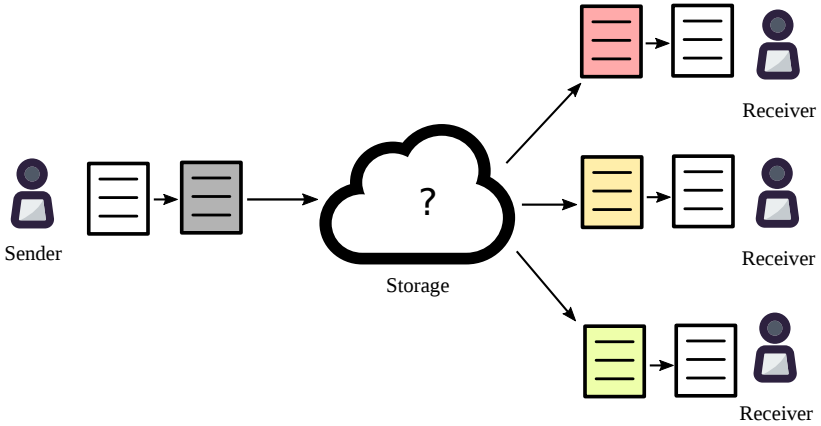
NuCypher

Michael Egorov, CTO of NuCypher

Big blockchain is watching you, 28 June 2018

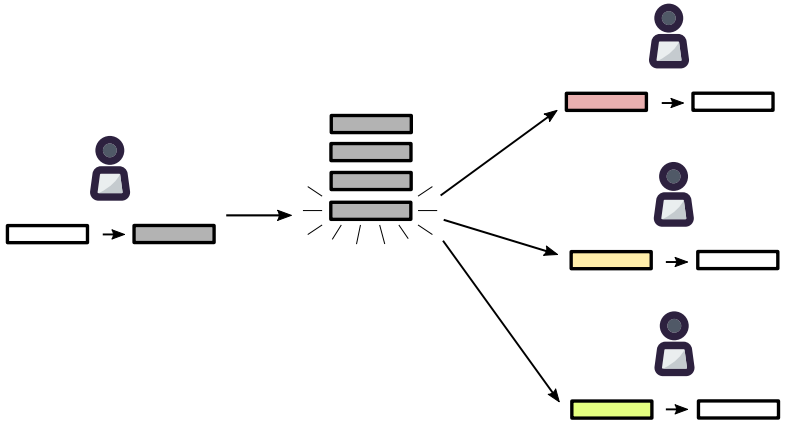
Why

Encrypted file sharing



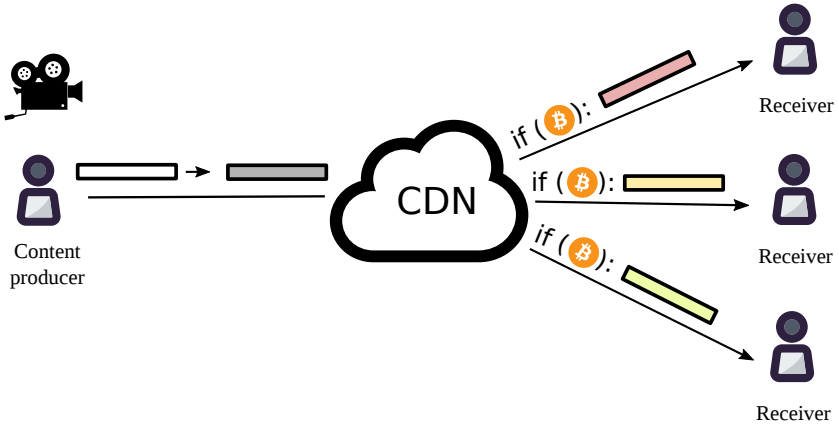
Why

Encrypted multi-user chats



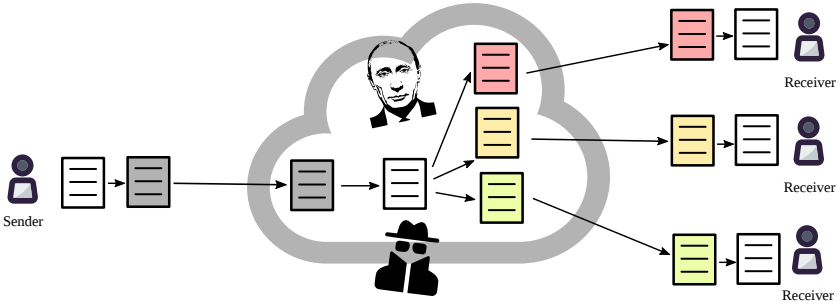
Why

Decentralized Netflix



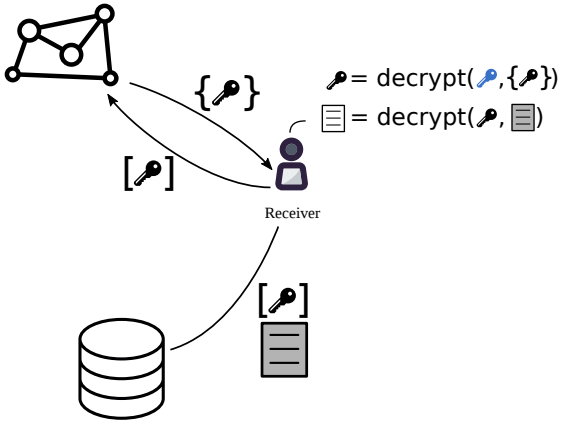
Central server + TLS

Data vulnerable to hackers, state actors etc

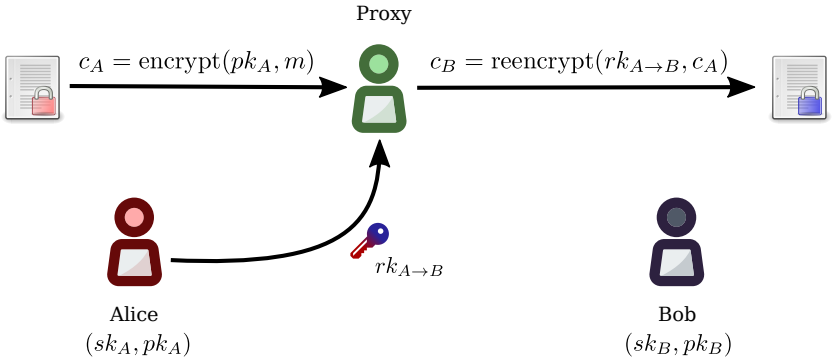


Solution

Proxy re-encryption + decentralization

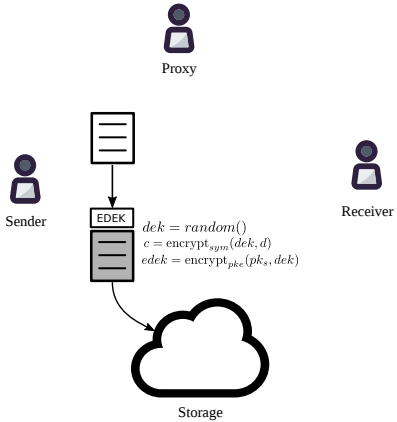


What is proxy re-encryption (PRE)



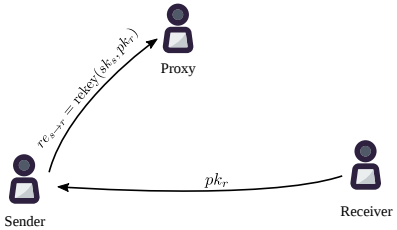
Centralized KMS using PRE

Encryption



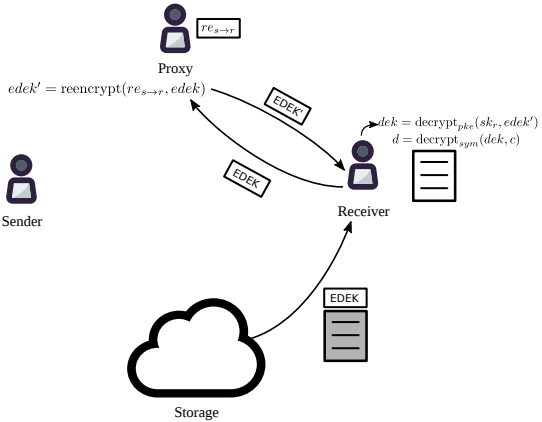
Centralized KMS using PRE

Access delegation



