OpenCoin

a protocol for privacy preserving electronic cash payments

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This version of the protocol build on previous work by the following authors:

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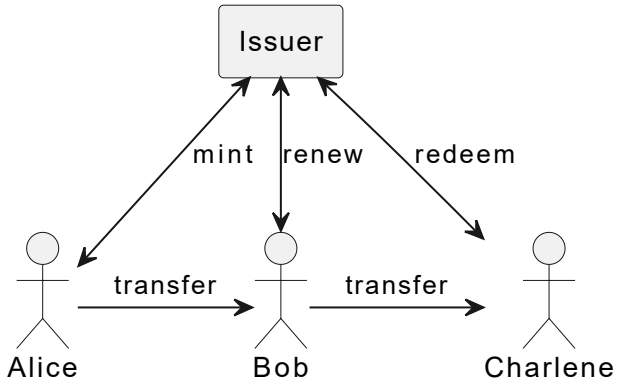
For more information go to **https://opencoin.org**

Intro

We propose a protocol that allows cash-like payments in the electronic world. It is based on the invention by David Chaum [1]. The main focus are *untraceable* payments, which means that even though there is a central entity (called the issuer, something like a bank), this central entity can't see the transactions happening. This is good for the privacy of the users.

The focus of the project is the protocol. This means we standardize the way we exchange messages and their content in order to make electronic cash payments. But we don't deliver an implementation here. That is the scope of other project(s). OpenCoin is the foundation to build upon.

How does it work?



This is a high level (but strongly simplified) image describing the basic system. We have three participants: Alice and Bob are normal users, while the Issuer is something like a bank, capable of minting coins. It also acts as an exchange for 'real-world' currency. At this high level it works as follows:

1. Alice asks the Issuer to **mint** coins. This is done in a special way using *blind signatures*, which means that the coins *can't be linked to her* later on.
2. Alice then **transfers** the coins to Bob. She can do that any way she wants, e.g. using WhatsApp, Email or any other system of her choice (also depending on what her client software supports). This could even be done by printing the coins and handing them over.
3. Bob then **renews** the coins. He swaps the coins he got from Alice for fresh coins. This way he protects himself against Alice "accidentally" using the coins

somewhere else. One can spend opencoins only once, so *double spending* needs to be ruled out, and this is done by immediately renewing received coins.
4. Bob might **transfer** the coins to yet another person, Charlene
5. Charlene decides to **redeem** the coins, meaning she asks the issuer to swap the opencoins for real-world money.

On **blind signatures**: at the core a coin is a serial number with a signature from the mint. In order to ensure that *a coin can't be traced back to the original client* we use blind signatures.
Imagine Bob hands in a coin that Alice had minted. In order to ensure the coin can't be traced back to Alice, the issuer has to sign the serial number without seeing it. In non-technical terms Alice puts the serial number in an envelope (along with carbon copy paper), and the issuer actually signs the envelope. Because of the carbon copy paper the signature presses through onto the serial number. Alice can then open up the envelope and has a signed serial, without the issuer ever seeing it.

Who is it for?

OpenCoin (the protocol) allows the development of applications for electronic cash. So firstly OpenCoin is targeted at developers. These applications however should allow everyone to make and receive electronic payments. It still requires somebody to run the central issuer. This issuer would issue an OpenCoin based electronic money system. Because electronic money is quite regulated in Europe (and other countries), the issuer would be most likely a regulated electronic money provider or a bank. We think, that a central bank would be the best issuer, because central banks issue money anyhow. But nothing technical stops you from using OpenCoin for your private project [2].

Alternatives

Why don't just use one of the alternatives?

Bitcoin / blockchain

Bitcoin (or blockchain in the more general form) is basically the opposite of OpenCoin: transfers have to happen within the system, they are visible to everybody, there is no central instance, there is no guaranteed value you can redeem the bitcoins for.

OpenCoin on the contrary makes the transfers invisible and untraceable, and has a central instance that is able to guarantee a value if you redeem the OpenCoin.

One could say that bitcoin behaves more like gold, while OpenCoin behaves more like cash.

GNU Taler

GNU Taler is build around the same central idea as OpenCoin. It started later, and is more complete than OpenCoin. They differ in the way the take care of the renewal step and coin splitting. They also make more assumptions regarding the clients (e.g. clients having key identifying them), they have clearer roles (e.g. consumer and merchant) and by all of this hope to get around the inherent problems of untraceable transfers, e.g. taxability.

The trade-off seems to be that their system is harder is more complex and harder to understand. We also doubt that this complexities are necessary to reach the stated goals. We also doubt that the goals can really be reached, and also find that the systems documentation is quite hard to understand. This might be because they deliver implementations for all necessary software components, and are not really targeted at other implementations of they system.

Because of all this one could say that GNU Taler is less open to other developers.

