University of Basel

Center for Innovative Finance


# Bitcoin, Blockchain and Cryptoassets

## Payment Systems

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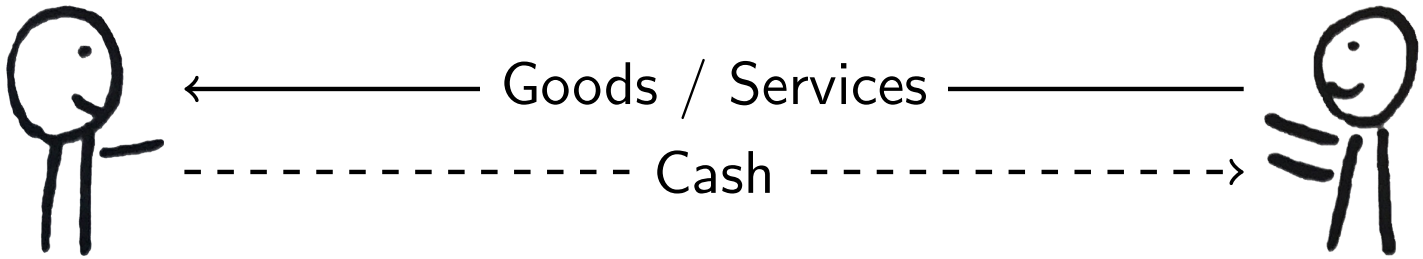
# Payment Systems: Today's Challenge

Physical Cash: Presence in the same place at the same time




Digital Cash: Proof of ownership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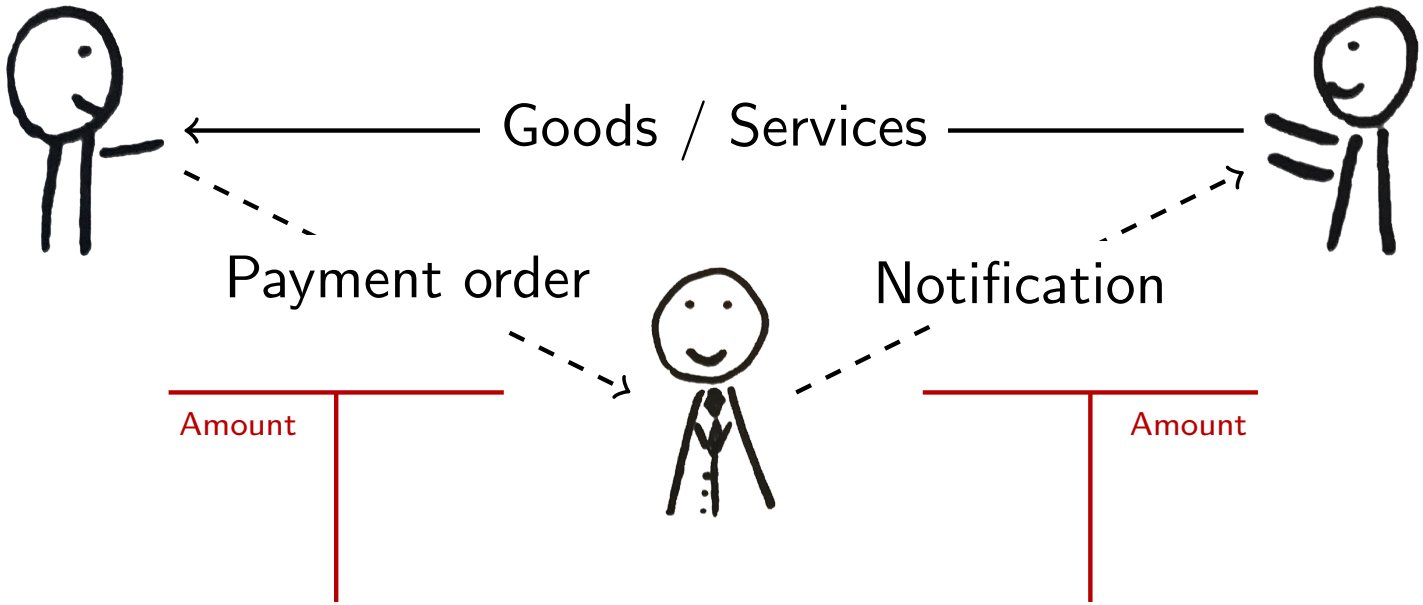
# Today's Solution: Intermediaries Keeping Money Registries



