GNU Taler

⟨Taler⟩

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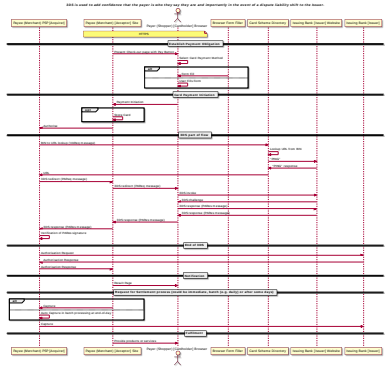
Technik und Informatik

The Bank's Online Payment Problem

3D secure ("verified by visa") is a nightmare:

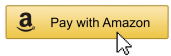
- Complicated process
- Shifts liability to consumer
- Significant latency
- Can refuse valid requests
- Legal vendors excluded
- No privacy for buyers



Online credit card payments will be replaced, but with what?

The Bank's Online Payment Problem

- Global tech companies push oligopolies
- Privacy and federated finance are at risk
- Economic sovereingity is in danger



The Distraction: Bitcoin

- Unregulated payment system and currency:
  $\Rightarrow$ lack of regulation is a feature!
- Implemented in free software
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The Distraction: Bitcoin

- Unregulated payment system and currency:
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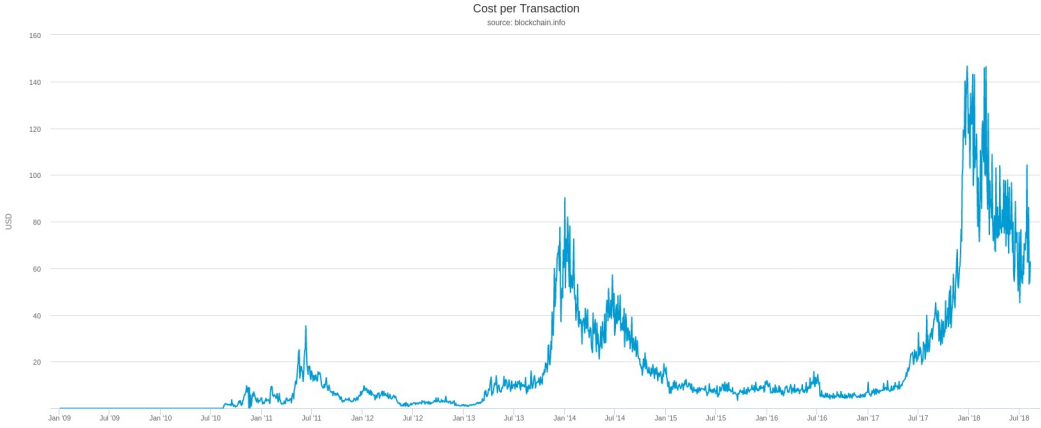
- Implemented in free software
- Decentralised peer-to-peer system
- Decentralised banking requires solving Byzantine consensus
- Creative solution: tie initial accumulation to solving consensus
  $\Rightarrow$ Proof-of-work advances ledger
  $\Rightarrow$ Very expensive banking



Average transaction value: $\approx$ 4215 USD (on 9.8.2018)

Cryptography is rather primitive:

All Bitcoin transactions are public and linkable!

$\Rightarrow$ no privacy guarantees

$\Rightarrow$ enhanced with “laundering” services

ZeroCoin, CryptoNote (Monero) and ZeroCash (ZCash) offer anonymity.

Do you want to have a libertarian economy?

Do you want to live under total surveillance?

Digital cash, made **socially responsible**.