Problems

- Tax
- Money laundering
- Blackmail and other crime

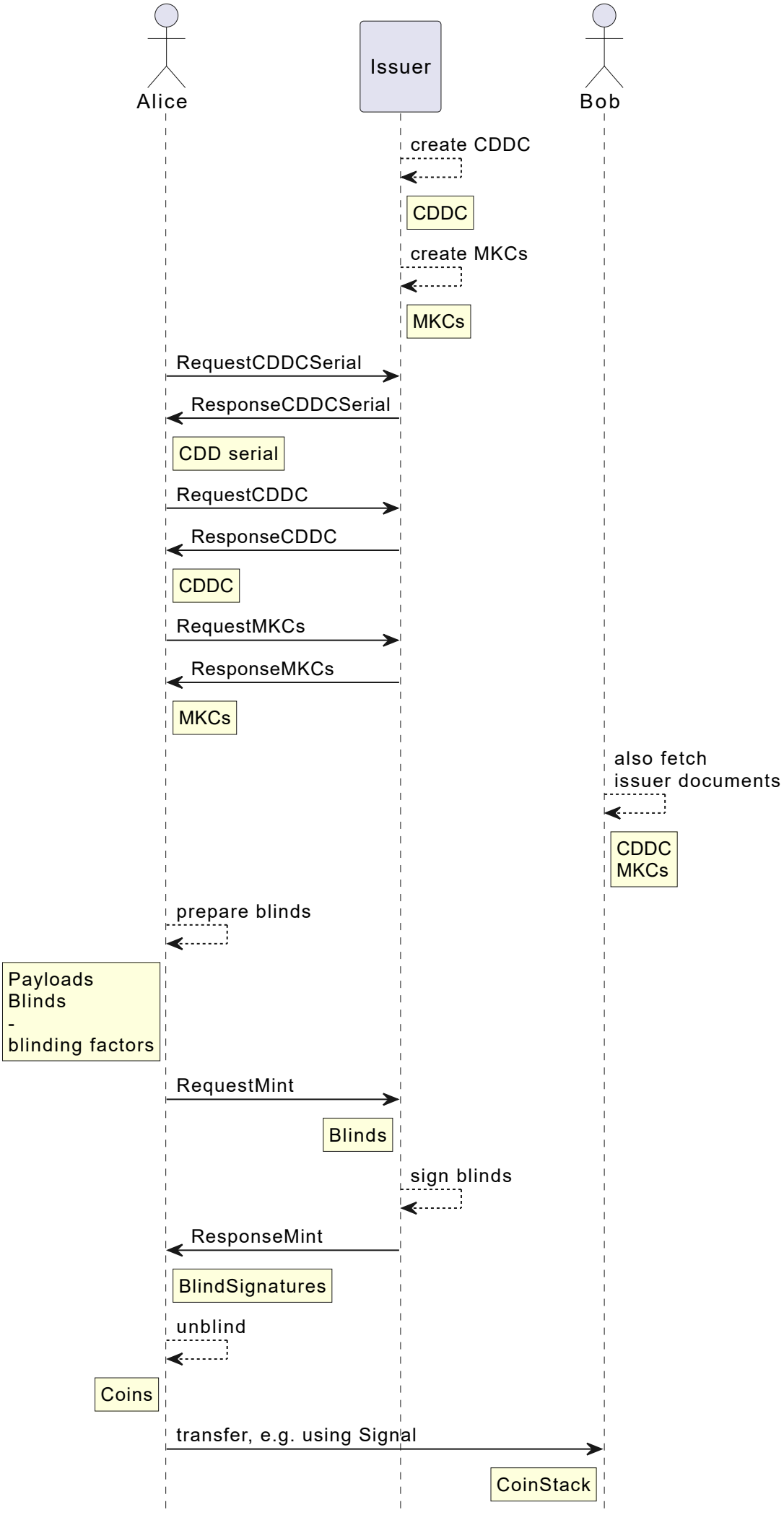
The OpenCoin protocol

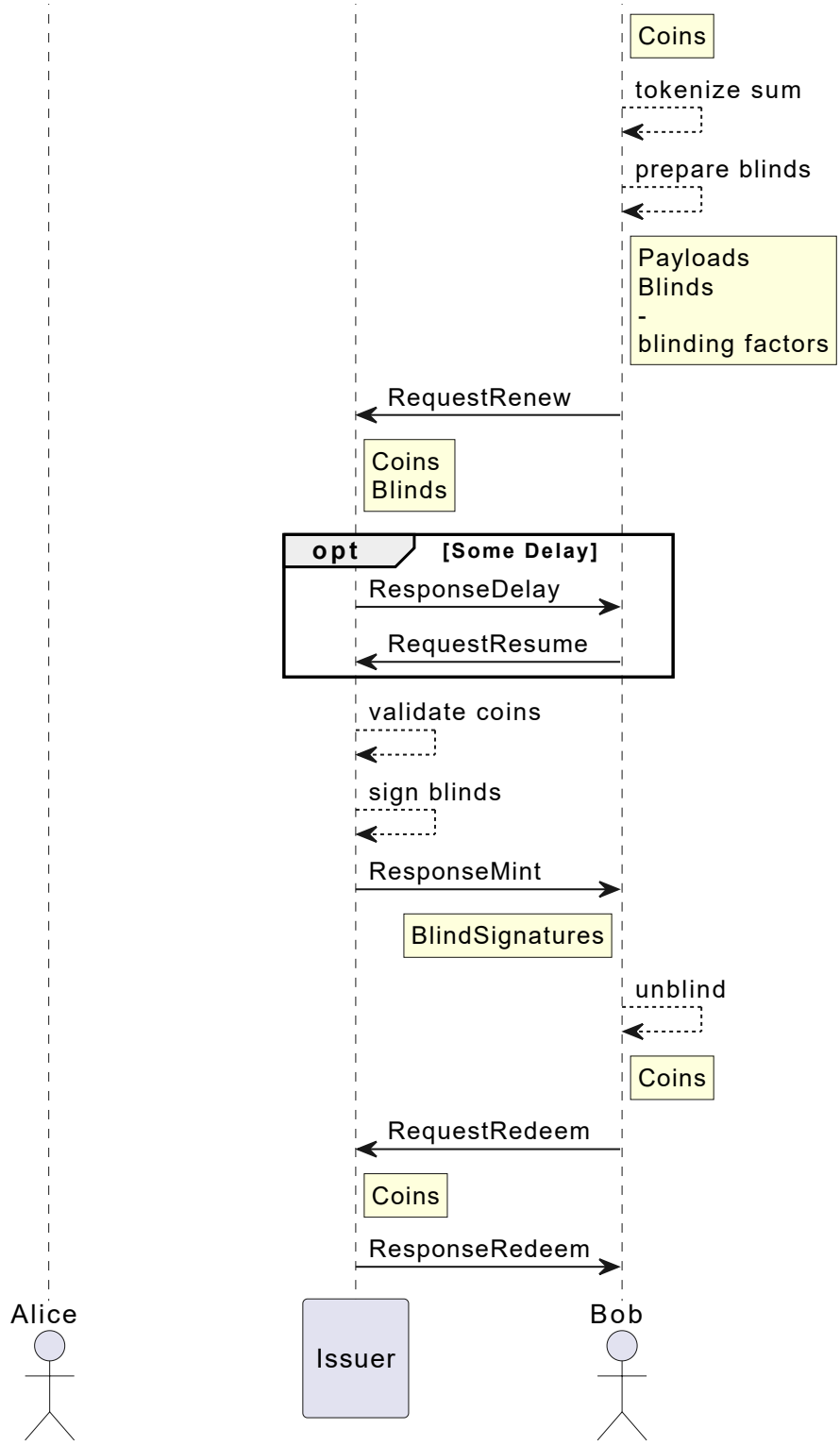
Assumptions

The exchange of messages MUST happen over a **secure channel**. For HTTPS this means TLS, but other channels like messengers provide their own. For an email exchange GPG would be recommended. Either way, it is the responsibility of the developer to take care of the transport security.

When requesting the issuer to mint or redeem coins some form of **authentication & authorization** is most likely required - the issuer needs to secure payment for the coins, or make a payment somewhere for redeemed coins. Because auth* might already be provided by the transport layer, we don't include it in the OpenCoin protocol.

Overview


Alice
Issuer
Bob
create CDDC
CDDC
create MKCs
MKCs
RequestCDDCSerial
ResponseCDDCSerial
CDD serial
RequestCDDC
ResponseCDDC
CDDC
RequestMKCs
ResponseMKCs
MKCs
also fetch
issuer documents
CDDC
MKCs
prepare blinds
Payloads
Blinds
-
blinding factors
RequestMint
Blinds
sign blinds
ResponseMint
BlindSignatures
unblind
Coins
transfer, e.g. using Signal
CoinStack



Description

This is a high level description of the actual steps, details follow in the chapters in Details.

Participants

Issuer can mint, refresh and redeem coins. This entity will probably an account handling system (a.k.a bank) behind it for doing actual real-world payments. The issuer is trusted to handle coins and payments correctly, but is *not trusted* in regards of privacy - the target of OpenCoin is to protect the privacy of the transfers.

Alice and **Bob** are clients using OpenCoin. Technically they are software clients, and they represent the *users* of the system.[3] They need to be known by the customer in order to mint or redeem coins. Authentication could be required to renew coin. This would allow a "closed" system, in which accounts of the users could be monitored.

Steps in the protocol

create CDDC

The issuer creates a pair of cryptographic keys (the currency keys), and signs a *Currency Description Document Certificate* (**CDDC**) with its secret key. This contains information about the currency, like denominations, urls but also the public key. This is the top document which establishes the trust in all other elements.

Not mentioned in the CDDC but probably somewhere on the issuer website is the relation between opencoins and actual real-world money. Let's say the currency of an example issuer is called "opencent". The rule might be that one opencent is given out for one EUR cent, and redeemed for one EUR cent, effectively binding the opencent to the EUR.

create MKCs