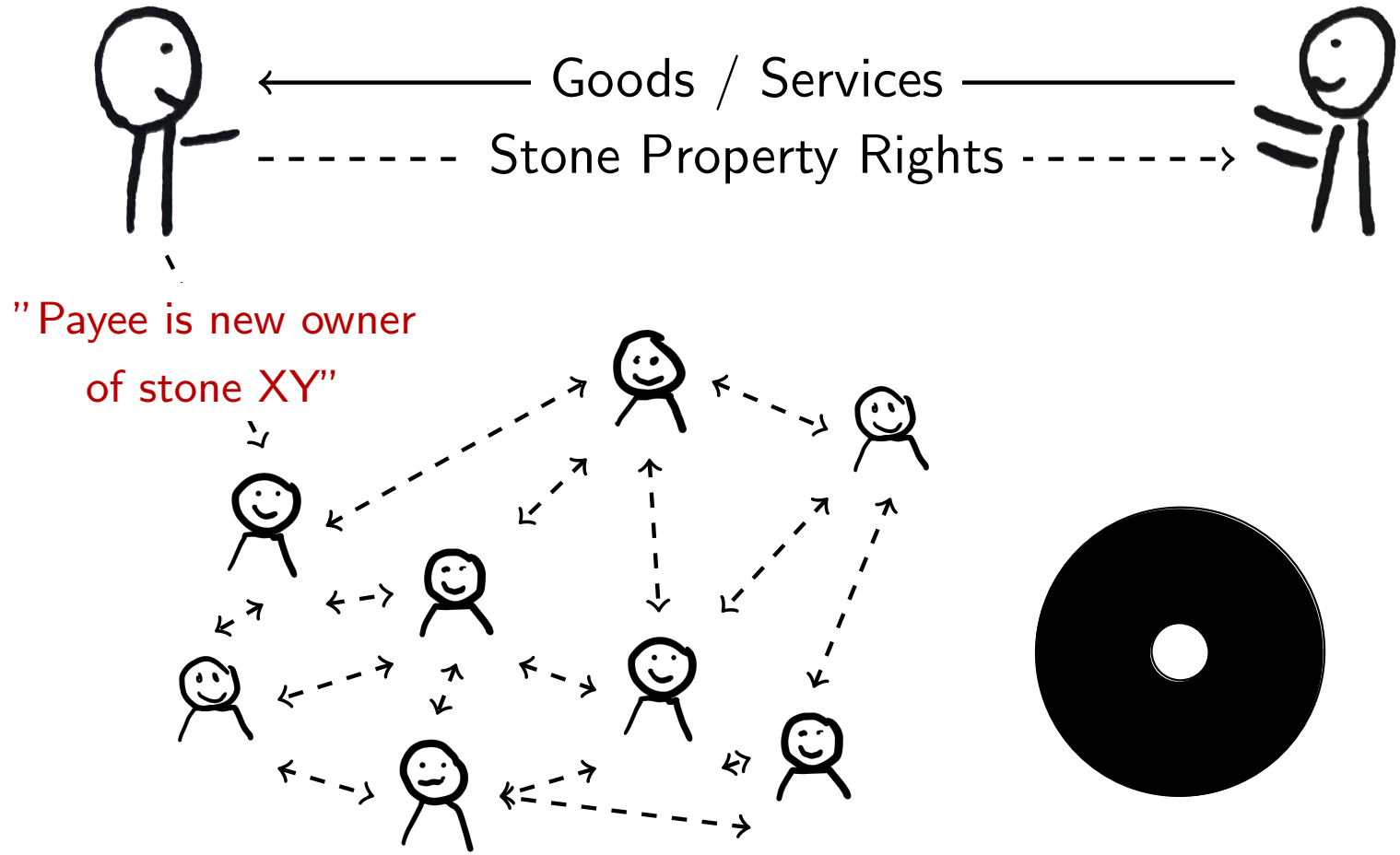

**Registry Types**

**Implicit:** Verbal agreements, limited to small groups.
**Explicit:** Records in written or digital databases.

# Implicit Registry Example: The Stone Money of Yap

Picture source: Eric Guinther

# Implicit Registry Example: The Stone Money of Yap



# Closed Loop Payment Systems

**Defining Characteristics**

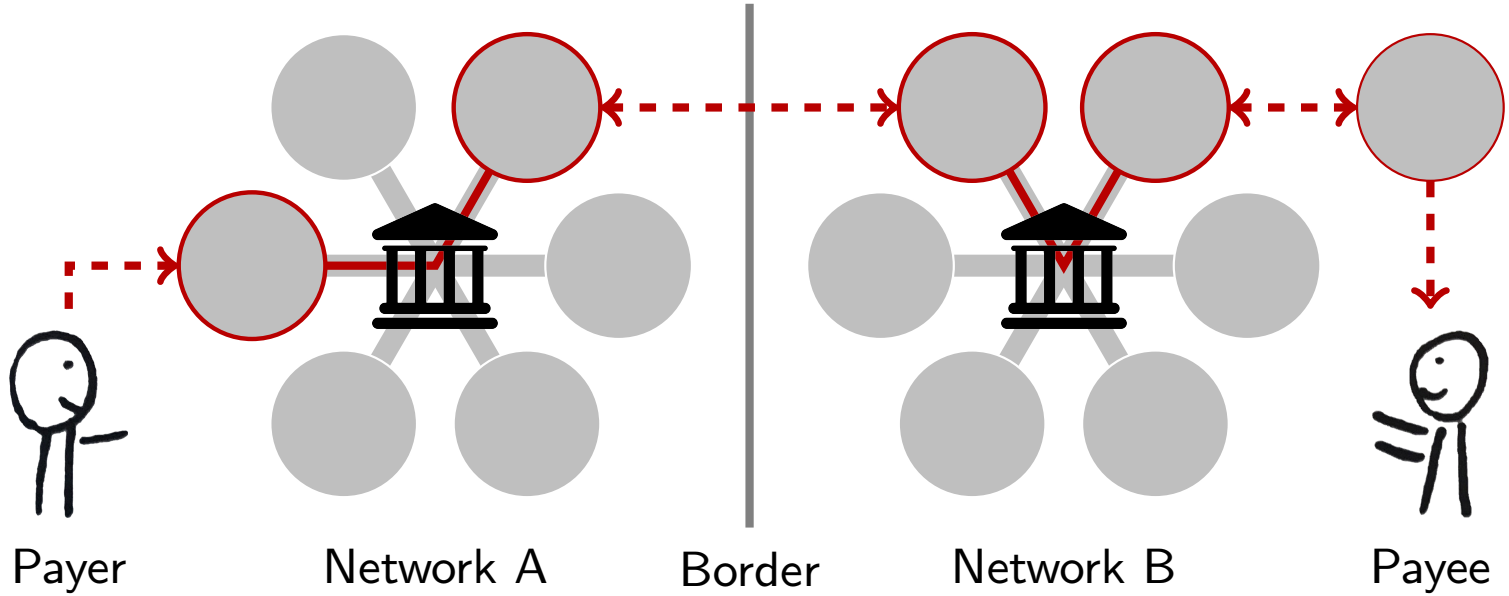
- Direct relationships with both, payer and payee.
- One operator, one set of rules.

**Examples of Closed Loop Systems**

- Merchant issued payment cards
- Western Union
- PayPal
- Several mobile payment services: MPesa, WeChat

$\Rightarrow$ Highly efficient but utility depends on number of end-users.

# Open Loop Payment Systems




**Multiple relationships and rule sets lead to compounding of:**

- Processing time (from switch to settlement)
- Fees (subscription and transaction based)
- Network dependencies
- Exception handling cost (fraud, errors, underfunding)

# Network Examples

**SWIFT**, global scope, since 1970s
Standardized transaction *messaging* system.

**SEPA**, EU and EFTA, since 2008/2009
Payment network for low cost EUR payments with a maximum transmission time.

**Credit Card Networks**, e.g. Visa, Mastercard
Focus on consumer transactions in multiple currencies.

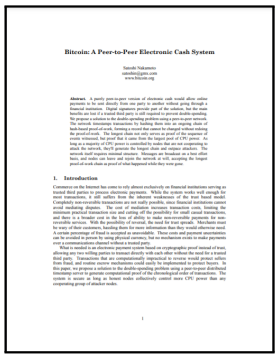
**National Payment Networks**, e.g., SIC, CHIPS, FedWire.
Connecting parties in one currency and one regulatory environment.

# Bitcoin as a Solution?

- A physical cash payment system does not meet today's needs.
- Today's digital payment solutions depend on one or several centrally maintained registries and proprietary networks.
- Centralized registries and proprietary networks introduce single points of failure or attacks, i.e., the risk of data loss, manipulation, or censorship.

$\Rightarrow$ A desirable solution would combine the efficiency of digitalization without dependency on centralized registries and intermediaries.

# References and Recommended Reading


Bitcoin: A Peer-to-Peer Electronic Cash System