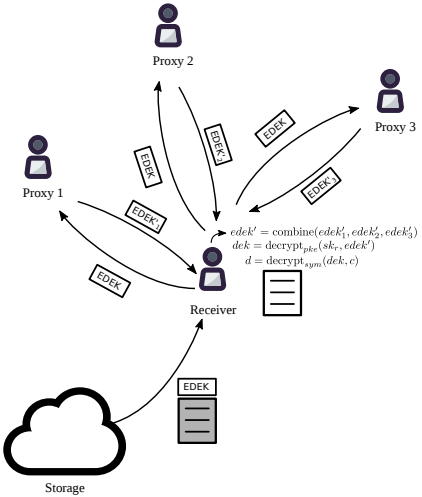
Centralized KMS using PRE

Decryption



Decentralized key management

Using threshold split-key re-encryption (Umbral)



https://github.com/nucypher/nucypher-kms/

Umbral: threshold proxy re-encryption

- “Umbral” is Spanish for “threshold”
- PRE properties: Unidirectional, single-hop, non-interactive
- It follows a KEM/DEM approach:
  - UmbralKEM provides the threshold re-encryption capability
  - Encryption is ECIES with extra things for proof of correctness, on curve secp256k1
  - The DEM can be any authenticated encryption (currently ChaCha20-Poly1305)
- IND-PRE-CCA security
- Verification of re-encryption correctness through Non-Interactive ZK Proofs
- Code: `https://github.com/nucypher/pyUmbral/`
- Documentation (WIP): `https://github.com/nucypher/umbral-doc`