For each denomination in the currency separate minting keys are generated, and a *Mint Key Certificate* (**MKC**) for them as well. Those MKCs are signed the secret currency key. The mint keys are only valid for a defined period of time.[4]

RequestCDDCSerial

This message asks for the current serial number of the CDDC. The currency description could change over time, maybe because urls have changed. Every time a new CDDC is created, with a new, increasing serial number. The clients need to make sure to always use the most current CDDC, but they can cache it, allowing them to skip the next step.

ResponseCDDCSerial

This message contains the **CDDC serial**.

RequestCDDC

This message asks for a CDDC. If no serial is provided, the message asks for the most current CDDC.

ResponseCDDC

This message contains the **CDDC**

RequestMKCs

With this message the client asks for the *Mint Key Certificates*. The client can specify specific denominations or *mint key ids*. An unspecified request will return all current MKCs.

ResponseMKCs

This reply contains the **MKCs**

prepare blinds

This step prepares a coin. In essence this is a **payload** with a serial number, which is later on signed by the issuer using a denomination specific mint key. The "envelope" mentioned above really means that the serial is blinded using a separate random secret **blinding factor** for each serial number. This factor is needed later on to "open up the envelope", reversing the blinding operation. Hence the client has to store the blinding factor for later on. As the blinding factor is individual for each serial number, a reference number is created to reference serial, blinding factor and blind.

The **blinds** contains the reference, the blind to be signed, and the mint key id for the denomination or value of the coin.

RequestMint

This message hands in the **blinds** created in the step before, asking for the blind to be signed.

Most likely the issuer has authenticated the client. The mint key id tells the issuer what denomination to use for the signing operation. This will allow the issuer to deduct a payment for the minting operation (outside OpenCoin).

The message also carries a transaction_reference (a random number), in case there is a delay in the minting process. The client can then later on ask again for the signatures to be delivered using the same transaction_reference.

sign blinds

The issuer uses the secret minting key for the desired operation to sign the blind, creating the **blind signatures**.

ResponseMint

This message contains the **blind signatures** for the blinds.

unblind

The client will unblind the signature using the before stored secret blinding factor. This gives the client the signature for the serial number, and both together give the **coin**.

