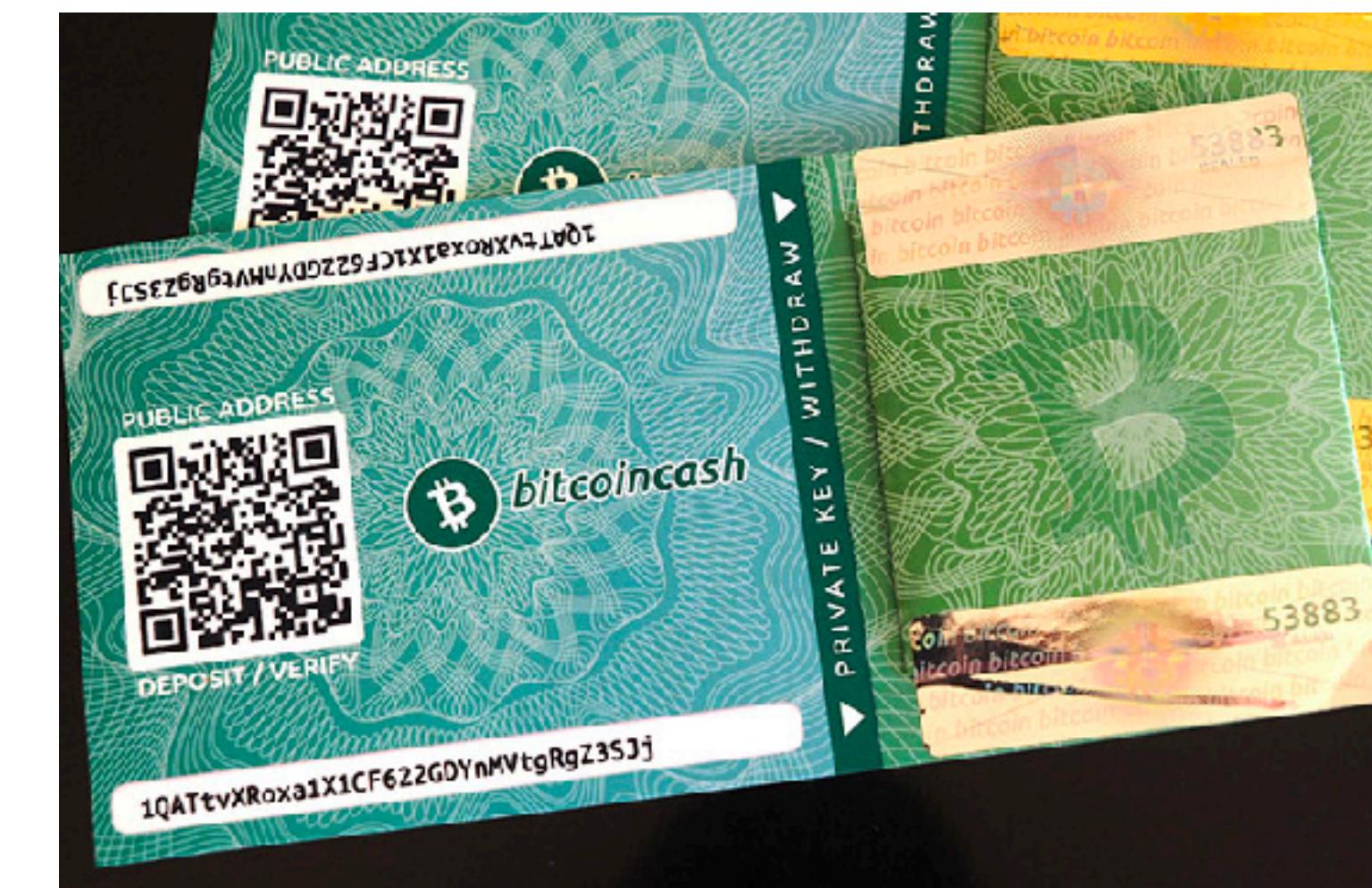
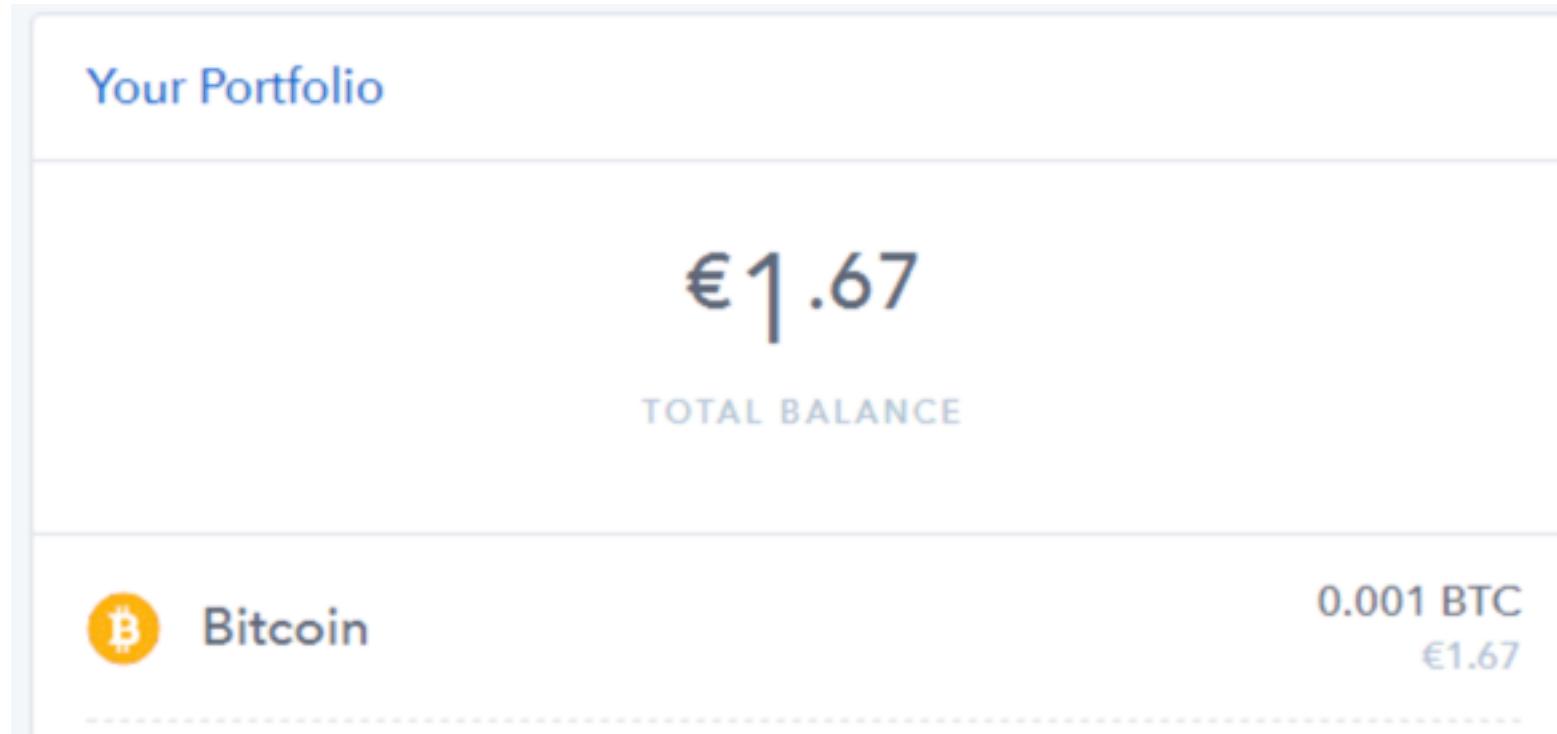
## Cold wallets

- ≈ Saving accounts
- Can be kept offline
- Hold more \$\$\$ than hot wallets

# Different types of wallets

- Online
- Mobile
- Desktop
- Paper
- Hardware

What do you use?



# Online wallet

Secrets are stored by a third-party (“cloud”), typically an exchange, credentials are used to login to the platform

Funds are generally transferred to the exchange’s hot or cold wallet, not to “your” individual address or wallet managed by the exchange

Most exchanges provide wallet management, e.g. Bitstamp, Coinbase, Kraken, Bittrex, etc.

The screenshot shows a top navigation bar with tabs: Trade, Funding (selected), Security, Settings, History, and Get Ver. Below this is a secondary navigation bar with tabs: Overview (selected), New Order, Orders, Positions, and Trades. The main content area is titled 'Balances' and contains a table with columns: Currency, Balance, and Rate. The table lists the following data:

Currency	Balance	Rate
US Dollar (USD)	\$0.02	—
Ripple (XRP)	0.00000	\$0.0066
Lumen (XLM)	*13.73132	\$0.0023
Euro (EUR)	€0.00	\$1.0679
Ether Classic (ETC)	£0.22846	\$1.2423
Ether (ETH)	£0.00000	\$9.7772
Bitcoin (XBT)	\$0.00000	\$808.1610
Total (USD):		\$0.33

The screenshot shows the Bitstamp account balance page. At the top, it displays 'Bitcoin price: \$25.95' and 'Balance: \$0.00 | 0.00000000 BTC'. It also shows the user's name 'VITALIK BUTERIN' and 'LOGOUT' options. The main content area is titled 'ACCOUNT BALANCE' and includes a sidebar with links: Account Balance, Transactions, Open Orders, Settings, and History. On the right, it shows the customer ID '02298' and the BTC balance '0.00000000 BTC'. Below this, it shows the USD balance '\$0.00'. At the bottom, there are buttons for 'DEPOSIT' and 'WITHDRAWAL'.

# Online wallet

## Pros:

- Convenience: no need to backup your keys, accessible from any device
- Convenience: directly integrated to an exchange

## Cons and risks:

- Security: Platform (e.g. exchange) may be hacked and funds stolen
- Availability: If the platform is down (e.g. DoS) you can't access your funds

# Online interfaces

Web app to manage your account **client-side**, given your key (or data required to recover it, such as a seed or passphrase), secrets are not known to the back-end

Hybrid systems: key encrypted client-side, stored encrypted in a cloud

The screenshot shows the MyEtherWallet website interface. At the top, there is a red banner with the text "DON'T GET PHISHED, please! 🚫 Thank you! 😊" and instructions "1. BOOKMARK MYETHERWALLET.COM 2. INSTALL EAL or MetaMask or Cryptonite". Below the banner, the header includes the MyEtherWallet logo, the version "3.11.3.3", language selection ("English"), gas price ("Gas Price: 21 Gwei"), and a note about network status ("The network is really full right now"). The main navigation menu has links for "New Wallet", "Send Ether & Tokens", "Swap", "Send Offline", "Contracts", "ENS", "DomainSale", "Check TX Status", "View Wallet Info", and "Help". The "New Wallet" link is underlined, indicating it is the active page. The main content area is titled "Create New Wallet" and contains a password input field with placeholder text "Enter a password" and a "Create New Wallet" button. To the right, there is a sidebar with "Language" set to "English" (with a UK flag icon), "Select a network" set to "Mainnet", and a "Enter your passphrase\*" input field with an "eye" icon for password visibility. At the bottom right are "NEW ACCOUNT" and "LOGIN" buttons.