⟨Taler⟩

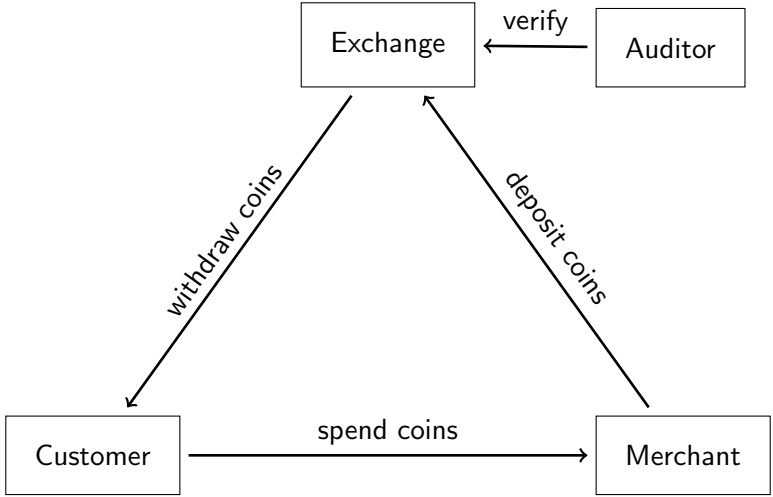
Privacy-Preserving, Practical, Taxable, Free Software, Efficient

What is Taler?

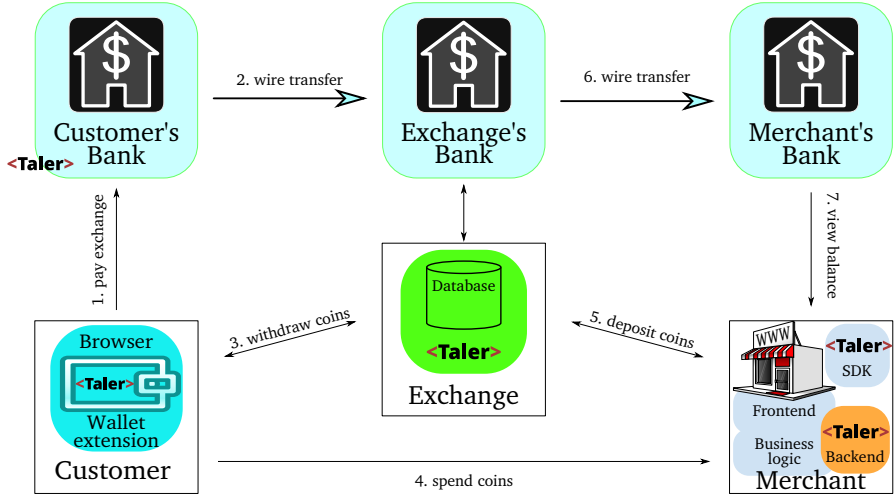
Taler is an electronic instant payment system.

- Uses electronic coins stored in **wallets** on customer's device
- Like **cash**
- Pay in **existing currencies** (i.e. EUR, USD, BTC),
  or use it to create new **regional currencies**

Taler Overview



Architecture of Taler



⇒ Convenient, taxable, privacy-enhancing, & resource friendly!

Usability of Taler

`https://demo.taler.net/`

1. Install Browser extension.
2. Visit the `bank.demo.taler.net` to withdraw coins.
3. Visit the `shop.demo.taler.net` to spend coins.

Use Case: Journalism

Today:

- Corporate structure
- Advertising primary revenue
- Tracking readers critical for business success
- Journalism and marketing hard to distinguish

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With GNU Taler:

- One-click micropayments per article
- Hosting requires no expertise
- Reader-funded reporting separated from marketing
- Readers can remain anonymous

Use Case: Anti-Spam

Today, p≡p provides authenticated encryption for e-mail:

- Free software
- Easy to use opportunistic encryption
- Available for Outlook, Android, Enigmail
- Spies & spam filters can no longer inspect content

