A.D. 1308
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UNIVERSITÀ DEGLI STUDI
DI PERUGIA

Politecnico
di Bari

5th Distributed Ledger Technology Workshop (DLT 2023)
Bologna, Italy | 25-26 May 2023

Towards a quantum-safe transaction signature in Ethereum

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Our proposal

- Interface implementation of an Ethereum node for supporting different signature methods.
- Post-quantum resistant Blockchain
- No fork needed

Background

- Blockchain systems depend heavily on cryptographic methods to ensure security, protect user privacy, and enhance system performance.

- Blockchain uses wallets with key-pairs for authentication and signing processes.
  - Private key: sign transactions
  - Public key: verify transactions

- The development of quantum computing prompts growing worries on the chain security.

State of the art

- Several related work in literature.
  - Secure cryptocurrency scheme[1].
  - Quantum key distribution[2].
  - Management of cryptographic primitives in smart contracts[3].
- Introducing new features and applying fixes to a Blockchain cause forks in the chain.
- Proposal: development of an interface to support different signature methods in an Ethereum client.

[1] Yulong Gao, et al. A Secure Cryptocurrency Scheme Based on Post-Quantum Blockchain. *IEEE Access* (2018).

[2] Evgeniy O, et al. Quantum-secured blockchain. *CoRR* (2017).

[3] Riccardo Longo, et al. Adaptable Cryptographic Primitives in Blockchains via Smart Contracts. *Cryptography* (2022).

Post-quantum algorithms

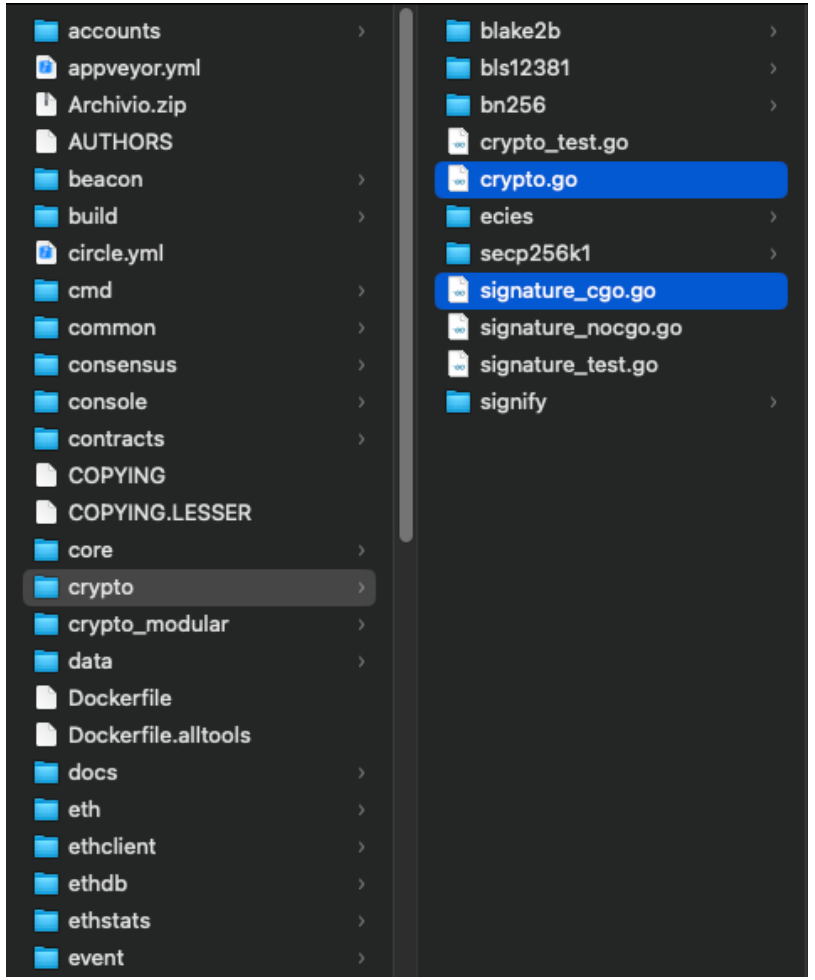
- Key-pair generation: generation of a user's private key starting from his public key.
- Transaction signature: generation of a user's private key starting from the signature of a transaction.
- Block hashes: writing new data in a block, rebuilding the chain.

Post-quantum algorithms

- Key-pair generation: a post-quantum algorithm can quickly generate a user's private key starting from his public key.
- Transaction signature: a post-quantum algorithm can quickly generate a user's private key starting from the signature of a transaction.
- Block hashes: a post-quantum algorithm can be used by an attacker to break the hash linking between blocks, writing new data in a block and quickly rebuilding the entire chain.

Changes in GO code

- Geth implementation – v1.11.0.
- Support multiple signature algorithms.
- *crypto.go* and *signature_cgo.go* files.



