



HPC and Big Data applications in Financial Technologies

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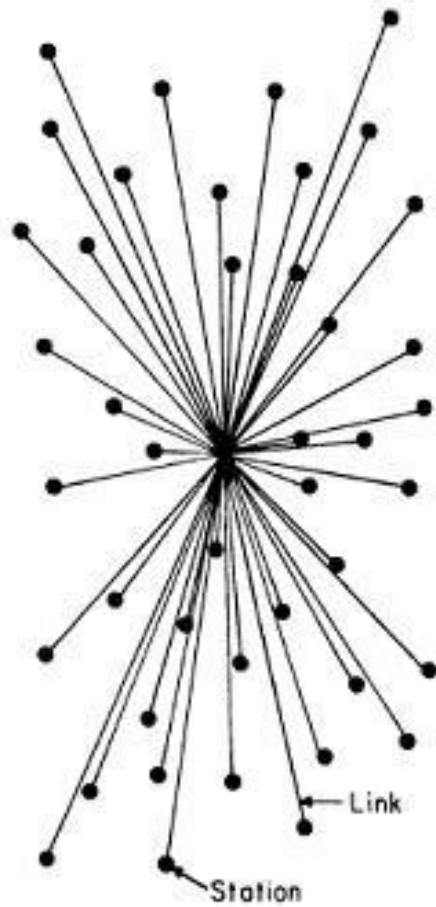
NESUS Winter School, 21 March 2017, Calabria, Italy



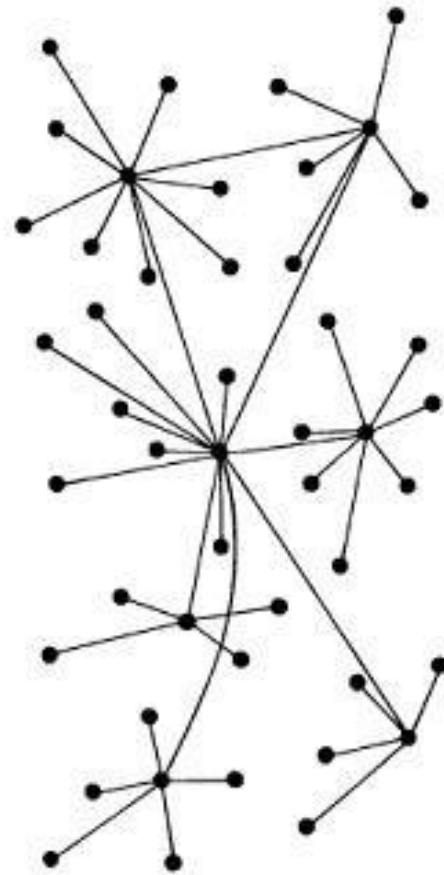
*“Blockchain will do for transactions
what the Internet did for information”*

MIT
Technology
Review

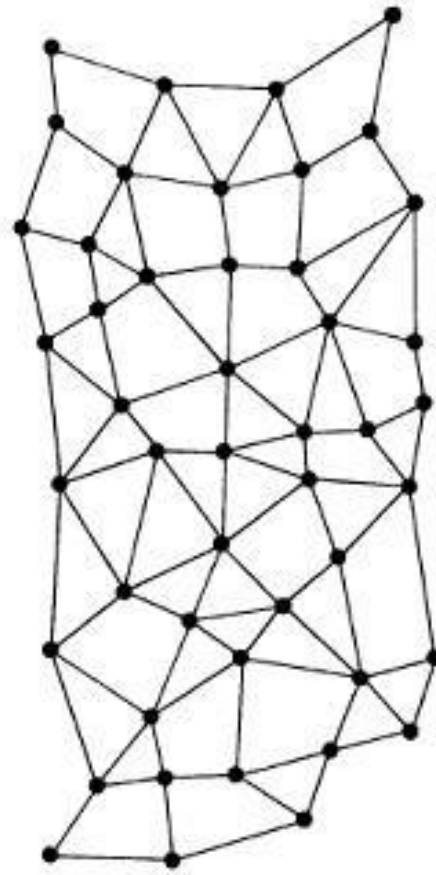
System evolution



CENTRALIZED
(A)

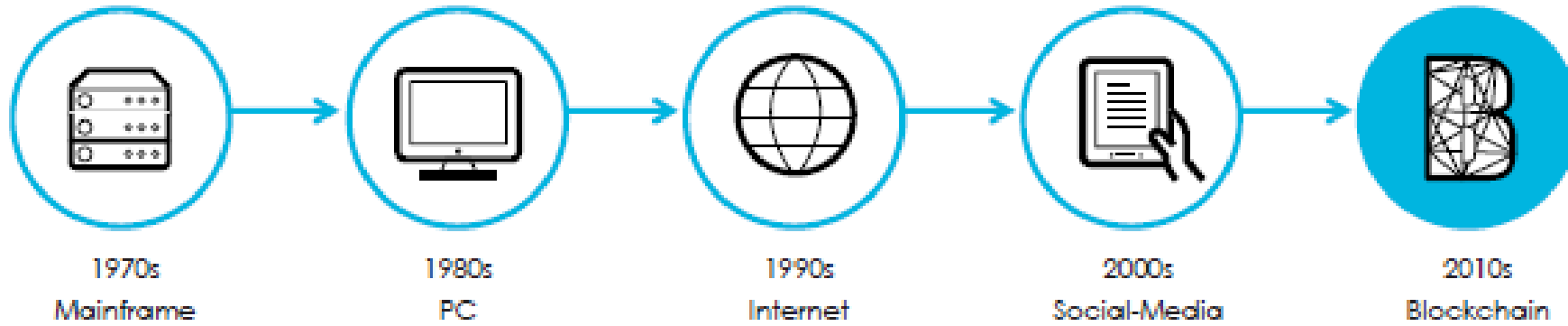


DECENTRALIZED
(B)