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- Free software
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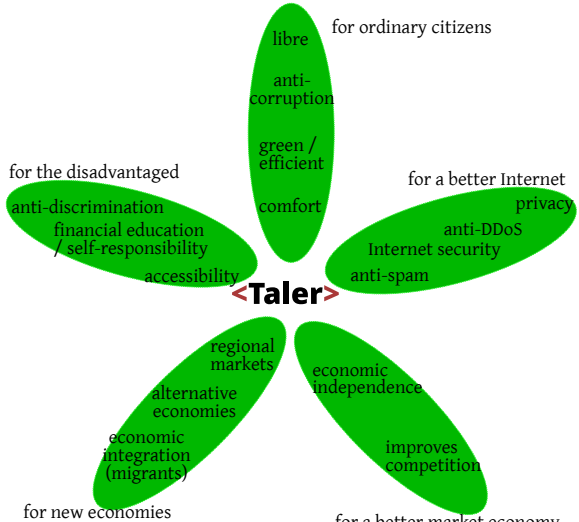
With GNU Taler:

- Peer-to-peer payments via e-mail
- If unsolicited sender, hide messages from user & automatically request payment from sender
- Sender can attach payment to be moved to inbox
- Receiver may grant refund to sender

Social Impact of Taler



Taxability

We say Taler is taxable because:

- Merchant's income is visible from deposits.
- Hash of contract is part of deposit data.
- State can trace income and enforce taxation.

How does it work?

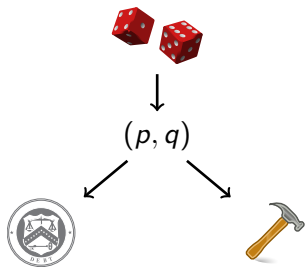
We use a few ancient constructions:

- Cryptographic hash function (1989)
- Blind signature (1983)
- Schnorr signature (1989)
- Diffie-Hellman key exchange (1976)
- Cut-and-choose zero-knowledge proof (1985)

But of course we use modern instantiations.

Exchange setup: Create a denomination key (RSA)

1. Pick random primes p, q.
2. Compute $n := pq$,
   $\phi(n) = (p-1)(q-1)$
3. Pick small $e < \phi(n)$ such that
   $d := e^{-1} \mod \phi(n)$ exists.
4. Publish public key (e, n).



Merchant: Create a signing key (EdDSA)

- pick random m mod o as private key
- $M = mG$ public key

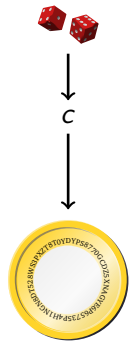
m

M

Capability: $m \Rightarrow$

Customer: Create a planchet (EdDSA)

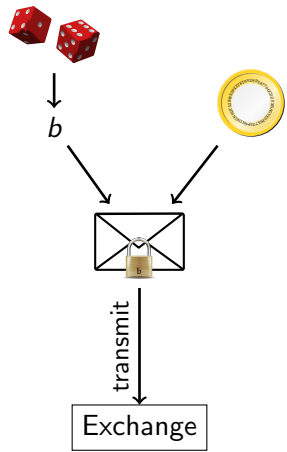
- Pick random c mod o private key
- $C = cG$ public key



Capability: $c \Rightarrow$

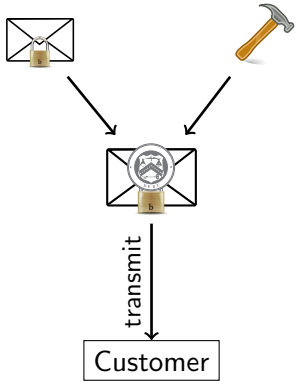
Customer: Blind planchet (RSA)

1. Obtain public key (e, n)
2. Compute $f := FDH(C)$, $f < n$.
3. Pick blinding factor $b \in \mathbb{Z}_n$
4. Transmit $f' := fb^e \mod n$



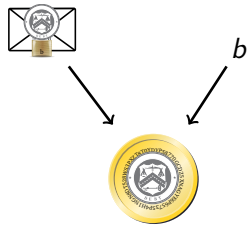
Exchange: Blind sign (RSA)

