

# NuCypher

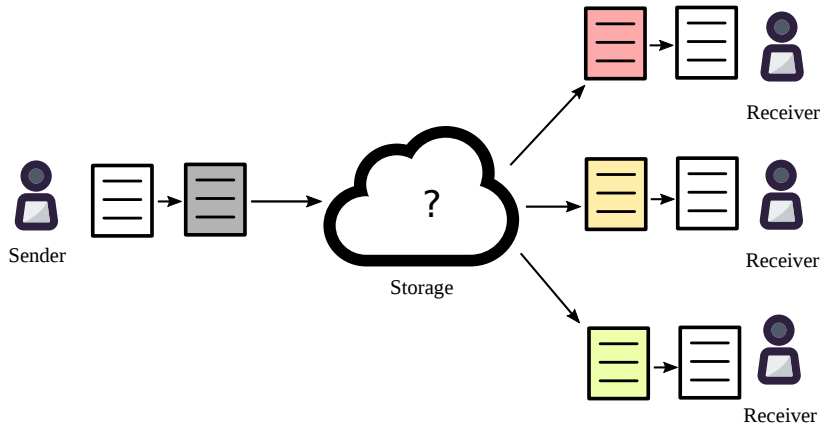
Michael Egorov, CTO of NuCypher

Big blockchain is watching you, 28 June 2018



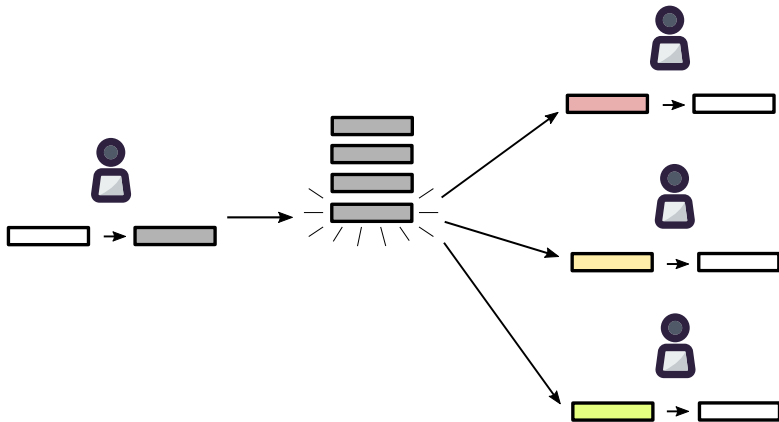
# Why

## Encrypted file sharing



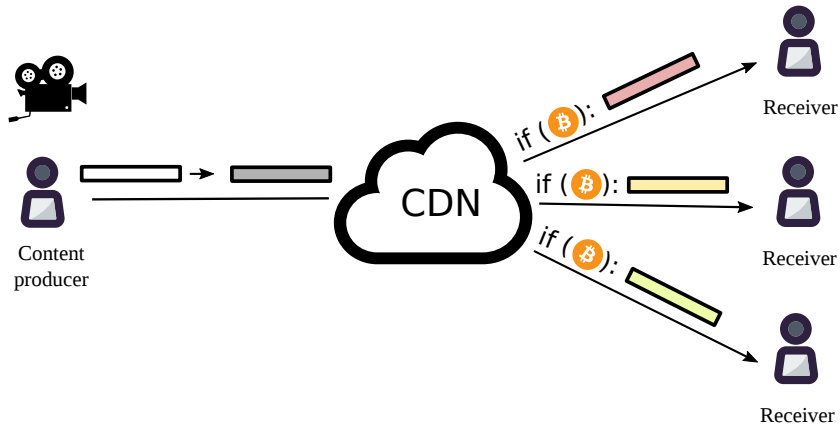
# Why

## Encrypted multi-user chats



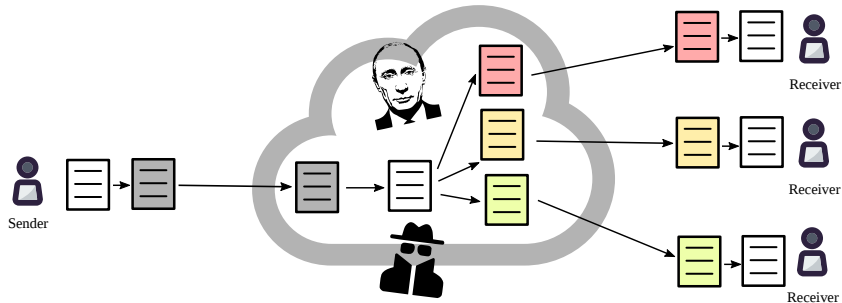
# Why

## Decentralized Netflix



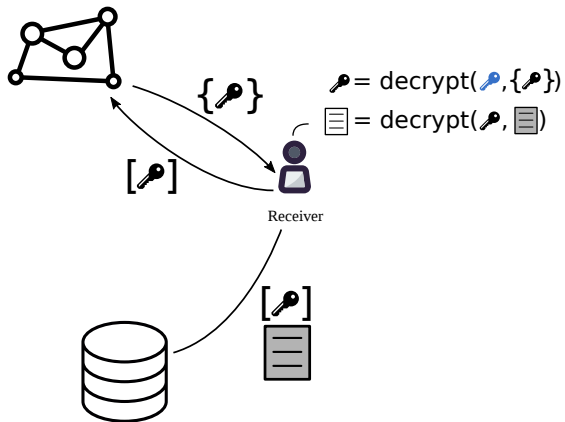
# Central server + TLS

Data vulnerable to hackers, state actors etc

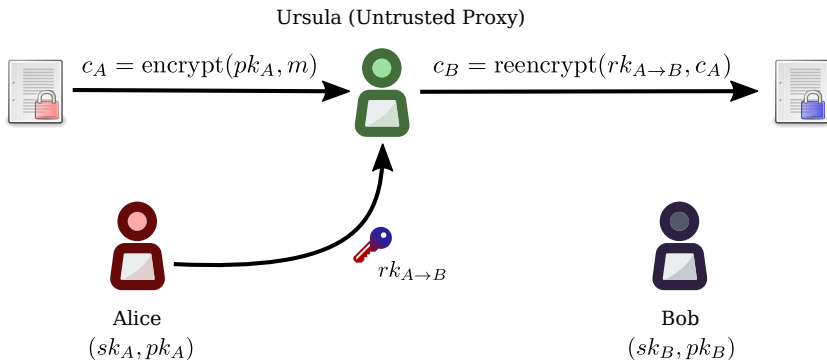


# Solution

## Proxy re-encryption + decentralization

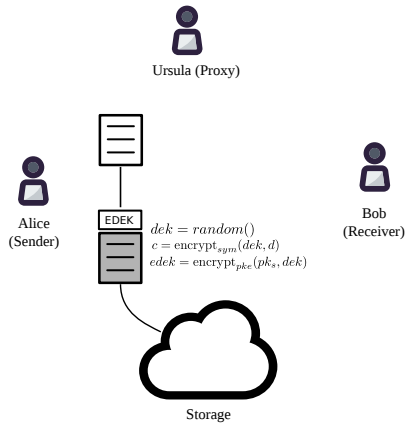


# What is proxy re-encryption (PRE)



# Centralized KMS using PRE

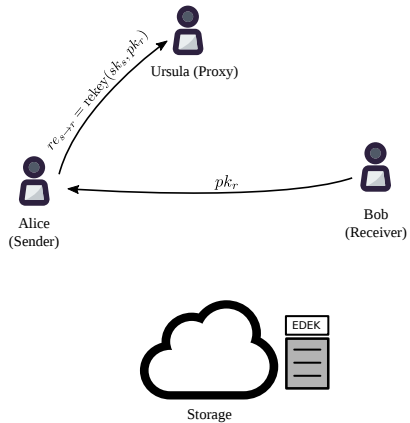