PRE demo

Demo network: `https://github.com/nucypher/mock-net/`

NU token

Purpose

- Splitting trust between re-encryption nodes (more tokens = more trust and more work);
- Proof of Stake for minting new coins according to the mining schedule;
- Security deposit to be at stake against malicious behavior of nodes

NU token

Mining

Mining reward:

$$\kappa = \left(0.5 + 0.5\frac{\min(T_i, T_1)}{T_1}\right) \quad (1)$$

$$T_{i,initial} \geq T_{min}, \quad (2)$$

$$\delta s_{i,t} = \kappa \frac{l_i}{\sum l_j} \frac{\ln 2}{T_{1/2}} \left(S_{max} - S_{t-1}\right). \quad (3)$$

(4)

Results into:

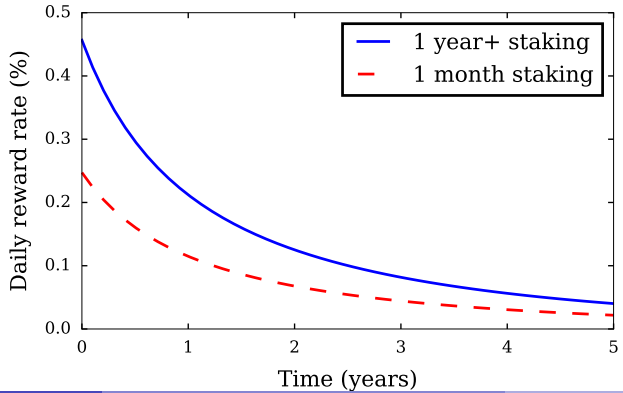
$$\text{reward} \propto 2^{\frac{t}{T_{1/2}}}$$

NU token

Graph of daily mining compensation

$$\mathsf{reward_i} = \kappa_\mathsf{i} \cdot \mathsf{reward}_0, \qquad \kappa^* = \langle \kappa_\mathsf{i} \rangle \,, \qquad \lambda = \frac{\mathsf{S_{locked}}}{\mathsf{S}}; \tag{5}$$

$$\mathsf{T}^*_{1/2} = \mathsf{T}_{1/2}/\kappa^*. \tag{6}$$

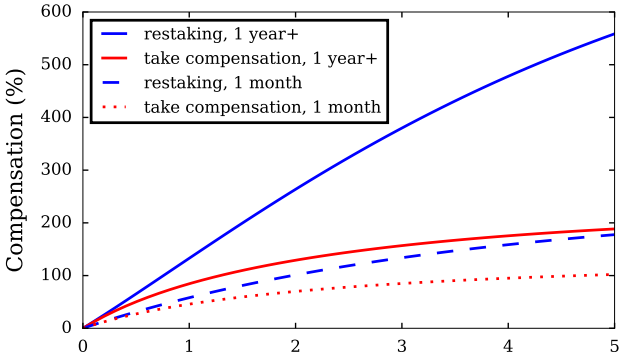


NU token

Relocking mining rewards

$$\frac{c_{dump}}{stake} = \frac{\kappa}{\kappa^* \lambda} \ln \frac{S(t)}{S_0}; \tag{7}$$

$$\frac{c_{hodl}}{stake} = \left[\frac{S(t)}{S_0}\right]^{\frac{\kappa}{\kappa^* \lambda}}; \tag{8}$$



Usage examples

Decentralized marketplaces:

- Datum;
- Origin protocol;
- The Seam;
- SwipeCrypto.

Decentralized databases:

- Bluzelle;
- Fluence;
- Wolk.

Medical data sharing

- Medibloc;
- IRYO;
- Medixain;
- Wholesome;
- Medcredits;
- HealthCombix / PointNurse;
- Genobank;
- iku.network.

IoT

- Spherity (together with BigchainDB);
- Carblock.io;
- XAIN.

Cryptocurrency keys

- Coval Emblem Vault.

Useful links

Website: `https://nucypher.com`
Github: `https://github.com/nucypher/`
PyUmbral on Github: `https://github.com/nucypher/pyUmbral/`
Mochnet: `https://github.com/nucypher/mock-net/`
Discord: `https://discord.gg/7rmXa3S`
Whitepaper: `https://arxiv.org/abs/1707.06140`
E-mail: `michael@nucypher.com`
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