1. Receive f'.
2. Compute $s' := f'^d \mod n$.
3. Send signature s'.

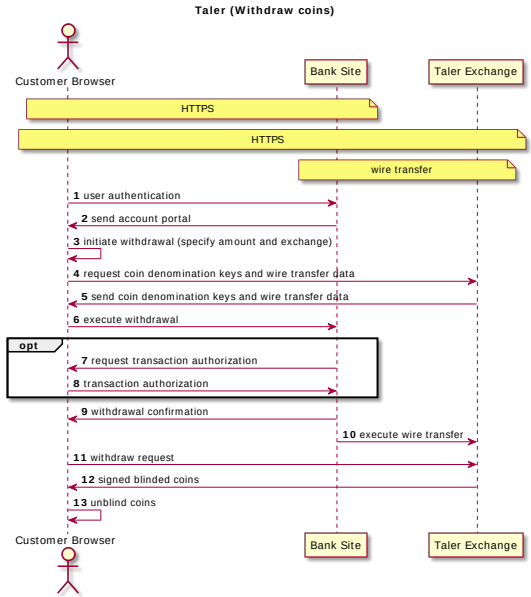


Customer: Unblind coin (RSA)

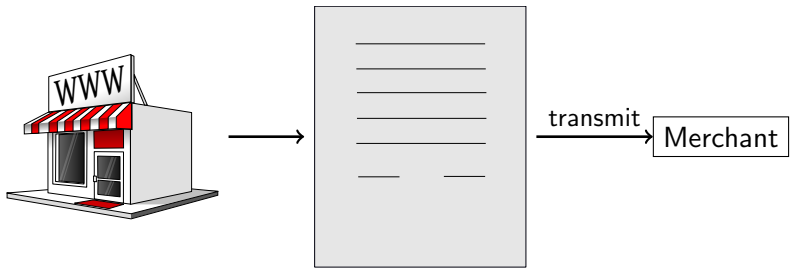
1. Receive s'.
2. Compute $s := s'b^{-1} \mod n$



Withdrawing coins on the Web



Customer: Build shopping cart



Merchant Integration: Wallet Detection

```
<script src="taler-wallet-lib.js"></script>
<script>
  taler.onPresent(() => {
    alert("Taler wallet is installed");
  });
  taler.onAbsent(() => {
    alert("Taler wallet is not installed");
  });
</script>
```

Merchant Integration: Payment Request

```
HTTP/1.1 402 Payment Required
Content-Type: text/html; charset=UTF-8
X-Taler-Contract-Url: https://shop/generate-contract/42

<!DOCTYPE html>
<html>
  <!-- fallback for browsers without the Taler extension -->
  You do not seem to have Taler installed, here are other
  payment options ...
</html>
```