# Online interfaces

## Pros:

- Doesn't store your credentials on a third-party system
- Convenient UI

## Cons and risks:

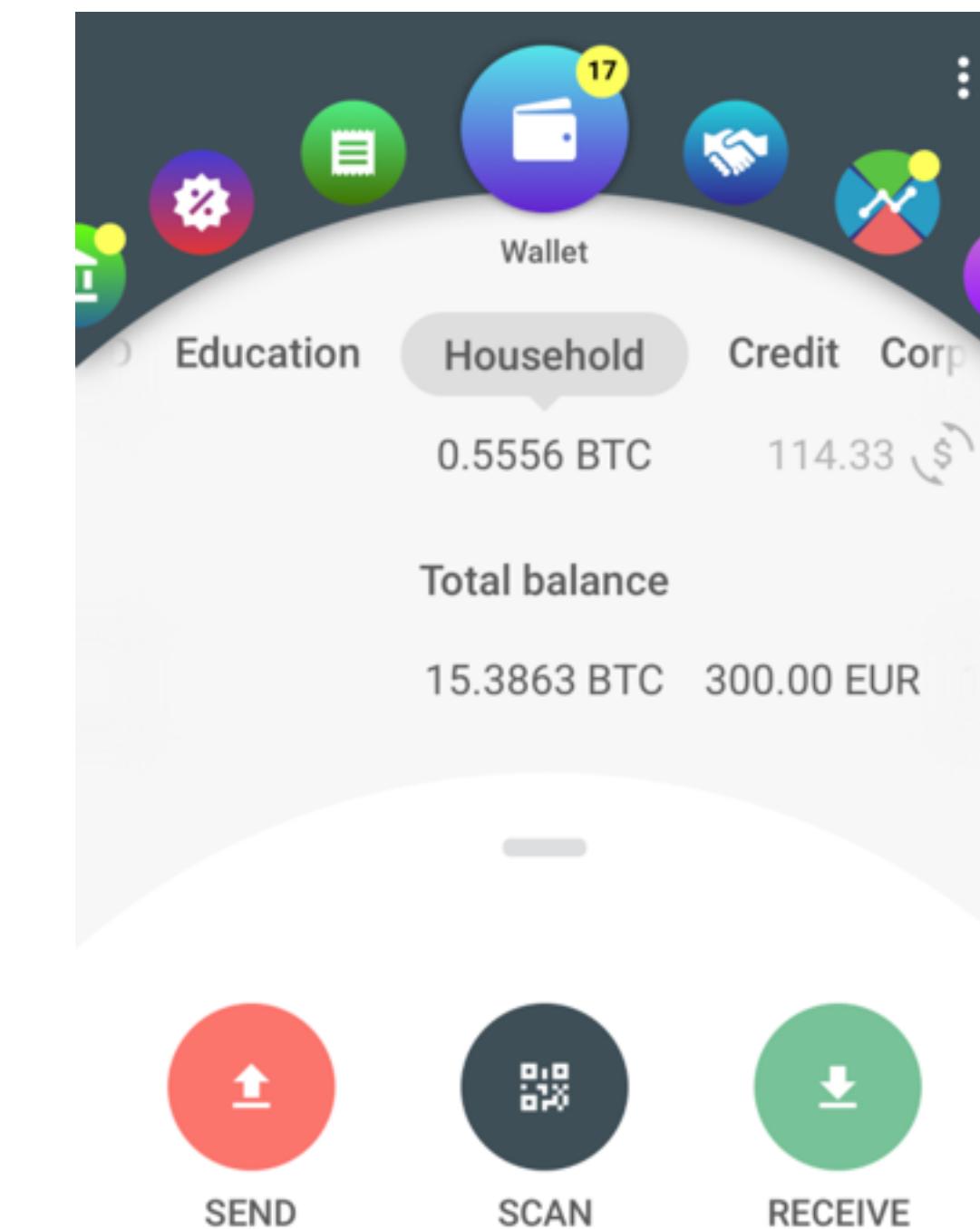
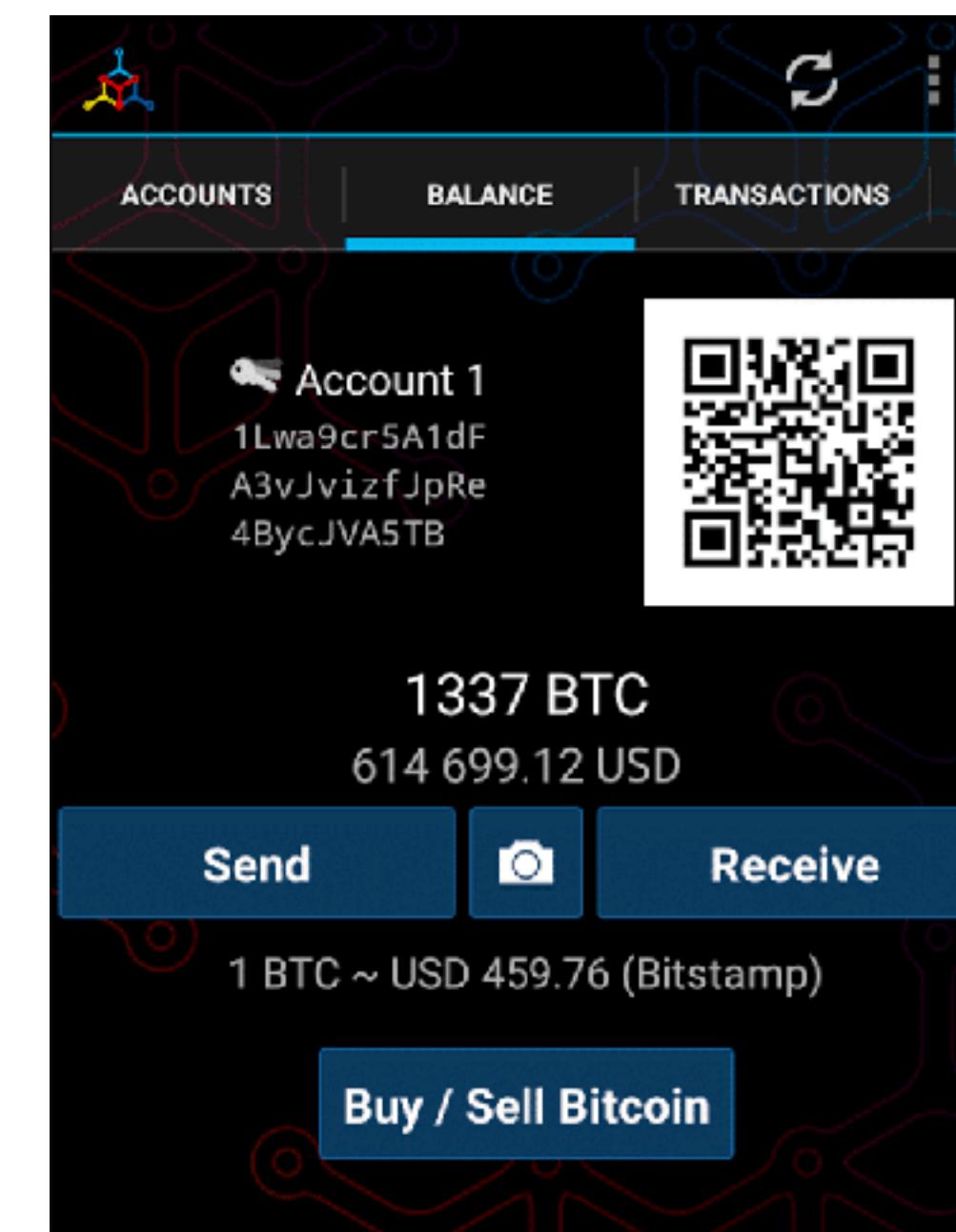
- Phishing: you might enter your credentials on a malicious website
- Web app might be hacked or malicious and surreptitiously collect your credentials
- You need an actual wallet to store your credentials

# Mobile wallet

Mobile application to manage your account, your **keys are stored locally**

May support extra features such as multi-signatures, 2FA, "cold storage"

Popular wallets include Copay, Jaxx, Mycelium



# Mobile wallet

## Pros:

- Security: more secure than online wallets
- Control: no third-party can access your funds
- Convenience: on-the-go management of your funds

## Cons and risks:

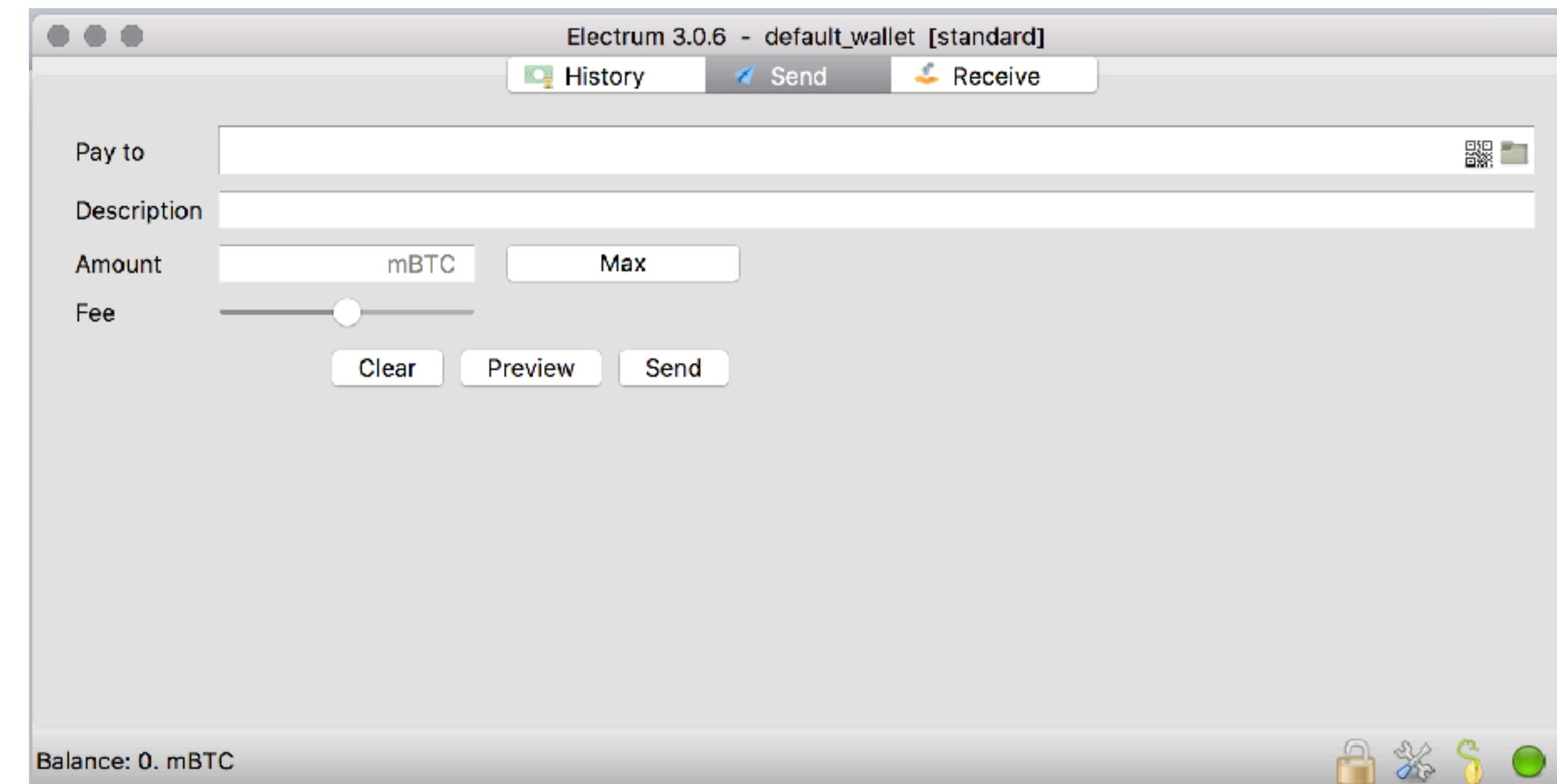
- Security: key exposed if OS compromised (Android riskier than iOS)
- Availability: key lost if device lost/stolen/destroyed