DISTRIBUTED
(C)

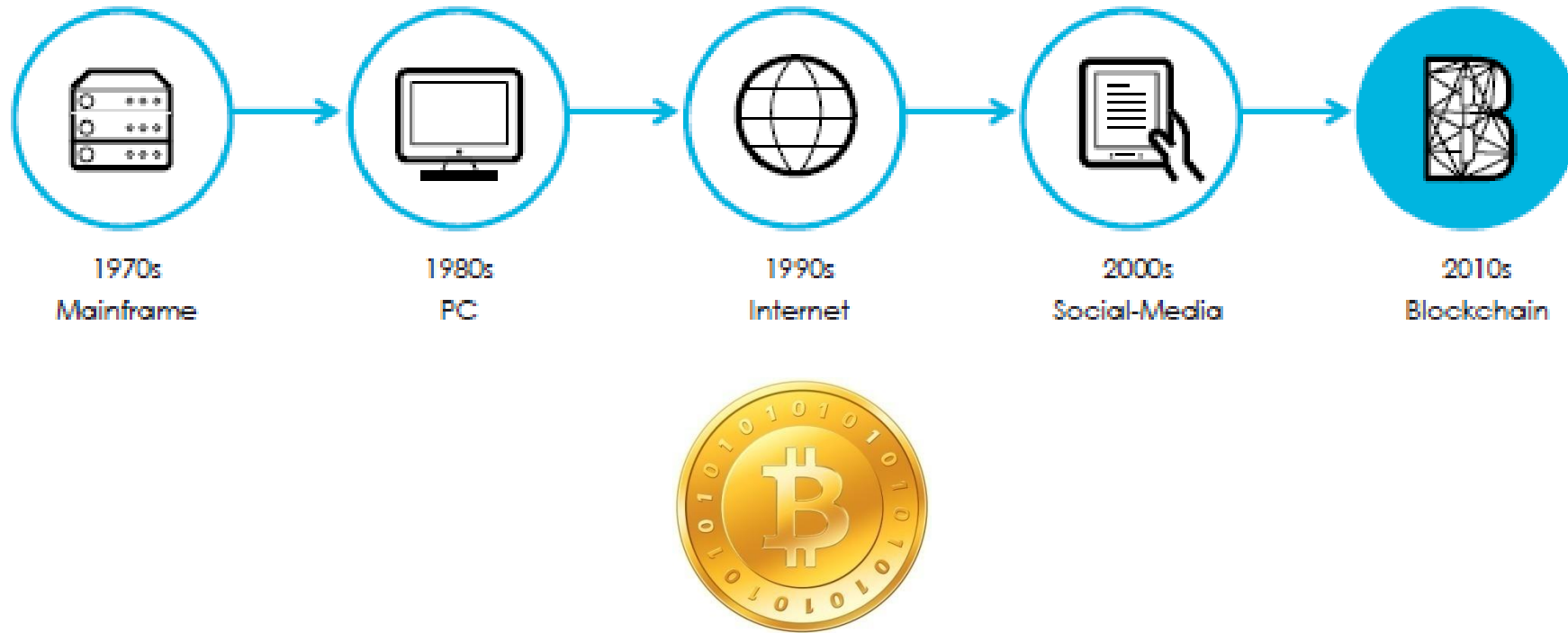
Blockchain technologies



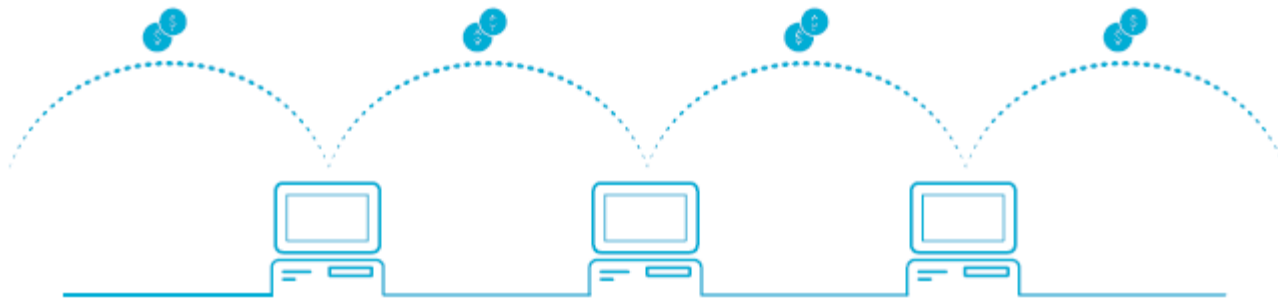
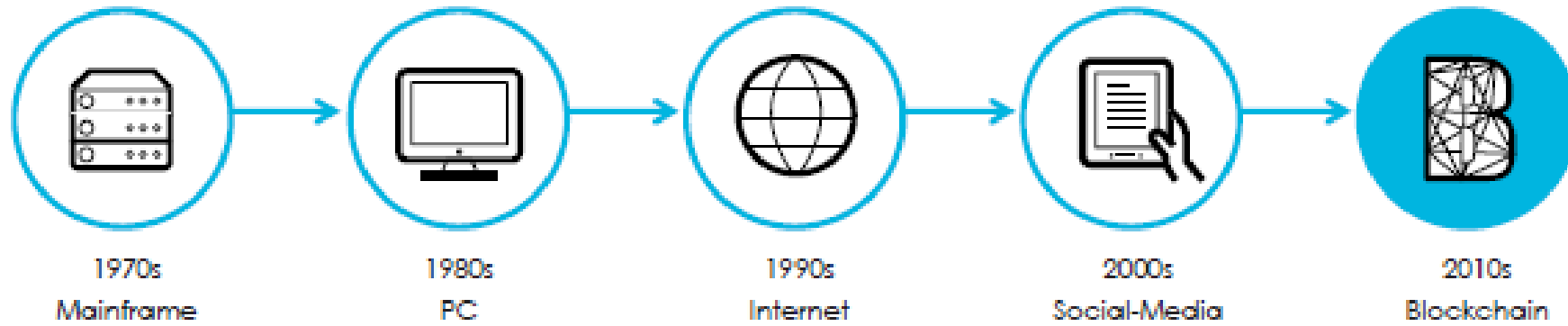
KPMG PwC Deloitte E&Y, Evry