Merchant Integration: Contract


```
{
  "H_wire":"YTH0C4QBCQ10VDNTJN0DCTTV2Z6JHT5NF43F0RQHZ8JYB5NG4W4G...",
  "amount":{"currency":"EUR","fraction":0,"value":1},
  "max_fee":{"currency":"EUR","fraction":100000,"value":0},
  "auditors":[{"auditor_pub":"42V6TH91Q83FB846DK1GW3JQ5E8DS273W4..."}],
  "exchanges":[{"master_pub":"1T5FA8VQHMMKBHDMYPRZA2ZFK2S63AKF0Y...",
                "url":"https://exchange/"}],
  "fulfillment_url": "https://shop/article/42?tid=249&time=14714744",
  "merchant":{"address":"Mailbox␣4242","jurisdiction":"Jersey",
              "name":"Shop␣Inc."},
  "merchant_pub":"Y1ZAR5346J3ZTEXJCHQY9NJN78EZ2HSKZK8M0MYTNRJG5N...",
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    "description":"Essay:␣The␣GNU␣Project",
    "price":{"currency":"EUR","fraction":0,"value":1},
    "product_id":42,"quantity":1}],
  "pay_deadline":"/Date(1480119270)/",
  "refund_deadline":"/Date(1471522470)/",
  "timestamp":"/Date(1471479270)/",
  "transaction_id":249960194066269
}
```
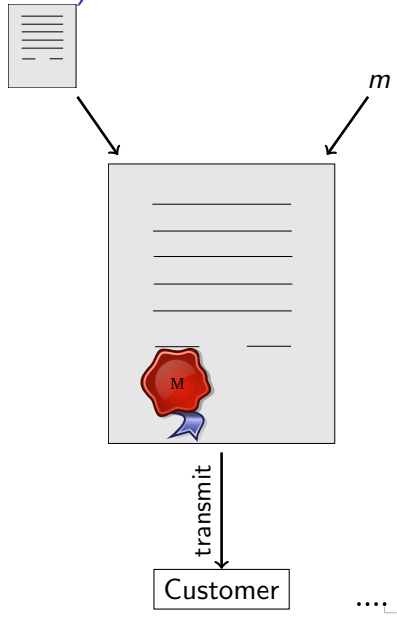
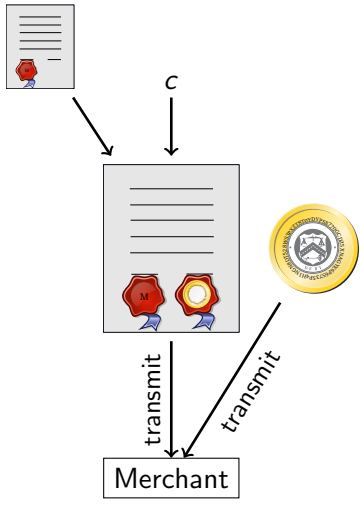

Merchant: Propose contract (EdDSA)

1. Complete proposal D.
2. Send D, $EdDSA_m(D)$



Customer: Spend coin (EdDSA)

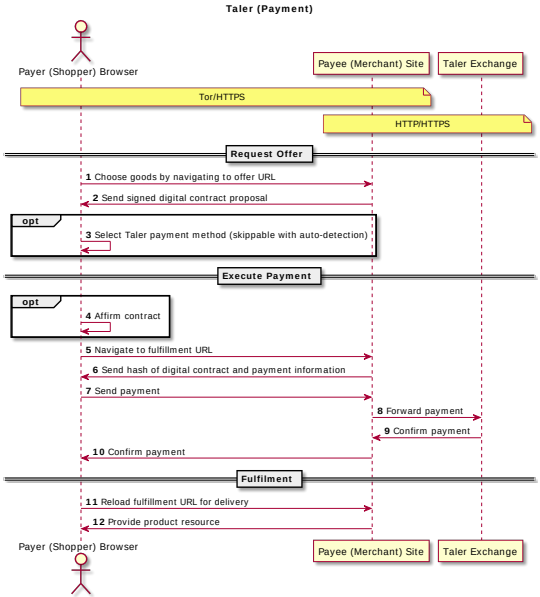
1. Receive proposal D, $EdDSA_m(D)$.
2. Send s, C, $EdDSA_c(D)$



Merchant and Exchange: Verify coin (RSA)

$$s^e \stackrel{?}{\equiv} FDH(C) \mod n$$

Payment processing with Taler



Giving change

It would be inefficient to pay EUR 100 with 1 cent coins!

- Denomination key represents value of a coin.
- Exchange may offer various denominations for coins.
- Wallet may not have exact change!
- Usability requires ability to pay given sufficient total funds.

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Key goals:

- maintain unlinkability
- maintain taxability of transactions

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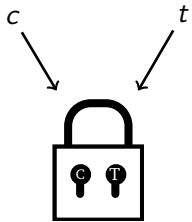
Method:

- Contract can specify to only pay *partial value* of a coin.
- Exchange allows wallet to obtain *unlinkable change* for remaining coin value.