# Desktop wallet

Desktop application to manage your account, your **keys are stored locally**

May support extra features such as multi-signatures, 2FA, "cold storage"

Popular wallets include Armory, Copay, Electrum, Exodus



# Desktop wallet

## Pros:

- Security: more secure than online wallets
- Control: no third-party can access your funds
- Availability: lower risk of theft/loss than mobile devices

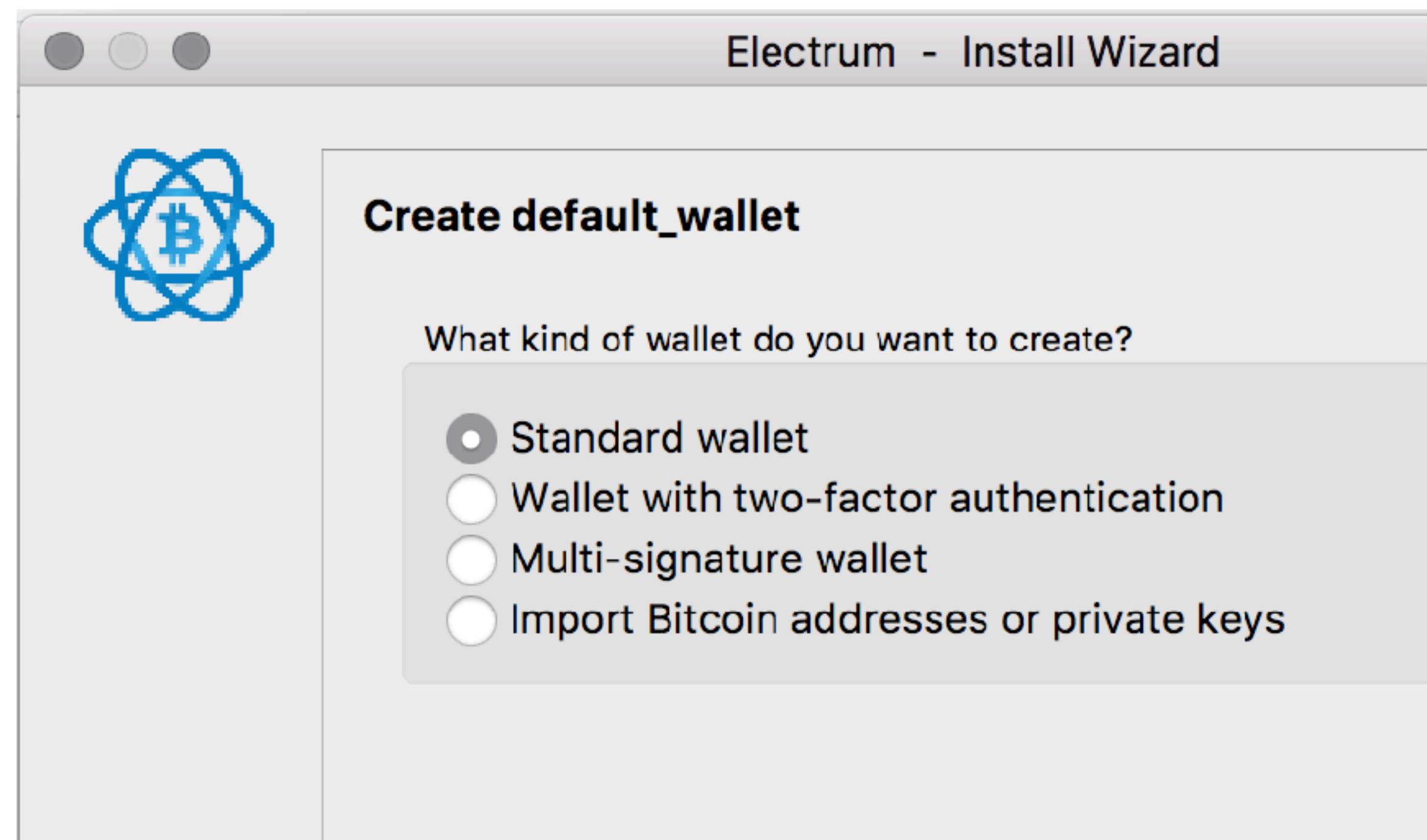
## Cons and risks:

- Security: key exposed if OS compromised (even if password-protected)
- Convenience: needs a better technical understanding than online wallets

# Desktop wallet

Example: Electrum wallet setup

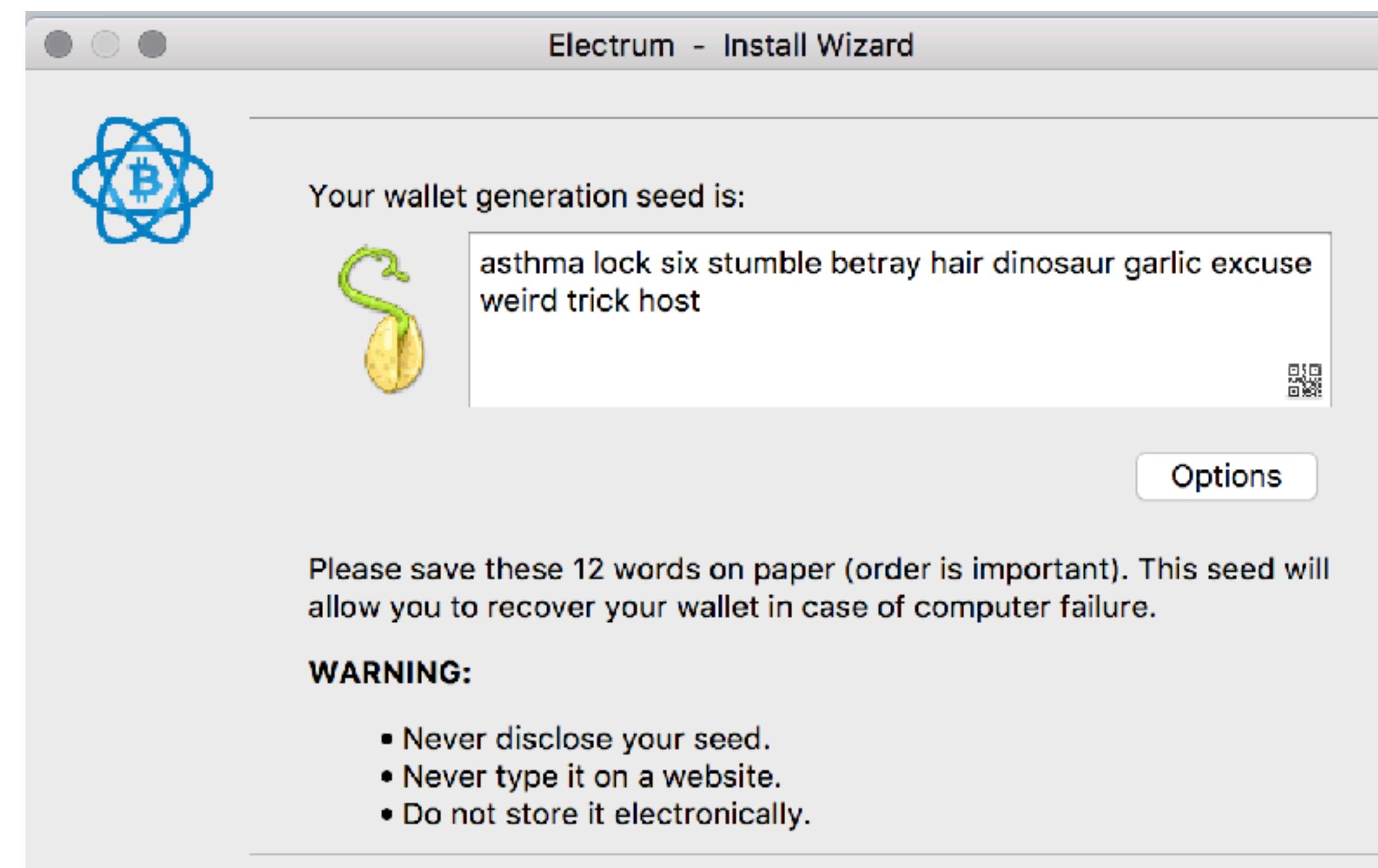
Different types of wallets, such as multisignature wallets