MIT Technology Review
Harvard Business Review

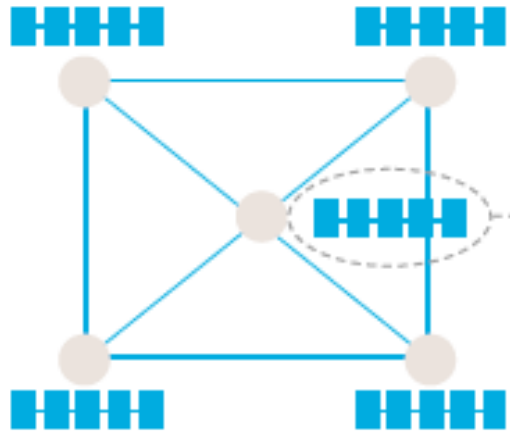
Blockchain technologies



Blockchain technologies



Simplified blockchain network diagram

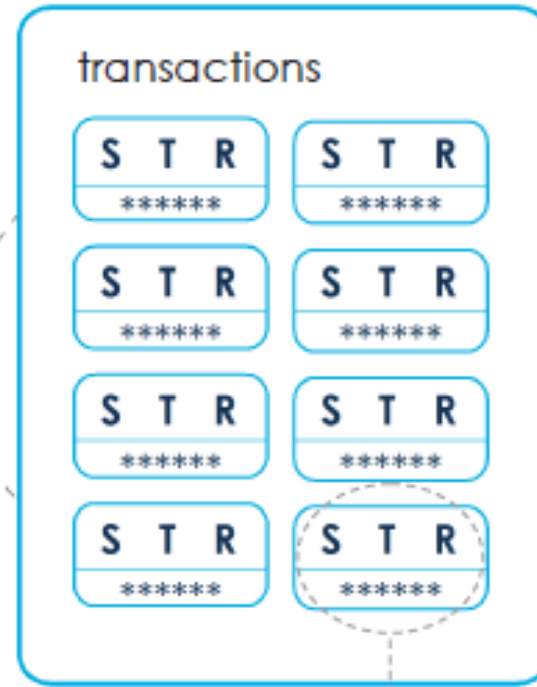


Blockchain

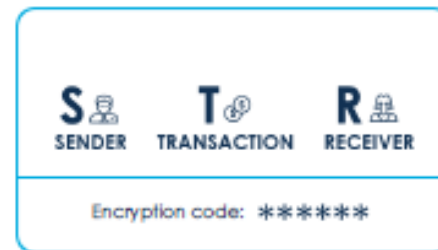


Distributed ledger

Recent block



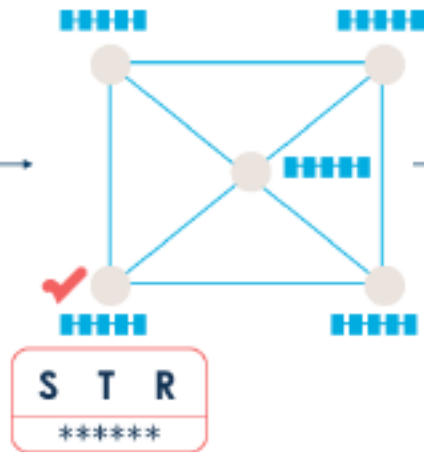
Transaction



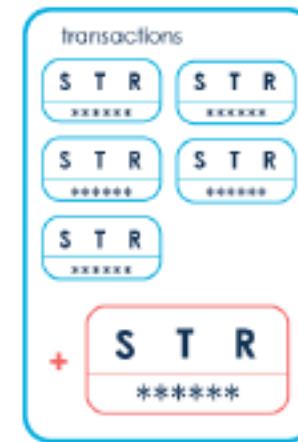
1 Transaction definition



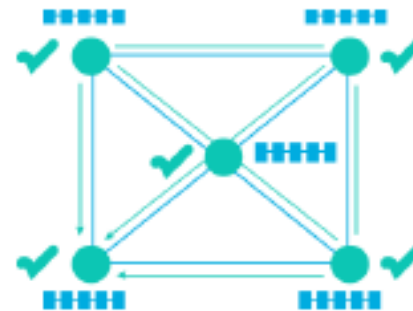
2 Transaction authentication



3 Block creation

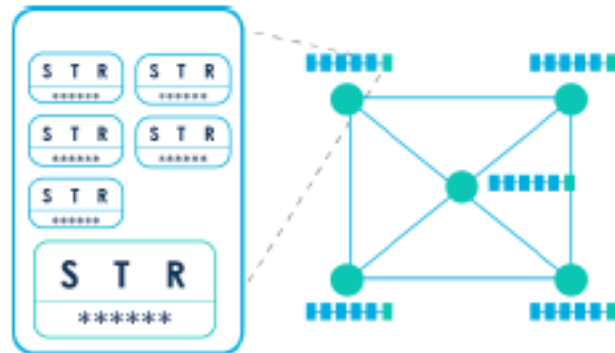


4 Block validation



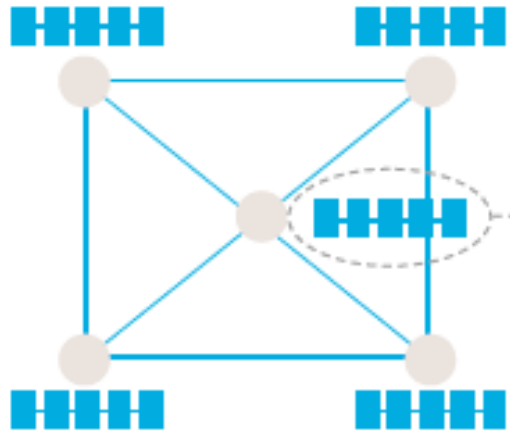
5 Block chaining

Validated block:



- Consensus from the majority of the network
- “Bitcoin mining”

Simplified blockchain network diagram



Blockchain

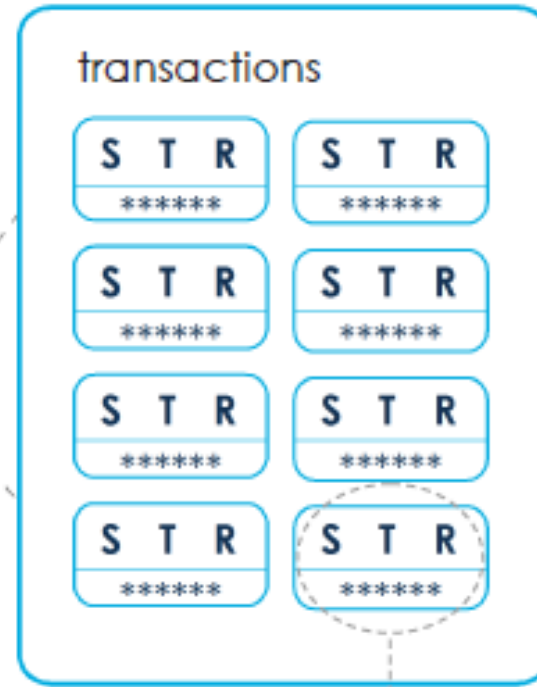


Distributed ledger

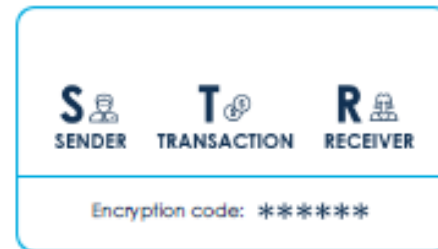


Crypto-currency
Value-registry
Value-ecosystem
Value-web

Recent block



Transaction



Crypto-currencies

- ▶ Bitcoin, Ethereum,...
- ▶ Benefits
 - ▶ Instant payment
 - ▶ No need for payment service provider, so the transaction costs are very low
- ▶ Challenges
 - ▶ High volatility leads to fluctuating value over time
 - ▶ The risk of deflation and inflation cannot be controlled, and only mitigated to a certain extent
 - ▶ There are no monetary policies due to lack of regulator authority

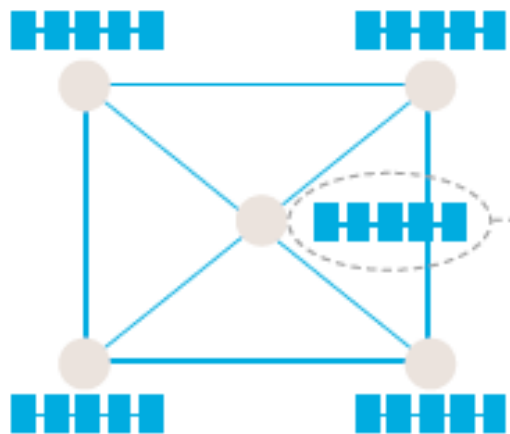
Bitcoin accepting map worldwide from Business Insider



Bitcoin's regulatory issues

- ▶ Luxembourg leads in acceptance
 - ▶ “Bitcoin is a currency”
 - ▶ Luxembourg “passport” for businesses into EU market
- ▶ The European Court of Justice decided to exempt bitcoin transactions from VAT, and in doing so effectively recognized crypto-currencies as a legitimate means of payment within Europe
- ▶ Bitcoin in Switzerland
- ▶ E-Commerce