Diffie-Hellman (ECDH)

1. Create private keys $c, t \mod o$
2. Define $C = cG$
3. Define $T = tG$
4. Compute DH
   $cT = c(tG) = t(cG) = tC$

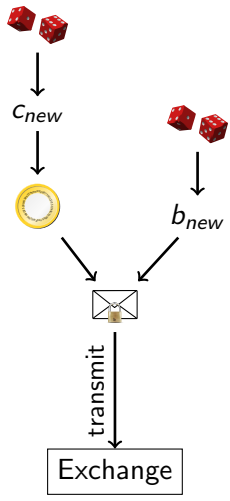


Strawman solution

Given partially spent private coin key c_{old}:

1. Pick random c_{new} mod o private key
2. $C_{new} = c_{new} G$ public key
3. Pick random b_{new}
4. Compute $f_{new} := FDH(C_{new})$, $m < n$.
5. Transmit $f'_{new} := f_{new} b^e_{new}$ mod n

... and sign request for change with c_{old}.



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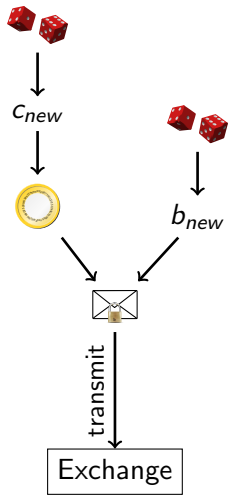
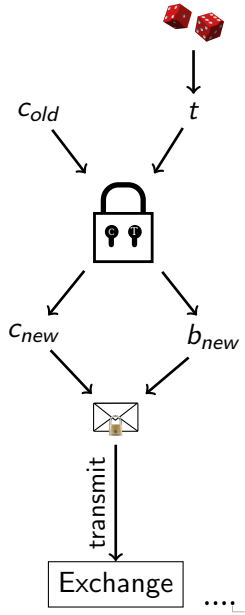


Problem: Owner of c_{new} may differ from owner of c_{old}!

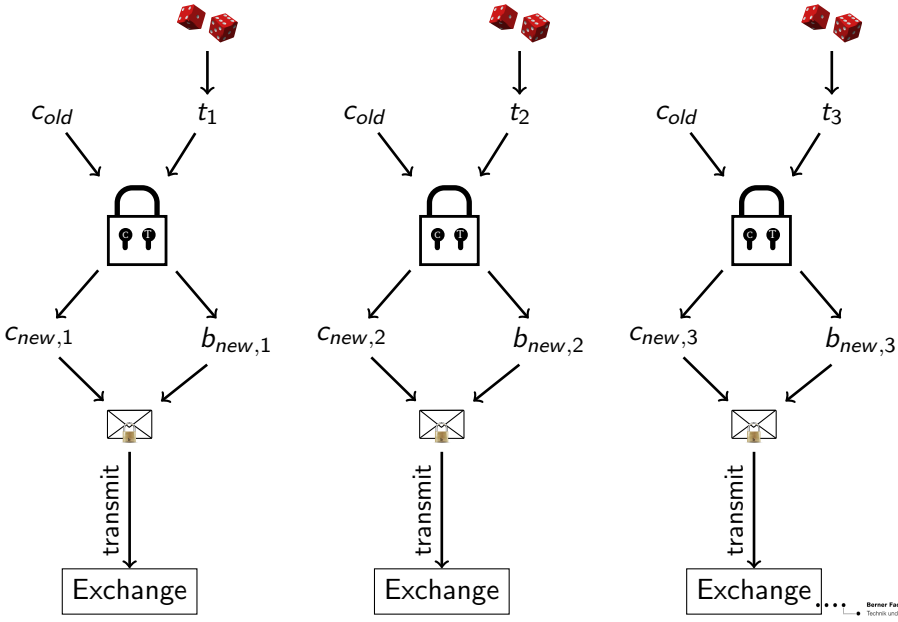
Customer: Transfer key setup (ECDH)

