



UNIVERSITY *of* NICOSIA

Session 10

Blockchain & Decentralization

DFIN-511 Introduction to Digital Currencies

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Objectives

- Understand the benefits and limitations of blockchain-enabled **decentralization**
- Learn how to think about blockchain in the wider context of innovation and the process of creative destruction
- Explore the world of tokens and the applications of **tokenization**
- Our focus areas will include:
 - Why are blockchains considered so revolutionary? In other words, what is the real underlying promise of the distributed ledger technology and how can this promise materialize in specific applications?
 - Which of the many application areas of blockchain hold the most promise for the future? What differentiates truly disruptive from simply interesting applications?
 - Is tokenization the future of blockchain? What are the main use cases of tokenization and why are they considered so innovative?

Agenda

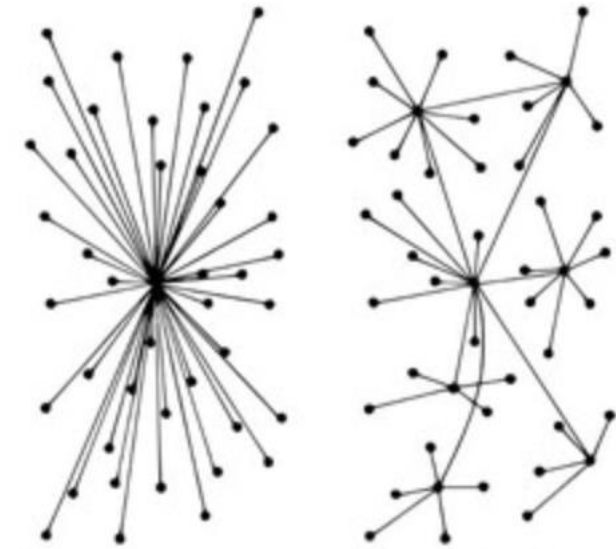
1. Towards a decentralized world
2. Innovation & the process of creative destruction
3. Stage I: Disintermediation
4. Stage II: Cybermediation
5. Tokenization
6. Conclusions
7. Further Reading

Session 10: Blockchain & Decentralization

1. Towards a Decentralized World

Centralization dominates

- The oxford dictionary defines centralisation as:
“The concentration of control of an activity or organization under a single authority”
- Almost all record-keeping is **centralized or semi-centralized**
- Trusted **record-keepers** keep track of transactions and status
 - Banks: financial transactions & account balances
 - Land registries: real estate transactions & asset owners/status
 - etc.



Centralization is so prevalent that we take it for granted



So, what's wrong with centralization?

- Record-keepers **must be trusted**
 - But, are they always trustworthy? (business failures, corruption, hacking, etc.)
- Record-keepers are **gatekeepers**
 - They control who can participate in the system and what transactions can take place
 - They control who has access to what data
- Record-keepers are **Single Points of Failure (SPF)**
 - They may lose records
 - They may be hacked
 - They may cease functioning due to force majeure
 - Research has shown that the **large size of individual firms**, such as banks, is a source of **systemic risk***

*In the context of finance systemic risk refers to the breakdown of the entire financial system, rather than simply the failure of its individual parts (e.g overdrawn banks)

Toward decentralization

- Decentralization is the antithesis of centralisation. It is defined as “The transfer of control of an activity or organization to several local offices or authorities rather than one single one.”
- **Decentralized systems** do not have gatekeepers/SPF
- Still, they allow unknown/untrusted parties to transact together on a peer-to-peer infrastructure
- What are the most well-known decentralized networks today?
 - **The Internet**
 - **Bitcoin** (and similar open, permissionless networks)



Characteristics of decentralized systems

Advantages:

- **Peer-to-peer:** transactions take place without intermediaries
- **Distributed:** the network is its participants
- **Reliable:** significant amount of replication
- **Censorship-resistant:** no party controls the flow of data
- (may be) **Public:** transactions may be publicly available/verifiable
- (may be) **Open / Permissionless:** anyone may be able to participate in the network
- (may be) **Immutable:** transactions may be permanently recorded and/or unalterable

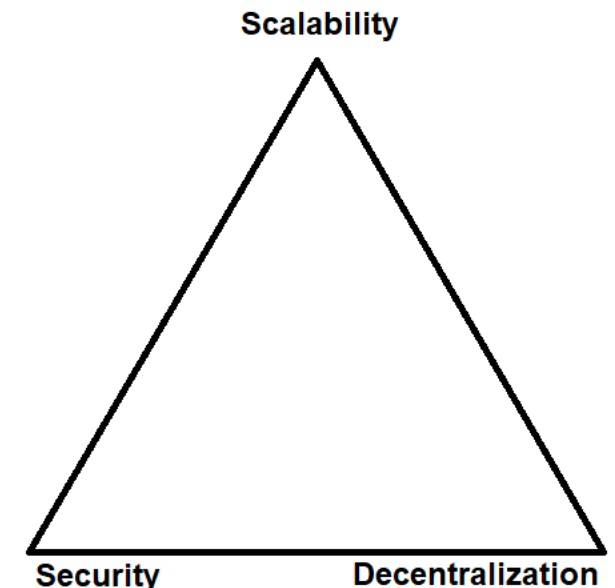
Disadvantages:

- **Secure:** majority of participants must be benevolent, otherwise not
- **Fast:** typically much less so than equivalent centralized systems
- In the context of blockchain, the limitations of decentralised systems are summarised by a term known as the “Blockchain Trilemma”.