Simplified blockchain network diagram



Blockchain

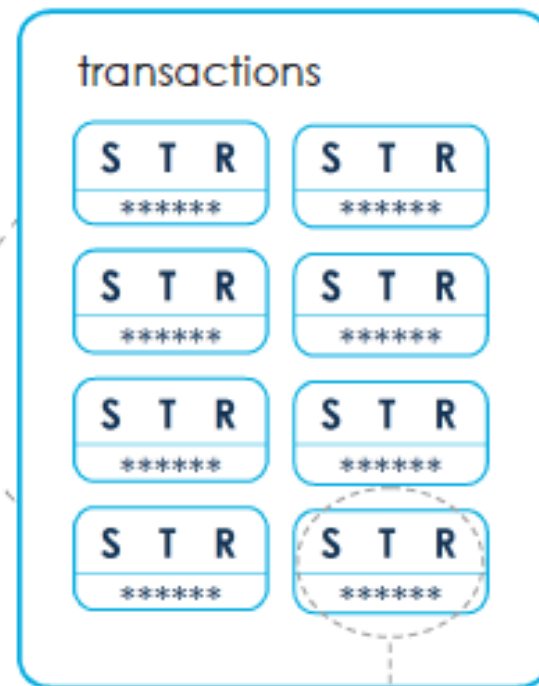


Distributed ledger



Crypto-currency
Value-registry
Value-ecosystem
Value-web

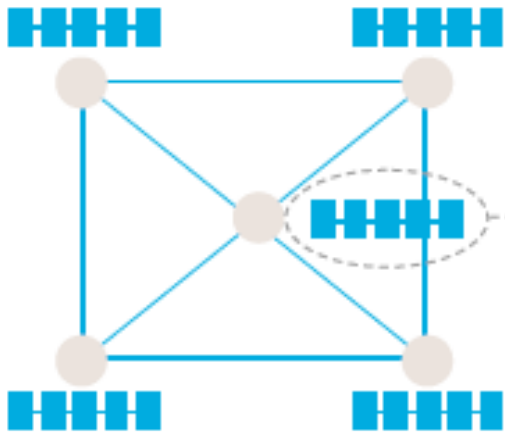
Recent block



Transaction



Simplified blockchain network diagram

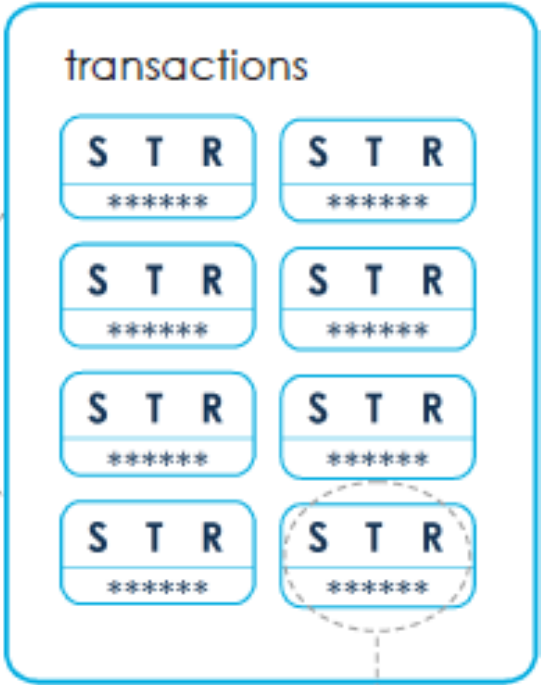


Blockchain



Distributed ledger

Recent block



Transaction



Value registry

- ▶ Public ledger to register physical assets
- ▶ Challenges of traditional document validation models
 - ▶ Relying on central authorities for storing and validating documents
 - ▶ Risks include transfer, breach, and deterioration
- ▶ Blockchain-based solution
 - ▶ Signature and timestamp associated with a document are stored in the blockchain
 - ▶ To register ownership of an asset, a transaction is created with a reference to the physical asset
 - ▶ This information is stored on a Blockchain record, holding roughly 40 bytes of data
 - ▶ The owner of the **private key** to that public record is then registered as the owner of that asset

Examples

- ▶ Factom for Land registry for the government of Honduras
- ▶ Sweden land registry on blockchain

Value ecosystem

- ▶ Ethereum - a public ledger platform that is accessible for all
 - ▶ Allows people to easily create the infrastructure to setup businesses on the Internet
 - ▶ A global platform like eBay and FaceBook
- ▶ R3CEV - private blockchain solution as a global fabric for finance
 - ▶ Secure, scalable enterprise use
 - ▶ Compliance, privacy, reporting and reconciliation
 - ▶ Partnership of 25 global financial institutions

Value web

**SMART
CONTRACTS**

**DOMESTIC
PAYMENTS**

**INTERNATIONAL
PAYMENTS**

**TRADE
FINANCE**

**CAPITAL
MARKETS**

Smart contracts

- ▶ Pre-defined contract
 - ▶ Variable interest rate
 - ▶ Currency of payments
 - ▶ Currency rate
 - ▶ Conditions for execution
- ▶ Events
- ▶ Execute and Value transfer
- ▶ Settlement
 - ▶ On-chain assets (Digital)
 - ▶ Off-chain assets (Physical)

Domestic payments

- ▶ “instant payment solution should become available for end-users in the short-term, consisting of a common scheme cooperatively developed on the market” - **PSD2 directive from the European Commission**
- ▶ Creation of a blockchain solution where Central Bank issues cryptoEURO, allowing **real-time** settlement between banks

International payments

- ▶ Third party is necessary
 - ▶ Automated clearing houses
 - ▶ Correspondent banks
 - ▶ Central banks
- ▶ Ripple and Transferwise example

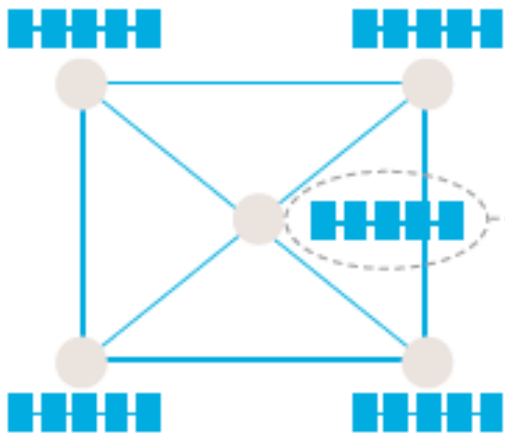
Trade finance

- ▶ Automation of the following process, instead of **paper work**
 - ▶ Extention of credit to customer
 - ▶ Informing the customer of credit status
 - ▶ Communication channels with banks
 - ▶ Updating status of goods
 - ▶ Execution of full or partial payment

Capital market

- ▶ Blockchain-based automation of trading on capital market
 - ▶ Digitalization of assents
 - ▶ Investors
 - ▶ Buyers
 - ▶ Blockchain-based transactions