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**Abstract.** A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.

1. Introduction

Commerce on the Internet has come to rely almost exclusively on financial institutions serving as trusted third parties to process electronic payments. While the system works well enough for most transactions, it still suffers from the inherent weaknesses of the trust based model. Completely non-reversible transactions are not really possible, since financial institutions cannot avoid mediating disputes. The cost of mediation increases transaction costs, limiting the minimum practical transaction size and cutting off the possibility for small casual transactions, and there is a broader cost in the loss of ability to make non-reversible payments for non-reversible services. With the possibility of reversal, the need for trust spreads. Merchants must be wary of their customers, hassling them for more information than they would otherwise need. A certain percentage of fraud is accepted as unavoidable. These costs and payment uncertainties can be avoided in person by using physical currency, but no mechanism exists to make payments over a communications channel without a trusted party.

What is needed is an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party. Transactions that are computationally impractical to reverse would protect sellers from fraud, and routine escrow mechanisms could easily be implemented to protect buyers. In this paper, we propose a solution to the double-spending problem using a peer-to-peer distributed timestamp server to generate computational proof of the chronological order of transactions. The system is secure as long as honest nodes collectively control more CPU power than any cooperating group of attacker nodes.

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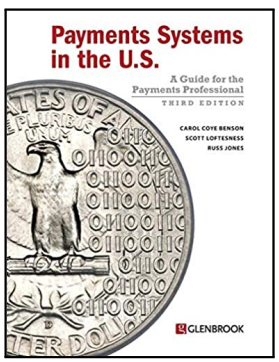
**Bitcoin: A Peer-to-Peer Electronic Cash System**
Satoshi Nakamoto
↗ Online version




**Payments Systems in the U.S.**
Carol Coye Benson
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