Given partially spent private coin key c_{old}:

1. Let $C_{old} := c_{old} G$ (as before)
2. Create random private transfer key $t \mod o$
3. Compute $T := tG$
4. Compute $X := c_{old}(tG) = t(c_{old} G) = tC_{old}$
5. Derive c_{new} and b_{new} from X
6. Compute $C_{new} := c_{new} G$
7. Compute $f_{new} := FDH(C_{new})$
8. Transmit $f'_{new} := f_{new} b^e_{new}$



Cut-and-Choose



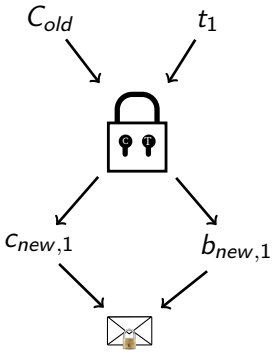
Exchange: Choose!

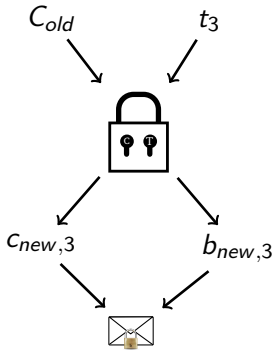
Exchange sends back random $\gamma \in \{1, 2, 3\}$ to the customer.

Customer: Reveal

1. If $\gamma = 1$, send t_2, t_3 to exchange
2. If $\gamma = 2$, send t_1, t_3 to exchange
3. If $\gamma = 3$, send t_1, t_2 to exchange

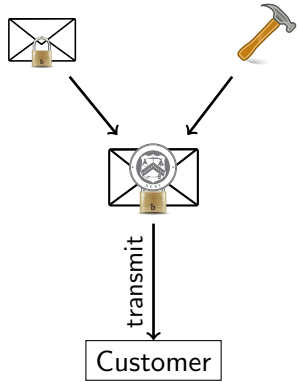
Exchange: Verify ($\gamma = 2$)





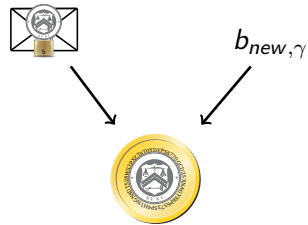
Exchange: Blind sign change (RSA)

1. Take $f'_{new,\gamma}$.
2. Compute $s' := f'^{d}_{new,\gamma} \mod n$.
3. Send signature s'.



Customer: Unblind change (RSA)

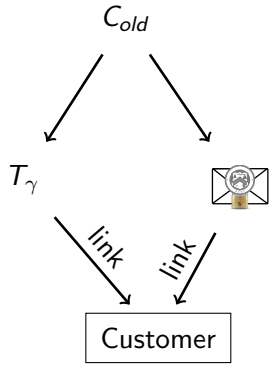
1. Receive s'.
2. Compute $s := s' b_{new,\gamma}^{-1} \mod n$.



Exchange: Allow linking change

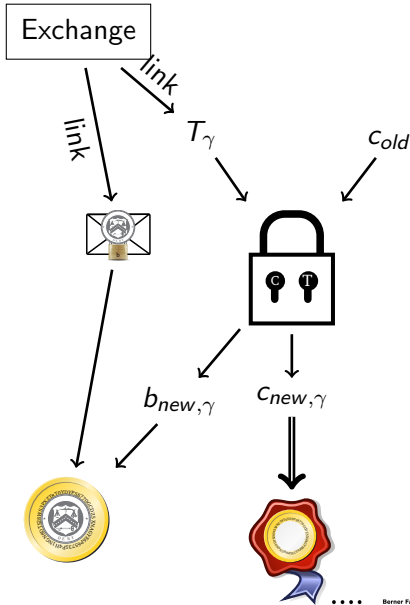
Given C_{old}

return T_γ, $s := s' b_{new,\gamma}^{-1} \mod n$.