CoinStack

When sending coins multiple coins can be combined into a **CoinStack**. This CoinStack can also have a "subject", maybe containing an order reference - the reason the CoinStack is handed over in the first place.

The transfer of the CoinStack is out of scope of the OpenCoin protocol. We imagine multiple ways: using a messenger like Signal, using email or using the Browser. A CoinStack can also be encoded using a QR code, and maybe printed out and sent using normal postal mail.

Anyhow, the point of this step is that Alice transfers a CoinStack to Bob. And because she is a fair user, she will delete all coins that were contained in the CoinStack on her side.

tokenize sum

prepare blinds

RequestRenew

ResponseDelay

RequestResume

validate coins

RequestRedeem

ResponseRedeem

Details

Cryptographic operations

- hashes
- signatures

Building blocks

Elements of messages, but never used standalone

RSA Public Key

Description

- **modulus**:
- **public_exponent**:
- **type**:

Example

```
{
  "modulus":
"8004826974ed9eecc9261c6a695cd3f1bd33710ef3ba1ca8fbb1425d20f305020e7c80
904d6d6e8a4358bf926f920e6167c2c780d9f34db6abe06a51c8ff2571",
  "public_exponent": 65537,
  "type": "rsa public key"
}
```

Source

CDDC

Description

- **cdd**:
    - **additional_info**:
    - **cdd_expiry_date**:
    - **cdd_location**:
    - **cdd_serial**:
    - **cdd_signing_date**:
    - **currency_divisor**:
    - **currency_name**:
    - **denominations**:
    - **id**:
    - **info_service**:
    - **invalidation_service**:
    - **issuer_cipher_suite**:
    - **issuer_public_master_key**:
    - **protocol_version**:
    - **renewal_service**:
    - **type**:
    - **validation_service**:
- **signature**:
- **type**:

Example

```
{
  "cdd": {
    "additional_info": "",
    "cdd_expiry_date": "2023-07-08T20:09:52.501723",
    "cdd_location": "https://opencent.org",
    "cdd_serial": 1,
    "cdd_signing_date": "2022-07-08T20:09:52.501723",
    "currency_divisor": 100,
    "currency_name": "OpenCent",
    "denominations": [1, 2, 5],
    "id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
    "info_service": [
```

```
        [10, "https://opencent.org"]
      ],
    "invalidation_service": [
        [10, "https://opencent.org"]
      ],
    "issuer_cipher_suite": "RSA-SHA512-CHAUM86",
    "issuer_public_master_key": {
      "modulus":
"8004826974ed9eecc9261c6a695cd3f1bd33710ef3ba1ca8fbb1425d20f305020e7c8
0904d6d6e8a4358bf926f920e6167c2c780d9f34db6abe06a51c8ff2571",
      "public_exponent": 65537,
      "type": "rsa public key"
    },
    "protocol_version": "https://opencoin.org/1.0",
    "renewal_service": [
        [10, "https://opencent.org"]
      ],
    "type": "cdd",
    "validation_service": [
        [10, "https://opencent.org"],
      [20, "https://opencent.com/validate"]
    ]
  },
  "signature":
"2bfa4a4c85a49f7c0493bef54cef40892cb23a613b3268d21689493f5a7825e93b22b
aa8cfc59f8dbf79d5916348e586eb046f16a16cda7182e7e85d9746e7ff",
  "type": "cdd certificate"
}
```

Source

Mint Key Certificate (MKC)

Description

- **mint_key**:
    - **cdd_serial**:
    - **coins_expiry_date**:
    - **denomination**:

        - **id**:
        - **issuer_id**:
        - **public_mint_key**:
        - **sign_coins_not_after**:
        - **sign_coins_not_before**:
        - **type**:
    - **signature**:
    - **type**:

Example

```
{
  "mint_key": {
    "cdd_serial": 1,
    "coins_expiry_date": "2023-10-16T20:09:52.501723",
    "denomination": 1,
    "id":
"bac419d0d8c235e31dae3d5419944e904169c12c3799087f4f9684176fd76d05",
    "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
    "public_mint_key": {
      "modulus":
"cdabcaff7484d35f43a7d9e2f51eabe23783c351be84e4ed39f955a012357ebdf56e7
1e1ac0c15994317b23f45345acdd03bc02af9cd1dd72143ce33b26b4d27",
      "public_exponent": 65537,
      "type": "rsa public key"
    },
    "sign_coins_not_after": "2023-07-08T20:09:52.501723",
    "sign_coins_not_before": "2022-07-08T20:09:52.501723",
    "type": "mint key"
  },
  "signature":
"71b1c58d449634ca3cf719f82ba324573d7c32c7a18c6f25e7432d3efcc9fb4d661e5
a9087f3ed5184d2e5987784cb50ae8bb354479401869cc13ac2db8ae790",
  "type": "mint key certificate"
}
```

Source

Payload

Description

- **cdd_location**:
- **denomination**:
- **issuer_id**:
- **mint_key_id**:
- **protocol_version**:
- **serial**:
- **type**:

Example

```
{
  "cdd_location": "https://opencent.org",
  "denomination": 1,
  "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
  "mint_key_id":
"bac419d0d8c235e31dae3d5419944e904169c12c3799087f4f9684176fd76d05",
  "protocol_version": "https://opencoin.org/1.0",
  "serial":
"93608b9fe7375a19df2ee880639ceb63cab925e111c1adcf564d96738be9cb75",
  "type": "payload"
}
```

Source

Blind

Description

- **blinded_payload_hash**:
- **mint_key_id**:
- **reference**:
- **type**:

Example

```
{
  "blinded_payload_hash":
"c6db722a94f7c500878c13cb9025d6003e6611db066ea71dc1c34b2005933b6431314a
e12719394679c7623a69f637dad6ecce300c36988da9d6df3e8c384815",
  "mint_key_id":
"bac419d0d8c235e31dae3d5419944e904169c12c3799087f4f9684176fd76d05",
  "reference": "a0",
  "type": "blinded payload hash"
}
```

Source

Blind Signature

Description

- **blind_signature**:
- **reference**:
- **type**:

Example

```
{
  "blind_signature":
"68f1e187086ad2d6333cc6b798397dda2390db6abd3ea603557afa54ac65600f504823
2a34922bbcb4c7584f4dd4004500b45d79ef43f33673defab6dc109186",
  "reference": "a0",
  "type": "blind signature"
}
```

Source

Coin

Description

coin

- **payload**:
- **signature**:
- **type**:

Example

```
{
  "payload": {
    "cdd_location": "https://opencent.org",
    "denomination": 1,
    "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
    "mint_key_id":
"bac419d0d8c235e31dae3d5419944e904169c12c3799087f4f9684176fd76d05",
    "protocol_version": "https://opencoin.org/1.0",
    "serial":
"93608b9fe7375a19df2ee880639ceb63cab925e111c1adcf564d96738be9cb75",
    "type": "payload"
  },
  "signature":
"1932c7352ba97a24cbdddade9747d93b22db145defbdd0441606772695f0ddb439dea
17a9ce09f8ea0ef590bea57293d40fef463372060b6eb4a50c4ab7194d0",
  "type": "coin"
}
```

Source

Messages

CDDSerial

RequestCDDSerial

Description

- **message_reference**:
- **type**:

Example

```
{
  "message_reference": 1,
  "type": "request cdd serial"
}
```

Source

ResponseCDDSerial

- **cdd_serial**:
- **message_reference**:
- **status_code**:
- **status_description**:
- **type**:

Description

Example

```
{
  "cdd_serial": 1,
  "message_reference": 1,
  "status_code": 200,
  "status_description": "ok",
  "type": "response cdd serial"
}
```

Source

CDDC

RequestCDDC

- **cdd_serial**:
- **message_reference**:
- **type**:

Description

Example

```
{
  "cdd_serial": 1,
  "message_reference": 2,
  "type": "request cddc"
}
```

Source

ResponseCDDC

Description

- **cddc**:
- **message_reference**:
- **status_code**:
- **status_description**:
- **type**:

Example

```
{
  "cddc": {
    "cdd": {
      "additional_info": "",
      "cdd_expiry_date": "2023-07-08T20:09:52.501723",
      "cdd_location": "https://opencent.org",
      "cdd_serial": 1,
      "cdd_signing_date": "2022-07-08T20:09:52.501723",
```

```
      "currency_divisor": 100,
      "currency_name": "OpenCent",
      "denominations": [1, 2, 5],
      "id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
      "info_service": [
        [10, "https://opencent.org"]
      ],
      "invalidation_service": [
        [10, "https://opencent.org"]
      ],
      "issuer_cipher_suite": "RSA-SHA512-CHAUM86",
      "issuer_public_master_key": {
        "modulus":
"8004826974ed9eecc9261c6a695cd3f1bd33710ef3ba1ca8fbb1425d20f305020e7c8
0904d6d6e8a4358bf926f920e6167c2c780d9f34db6abe06a51c8ff2571",
        "public_exponent": 65537,
        "type": "rsa public key"
      },
      "protocol_version": "https://opencoin.org/1.0",
      "renewal_service": [
        [10, "https://opencent.org"]
      ],
      "type": "cdd",
      "validation_service": [
        [10, "https://opencent.org"],
        [20, "https://opencent.com/validate"]
      ]
    },
    "signature":
"2bfa4a4c85a49f7c0493bef54cef40892cb23a613b3268d21689493f5a7825e93b22b
aa8cfc59f8dbf79d5916348e586eb046f16a16cda7182e7e85d9746e7ff",
    "type": "cdd certificate"
  },
  "message_reference": 2,
  "status_code": 200,
  "status_description": "ok",
  "type": "response cddc"
}
```


Source

MKCs

RequestMKCs

- **denominations**:
- **message_reference**:
- **mint_key_ids**:
- **type**:

Description

Example

```
{
  "denominations": [1, 2, 5],
  "message_reference": 3,
  "mint_key_ids": [],
  "type": "request mint key certificates"
}
```

Source

ResponseMKCs

- **keys**:
- **message_reference**:
- **status_code**:
- **status_description**:
- **type**:

Description

Example

```
{
  "keys": [
    {
      "mint_key": {
        "cdd_serial": 1,
        "coins_expiry_date": "2023-10-16T20:09:52.501723",
```

```
        "denomination": 1,
        "id":
"bac419d0d8c235e31dae3d5419944e904169c12c3799087f4f9684176fd76d05",
        "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
        "public_mint_key": {
          "modulus":
"cdabcaff7484d35f43a7d9e2f51eabe23783c351be84e4ed39f955a012357ebdf56e7
1e1ac0c15994317b23f45345acdd03bc02af9cd1dd72143ce33b26b4d27",
          "public_exponent": 65537,
          "type": "rsa public key"
        },
        "sign_coins_not_after": "2023-07-08T20:09:52.501723",
        "sign_coins_not_before": "2022-07-08T20:09:52.501723",
        "type": "mint key"
      },
      "signature":
"71b1c58d449634ca3cf719f82ba324573d7c32c7a18c6f25e7432d3efcc9fb4d661e5
a9087f3ed5184d2e5987784cb50ae8bb354479401869cc13ac2db8ae790",
      "type": "mint key certificate"
    },
    {
      "mint_key": {
        "cdd_serial": 1,
        "coins_expiry_date": "2023-10-16T20:09:52.501723",
        "denomination": 2,
        "id":
"3f19f49247122834f1f46fa1602be004f7b1b159da04935e5957c6f509ccfea7",
        "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
        "public_mint_key": {
          "modulus":
"815def3cad88224295806821379fb11abd18a87b205aee79db4d65181e4a09a385526
ca72e968e672b94135f931a45ebdeeae29e4740372ffbd25b97cfa81c6d",
          "public_exponent": 65537,
          "type": "rsa public key"
        },
        "sign_coins_not_after": "2023-07-08T20:09:52.501723",
        "sign_coins_not_before": "2022-07-08T20:09:52.501723",
        "type": "mint key"
      },
```

```
      "signature":
"40bbaa15442c029d49e869364a4731abb04dc601505b84a8da804b22841dda07dd0f3
fdc77febe58705bc73a31cd8b9c9d791b17f1502ca6745c2d0a110f8c0b",
      "type": "mint key certificate"
    },
    {
      "mint_key": {
        "cdd_serial": 1,
        "coins_expiry_date": "2023-10-16T20:09:52.501723",
        "denomination": 5,
        "id":
"6c6da7d032dff8b2489dca9398d1fa2d9ff11ed8bfd3e4144deb1ceaa7eb8818",
        "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
        "public_mint_key": {
          "modulus":
"9264f36d49bfb333856bad3a3769b7334be69830bdffaffe3cf792ce8e179b9dcebbe
68c708fe88394ed3b14baadde2d58bde1ad6d09fc7e9e011c40cb3875f1",
          "public_exponent": 65537,
          "type": "rsa public key"
        },
        "sign_coins_not_after": "2023-07-08T20:09:52.501723",
        "sign_coins_not_before": "2022-07-08T20:09:52.501723",
        "type": "mint key"
      },
      "signature":
"3a489dced0e11d79598cea3107b5acfe07060e378ad0df679f7aeaef12f9cd75fb1fc
9f58be83d032c0503a00f46bd282ab870976a20a119d07025051f101899",
      "type": "mint key certificate"
    }
  ],
  "message_reference": 3,
  "status_code": 200,
  "status_description": "ok",
  "type": "response mint key certificates"
}
```


Source

Mint

RequestMint

Description

- **blinds**:
- **message_reference**:
- **transaction_reference**:
- **type**:

Example

```
{
  "blinds": [
    {
      "blinded_payload_hash":
"c6db722a94f7c500878c13cb9025d6003e6611db066ea71dc1c34b2005933b6431314
ae12719394679c7623a69f637dad6ecce300c36988da9d6df3e8c384815",
      "mint_key_id":
"bac419d0d8c235e31dae3d5419944e904169c12c3799087f4f9684176fd76d05",
      "reference": "a0",
      "type": "blinded payload hash"
    },
    {
      "blinded_payload_hash":
"39a10d283dd0443389f2c5cf4a83f281770079b0816a1b2e1a1fac2c53e3644b89306
921d5ebc2de2d96077f9125d375ffe280d3c3468a606db3f7b7f2bd6421",
      "mint_key_id":
"3f19f49247122834f1f46fa1602be004f7b1b159da04935e5957c6f509ccfea7",
      "reference": "a1",
      "type": "blinded payload hash"
    },
    {
      "blinded_payload_hash":
"182def4dd07bfd73c403486b40c66b43e9df253b182115d108173f30d84041015776a
dee8f76623ba40e3be0bb3aeb1daecb30ad2714ff2a7bfb7e3924128ddf",
      "mint_key_id":
"6c6da7d032dff8b2489dca9398d1fa2d9ff11ed8bfd3e4144deb1ceaa7eb8818",
      "reference": "a2",
      "type": "blinded payload hash"
```

```
    }
  ],
  "message_reference": 4,
  "transaction_reference":
"f8b995ff44baa7df7c848ae67de72cfc55d241a7d393aa3392c6c3f0bd269551",
  "type": "request mint"
}
```

Source

ResponseMint

Description

- **blind_signatures**:
- **message_reference**:
- **status_code**:
- **status_description**:
- **type**:

Example

```
{
  "blind_signatures": [
    {
      "blind_signature":
"68f1e187086ad2d6333cc6b798397dda2390db6abd3ea603557afa54ac65600f50482
32a34922bbcb4c7584f4dd4004500b45d79ef43f33673defab6dc109186",
      "reference": "a0",
      "type": "blind signature"
    },
    {
      "blind_signature":
"4338c5154ce6a878d31aca476bf1d79d633df976a534f8fbefb24930c75c9bd25e87c
1d0a2bda1ada7915ec7717a2aaba27dd7fd5ea58db900c4c5cf1c33cad5",
      "reference": "a1",
      "type": "blind signature"
    },
    {
```

```
      "blind_signature":
"7bf88ddc25e9c0c65813c25d694cb444777c54b385b06b59e3d783e9abe9be71ccebe
820295cb2c0968619d7ab83daf4f3ba180b787a8612c2c76913d0774125",
      "reference": "a2",
      "type": "blind signature"
    }
  ],
  "message_reference": 4,
  "status_code": 200,
  "status_description": "ok",
  "type": "response mint"
}
```


Source

CoinStack

CoinStack

Description

- **coins**:
- **subject**:
- **type**:

Example


```
{
  "coins": [
    {
      "payload": {
        "cdd_location": "https://opencent.org",
        "denomination": 1,
        "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
        "mint_key_id":
"bac419d0d8c235e31dae3d5419944e904169c12c3799087f4f9684176fd76d05",
        "protocol_version": "https://opencoin.org/1.0",
```

```
        "serial":
"93608b9fe7375a19df2ee880639ceb63cab925e111c1adcf564d96738be9cb75",
        "type": "payload"
      },
      "signature":
"1932c7352ba97a24cbdddade9747d93b22db145defbdd0441606772695f0ddb439dea
17a9ce09f8ea0ef590bea57293d40fef463372060b6eb4a50c4ab7194d0",
      "type": "coin"
    },
    {
      "payload": {
        "cdd_location": "https://opencent.org",
        "denomination": 2,
        "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
        "mint_key_id":
"3f19f49247122834f1f46fa1602be004f7b1b159da04935e5957c6f509ccfea7",
        "protocol_version": "https://opencoin.org/1.0",
        "serial":
"ffe8691a219a543bc1f51f3dd697a5e17fe9e5a6dfbf0537a515766d19f216a5",
        "type": "payload"
      },
      "signature":
"202a2724f3007a43e6f082f381acb91fcfc908c6a3170c30d1e95e9d13dea03f9042d
6cd0ff73a85ad8df0b82ede07d1427dd0fc9c999cdf96656734e6999e00",
      "type": "coin"
    },
    {
      "payload": {
        "cdd_location": "https://opencent.org",
        "denomination": 5,
        "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
        "mint_key_id":
"6c6da7d032dff8b2489dca9398d1fa2d9ff11ed8bfd3e4144deb1ceaa7eb8818",
        "protocol_version": "https://opencoin.org/1.0",
        "serial":
"9912a994b8a2372c23ed0c13f8f3f4bef1b3b05b4123ab40d5cc73858dbedc9b",
        "type": "payload"
      },
```

```
      "signature":
"6cc66cb2109120199c997608fab249d06b8b9ca0f1cb52289931d6ddf3ed7350b3379
22bac196abf2dbfcaa6618d590fe175be31f83fc3264fbdb14e4b29e550",
      "type": "coin"
    }
  ],
  "subject": "a little gift",
  "type": "coinstack"
}
```

Source

Renew

RequestRenew

Description

- **blinds**:
- **coins**:
- **message_reference**:
- **transaction_reference**:
- **type**:

Example

```
{
  "blinds": [
    {
      "blinded_payload_hash":
"56436a49564ee8153bbaae034be9fbe6e314067f7b6de70c47219b36dd5103403614e
f5fc93d7eb0879ce5c8ccf1017a9d6f74e0c3a1c06d4b62a206565e4ef7",
      "mint_key_id":
"3f19f49247122834f1f46fa1602be004f7b1b159da04935e5957c6f509ccfea7",
      "reference": "b0",
      "type": "blinded payload hash"
    },
    {
```

```
      "blinded_payload_hash":
"6f1e2f96c277b0529f8bf097b8b57d6a5e950db7e2f64d70b847fcb09cb84596bf1dc
eccf14078bfb59acf26bd71e6f85e4a588d859980796051dff937be58e9",
      "mint_key_id":
"3f19f49247122834f1f46fa1602be004f7b1b159da04935e5957c6f509ccfea7",
      "reference": "b1",
      "type": "blinded payload hash"
    },
    {
      "blinded_payload_hash":
"f8fad20dda2dc1ed0da2727d6f81c94e5011ccbc1bcdd2e89905fdc69d78310ac510c
5e52d5f7675b8a4259905fc8fef703bab6d73c907e31b5657ea9090d81",
      "mint_key_id":
"3f19f49247122834f1f46fa1602be004f7b1b159da04935e5957c6f509ccfea7",
      "reference": "b2",
      "type": "blinded payload hash"
    },
    {
      "blinded_payload_hash":
"7a7a001b8b79667eb79388b1e6e69e9618f2613f561b01282d625d4c20b3e09845d9b
0ef2f5298d2ff6b6280061cbdf16b71170ad2051a128f7360baa817940e",
      "mint_key_id":
"3f19f49247122834f1f46fa1602be004f7b1b159da04935e5957c6f509ccfea7",
      "reference": "b3",
      "type": "blinded payload hash"
    }
  ],
  "coins": [
    {
      "payload": {
        "cdd_location": "https://opencent.org",
        "denomination": 1,
        "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
        "mint_key_id":
"bac419d0d8c235e31dae3d5419944e904169c12c3799087f4f9684176fd76d05",
        "protocol_version": "https://opencoin.org/1.0",
        "serial":
"93608b9fe7375a19df2ee880639ceb63cab925e111c1adcf564d96738be9cb75",
        "type": "payload"
      },
```

```
      "signature":
"1932c7352ba97a24cbdddade9747d93b22db145defbdd0441606772695f0ddb439dea
17a9ce09f8ea0ef590bea57293d40fef463372060b6eb4a50c4ab7194d0",
      "type": "coin"
    },
    {
      "payload": {
        "cdd_location": "https://opencent.org",
        "denomination": 2,
        "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
        "mint_key_id":
"3f19f49247122834f1f46fa1602be004f7b1b159da04935e5957c6f509ccfea7",
        "protocol_version": "https://opencoin.org/1.0",
        "serial":
"ffe8691a219a543bc1f51f3dd697a5e17fe9e5a6dfbf0537a515766d19f216a5",
        "type": "payload"
      },
      "signature":
"202a2724f3007a43e6f082f381acb91fcfc908c6a3170c30d1e95e9d13dea03f9042d
6cd0ff73a85ad8df0b82ede07d1427dd0fc9c999cdf96656734e6999e00",
      "type": "coin"
    },
    {
      "payload": {
        "cdd_location": "https://opencent.org",
        "denomination": 5,
        "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
        "mint_key_id":
"6c6da7d032dff8b2489dca9398d1fa2d9ff11ed8bfd3e4144deb1ceaa7eb8818",
        "protocol_version": "https://opencoin.org/1.0",
        "serial":
"9912a994b8a2372c23ed0c13f8f3f4bef1b3b05b4123ab40d5cc73858dbedc9b",
        "type": "payload"
      },
      "signature":
"6cc66cb2109120199c997608fab249d06b8b9ca0f1cb52289931d6ddf3ed7350b3379
22bac196abf2dbfcaa6618d590fe175be31f83fc3264fbdb14e4b29e550",
      "type": "coin"
    }
  ],
```

```
  "message_reference": 5,
  "transaction_reference": "e4f0b9b0d835ade72ee71d7d5f5bd6fd",
  "type": "request renew"
}
```