## Encryption





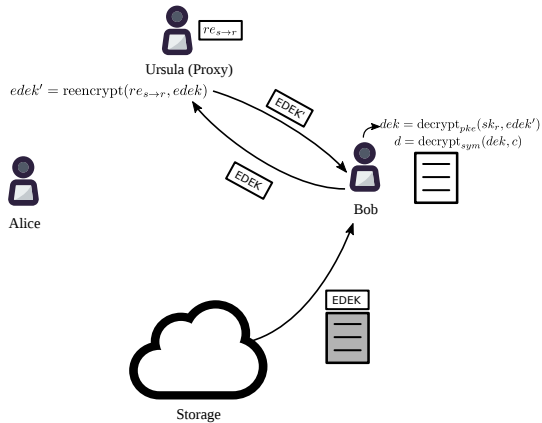
# Centralized KMS using PRE

## Access delegation



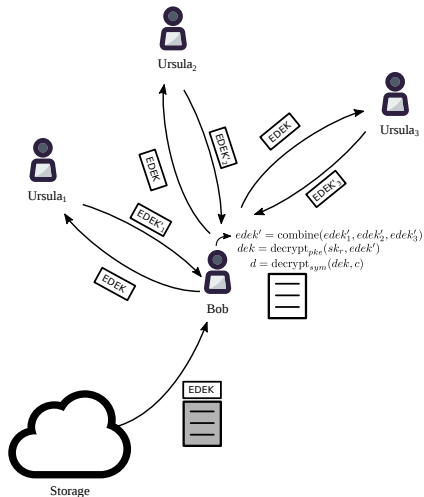
# Centralized KMS using PRE

## Decryption



# Decentralized key management

Using threshold split-key re-encryption (Umbral)

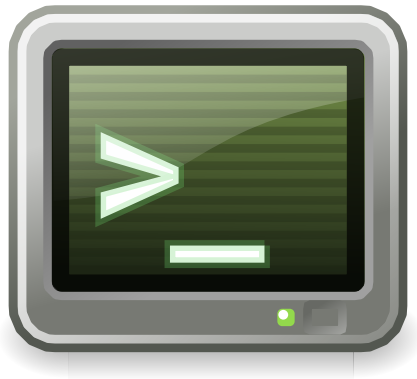


<https://github.com/nucypher/nucypher-kms/>

# 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:

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

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

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

$$(4)$$

Results into:

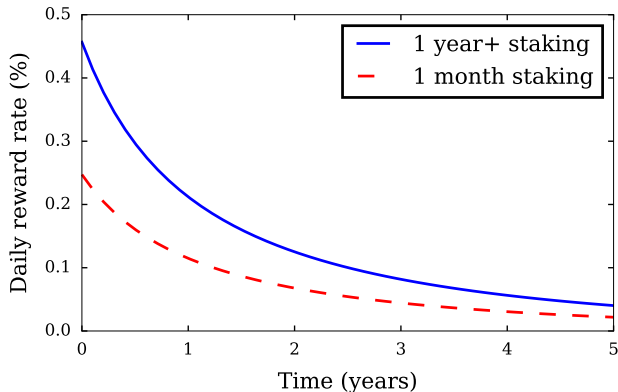
