

20598 – Finance with Big Data

Week 10 Lecture: Payment Technology & Foundations of Blockchain

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Final Presentations: Schedule

Day	Time	Where?	Groups
Monday (02/12)	16:30-19:00	Aula 33	1, 9, 4, 5
Tuesday (03/12)	8:30-10:00	Aula D	6, 7, 8
Wednesday (04/12)	TBD	TBD	2, 10, 11

- To be confirmed (let me know if you have some constraints)
- 20' presentation + 5-10' Q&A → bring your slides in a USB key
- Group 3 : Let's coordinate so you present online next week

Written exam

- Exam: 1 hour only
- Calculators allowed
- MCQ + 1 open question (e.g., How alternative data can be used in credit scoring, with what consequences?)
- All answers are in the slides!
 - just to check that you've learnt basic concepts and finance intuitions

Written exam: Examples

Q1. In the Fama-French 3-factors model, what does SMB mean?

- a. Small-Medium-Big
- b. Signal-Minus-Bid
- c. Small-Minus-Big
- d. Strong-Minus-Boost

Q2. An asset has a (nominal) rate of return of 5% per year. Inflation is 3%. What is the real rate of return of this investment?

- a. 1.9%
- b. 2.3%
- c. 5%
- d. 0.5%

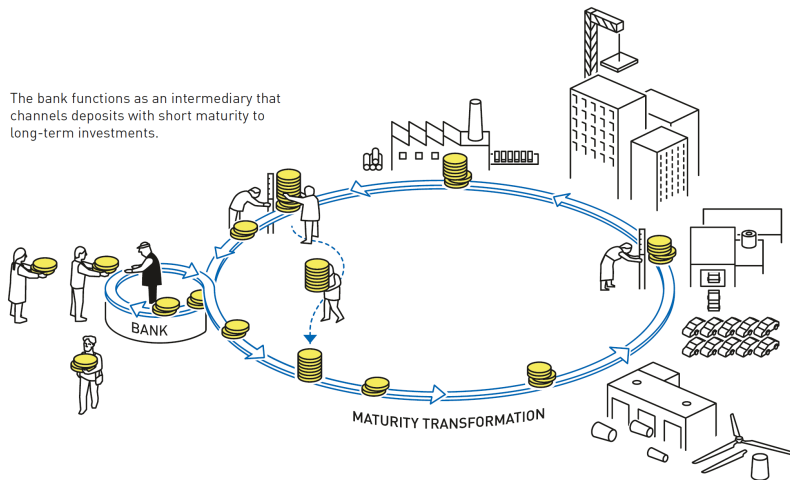
Q3. You have \$50,000 and you borrow \$50,000 from the market (riskless bonds). You invest in three stocks: 200 shares of stock A (\$50 per share), 1,000 shares of stock B (\$60 per share), and 750 shares of stock C (\$40 per share). What are the weights of this portfolio (in this order: A, B, C, and riskless bonds)?

- a. 10%, 80%, 10%, 10%
- b. 50%, 20%, -20%, 50%
- c. 20%, 120%, 60%, -100%
- d. 20%, 100%, 60%, -80%

→ Short and **very simple questions** about basic financial logic/definitions

A Few Weeks Ago: Diamond and Dybvig (1983)

The bank functions as an intermediary that channels deposits with short maturity to long-term investments.



- Liquidity risk: depositors may withdraw their money at the same time = bank run
- Key policy implication: we need a lender of last resort + banking regulation

Two years ago

Diamond & Dybvig (1983) + Crypto =

Two years ago

Diamond & Dybvig (1983) + Crypto =



SBF 
@SBF_FTX

...

1) I'm sorry. That's the biggest thing.

I fucked up, and should have done better.

3:13 PM · Nov 10, 2022 · Twitter Web App

14.1K Retweets **7,285** Quote Tweets **59.4K** Likes

FTX: What and Why?

- FTX was a **centralized exchange platform** for crypto-currencies headquartered in the Bahamas
- Founded by Sam Bankman-Fried (richest under 30)
- Enables customers to trade digital currencies for other digital currencies or traditional money, and vice versa
- Second largest crypto exchange: **1M monthly users**, \$10billion daily trading volume, $\approx$ **\$30bn market capitalization**

FTX: What and Why?

A photograph of Stephen Curry, wearing a brown jacket and a black beanie, smiling and holding a large, shiny silver trophy (the Vince Lombardi Trophy) with both hands. He is standing outdoors in front of a modern building with large windows. The background is a blue gradient with white and yellow dots and lines, suggesting a digital or crypto theme.

**Crypto.
You'll be
anything
but bored.**

 **FTX**
#NotAnExpert

FTX: What and Why?

 **FTX**
arena

[EVENTS & TICKETS](#) [PLAN YOUR VISIT](#) [PREMIUM DINING](#) [GUEST SERVICES](#) [ABOUT](#) [CONNECT](#)

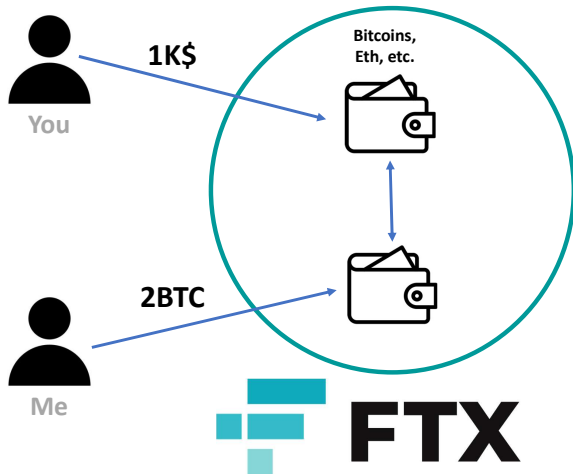
[SEARCH](#) [SIGN-UP](#)