Characteristics of decentralized systems

- The disadvantages (limitations) of decentralised blockchain systems are summarized by the **blockchain trilemma**, proposed by Vitalik Buterin.
- It states that blockchains **by desing** can **only** be:
 - Scalable and Secure, **but not Decentralized**
 - Secure and Decentralized, **but not Scalable**
 - Scalable and Decentralized, **but not Secure**
- The blockchain trilemma is an oversimplification of the **mutually exclusive choices** made by developers, users, speculators etc
- It explains why so many different blockchain protocols exist
 - **Different priorities**, result in **different design tradeoffs**

The Blockchain Trilemma



But...

The future of blockchain will not be 100% decentralized

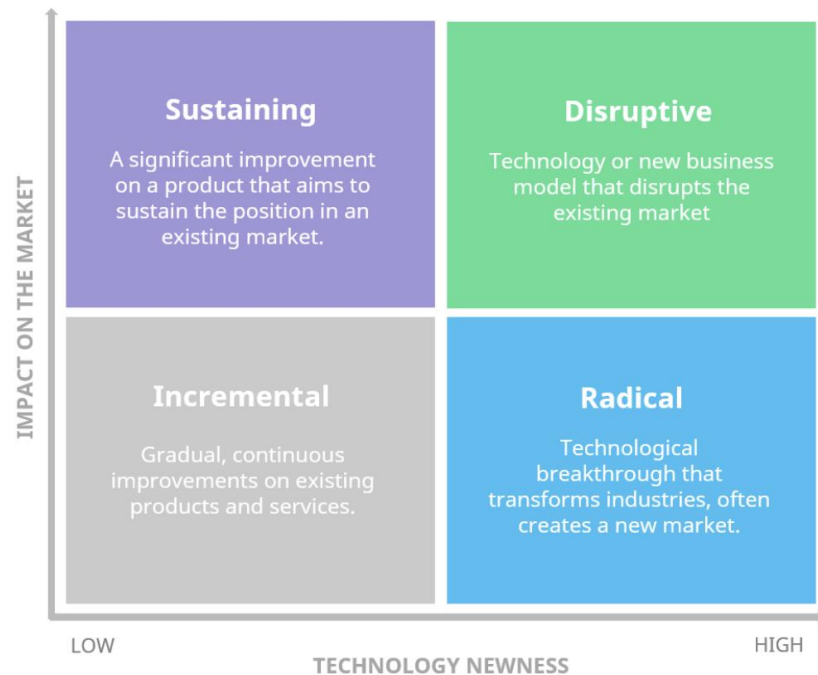
- The first generation of blockchains has been characterized by expectations about full decentralization and disintermediation
 - **Such expectations are frequently inflated**
- The future will most probably look more like the (Internet) past:
 - A wave of **creative disruption** as old players lose their market dominance
 - New business models & markets emerging (**token economy**)
 - **New intermediaries** to capture new markets

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2. Innovation & The process of creative destruction

Understanding Innovation

- Innovation is a well-defined topic – many definitions exist but most agree that it is “**the implementation of something new, that generates value**”



- Different types of innovation exist
 - Some blockchain applications might fall under incremental, sustaining, or disruptive innovation
 - Blockchain technology **as a whole** is a discontinuation from the status-quo, providing solutions to problems we didn't know existed, and introducing markets and products we didn't know were possible
 - Along with technologies like the personal computer, the internet, and AI it is an example of radical innovation.

How did the Internet revolutionize our world?

- The internet was another radical innovation that changed the world through a process known as **creative destruction**
 - The term is used to describe the **dismantling** of **long-standing** practices to make way for **innovation**.
 - Creative destruction is thought as a driving force of capitalism
- First, technology creates a new foundational **infrastructure**
 - Internet democratizing exchange of **information**
- Initially, we think about moving **existing business** to the new infrastructure
 - From brick-and-mortar to **B2B/B2C commerce**
- But, then two things happen:
 - First, **disintermediation (creative destruction)**
 - Irrelevant players that won't reinvent themselves get eliminated (or pivot)
 - Then, **cybermediation (new business models)**
 - Which couldn't have existed earlier
 - Think Instagram, Netflix, AirBnB, etc.

How will Blockchain revolutionize our world?

First, technology creates a new foundational **infrastructure**

Internet democratizing exchange of **information**

Initially, we think about moving **existing business** to the new infrastructure

From brick-and-mortar to **B2B/B2C commerce**

But, then two things happen:

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Which couldn't have existed earlier

Think Instagram, Uber/Lyft, AirBnB, etc.