Simplified blockchain network diagram

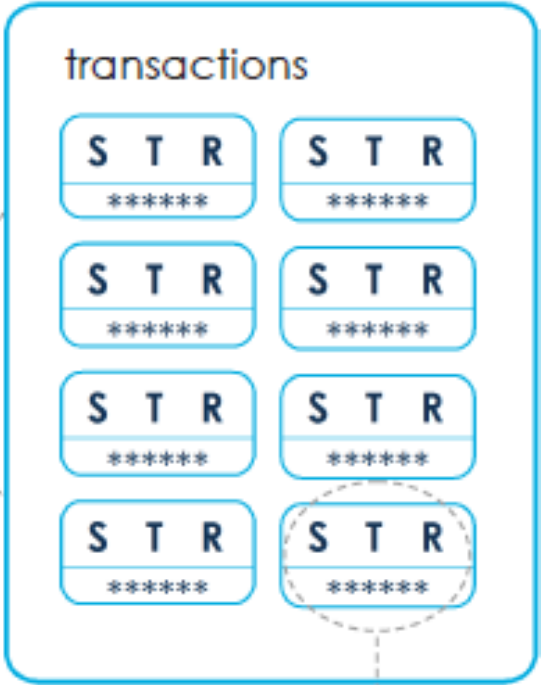


Blockchain



Distributed ledger

Recent block



Transaction

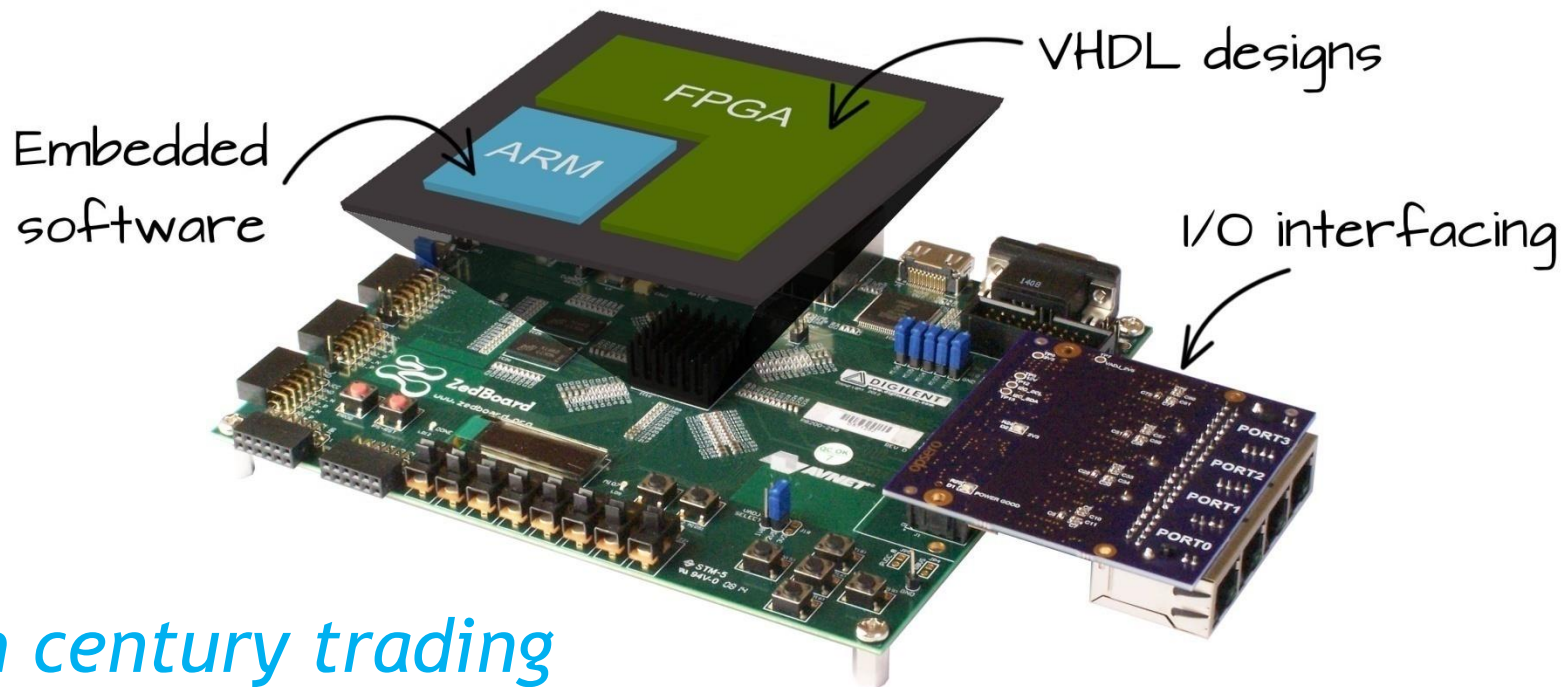




Stock market in 20th century







21th century trading



High Frequency Trading - HPC - FPGA



- **Nanosecond trading!**
- **FPGA vs. ASIC**

“technical problems at the NYSE led to delays as long as five minutes ... at the same time, many high-frequency trading algorithms attempted to exit the market with market orders (which were executed at the stub quotes) leading to a domino effect that resulted in the flash crash plunge”