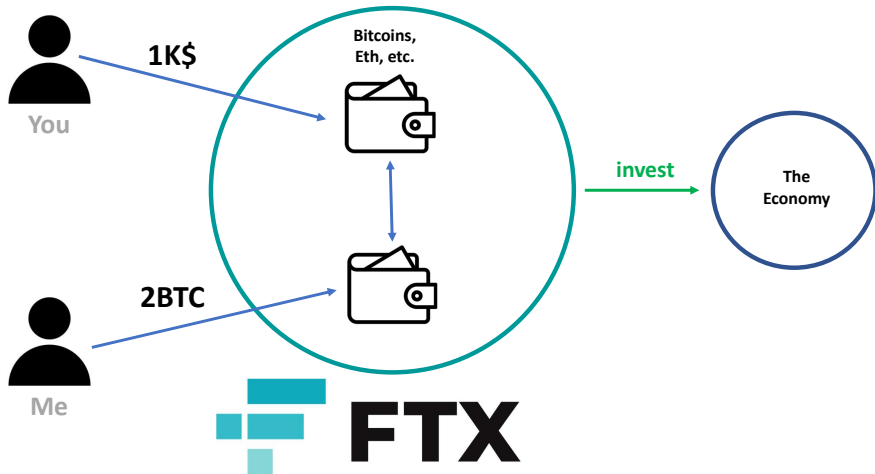


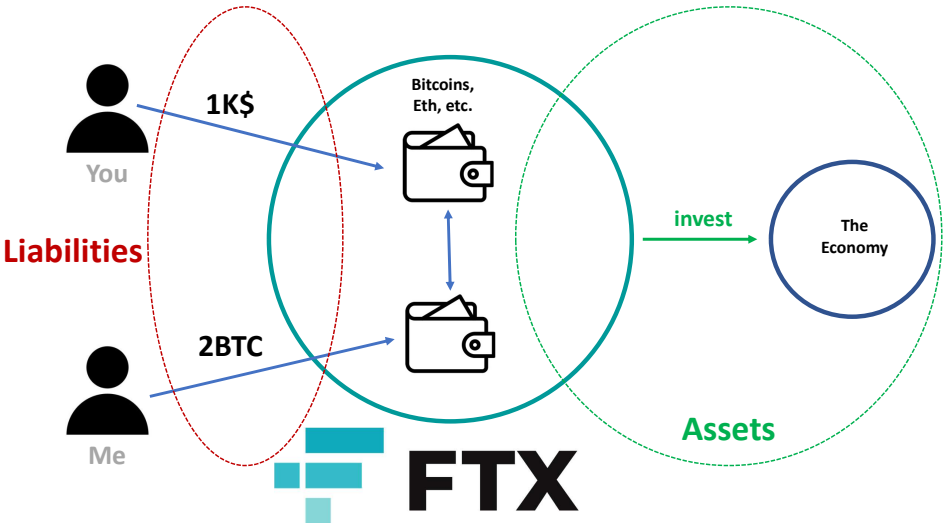
MIAMI-DADE COUNTY AND THE MIAMI HEAT HAVE RELEASED THE FOLLOWING STATEMENT

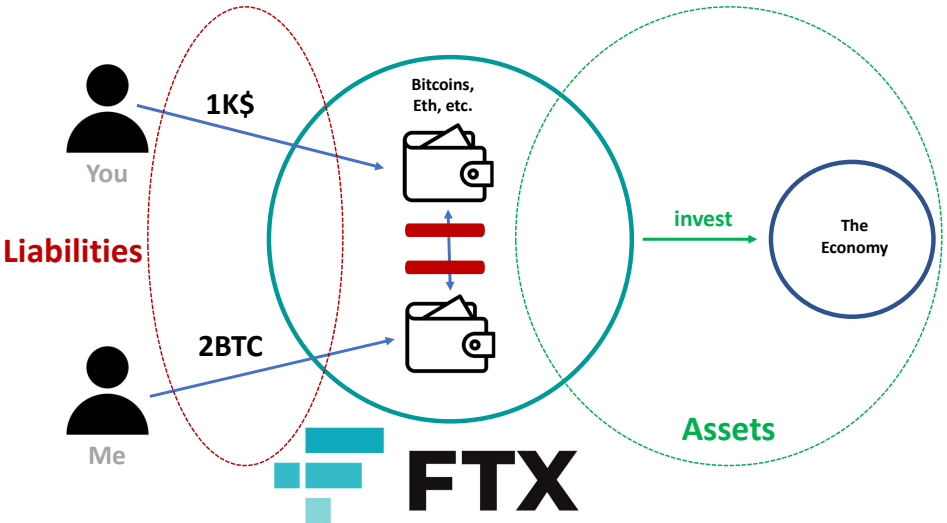
[MORE INFO](#)

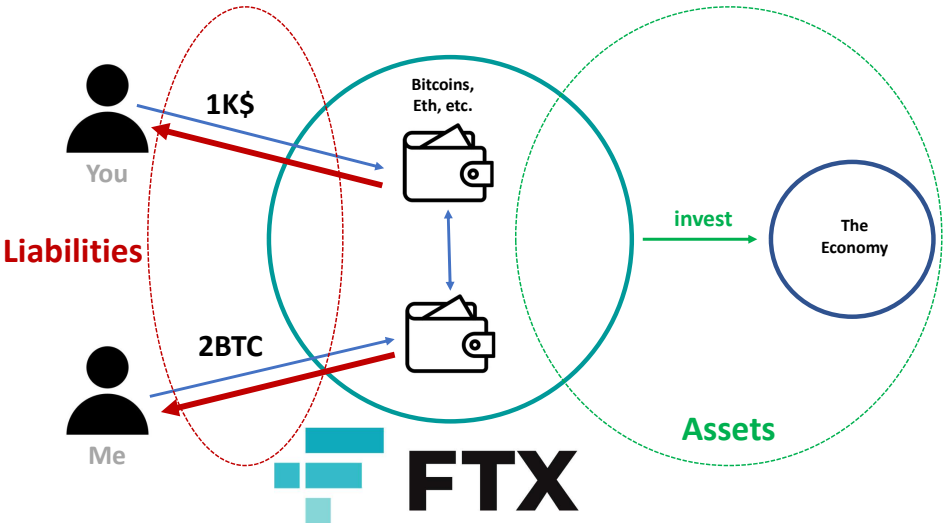




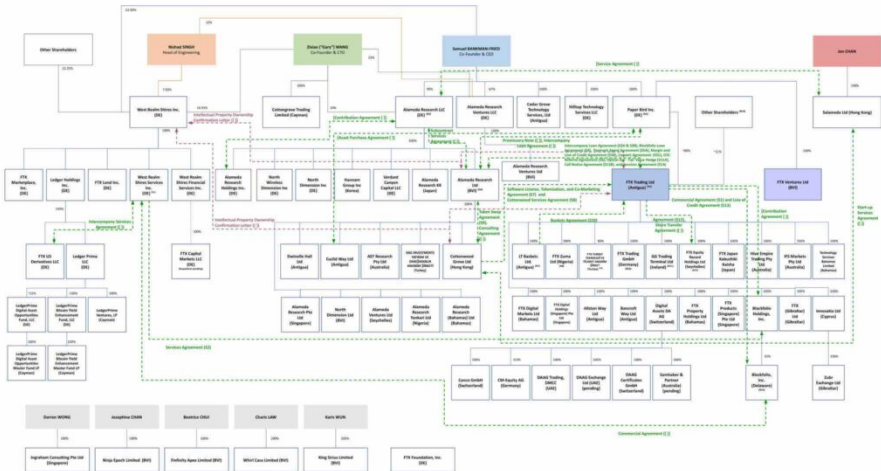








FTX: What did happen?



FTX: What did happen?

	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	Notes: all of these are rough values, and could be slightly off, there is also obviously a chance of typos etc. They also change a bit over time as trades happen.																	
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Source : FTX Balance Sheet by SBF

FTX: What did happen?