Customer: Link (threat!)

1. Have c_{old}.
2. Obtain T_γ, s from exchange
3. Compute $X_\gamma = c_{old}\, T_\gamma$
4. Derive $c_{new,\gamma}$ and $b_{new,\gamma}$ from X_γ
5. Unblind $s := s' b_{new,\gamma}^{-1} \mod n$



Refresh protocol summary

- Customer asks exchange to convert old coin to new coin
- Protocol ensures new coins can be recovered from old coin

$\Rightarrow$ New coins are owned by the same entity!

Thus, the refresh protocol allows:

- To give unlinkable change.
- To give refunds to an anonymous customer.
- To expire old keys and migrate coins to new ones.
- To handle protocol aborts.

Performance: `taler-exchange-benchmark`

Setup:

- AMD 1950X CPU
- Debian GNU/Linux
- Postgres 10.4
- Compiled with $-O0-g$ (except for libgcrypt)
- 800 parallel "clients" (on loopback)
- 60 reserves per client
- 15 coins per reserve
- RSA-2048
- No network latency
- No auditor

Results:

- 30% CPU Taler exchange
- 60% CPU Taler "clients"
- 3% CPU Postgres database
- $\approx$ 4 ms / coin (withdraw, deposit, 10% refresh chance)

  $\Rightarrow \approx$ **250 transactions/s**

Caveats:

- **2/3rds for clients**
- HTTP Keep-Alive diabled (for load-balancing)
- Used HTTP, not HTTPS
- No outgoing wire transfers

Competitor comparison

	Cash	Bitcoin	Zerocoin	Creditcard	GNU Taler
Online	−−−	++	++	+	+++
Offline	+++	−−	−−	+	−−
Trans. cost	+	−−−	−−−	−	++
Speed	+	−−−	−−−	o	++
Taxation	−	−−	−−−	+++	+++
Payer-anon	++	o	++	−−−	+++
Payee-anon	++	o	++	−−−	−−−
Security	−	o	o	−−	++
Conversion	+++	−−−	−−−	+++	+++
Libre	−	+++	+++	− − −	+++

payto: Uniform Identifiers for Payments and Accounts

Like `mailto:`, but for bank accounts instead of email accounts!

```
payto://<PAYMENT-METHOD>/<ACCOUNT-NR>
  ?subject=InvoiceNr42
  &amount=EUR:12.50
```

Default action: Open app to review and confirm payment.

Benefits of `payto://`

- Standardized way to represent financial resources (bank account, bitcoin wallet) and payments to them
- Useful on the client-side on the Web and for FinTech backend applications
- Payment methods (such as SEPA, ACH, Bitcoin) are registered with IANA and allow extra options
- Under standardization with IETF as `draft-dold-payto`

Please voice your support!

How to support?

- Join: taler@gnu.org, #taler
- Coding & design: `https://gnunet.org/bugs/`
- Translation: `https://git.taler.net/www.git/tree/locale/fr/LC_MESSAGES/messages.po`
- Integration: `https://docs.taler.net/`
- Donations: `https://gnunet.org/ev`
- Funding: `https://taler.net/en/investors.html`

And of course we are looking for banks as partners!

Team & Advisory Board

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co-founder

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co-founder

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Jurist

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PostDoc

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Ante Gulam
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former Group Head Security/ Fraud/Geo Risk HSBC

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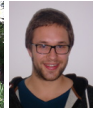
MIT Media Lab










Conclusion

What can we do?

- Suffer mass-surveillance enabled by credit card oligopolies with high fees, and
- Engage in arms race with deliberately unregulatable blockchains, and
- Enjoy the “benefits” of cash

OR

- Establish free software alternative balancing social goals!

Do you have any questions?

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Let money facilitate trade; but ensure capital serves society.