# Desktop wallet

## Example: Electrum wallet setup

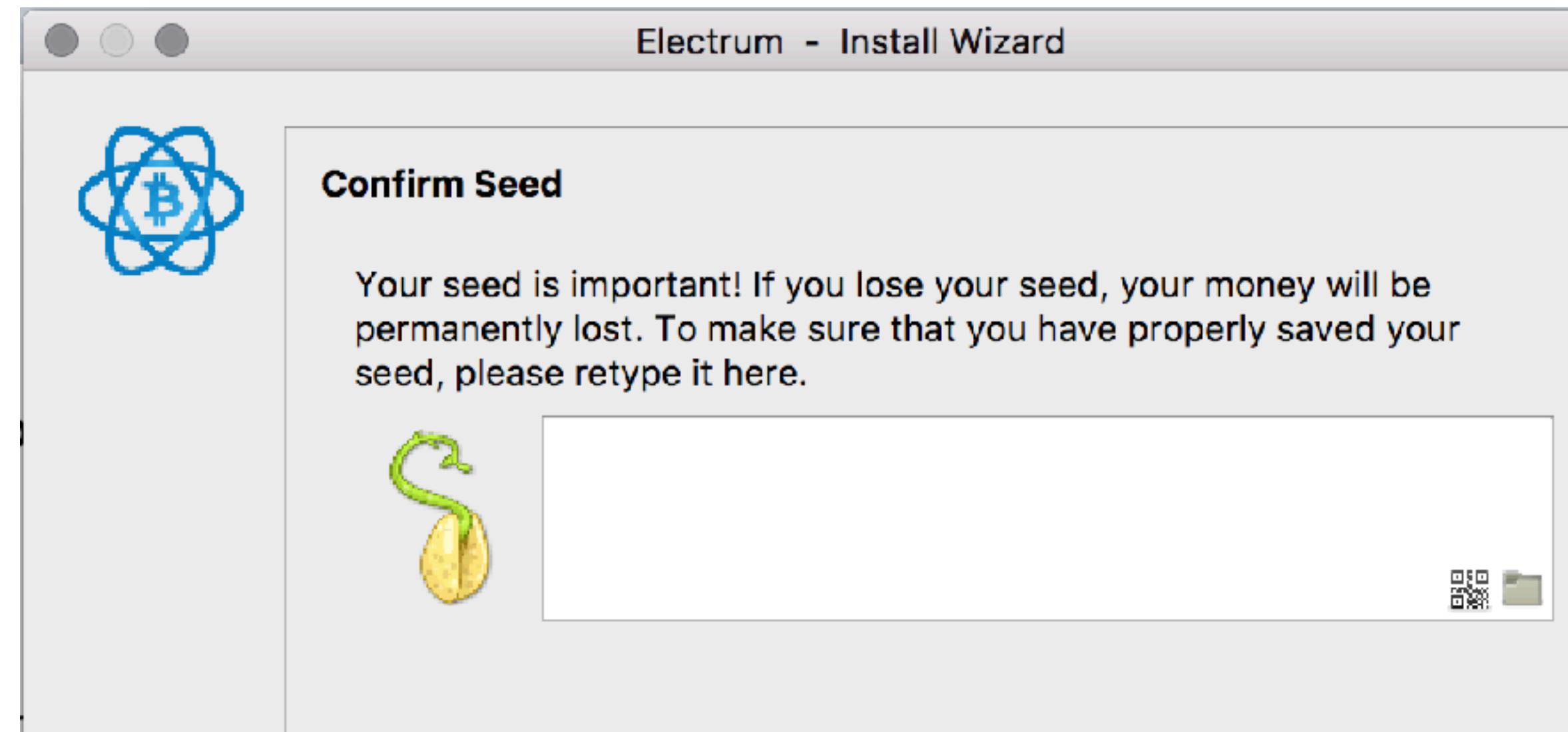
BIP39 passphrase randomly generated, will be used to derive a seed that will serve as the root of a BIP32 hierarchical wallet



# Desktop wallet

Example: Electrum wallet setup

Seed/passphase confirmation step to ensure that you've copied the passphrase



# Desktop wallet

Example: Electrum wallet setup

Password-protect the seed/passphrase (symmetric encryption derived from this password, used to encrypt the secrets on the local filesystem)



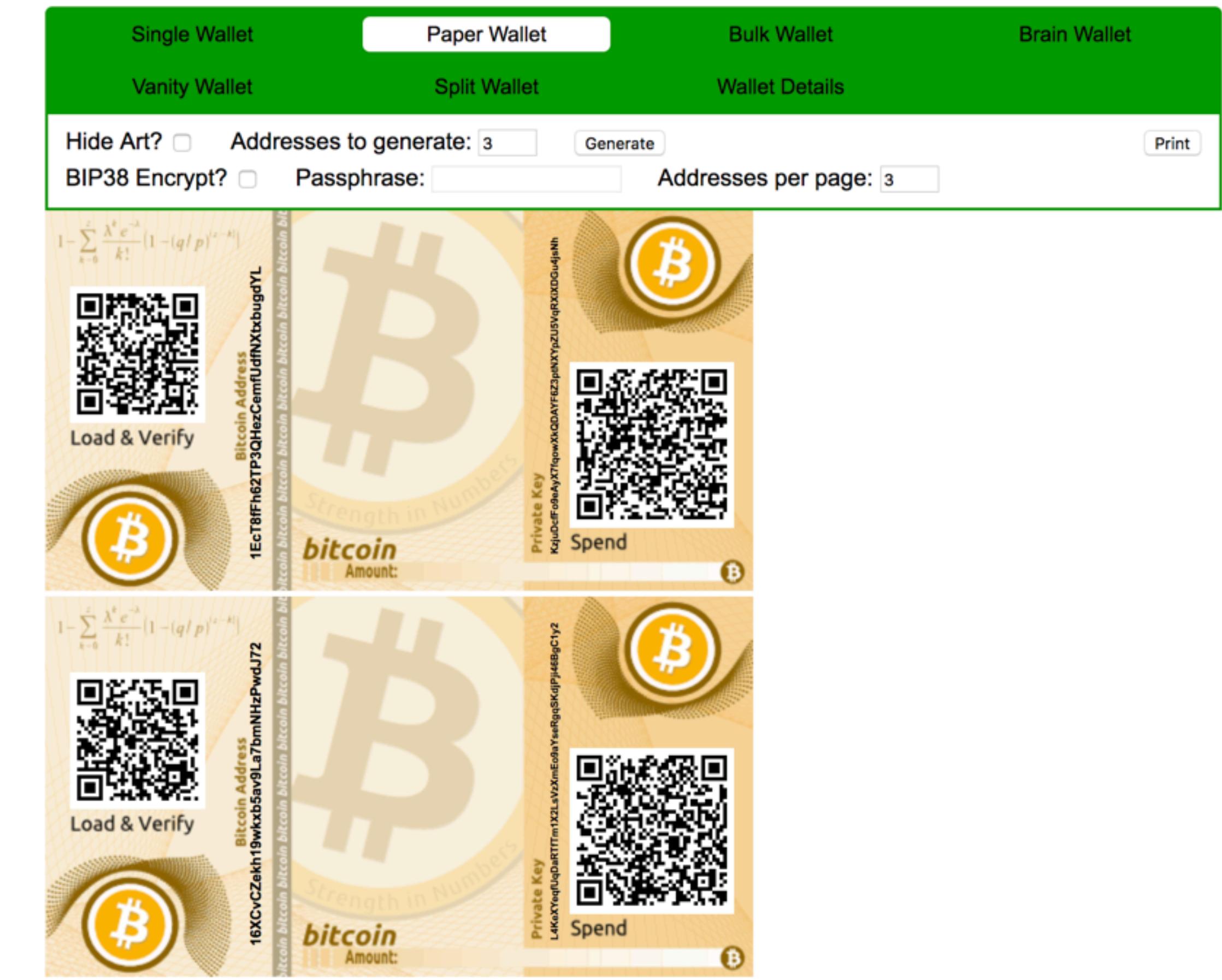
# Paper wallet

Key printed on a piece of paper, as QR code, hex digits, or passphrase  
(Other media: laminated paper, engravings, etc.)

[bitaddress.org](http://bitaddress.org)

[bitcoinpaperwallet.com](http://bitcoinpaperwallet.com), etc.

The screenshot shows the bitaddress.org website. At the top, there are four green buttons labeled "Single Wallet", "Paper Wallet" (which is highlighted), "Bulk Wallet", and "Brain Wallet". Below these are four smaller buttons: "Vanity Wallet", "Split Wallet", "Wallet Details", and a "Print" button. The main content area has a green header with "19%" repeated four times and "Brain Wallet" and "Wallet Details" buttons. A progress bar at the bottom says "Generating Bitcoin Address..." and "MOVE your mouse around to add some extra randomness... 19%". Below the progress bar is a text input field with placeholder text "OR type some random characters into this textbox". A large text area displays a long string of hex digits:   
4d76ffbfebc95b4a19093b45c3f0d86b615d2f993cd0f51276c8027d1f36feaa4  
b6797dd5bc8d81b0dc6d4a5d00ff44b26edcd8e8e7e9f324532892a858d743980  
7c7c0a3250b24b749dddbe3e4de69503c94e968a48522be4f75789be08ed016f9  
69b5147314f16e7f9400c643156d5f8427762bfe5a2df6b0f15af78ded457826a  
84d9d6f6d160452c520a8dad291796e4dc9c4bf6364b61327eabe0f4a02dd53c4  
7cc4571be6328deac50a31ab4204d1b038c9283b57588c2d1f2d0a48f74b7cffa  
77882630eb2f82fb008e51bd9ffe81b2a22655c75c6d983a16ab2c469033bbd27  
4cb935297fc631fd21be30d11d6f7e9bfd19db9cf2bc539355d25d1e3



# Paper wallet

## Pros:

- Security: more secure than online, mobile, or desktop wallets
- Security: safe even if all your devices are fully compromised

## Cons and risks:

- Availability: can be lost, stolen, burnt, damaged with time
- Convenience: needs more technical understanding to use than desktop wallets
- Security: can be hijacked by taking a picture, video surveillance, etc.

# Hardware wallet

Physical device that stores keys securely, without exposing them to the host OS

Features such as U2F (FIDO), multiple wallets, hidden passphrase, etc.

Popular consumer hardware wallets are Ledger and Trezor devices



# Hardware wallet

## Pros:

- Security: keys never directly exposed to the OS, acts like a black box
- Security: even if stolen, extracting the key requires advanced equipment & skills
- Security: some devices support plausible deniability (“emergency PIN”, multiple PINs)

## Cons and risks:

- Availability: Lock-out, e.g. if wrong PIN entered and the device “self-destructs”
- Functionality: Limited number of coins supported, can’t always have multiple seeds
- Loss of the device + no backup

# Hardware wallet: not perfect



## wallet.fail

*Thomas Roth, nedos, Josh Datko*

In this presentation we will take a look at how to break the most popular cryptocurrency hardware wallets. We will uncover architectural, physical, hardware, software and firmware vulnerabilities we found including issues that could allow a malicious attacker to gain access to the funds of the wallet. The attacks that we perform against the hardware wallets range from breaking the proprietary bootloader

# Typical setup for individuals

- **Hot:** online wallet(s) for day-to-day trading, on different exchanges
- **Cold:** long-term investment stored on a hardware wallet
- **Backup:** paper copy of the hardware wallet key, on laminated paper, in a safe



# Recommendations

- Only use online wallet as hot wallets
- Use only recommended/popular online wallets (such as MEW)
- Distribute between hot and cold storage, depending on your activity
- **BACKUP!** (mobile, desktop, paper, hardware): encrypted or paper copies

# Exchanges and wallets

- **Hot wallet(s)** guarantees liquidity for daily operations (mainly withdrawals)
- **Cold wallet(s)** contain the majority of the exchange's funds

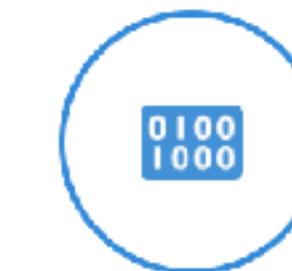
## 98% of customer funds are stored offline

Offline storage provides an important security measure against theft or loss.