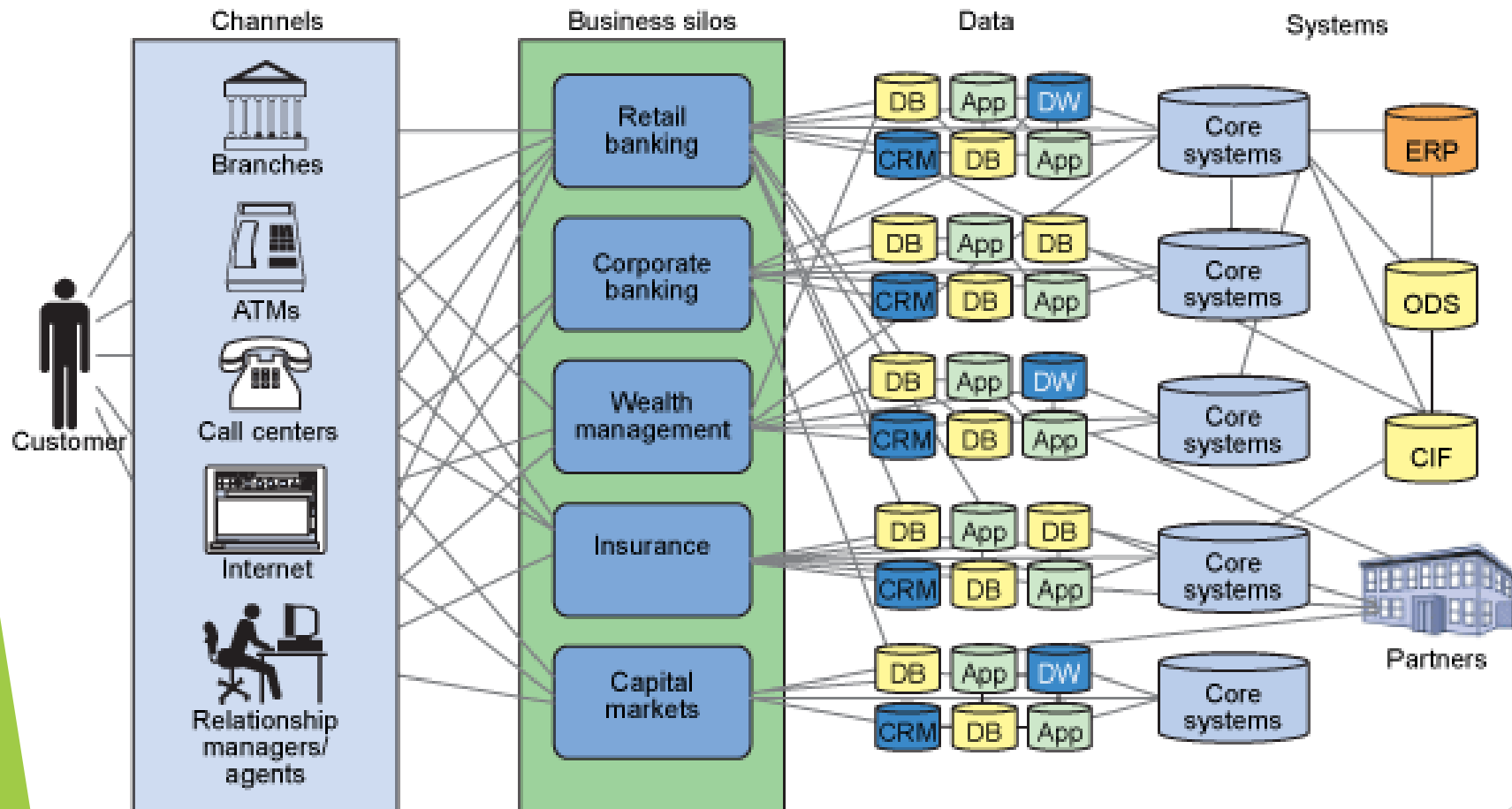
Flood, Joe (August 24, 2010). ["NYSE Confirms Price Reporting Delays That Contributed to the Flash Crash"](#). [Archived](#) from the original on 27 August 2010.

“Banking is necessary, banks are not” –
Bill Gates (2010)



**Harvard
Business
Review**

Banking information system



Source: **IBM**

Terminology

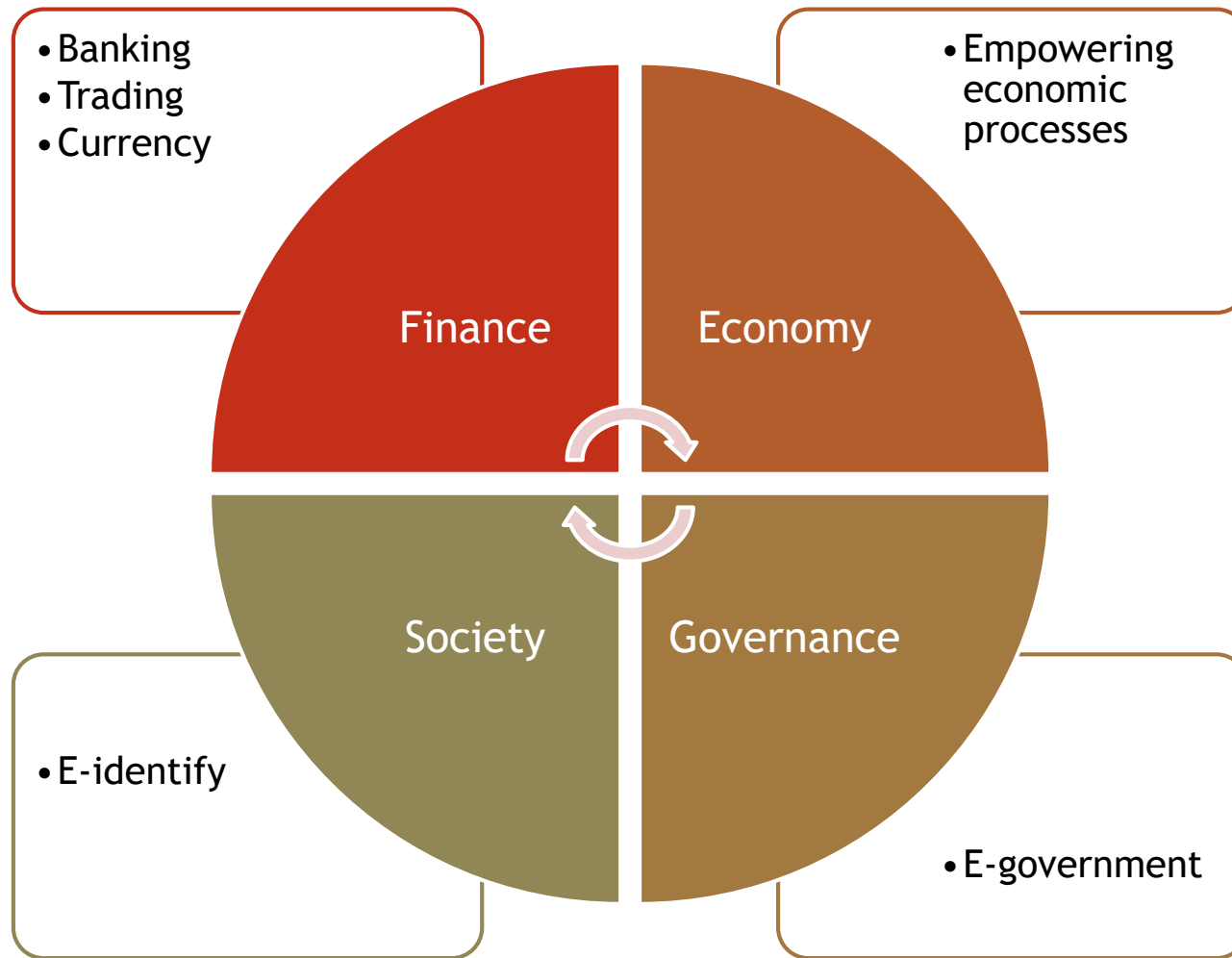
- ▶ ERP - Enterprise Resource Planning
- ▶ ODS - Operational Data Store
- ▶ CIF - Customer Information File
- ▶ CRM - Customer Relationship Management