	A	B	C	D
1	Note: all of these are rough values, and could be slightly off; there is also obviously a chance of typos etc.			
2				
3		Liabilities		
4			-8,859,042,572	
5		Ticker	Liability	
6		LayerZero	-45,000,000	
7		EUR	-114,536,254	
8		Genesis	-200,000,000	
9		BlockFi	-215,000,000	
10		USDT	-796,482,404	
11		ETH	-671,542,668	
12		BTC	-1,412,738,406	
13		USD	-5,135,280,129	
14		Other	-268,462,711	
15				
16				
17				
18				
19				
20				
21				
22				
23	Hidden, poorly internally labeled "fiat@" account	-8,000,000,000		

Source : FTX Balance Sheet – Zoom on Liabilities by [SBF](#)

FTX: What did happen?

Assets					
Liquid	899,859,124	1,012,262,574	Less liquid	5,449,513,085	15,415,519,517
Ticker	Deliverable now	Before this week	Ticker	Deliverable	Before this week
HOOD	472,291,833	579,183,374	FTT	553,903,773	5,905,299,356
USD in Ledger Prime	200,000,000	200,000,000	SRM	2,187,876,172	5,430,110,335
USDB	73,001,646	73,223,641	SOL	981,902,267	2,245,516,953
DAI	28,491,686	28,464,601	MAPS	616,372,827	865,376,279
DOT	28,384,450	32,522,098	Locked USDT	500,000,000	500,000,000
PAXG	23,767,062	23,244,430	OXY	54,008,094	100,105,976
JPY	21,758,186	21,979,251	STG	45,511,034	66,499,913
TUSD	15,991,381	16,034,265	ETHE	53,155,549	64,420,529
EURT	12,117,879	11,847,808	FIDA	36,492,962	62,127,831
BRZ	9,049,093	8,708,731	MSOL	26,558,417	60,394,582
BRL	7,017,295	6,753,417	ASD	33,946,248	49,967,401
WXRPP	6,987,896	9,298,681	BITW	26,527,697	31,939,957
PAX	1,000,714	1,002,277	Others	17,860,159	29,105,657
			GBTC	3,304,945	4,387,145
			APT	312,092,943	267,602

Source : FTX Balance Sheet – Zoom on Assets by SBF

FTX: What did happen?

- FTX exchange held just \$900mn in easily sellable assets against \$9bn of liabilities the day before it collapsed into bankruptcy
- The vast majority of FTX Trading's recorded assets are either illiquid venture capital investments or crypto tokens that are not widely traded

FTX: What did happen?

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- The company's biggest asset was \$2.2bn worth of a cryptocurrency called Serum. But Serum's market value was \$88mn on Saturday.
 - Serum was created and promoted by FTX and Alameda Research, the FTX-affiliated crypto hedge fund, also founded by Bankman-Fried!
 - SRM value was indexed on FTX performance: it's like owning your own shares (!!)

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 - Serum was created and promoted by FTX and Alameda Research, the FTX-affiliated crypto hedge fund, also founded by Bankman-Fried!
 - SRM value was indexed on FTX performance: it's like owning your own shares (!!)
- On top of that, \$5bn of its own crypto tokens, FTT (they never bought it, they created it)

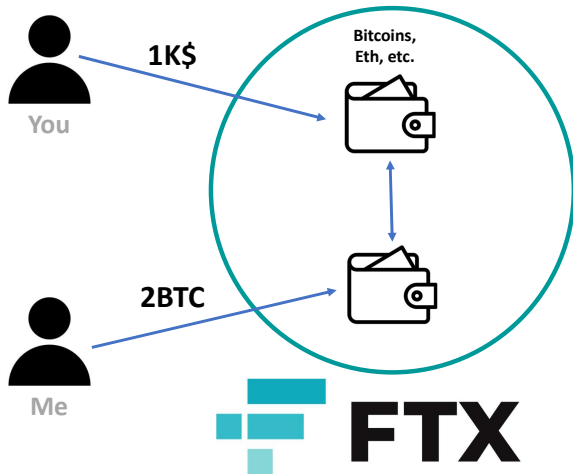
FTX: What did happen?

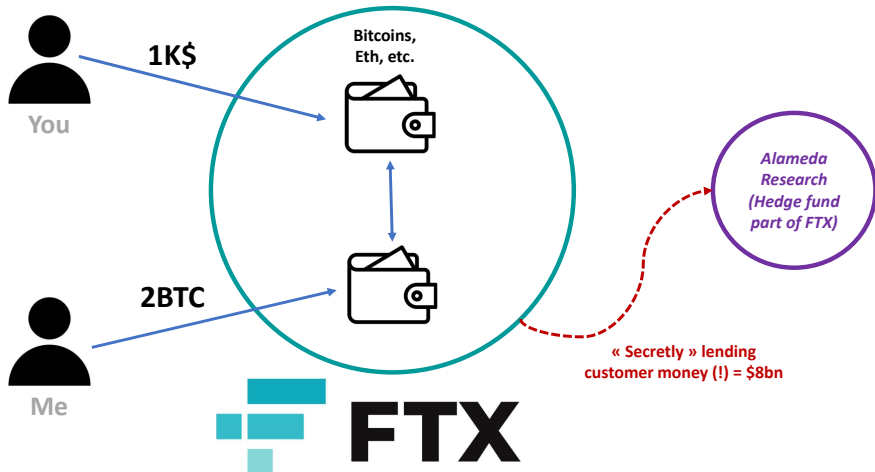
Liabilities: Money customers gave you, which you owe to them;

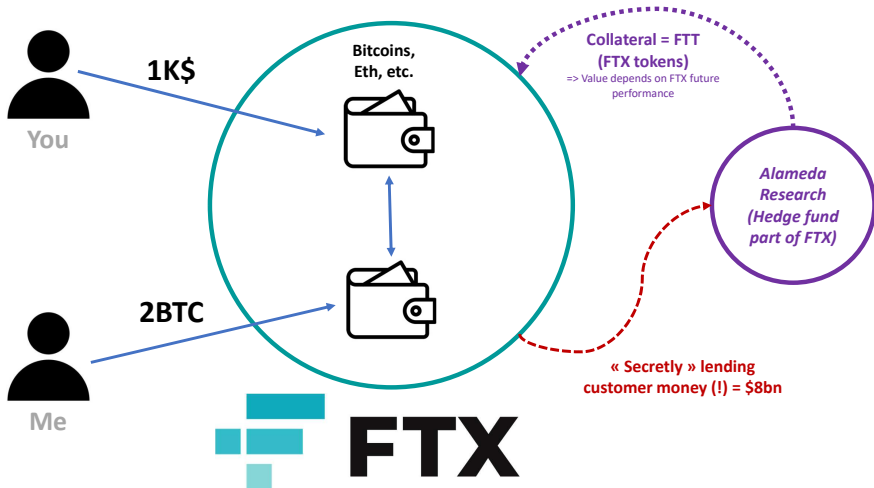
Assets: Stuff you bought with that money.