We distribute bitcoin geographically in safe deposit boxes and vaults around the world.



Sensitive data that would normally reside on our servers is disconnected entirely from the internet.



Data is then [split](#) with redundancy, AES-256 encrypted, and copied to FIPS-140 USB drives and paper backups.



Drives and paper backups are distributed geographically in safe deposit boxes and vaults around the world.

# Exchanges and wallets

- **Hot wallet(s)** guarantees liquidity for daily operations (mainly withdrawals)
- **Cold wallet(s)** contain the majority of the exchange's funds

## Coin Storage

- All new deposits go directly to cold wallets, with complete air-gap isolation from any online system.
- The vast majority of coins are stored in cold wallets, with complete air-gap isolation from any online system.
- A limited number of coins are stored in semi-cold wallets, on protected machines with locked drives.
- Only the coins that are needed to maintain operational liquidity are stored in hot (online) wallets.
- All wallets are encrypted.

# Exchanges and hardware wallets?

- Most exchanges do NOT use hardware wallets – is it really a problem?
- Gemini is an exception

## HOT WALLET

- Our Hot Wallet environment is hosted on Amazon Web Services (“AWS”). AWS has a proven track record for physical security and internal controls. More information can be found [here](#).
- Tiered access-controls are applied to our production environment to restrict access to employees based on role, following the principle of least-privilege.
- Administrative access to our production environment requires multi-factor authentication.
- Hot Wallet key management is rooted in hardware security modules (“HSMs”). We use the hosted CloudHSM service provided by AWS, which offers dedicated HSMs within the AWS cloud.
- The specific hardware used by CloudHSM has been evaluated according to federal information processing standard publication 140-2 (“FIPS PUB 140-2”) and achieved a rating of [Level 2](#).

# Exchanges and hardware wallets?

- Anything missing here? What about backups?

## COLD STORAGE

Our Cold Storage system provides two tiers of offline storage dubbed “cold” and “cryo” (short for “cryogenic”) for improved security and redundancy.

- We use HSMs that have achieved a rating of FIPS PUB 140-2 [Level 3](#) (or higher).
- All cold and cryo private keys are generated, stored and managed onboard our HSMs for the lifetime of the key.
- We use Multisignature technology (“Multisig”) to provide both security against attacks and tolerance for losing access to a key or facility, eliminating single points of failure.
- All HSMs are stored in guarded, monitored and access-controlled facilities that are geographically distributed.
- Hardware is sourced from diverse manufacturers to guard against supply-chain risks.
- All fund transfers require the coordinated actions of multiple employees (i.e., all facilities are “no-lone zones”).

# “Warm” wallets

- Not completely airgapped (must allow the broadcast of transactions)
- Typically based on hardware storage to minimize risks
- Used by banks to ensure compliance with banking regulations
  - Needs manual traceable procedures (“4-eyes” control, 3 lines of defense, etc.)
  - Must integrate in bank networks (Avaloq, Temenos, etc.) and have a familiar UI

# **PART II: Horror stories**

# Are blockchains secure?

- **No major issue** ever in Bitcoin nor Ethereum internals
- **But:** lot of new code, new protocols, complex logic, wide attack surface, unexperienced developers; a recipe for blockchain bugs

# Blockchain bugs?

- **Design** bugs: functionality works as intended, but can be abused by an attacker
- **Software** bugs: software errors allow the program to enter an insecure state, unintended by the design

Such bugs can be found either in the blockchain itself, or on the applications running on top of it (smart contracts, etc.)

# Multiple targets

A typical cryptocurrency needs several applications

- **Wallets:** desktop, mobile, where private keys are stored
- **Validation nodes:** which run a consensus mechanism to authorize transactions and ensure the blockchain's consistency – be it PoW or PoS

# Attackers goals

Main goal: **free money**

- Steal private keys/seeds/wallets
- Issue transactions on behalf of other clients
- Create coins/tokens out of thin air



Other goals: network denial-of-service, user lock out, harm competitors' reputation, etc.

1. Bitcoin overflow
2. Ethereum reentrancy
3. Zerocoin multi-spend
4. Lisk accounts hijack
5. Parity wallet bug
6. IOTA's hash function
7. Bitgrail withdrawal
8. BatchOverflow
9. Verge consensus
10. BIP32 utilities

# 1. Bitcoin overflow (CVE-2010-5139)

The worst problem ever in Bitcoin

Author Topic: Version 0.3.10 - block 74638 overflow PATCH! (Read 5059 times)

**satoshi** Founder Sr. Member August 15, 2010, 11:48:22 PM [quote](#) #1

Version 0.3.10 patches the block 74638 overflow bug. <http://bitcointalk.org/index.php?topic=823>

Activity: 364

The Linux version includes tcatk's 4-way SSE2 SHA-256 that makes generating faster on i5, i7 (with hyperthreading) and AMD CPU's. Try the "-4way" switch to enable it and check if it's faster for you.

Ignore

Download from sourceforge:  
<http://sourceforge.net/projects/bitcoin/files/Bitcoin/bitcoin-0.3.10/>

SHA1 16645ec5fcdb35bc54bc7195309a1a81105242bb bitcoin-0.3.10-win32-setup.exe  
SHA1 4f35ad7711a38fe8c880c6c9beab430824c426d3 bitcoin-0.3.10-win32.zip  
SHA1 e3fda1ddb31b0d5c35156cacd80dee6ea6ae6423 bitcoin-0.3.10-linux.tar.gz  
SHA1 b812ccff4881778b9090f7c0b0255bcba7b078ac bitcoin-0.3.10-macosx.zip

It is no longer necessary to delete blk\*.dat. The good block chain has overtaken the bad block chain, so you can just upgrade and it'll automatically reorg away the bad block chain.

# What happened?

jgarzik  
Legendary  
Activity: 1498

Strange block 74638  
August 15, 2010, 06:08:49 PM

The "value out" in this block #74638 is quite strange:

**Code:**

```
{  
    "hash" : "000000000790ab3f22ec756ad43b6ab569abf0bddeb97c67a6f7b1470a7ec1c",  
    "ver" : 1,  
    "prev_block" : "000000000606865e679308edf079991764d88e8122ca9250aef5386962b6e84",  
    "mrkl_root" : "618eba14419e13c8d08d38c346da7cd1c7c66fd8831421056ae56d8d80b6ec5e",  
    "time" : 1281891957,  
    "bits" : 469794830,  
    "nonce" : 28192719,
```

- The sum of output values in a transaction overflowed the integer variable
- Transaction check validated the (negative) sum
- **184,467,440,737.09551616** bitcoins were created...

# Lessons and solutions

- Simple input validation bug, would likely have been caught in a security audit of the code
- Soft fork de facto invalidated the transaction
- Fixed within 5h, patched in 0.3.10

```
1009 +
1010 +      // Check for negative or overflow input values
1011 +      if (txPrev.vout[prevout.n].nValue < 0)
1012 +          return error("ConnectInputs() : txin.nValue negative");
1013 +      if (txPrev.vout[prevout.n].nValue > MAX_MONEY)
1014 +          return error("ConnectInputs() : txin.nValue too high");
1015 +      if (nValueIn > MAX_MONEY)
1016 +          return error("ConnectInputs() : txin total too high");
```

## 2. Ethereum reentrancy (a.k.a. DAO bug)



The screenshot shows a news article from a website. At the top, there's a dark banner with a small white logo on the left. Below it, a blue header bar contains the word "CRYPTOCURRENCY" in white capital letters. The main title of the article is "The Biggest Hacker Whodunnit of the Summer", displayed prominently in large black font. Below the title, the author is listed as "Jan Vollmer" and the date as "Jul 14 2016, 4:30pm". A horizontal line separates the title area from the body text. The body text starts with a bold statement: "It's been almost a month since a \$53 million hack sent the Ethereum community into crisis." Below this, there are social sharing buttons for "SHARE" (with a Facebook icon), "TWEET" (with a Twitter icon), and "EMAIL" (with an envelope icon). The background of the page features a dark, abstract graphic.

# The Biggest Hacker Whodunnit of the Summer

Jan Vollmer  
Jul 14 2016, 4:30pm

**It's been almost a month since a \$53 million hack sent the Ethereum community into crisis.**

SHARE  TWEET 

June 17 marked the beginning of perhaps the biggest digital bank robbery this summer: Unknown attackers disappeared \$53 million in the cryptocurrency Ether from one of the startup finance world's most promising and futuristic projects.

# What happened? (*simplified*)

- Smart contract DAO.sol vulnerable to reentrancy (~smart contract cousin of concurrency)
- Attacker creates a contract that interacts with the vulnerable contract, to fool the contract into “thinking” it has more money than it actually has, using nested function calls
- Exploit idea: attacker “pretends” to withdraw money so that the contract “thinks” it has less money than it has, then attacker can steal this extra money..

```
5     modifier checkInvariants {
6         -
7             - if (this.balance != totalSupply) throw;
8             + if (this.balance < totalSupply) throw;
9     }
```

# Lessons and solutions

- Smart contract programming and reasoning is hard, because based on an unconventional model
- Need for audits and best practices (safe arithmetic, avoid external calls, check invariants, etc.)
- Some platforms use simpler, non-Turing complete logic (yet richer than Bitcoin's scripts) to reduce the risk

# 3. Zerocoins multi-spend

The screenshot shows the Zerocoins website. At the top, there is a navigation bar with four items: 'HOME' (which is highlighted in grey), 'PEOPLE', 'Q AND A', and 'PAPERS, PRESS, ETC'. Below the navigation bar is a green header section containing the 'Zerocoins Project' logo, which consists of a stylized 'Z' inside a circle, followed by the word 'Zerocoins' in a serif font. To the right of the logo, the word 'Project' is written in a sans-serif font. Below this green section is a white area containing a purple callout box. The callout box contains the text: 'Zerocash, the protocol that succeeded Zerocoins, is being developed into a full-fledged digital currency, [Zcash](#)'.