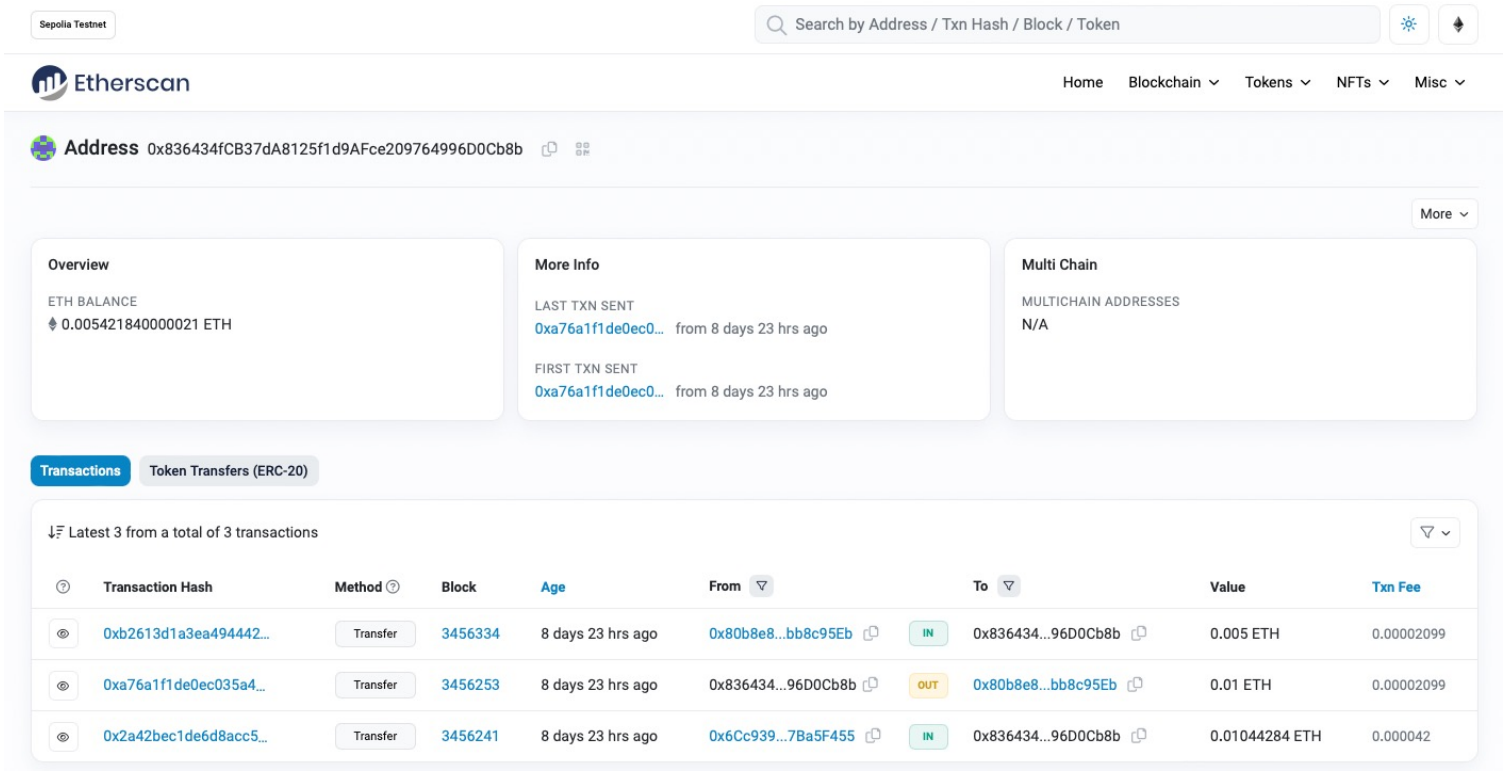
Changes in GO code

- We create *crypto_ecdsa*.go and *signature_cgo_ecdsa.go*.
- Constraint: ECDSA-compliant algorithm required.
- Example: generation of a key-pair using the interface.

```go
/* Generation of a key-pair using an interface
*/
func GenerateKey() (*privateKey, error) {
    switch actualAlgorithm {
    case "ECDSA":
        return crypto_ecdsa.GenerateKey()
    case "SPHINCS":
        return crypto_sphincs.GenerateKey()
    case "OTHER":
        return crypto_other.GenerateKey()
    default:
        return error("Unknown algorithm")
    }
}
```

Validation

- A node has been run and tested using the interface.
- Connection to Ethereum mainnet and transaction submission in Sepolia testnet.



Conclusion

- Interface implementation of an Ethereum node for supporting different signature methods.
- Post-quantum resistant Blockchain.
- Future work: extension of the interface to support algorithms with a different structure than ECDSA.

Thank you for your attention

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