And then the basic question is, how bad is the mismatch. Like, \$16 billion of dollar liabilities and \$16 billion of liquid dollar-denominated assets? Sure, great. \$16 billion of dollar liabilities and \$16 billion worth of Bitcoin assets? Not ideal, incredibly risky, but in some broad sense understandable. \$16 billion of dollar liabilities and assets consisting entirely of some magic beans that you bought in the market for \$16 billion? Very bad. \$16 billion of dollar liabilities and assets consisting mostly of some magic beans *that you invented yourself and acquired for zero dollars?* WHAT? Never mind the *valuation* of the beans; where did the *money* go?

Source : Matt Levine's [Blog](#)



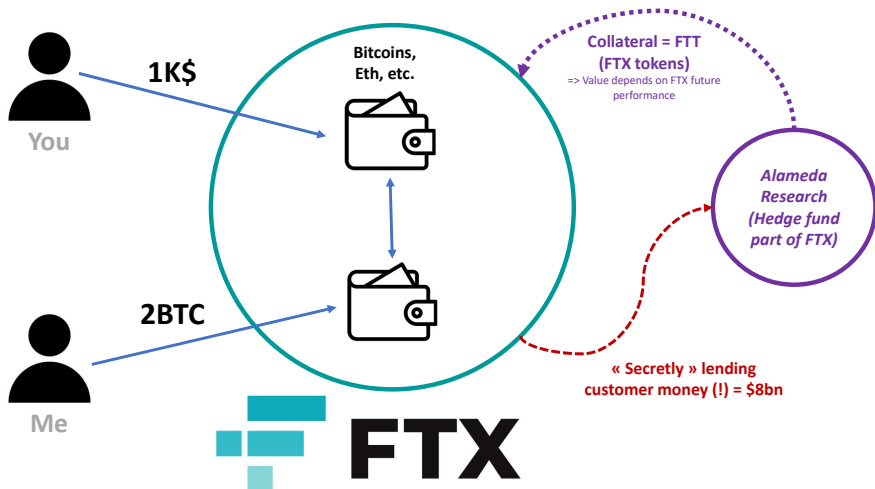




The value of FTT as collateral



Source : CoinMarketCap – [Market Price of FTT](#)



- According to SBF, \$8bn of extra liabilities = old cash deposits from before FTX had bank accounts (debts had been forgotten about for years)

Don't forget about a \$8bn liability

Source : Vox – [article](#)

but not about whether you were lending out customer funds? seems like such an obvious thing for them to worry about!

Yesterday, 9:37 PM

ya

but it's complicated:

a) it wasn't quite lending them out--it was messier and more organic than that; each step was in isolation rational and reasonable, and then when I finally added it all up last week it wasn't

b) most exchanges did some variant on what we did--just not as big and without the run on the bank (at least recently) and more intentionally

c) everyone wants to be clever, and the clever thing to do is some complicated 3d chess involving customer orders or data or something like that which makes no actual sense

like, "oh FTX doesn't have a bank account, I guess people can wire to Alameda's to get money on FTX"

....3 years later...

'oh fuck it looks like people wired \$8b to Alameda and oh god we basically forgot about the stub account that corresponded to that and so it was never delivered to FTX'

Yesterday, 9:41 PM

Don't rely on a Metaverse-based auditing firm

C. Financial Reporting

55. The FTX Group received audit opinions on consolidated financial statements for two of the Silos – the WRS Silo and the Dotcom Silo – for the period ended December 31, 2021. The audit firm for the WRS Silo, Armanino LLP, was a firm with which I am professionally familiar. The audit firm for the Dotcom Silo was Prager Metis, a firm with which I am not familiar and whose website indicates that they are the “first-ever CPA firm to officially open its Metaverse headquarters in the metaverse platform Decentraland.”⁴

56. I have substantial concerns as to the information presented in these audited financial statements, especially with respect to the Dotcom Silo. As a practical matter, I do not believe it appropriate for stakeholders or the Court to rely on the audited financial statements as a reliable indication of the financial circumstances of these Silos.

Source : FTX Chapter 11 First Declaration by John Ray III

Conclusions?

- Nothing specific to crypto



Emin Gün Sirer  @el33th4xor · Nov 19

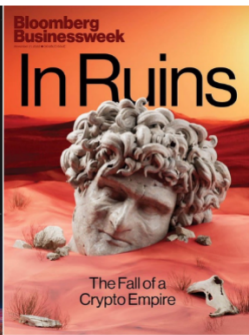
That, plus the thing that failed was a centralized exchange (CEX).

...



Peter Brandt  @PeterLBrandt · Nov 19

This is the type of news that comes at or near a major market bottom
\$BTC \$ETH



 43

 52

 331



Conclusions?

- Nothing specific to crypto but...
- Lender of last resort + regulation is important (Diamond and Dybvig, 1983)
- Transparency (public disclosure)
- Corporate control enforcement + audit: good accounting system for keeping track of where the money is

A Central Bank for crypto?



CZ ♦ **Binance** ✓

@cz_binance

...

To reduce further cascading negative effects of FTX, Binance is forming an industry recovery fund, to help projects who are otherwise strong, but in a liquidity crisis. More details to come soon. In the meantime, please contact Binance Labs if you think you qualify.
1/2

7:39 AM · Nov 14, 2022 · Twitter Web App

- But was it really liquidity risk?

Survey

Who knows how to define:

Who knows how to define:

(i) Blockchain

Who knows how to define:

- (i) Blockchain
- (ii) A Cryptocurrency

Who knows how to define:

- (i) Blockchain
- (ii) A Cryptocurrency
- (iii) A Token

WHERE SHOULD
WE FOCUS
THIS YEAR?

"BLOCKCHAIN"



IT WILL
CHANGE
EVERYTHING.



EVERYBODY
IS TALKING
ABOUT IT.



THE POTENTIAL
APPLICATIONS
ARE ENDLESS.



WE DON'T
WANT TO BE
LEFT BEHIND.



WHAT
EXACTLY IS
BLOCKCHAIN?



ALSO,
"ARTIFICIAL
INTELLIGENCE"



TOM
FISH
BURNÉ

© marketoonist.com

Outline

Payment Technology Evolving

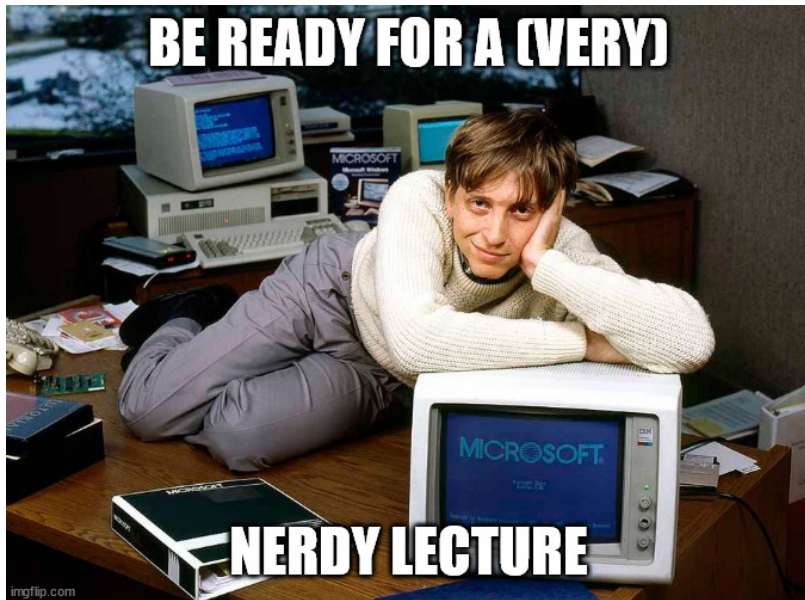
Origins of Payment Technology

Peer-to-peer networks

Cryptography 1-0-1

The first Blockchain

Disclaimer



Payment Technology: Why **should** we care?