## What is Zerocoins?

Zerocoins is a project to fix a major weakness in Bitcoin: the lack of privacy guarantees we take for granted in using credit cards and cash. Our goal is to build a cryptocurrency where your neighbors, friends and enemies can't see what you bought or for how much.

This project began with a proposed extension, called "Zerocoins", to the Bitcoin protocol that allowed users to mix their own coin. A collaboration between the original Zerocoins project members and cryptographers at MIT, The Technion, and Tel Aviv University, has produced a far more efficient protocol that allows for direct private payments to other users of hidden value. For disambiguation, we refer to this new protocol as Zerocash, and detail its technical underpinnings [here](#).

Experimental academic project, warned people not to use their code in production..



# What happened?



- Zero-knowledge proof checking that a coin isn't already spent before spending it..
- Bug: actually using the coin "**serial mod q**"'s value, without checking "**serial < q**"
- Consequence: coins with distinct serial numbers but same value mod q could all be spent, as if they were several copies of the same coin

```
81      86
82      87  + bool CoinSpend::HasValidSerial() const
83      88  +
84      89  +     return coinSerialNumber > 0 && coinSerialNumber < params->coinCommitmentGroup.groupOrder;
85      90  +
86      91  +
87      92  } /* namespace libzerocoins */
```

# Lessons and solutions

- Cryptography is fragile and complex to audit
- Don't use experimental code for critical operations  
(especially if their authors warn you against it)

## Can I use it now?

Not yet. We are planning on releasing an alt-coin using the Zerocash protocol. We are currently in the process of finishing a release version of the client, based on the Bitcoin 0.9.1 codebase: there's a big difference between research software, and a working release grade client we can stand behind. Our goal is to release this code in a production-quality form that the community can use to stand up a real, functioning currency. We will be providing further updates on this site.

# 4. Lisk account hijack

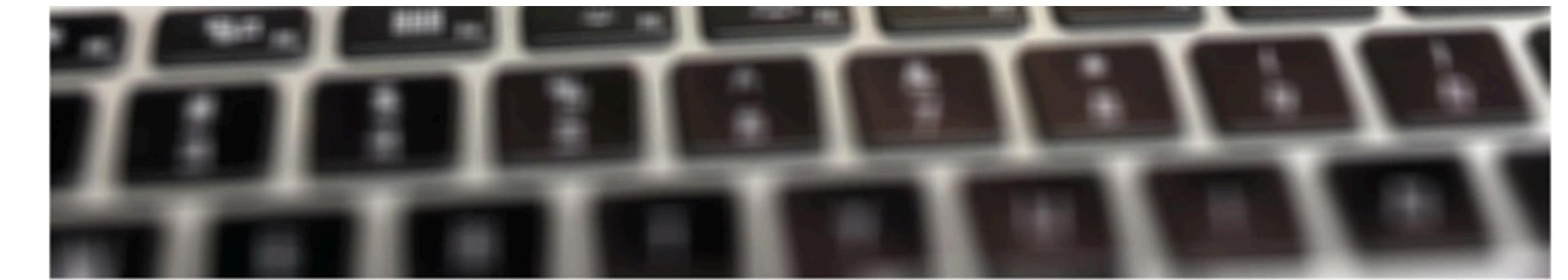


**Access the power of blockchain**

Lisk makes it easy for developers to build and deploy blockchain applications in JavaScript. Join the leading ecosystem for world-changing dapps.

[Watch video](#)

The advertisement features a dark blue background with white text. It includes a large play button icon at the bottom left.



## BLOCKCHAINS: HOW TO STEAL MILLIONS IN $2^{64}$ OPERATIONS

January 16, 2018 · JP Aumasson · Crypto, cryptocurrency · 11 comments

I've been reviewing the source code of a number of blockchain thingies, both for paid audits and for fun on my spare time, and I routinely find real security issues. In this post I'll describe a vulnerability noticed a while ago, and now that [Lisk](#) finally describes it and [warns its users](#), I can comment on its impact and exploitability.

*TL;DR: you can hijack certain Lisk accounts and steal all their balance after only  $2^{64}$  evaluations of the address generation function (a combination of SHA-256, SHA-512, and a scalar multiplication over Ed25519's curve).*

# What happened?

Like in any cryptocoin platform, coin owners are identified by an *address*. In Lisk, addresses are 64-bit numbers, such as [3040783849904107057L](#). Whereas in Bitcoin, for example, an address is simply a hash of one's public key, a Lisk address is derived deterministically from a *passphrase*, while generating the user's keypair along the way. In more details, it works like this:

1. Given a passphrase, compute a 256-bit seed as  $\text{seed} = \text{SHA-256}(\text{passphrase})$ .
2. Derive an [Ed25519](#) keypair from this seed, which involves computing  $\text{SHA-512}(\text{seed})$  and a scalar multiplication.
3. Compute the SHA-256 hash of the public key, and define the address as the last 8 bytes of the 32-byte hash.

- Trivial collisions  $\text{Address}(\text{passphrase 1}) = \text{Address}(\text{passphrase 2})$
- Preimage search for a valid passphrase of a given address in  $\sim 2^{64}$  trials

# What happened?

## Second problem: no address-key binding

Ideally, short addresses shouldn't be a huge problem: if an address already exists and is bound to a key pair, you shouldn't be able to hijack the account by finding another passphrase/keypair mapping to this address.

And that's the second problem: an address isn't bound to a keypair until it has sent money to another address (or voted for a delegate). What this means is that if an account only receives money but never sends any, then it can be hijacked by finding a preimage—and once the attacker has found a preimage, they can lock the original user out of their account by issuing a transaction and binding the address to their new passphrase/keypair.

- Latency of  $\sim 2^{49}$  operations to attack attack a one-in-64 target address with 256 cores
- Mitigation: send one transaction from any new address in order to broadcast the public key to the network, thereby binding the key to the address

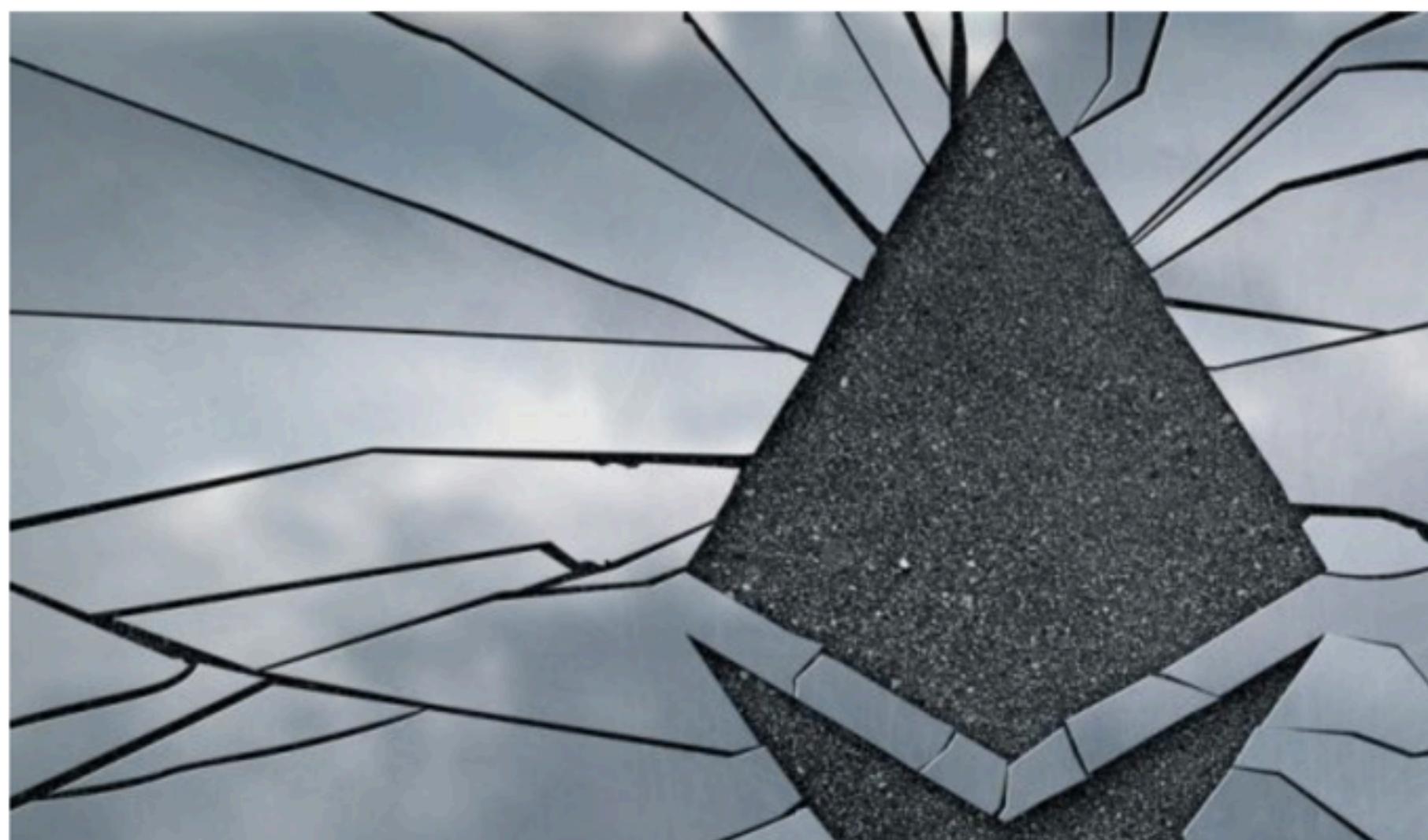
# Lessons and solutions

- Flawed address derivation scheme, despite good choice of cryptographic algorithm
- Other embarrassing security issues in Lisk (secret sent in clear to validators, etc.), evidently wasn't designed nor reviewed by security people
- Lisk published an advisory, but cannot fix the problem

# 5. Parity wallet bug

ETHEREUM NEWS NOVEMBER 09, 2017 16:21

## 'I Accidentally Killed It': Parity Wallet Bug Locks \$150 Million in Ether



paritytech / parity

Watch ▾ 337

Code Issues 165 Pull requests 26 Projects 5 Insights

anyone can kill your contract #6995

Closed ghost opened this issue on Nov 6, 2017 · 16 comments

ghost commented on Nov 6, 2017 • edited by ghost +

I accidentally killed it.

<https://etherscan.io/address/0x863df6bfa4469f3ead0be8f9f2aae51c91a907b4>

37 1 80 39 18 31

Whoops!