- ▶ DW - Data Warehouse

Credit rating and Big Data

- ▶ Young people and loans, credit calculation, rating
- ▶ Social web information gathering
- ▶ Recommendation systems

European Consultation consultation on the impact of Blockchain (June 2016)





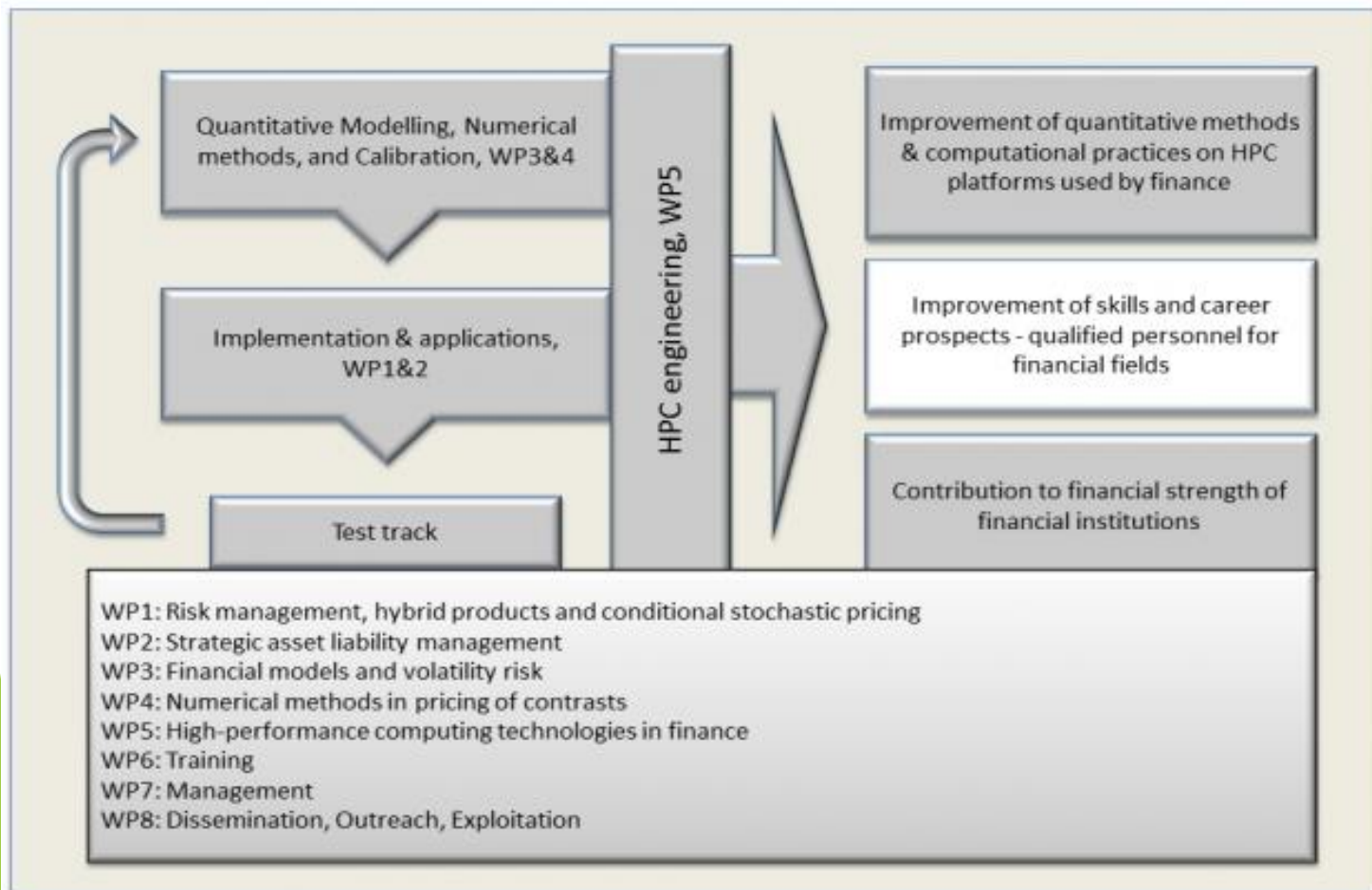
THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MIT FINTECH CERTIFICATE COURSE:
FUTURE COMMERCE

**Are you ready to turn
disruption into opportunity?**

Q&A





WG5 - High Performance Computing Technologies in Finance

5

High Performance Computing
Technologies in Finance

- | | | |
|----|---|---------|
| 11 | Selection and implementation of high-performance platforms in finance: The end-user's point of view | UNIMAN |
| 12 | Distributed computing in finance | TECHILA |
| 13 | Efficient numerical methods on high-performance computing platforms for the underlying financial models | TUT |
| 14 | Multivariate Modeling for Efficient Pricing and Hedging of Multi-asset Derivatives with HPC | AU |