- Until very recently, payment technology played a (very) secondary role in the world of finance
- Considered the bureaucratic part of financial business : purely mechanical settling of payments, little upside potential
- Relatively few finance professionals were interested in it

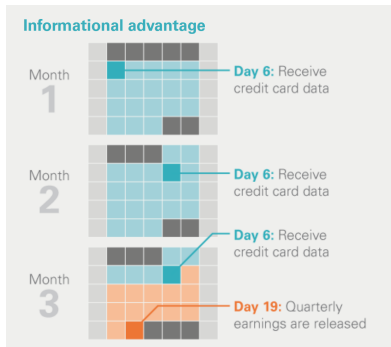
Payment Technology: Why **do** we care?

This has changed dramatically

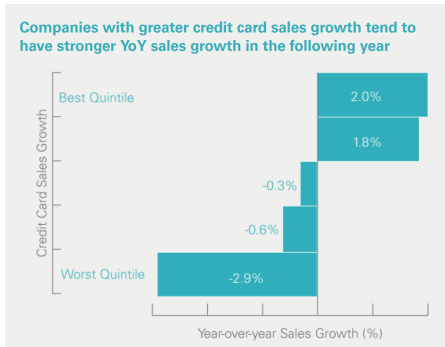
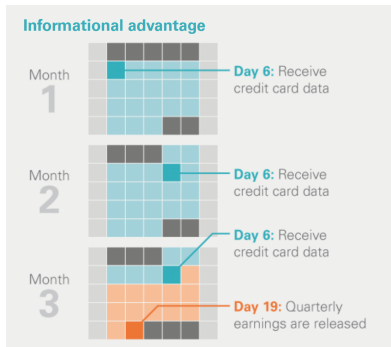
This has changed dramatically

Why?

Earlier this semester: Predictive power of payment data



Earlier this semester: Predictive power of payment data



- Asset pricing, nowcasting GDP, etc. (see Lecture 4)

Earlier this semester: Financial inclusion (?)

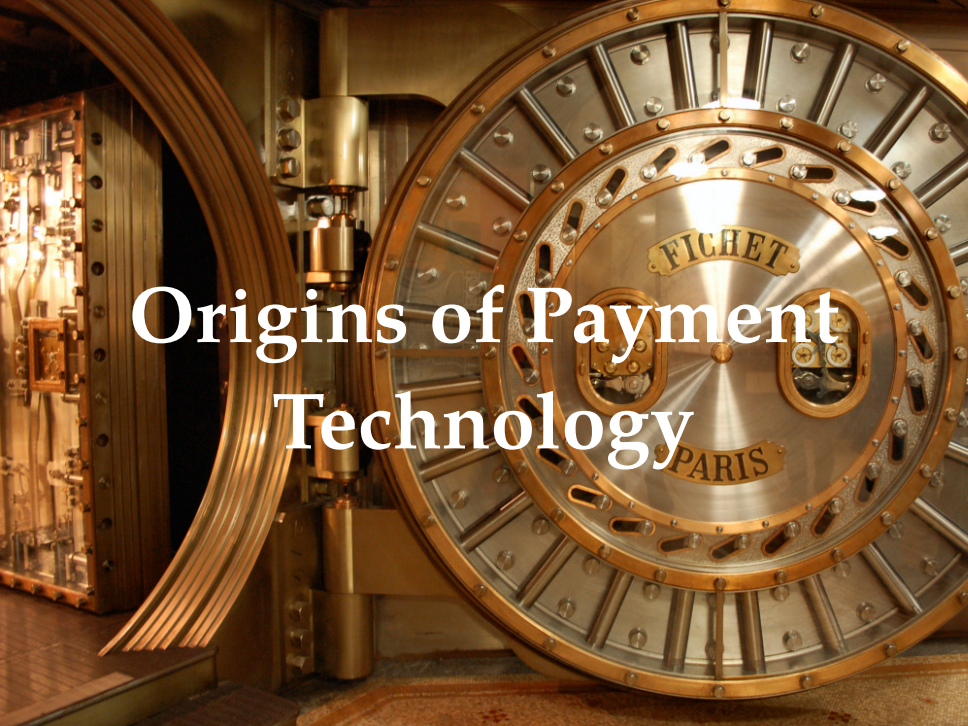
- Digital footprint has been shown to foster financial inclusion
- Credit card data may be a fair substitute to other traditional socio-economic variables (age, gender, race, ethnicity, neighborhood)

Digital payment technology in emerging markets

- Large adoption in emerging markets
- Allows buyers and merchants to ameliorate severe frictions and risks involved with the use of actual cash
 - theft or geographical distance to the next bank

Obviously, the Blockchain!

- Blockchain has put the idea of payment processing upside down
- The most fruitful application of blockchain might not even be payments

A large, ornate metal safe door, likely made of brass or copper, is the central focus. The door features a circular design with a central panel inscribed with 'FICHET' and 'PARIS'. The door is surrounded by a thick, multi-layered metal frame. In the background, the interior of a vault is visible, showing a large, arched opening and a complex mechanical structure. The lighting is warm and dramatic, highlighting the metallic textures and the intricate details of the safe.

Origins of Payment Technology

(Low-Tech) Payment Technology:

(Low-Tech) Payment Technology: Cash



Denarius coin of Marcus Aurelius (Rome, 121-180)

(Low-Tech) Payment Technology: Cash

- Cash is the **most immediate way** to pay for goods or services
- Across cultures, the type of objects that could play a money-like role has been quite different: commodities like metals or seashells to fiat money
- What are the common properties of physical objects that have played the role of money?

(Low-Tech) Payment Technology: Cash

- Cash is the **most immediate way** to pay for goods or services
- Across cultures, the type of objects that could play a money-like role has been quite different: commodities like metals or seashells to fiat money
- What are the common properties of physical objects that have played the role of money?
 - limited supply
 - durable, not easily damaged
 - difficult to forge (so to copy)
 - easy to transport

(Low-Tech) Payment Technology: Cash's drawbacks

(Low-Tech) Payment Technology: Cash's drawbacks

- Precious metal = metal bits were often scraped off the coin before using it
Payees often consulted goldsmiths before accepting a coin
- Easy to steal, not easy to store safely
 - cash is terrible for settling payments at a geographically distant place
 - the risks of loss grew with distance, the probability of acceptance decline with it
- You can find amazing castles and fortresses along all the big historical trade routes in Europe. Why?