# What happened?

- Library contract with **uninitialized owner**
- Attacker took over the contract using the `initWallet()` function

```
// constructor - just pass on the owner array to the multiowned and
// the limit to daylimit
function initWallet(address[] _owners, uint _required, uint
_daylimit) only_uninitialized {
    initDaylimit(_daylimit);
    initMultiowned(_owners, _required);
}
```

- Then he killed the contract, thereby **freezing all wallets** that were dependent on this library

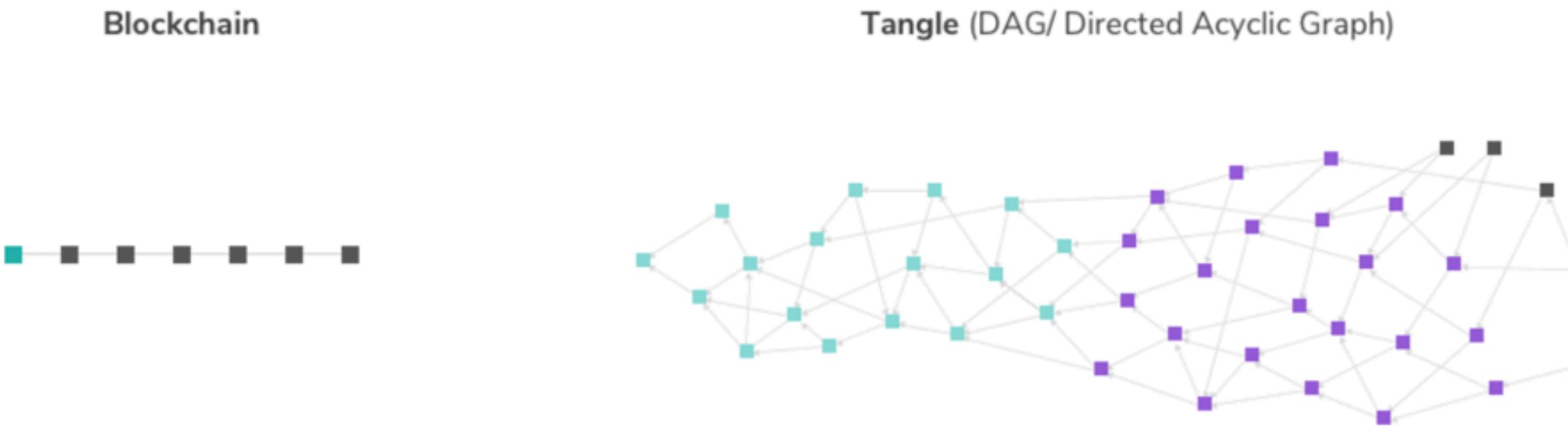
# Lessons and solutions

- Smart contracts are hard, embarrassing issue for Parity
- Issue actually in the patch of a previous security issue (!)

Following the fix for the [original multi-sig vulnerability](#) that had been exploited on 19th of July (function visibility), a new version of the Parity Wallet library contract was deployed on 20th of July.

Unfortunately, that code contained another vulnerability which was undiscovered at the time - it was possible to turn the Parity Wallet library contract into a regular multi-sig wallet and become an owner of it by calling the `initWallet` function. It is our current understanding that this vulnerability [was triggered](#) accidentally on 6th Nov 2017 02:33:47 PM +UTC and subsequently a user deleted the [library-turned-into-wallet](#), wiping out the library code which in turn rendered all multi-sig contracts unusable and funds frozen since their logic (any state-modifying function) was inside the library.

# 6. IOTA's hash function



IOTA = blockchain-less blockchain, using trinary rather than binary arithmetic, post-quantum signature, and... a custom hash function!

- ↪ **IOTA Vulnerability Report: Cryptanalysis of the Curl Hash Function Enabling Practical Signature Forgery Attacks on the IOTA Cryptocurrency**

By Ethan Heilman (Boston University, Paragon Foundation, Commonwealth Crypto), Neha Narula (MIT Media Lab), Thaddeus Dryja (MIT Media Lab, Lightning Network Dev), Madars Virza (MIT Media Lab, Zcash)

Team contact e-mail: [curl@mit.edu](mailto:curl@mit.edu)

# What happened?

- IOTA's transaction signatures are not standard public key signatures..
- But one-time hash-based signatures, using  $\text{key} = f(\text{seed}, \text{index})$ , with incremented index..
- Instead of using a standard hash function, IOTA initially used **a custom hash (curl)**...
- For which **collisions** were easy to find (i.e.  $M_1$  and  $M_2$  such that  $H(M_1) == H(M_2)$ )

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- For which **collisions** were easy to find (i.e.  $M_1$  and  $M_2$  such that  $H(M_1) == H(M_2)$ )
- But... exploitation not trivial because each key is used once.. still a security issue

# Lessons and solutions

- Crypto by non-cryptographers is often a disaster
- Innovating is good, but frankenstein experiments with \$Bs at stake can be scary, should be done responsibly
- PR disaster for IOTA, but token value didn't suffer much
- IOTA needs more analysis!

# 7. Bitgrail withdrawals



Tony Arcieri  
@bascule

Following

BitGrail lost \$170 million worth of Nano XRB tokens because... the checks for whether you had a sufficient balance to withdraw were only implemented as client-side JavaScript reddit.com/r/CryptoCurren ...

Anonymous (ID: [phc54n](#)) 02/10/18(Sat)22:27:38 No.7535244 > [75352400](#) >  
There was a bug, on the withdrawal page.  
But this check was only on java-script client side, you find the js which is sending the request, then you inspect element - console, and run the java-script manually, to send a request for withdrawal of a higher amount than in your balance.  
Bitgrail delivered this withdrawal.  
How many people did this? Who knows. This bug was later closed.  
There was another bug, you could request a withdrawal to your address - from another user id, from another user account. That would cause the other users balance to have "missing funds" or "negative balance".  
Bitgrail bomber solved this bug by manually entering the "correct" numbers in his database.  
This is what you get for using a PHP website coded by same skill-level as CFB of IDIOTA.

6:31 PM - 11 Feb 2018

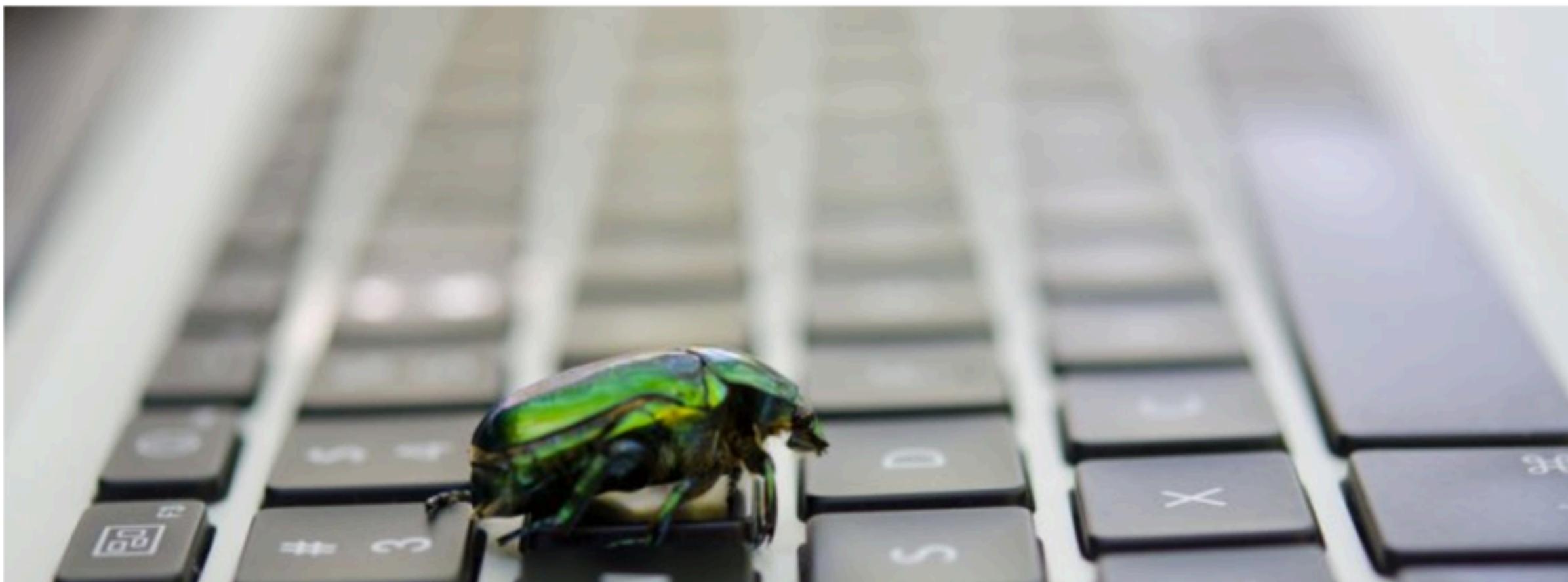
---

Reminder: client-side validation can't be trusted

# 8. BatchOverflow

ETHEREUM NEWS APRIL 25, 2018 14:42

**OKEx Suspends ERC20 Deposits on Discovery of Critical Ethereum Smart Contract Bug**



# What happened?

- Several alt coins added a “batch transfer” functionality to ERC20 contracts..
- Sends a same amount `_value` of tokens to a list of receivers:

```
255 function batchTransfer(address[] _receivers, uint256 _value) public whenNotPaused returns (bool) {
256     uint cnt = _receivers.length;
257     uint256 amount = uint256(cnt) * _value; // Line 257
258     require(cnt > 0 && cnt <= 20);
259     require(_value > 0 && balances[msg.sender] >= amount);
260
261     balances[msg.sender] = balances[msg.sender].sub(amount);
262     for (uint i = 0; i < cnt; i++) {
263         balances[_receivers[i]] = balances[_receivers[i]].add(_value);
264         Transfer(msg.sender, _receivers[i], _value);
265     }
266     return true;
267 }
268 }
```

- Integer overflow in total amount computation: attacker can set amount to a low (or even zero) value, passing the check line 259, yet sending high amount `_value` to receivers

# Lessons and solutions

- Beginner error in simple smart contract function
- Would have been spotted in 5min in a security audit

Dear valued customers,

We are suspending the deposits of all ERC-20 tokens due to the discovery of a new smart contract bug - "BatchOverFlow". By exploiting the bug, attackers can generate an extremely large amount of tokens, and deposit them into a normal address. This makes many of the ERC-20 tokens vulnerable to price manipulations of the attackers.

To protect public interest, we have decided to suspend the deposits of all ERC-20 tokens until the bug is fixed. Also, we have contacted the affected token teams to conduct investigation and take necessary measures to prevent the attack.

If you have already made a deposit request, your funds will arrive safely after our deposit service resumed. We apologize for any inconvenience caused.