$$\text{reward} \propto 2^{\frac{t}{T_{1/2}}}$$

# NU token

## Graph of daily mining compensation

$$\text{reward}_i = \kappa_i \cdot \text{reward}_0, \quad \kappa^* = \langle \kappa_i \rangle, \quad \lambda = \frac{S_{\text{locked}}}{S}; \quad (5)$$

$$T_{1/2}^* = T_{1/2} / \kappa^*. \quad (6)$$



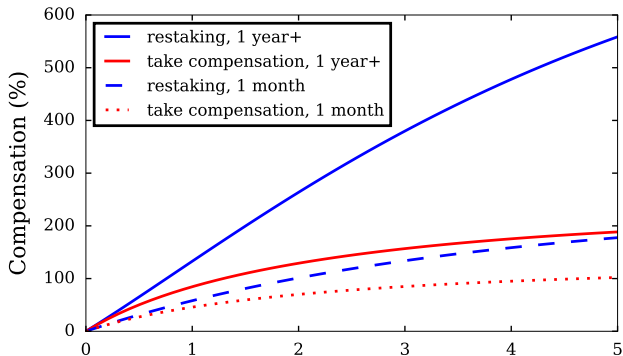


# NU token

## Relocking mining rewards

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

$$\frac{C_{\text{hodi}}}{\text{stake}} = \left[ \frac{S(t)}{S_0} \right]^{\frac{\kappa}{\kappa^* \lambda}}; \quad (8)$$



# 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>

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