(Low-Tech) Payment Technology: Cash's drawbacks

- Problems of cash management and payment over distance → emergence of **warehouse-like intermediaries** (predecessors of modern banks)



- accepting deposits of coins for storage
- issuing deposit receipts that were payable in good money, i.e. intact coins
- netting of claims versus other banks, thus enabling payments to payees in other cities without the transport of physical cash.

(Old-Tech) Payment Technology: Bank deposits as money

I pay you

=

≠

I send the money to
your bank account

(Old-Tech) Payment Technology: Bank deposits as money

In fact, they are clearly **not the same**

- I pay you = you receive **currency**
- I wire money to your account = you receive a private **liability** of a bank: a **deposit**

(Old-Tech) Payment Technology: Bank deposits as money

- Bank deposits **have acquired equivalent function of money**: deposits are transferred easily between many banks and depositors
- For this to work, banks need **reliable channels of settling** claims against each other in definitive currency
- We will now look at what these channels. Do you know some of them?



Payments Infrastructure:

Large Value Payment Systems

Large Value Payment Systems

- Most central banks operate large value payment systems (LVPS) through which banks make and settle payments to each other
 - Settlement refers to the actual payment of an obligation
- LVPS settle extremely large volumes of transactions. How much?

Large Value Payment Systems

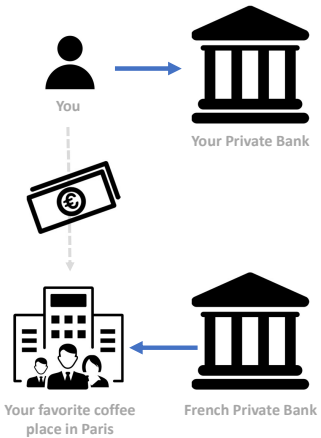
- Most central banks operate large value payment systems (LVPS) through which banks make and settle payments to each other
 - Settlement refers to the actual payment of an obligation
- LVPS settle extremely large volumes of transactions. How much?
 - The European payment system TARGET2 settles every 5 days $\approx$ annual Eurozone GDP (\$14.000 billion).
 - A similar system in the United States is Fedwire.

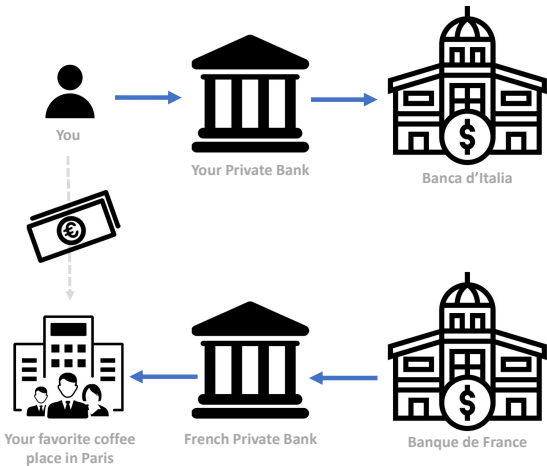


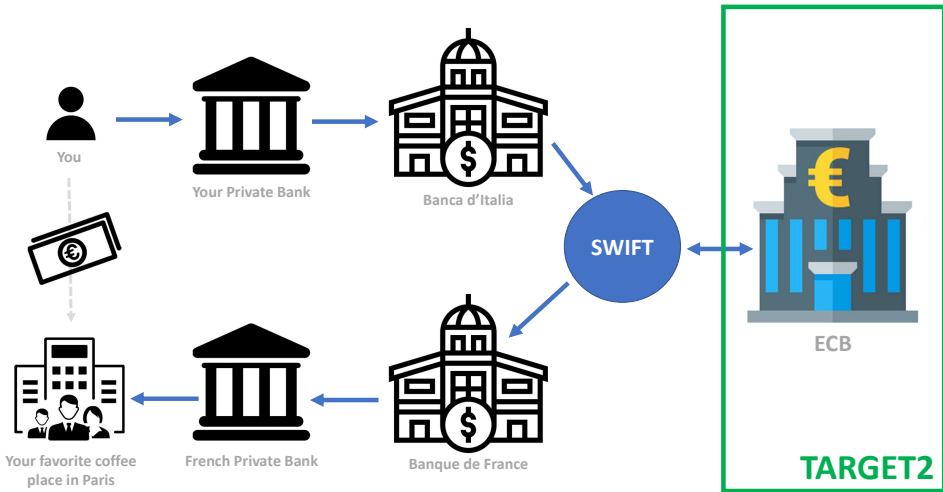
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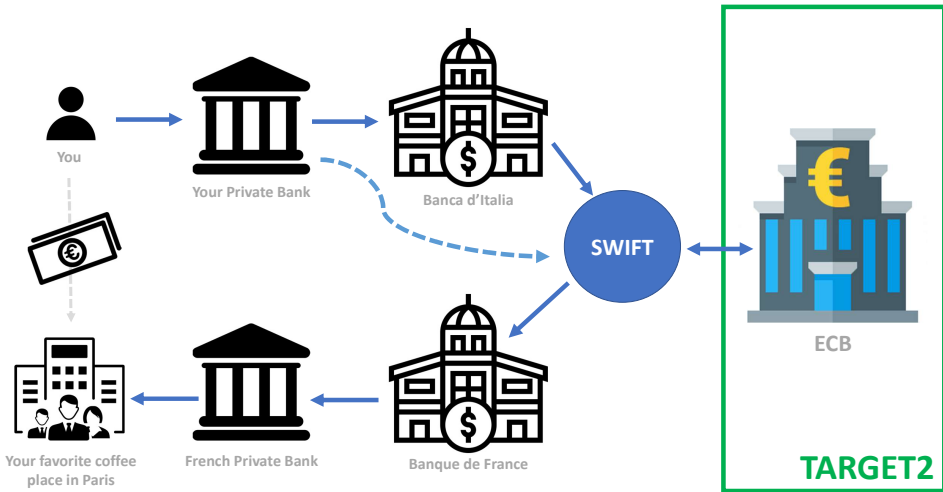


Your favorite coffee
place in Paris





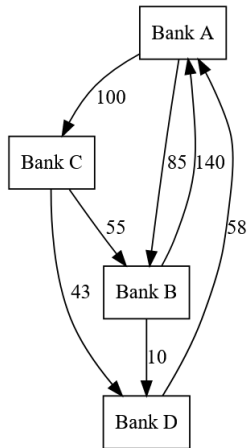




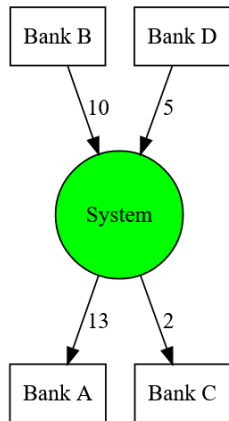
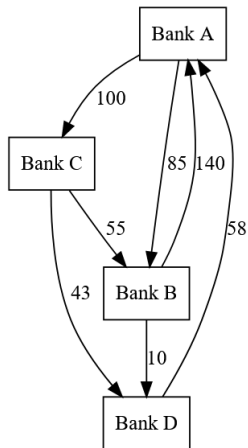
Large Value Payment Systems

- We distinguish two different flavors of LVPS systems :
 - **Deferred net settlement** accumulate payments for a certain period of time and subsequently net all positions
 - **Real time gross settlement** (RTGS) systems instantly transfer the gross amount of funds for every transaction → TARGET2, Fedwire, etc.