Source

Resume

ResponseDelay

Description

- **message_reference**:
- **status_code**:
- **status_description**:
- **type**:

Example

```
{
  "message_reference": 5,
  "status_code": 300,
  "status_description": "ok",
  "type": "response delay"
}
```

Source

RequestResume

Description

- **message_reference**:
- **transaction_reference**:
- **type**:

Example

```
{
  "message_reference": 6,
  "transaction_reference": "e4f0b9b0d835ade72ee71d7d5f5bd6fd",
  "type": "request resume"
}
```

Source

Redeem

RequestRedeem

Description

- **coins**:
- **message_reference**:
- **type**:

Example

```
{
  "coins": [
    {
      "payload": {
        "cdd_location": "https://opencent.org",
        "denomination": 2,
        "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
        "mint_key_id":
"3f19f49247122834f1f46fa1602be004f7b1b159da04935e5957c6f509ccfea7",
        "protocol_version": "https://opencoin.org/1.0",
        "serial":
"efa42f53f82bae3b7a2cb5e9b9ee1549b0adab6f2aab5887a83dd31921ffd1fb",
        "type": "payload"
      },
      "signature":
"2f67f48830dd28f4692a5208e87e238f12b9458fa732d3f6de9c8e96b9471a4e2c1f9
fb514df75f3907ae5168118852c61c62f791ae3b41fd6eb08dafc9615e4",
```

```
      "type": "coin"
    },
    {
      "payload": {
        "cdd_location": "https://opencent.org",
        "denomination": 2,
        "issuer_id":
"85c24031572f2e0a04a41a29eb74990f4651c7f0b4afc0b53cfa03bed30822e1",
        "mint_key_id":
"3f19f49247122834f1f46fa1602be004f7b1b159da04935e5957c6f509ccfea7",
        "protocol_version": "https://opencoin.org/1.0",
        "serial":
"de8e5f5180fe3c029c9ad002e806246ce9d51a0d8f970f58ccae2e480be4bd31",
        "type": "payload"
      },
      "signature":
"3370d7e5ad2a2547ee3c5e2deae7d67230162db224553306804fa638a7cd54eaddf43
7625fd5a9930b6c1e936f7c70f8bc9df761f51600a3ac9a104f438ebf27",
      "type": "coin"
    }
  ],
  "message_reference": 7,
  "type": "request redeem"
}
```


Source

ResponseRedeem

Description

- **message_reference**:
- **status_code**:
- **status_description**:
- **type**:

Example

```
{
  "message_reference": 7,
  "status_code": 200,
  "status_description": "ok",
  "type": "response redeem"
}
```

Source

Reference

Appendix

Scope

Having said all of the above, we scope the protocol and it's description in the following way:

Targeted at developers - developers should be enabled (and motivated) by the OpenCoin protocol to implement standard confirming software components and apps. However we hope that this documentation is also understandable for the interested user (or founder, investor, auditor, etc.)

Just the protocol - we don't deliver any ready to use implementations. This allows us to fully focus on the protocol, and keeps a separation to actual implementations.

Easy to understand - we try to avoid complexity. This affects the protocol itself as well as it's documentation. This means: if you, the reader, don't understand a sentence or a concept, please contact us. We will improve the description. Being easy to understand is one of the main goals of OpenCoin.

Only the core - lots of developments have happened since we started. Take the example of messengers like Signal, Telegram or WhatsApp. The have opened new ways to transport messages, and they take care of identifying the communication partner. This especially means that message transport and authentication stays out of scope.

History and old results

- Project history
- Project papers
- Crypto report
- Legal report
- Code bases (v1, sandbox, javascript implementation)

Artifacts

Details of the documents in the artifacts directory

JSON Schemata

Ideas

- use .oc file ending
- oc over html
- opencoin.org as a web interface demo provider, that can handle .oc files

Building blocks for writing

create CDDC
create MKCs
RequestCDDSerial
ResponseCDDSerial
RequestCDDC
ResponseCDDC
RequestMKCs
ResponseMKCs
prepare blinds
RequestMint
sign blinds
ResponseMint
unblind
transfer CoinStack, e.g. using Signal
tokenize sum
prepare blinds
RequestRenew
ResponseDelay
RequestResume
validate coins
RequestRedeem
ResponseRedeem

Header

Description

Example

```
1
```

Source

Request

Description

Example

```
1
```

Source

Response

Description

Example

```
1
```

Source

Footnotes

1. David Chaum, “Blind signatures for untraceable payments”, Advances in Cryptology - Crypto ‘82, Springer-Verlag (1983), 199-203. ↩

2. Please check with your lawyer if this is a good idea. ↩

3. To keep the diagram simple we have left out Charlene who was mentioned above in "How does it work?". Bob does everything she does. ↩

4. This is to minimize damage in case the mint keys get compromised. ↩