Regards,

OKEx

Apr 25, 2018

# 9. Verge

## The Verge Hack, Explained

*Time Warps, Mining Exploits, Denial of Service, and More!*



Privacy as a *choice*.  
A secure and anonymous  
cryptocurrency.

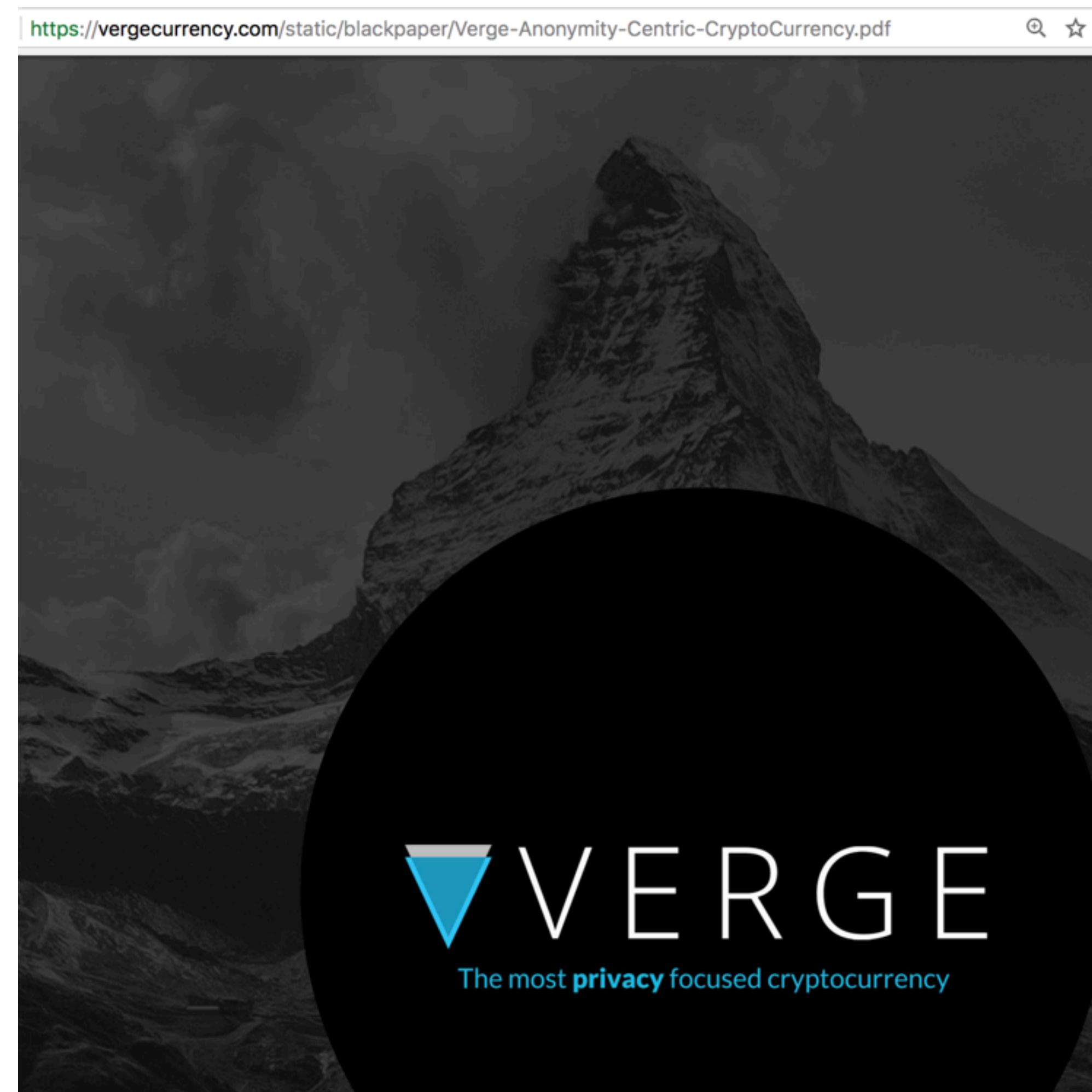
Built with a focus on privacy.

 OSX Tor QT Wallet

Get Started with Verge

Read the *Blackpaper* of Verge Currency

# 9. Verge



# What happened?

- Consensus protocol adapts the proof-of-work difficulty based on the number of blocks confirmed in the **last two hours**..
- Attacker kept sending blocks with spoofed (earlier) timestamps to fool the difficulty calculation algorithm..

be too difficult—let's make it easier!” Since timestamps were continuously being spoofed, the protocol continuously lowered the difficulty, until mining got laughably easy. To give a general idea, the average difficulty in the hours before the initial attack was 1393093.39131, while during the attack, it got as low as 0.00024414, a decrease in difficulty of over 99.99999%. Lower difficulty in submitting a block means more blocks get submitted— in this case, roughly a block every second.

- 
- Exploit facilitated by Verge’s (nonsensical) use of 5 hashing algorithms: attacker only lowered the difficulty for Scrypt, thereby only competing with Scrypt miners

# Lessons and solutions

- Complexity tends to bring insecurity
- Secure-sounding features (5 algorithms!) can backfire
- Consensus parameters depending on untrusted input is a recipe for disasters
- Many coins vulnerable to time manipulation (e.g. via forged NTP responses that could fool the OS)
- A black paper instead of a white paper doesn't help

# 10. BIP32 tools (pt. 1)

Derivation of BIP32 accounts (key pair, address)  
from a seed and a path  
<https://github.com/prusnak/bip32utils> (Python)

```
$ bip32gen
usage: bip32gen [-h] [-x] [-X] -i {entropy,xprv,xpub} [-n AMOUNT]
                  [-f FROM_FILE] [-F TO_FILE] -o OUTPUT_TYPE [-v] [-d]
                  chain [chain ...]
bip32gen: error: the following arguments are required:
-i/--input-type, -o/--output-type, chain
```

# What happened?

Generate an address from a 32-byte seed:

```
$ echo bc0ef283f57fd5e4f36657053228eae8d2d5b0e4d87c6ee069a9cade39411d63 |  
bip32gen -x -i entropy -o addr m  
1Jzuo5xm62i8gFQLQb58f2F5a7nTK3o8bD
```

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Generate an address from the 16-byte truncated seed:

```
$ echo bc0ef283f57fd5e4f36657053228eaе8 | bip32gen -x -i entropy -o addr m  
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**WTF?!**

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```

**WTF?!**

- Length of the seed is a parameter `-n AMOUNT`, default to 16 bytes
- Longer seeds will be silently truncated to 16 bytes without warning/error
- Did a PR to fix this, now merged..

# Lessons and solutions

- Don't use any open-source utility in production!
- Node/JS dependency trees can hide insecure||deprecated code, not always reported by tools like nsp or npm-dview
- A crypto API should default to the most secure behavior, be “misuse resistant” / fail-safe

# Conclusions

- Many more bugs to be found
- Usual suspects: complex logic, unsafe language, rushed deployment, lack of testing, third-party dependencies

# Conclusions

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- Usual suspects: complex logic, unsafe language, rushed deployment, lack of testing, third-party dependencies
- Recent example: EOS

Some of the groundbreaking features of EOSIO include:

1. Free Rate Limited Transactions
2. Low Latency Block confirmation (0.5 seconds)
3. Low-overhead Byzantine Fault Tolerant Finality
4. Designed for optional high-overhead, low-latency BFT finality
5. Smart contract platform powered by Web Assembly
6. Designed for Sparse Header Light Client Validation
7. Scheduled Recurring Transactions
8. Time Delay Security
9. Hierarchical Role Based Permissions
10. Support for Biometric Hardware Secured Keys (e.g. Apple Secure Enclave)
11. Designed for Parallel Execution of Context Free Validation Logic
12. Designed for Inter Blockchain Communication

<a href="#">authorization_manager.cpp</a>	Update FC_ASSERT for abi_generator and abi_serializer
<a href="#">block_header.cpp</a>	move id() from signed_block_header to block_header
<a href="#">block_header_state.cpp</a>	Remove the redundant signature recovery and block digest when applyin...
<a href="#">block_log.cpp</a>	Update FC_ASSERT for abi_generator and abi_serializer
<a href="#">block_state.cpp</a>	Fix eosio.system abi & skip sig checks
<a href="#">chain_config.cpp</a>	action setparams added to system contract, unit-test of producers cha...
<a href="#">chain_id_type.cpp</a>	Update FC_ASSERT for abi_generator and abi_serializer
<a href="#">controller.cpp</a>	Fix unchecked unapplied transaction growth on relays
<a href="#">eosio_contract.cpp</a>	Update FC_ASSERT for abi_generator and abi_serializer
<a href="#">eosio_contract_abi.cpp</a>	Add common_type_defs for abi_generator to use
<a href="#">fork_database.cpp</a>	Merge pull request #4566 from spartucus/patch-1

## 360 Security found critical bug of EOS, Dawn might be postponed(Updated)

MAY 29, 2018, 14:17 by RED LI in TECHNOLOGY

17926 3 4

The 360 Vulcan team discovered a series of critical vulnerabilities in EOS, which is about to launch its mainnet on 2nd June. It has been verified that some of these vulnerabili-

## PSA: Major EOS bug makes it possible to steal valuable resources directly from users

RAM can be siphoned from users and dApps alike

## Hacker exploits EOS betting platform to ‘win’ jackpot 24 times in a row

EOS gambling dApps are being picked apart



Jon Bottarini @jon\_bottarini · Jun 5, 2018



How to make \$80k in one day: Blockchain bugs. Congrats @GuidoVranken and best of luck on your future bugs! #bugbounty @Hacker0x01 Find bugs on @eos\_io and get rewarded on HackerOne! [hackerone.com/eosio](https://hackerone.com/eosio) #EOS pic.twitter.com/ZHrr6ifoKV

### Hacker Activity

Rank	Impact	Signal	Percentile
4.15	87th	Signal	Percentile
11.40	76th	Impact	Percentile
1603	-	Reputation	Rank
<b>Credits</b>			
93	Bugs found		
32	Thanks received		
<a href="#">All Thanks</a>			
<b>Recent Badges</b>			
	Belle of the Ball		
	Greybeard		
	Skills		



Guido Vranken  
@GuidoVranken

Thank you. A couple more waiting to be rewarded. I think the final tally was \$120K but I lost count. Took me about a week.

1:37 AM - Jun 5, 2018

136 30 people are talking about this



# Conclusions

- Many more bugs to be found
- Usual suspects: complex logic, unsafe language, rushed deployment, lack of testing, third-party dependencies
- Recent example: EOS
- Security audits help, but won't find all the bugs
- Nice way to make money for bug hunters :-)

# Thank you!

<https://kudelskisecurity.com>

<https://aumasson.jp>

@veorq