Large Value Payment Systems: Deferred net settlement

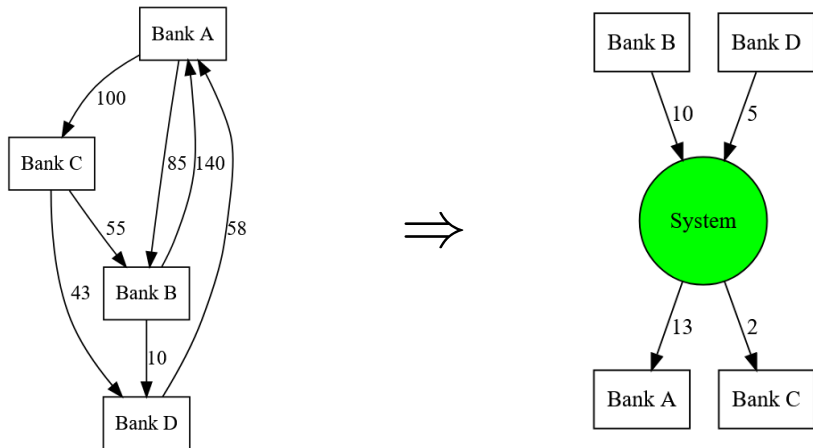


Large Value Payment Systems: Deferred net settlement



- What's the risk?

Large Value Payment Systems: Deferred net settlement



- What's the risk? → What if in the evening at netting, it is found that bank B doesn't have 10 (and goes bankrupt)?

Large Value Payment Systems: RTGS Systems

- RTGS systems settle in real time, so they don't create any credit risk
 - However, RTGS systems have much higher liquidity needs than deferred net settlement systems
 - Even worse, they can suffer from liquidity starvation and freeze up
- Robustness of RTGS systems are a major concern during crises

Large Value Payment Systems: RTGS Systems

- You want to know more?
- [ECB Bluebook](#) on the payment system
- With over 250 pages, it's not a quick read though



RTGS Systems: Innovations

RTGS Systems: Innovations

1. Instant payments

- Payments are only accepted during certain hours of the day
- TIPS which runs since Nov 2018 as an extension of TARGET2

RTGS Systems: Innovations

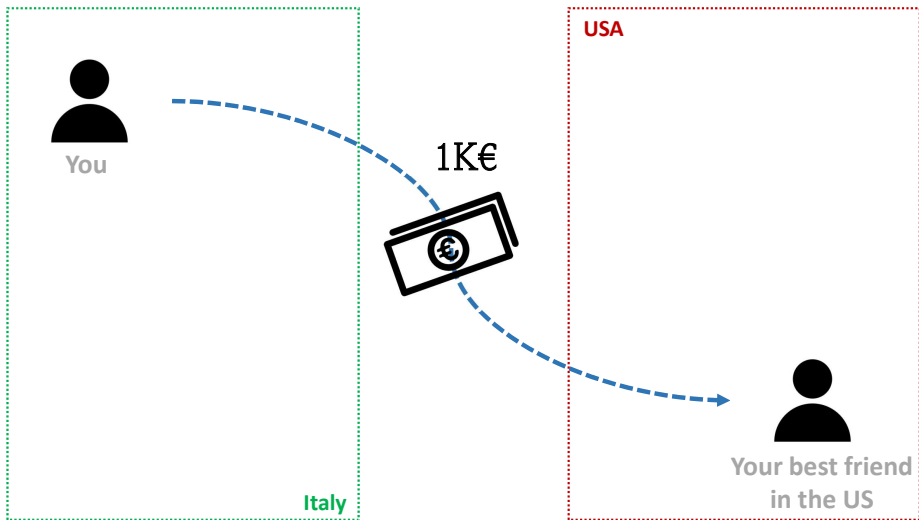
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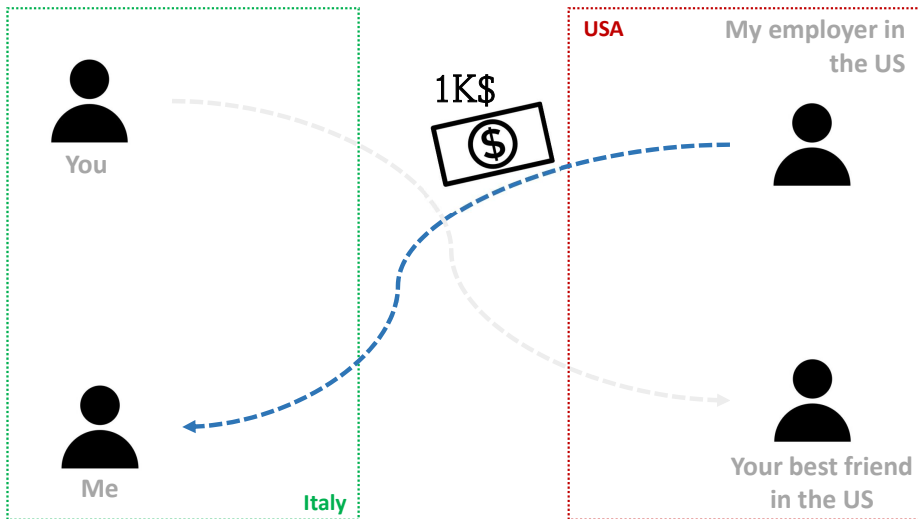
2. Cross border retail payments are a nightmare

- The different currencies, jurisdictions and time zones add many more complications
- Herstatt risk (1974)
- Lot of innovation: Revolut and TransferWise

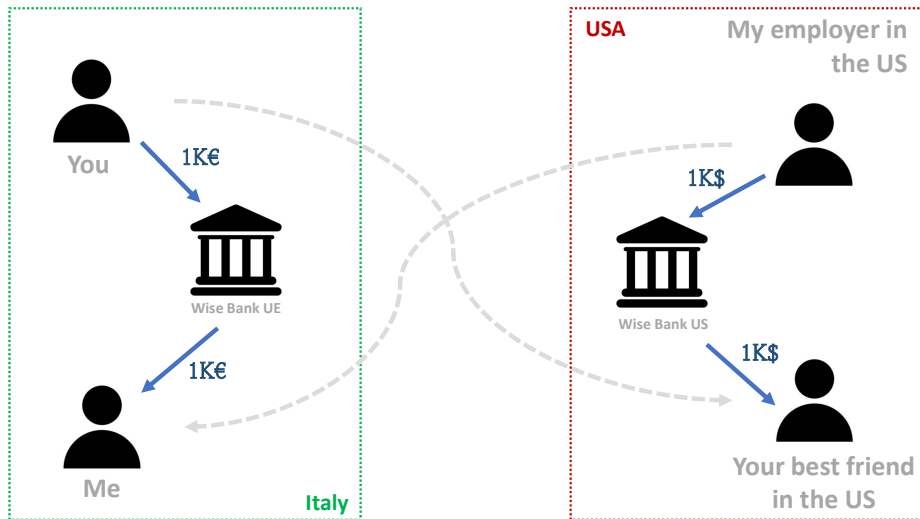
TransferWise: Case Study



TransferWise: Case Study



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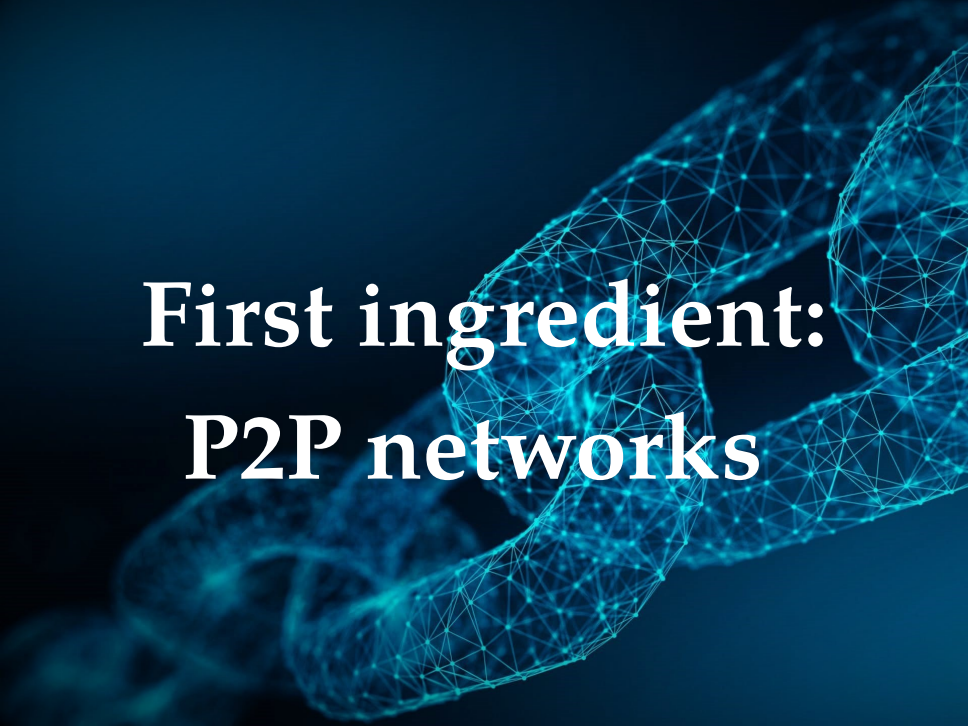
RTGS Systems: Innovations

3. Blockchain for RTGS?

- RTGS systems are centralized, notoriously expensive to operate
 - BoE was unable to settle GBP 290 billion of payments in 2014 when its system went down
 - RTGS systems cannot track the owner of the digital money and are prone to cyberattacks
 - Blockchain by design allows for a more decentralized handling of transactions than traditional settlement systems and thus potentially have better failover behavior, plus they require cheaper hardware and less complex software
- Great, but what is Blockchain again?



5' break

The background of the slide is a dark blue gradient. Overlaid on this is a complex, glowing blue wireframe structure that resembles a network or a molecular model. It consists of numerous small dots connected by thin lines, forming a series of interconnected loops and shapes that flow across the frame from the bottom left towards the top right.

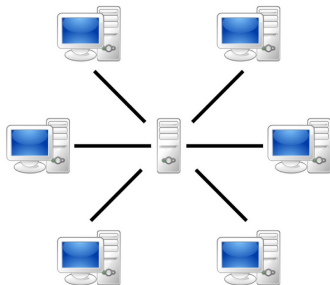
**First ingredient:
P2P networks**

The peer-to-peer origins of Blockchain

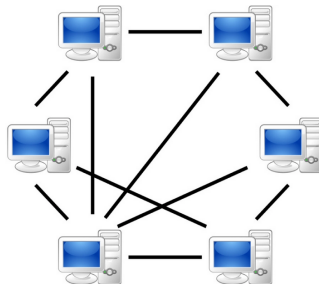
- From a technological point of view, blockchains rely on **old techniques** that already have a long history as cornerstones of peer-to-peer network software
- What are P2P networks?

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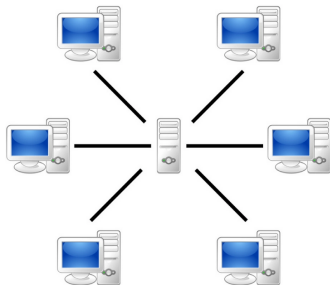
Server-based



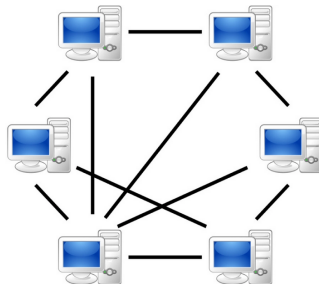
P2P-network

The peer-to-peer origins of Blockchain

- From a technological point of view, blockchains rely on **old techniques** that already have a long history as cornerstones of peer-to-peer network software
- What are P2P networks? **What about the web?**



Server-based



P2P-network

Internet as a P2P network: Every computer can be a server

- Technologically there is no reason that would dictate a strong asymmetry between internet (client) users and servers

```
import socket
server_address = ('localhost', 10000)
sock.bind(server_address)
sock = socket.socket(socket.AF_INET, socket.SOCK_STREAM)
sock.listen(1)
while True:
    # Wait for a connection
    connection, client_address = sock.accept()
    # then do whatever you want to do with the connection
    #....
    connection.close()
```

- With code as simple as this, one can serve incoming requests from other machines

Peer-to-peer networking

- P2P networking is a distributed alternative to the predominant heavily centralized content provision model
- For a P2P network, it suffices to run P2P software which connects to computers of other users that are running the same software
- Prominent application of P2P?

Peer-to-peer networking

- P2P networking is a **distributed alternative to the predominant heavily centralized** content provision model
- For a P2P network, it suffices to run P2P software which connects to computers of other users that are running the same software
- Prominent application of P2P? → the **illegal distribution of copyrighted information** that nobody would want to load on a web server for the fear of legal consequences