First, technology creates a new foundational **infrastructure**

Blockchain democratizing exchange of **value/trust**

Initially, we think about moving **existing business** to the new infrastructure

From e-commerce to **blockchain-enabled commerce**

But, then two things happen:

First, **disintermediation (creative destruction)**

Irrelevant players that won't reinvent themselves get eliminated (or pivot)

Then, **cybermediation (new business models)**

Which couldn't have existed earlier

TODAY

TOMORROW

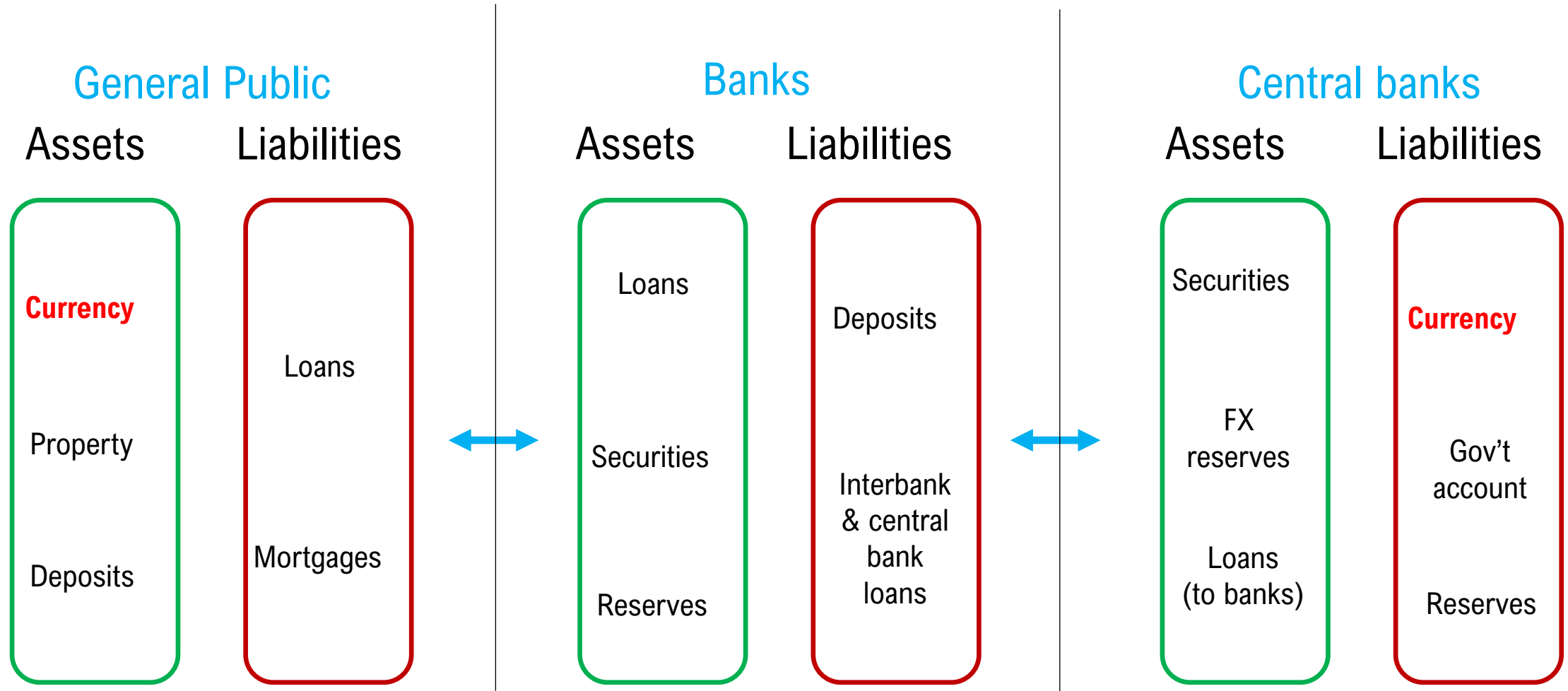
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4. Stage I: Disintermediation

Who becomes irrelevant with blockchain?

A blockchain allows **untrusted parties** to reach **consensus** on a shared digital history, **without a middleman.**

Who's the middleman?



Why the buzz about Central Bank Digital Currencies?

CBDCs are a new form of money

- Natively digital
- Legal tender (**means of exchange**)
- Stable by design (**store of value**)
- Can incorporate features that do not exist in today's money:
 - **Programmability**
 - **Smart contracts**
- Thank will result in new applications:
 - **Nano-payments**
 - **Machine to machine economy**
 - **Novel monetary policy tools**



Why the buzz about Central Bank Digital Currencies?

But, also, a new infrastructure for digital payments

- Replacing slow-to-innovate RTGSs
- Open, neutral payment architecture
- Fast innovation and competition
- New infrastructures can facilitate the settlement of not only money, but also other financial assets
- Toward **tokenization** of financial assets such as securities, commodities and others



The road to CBDC is not easy

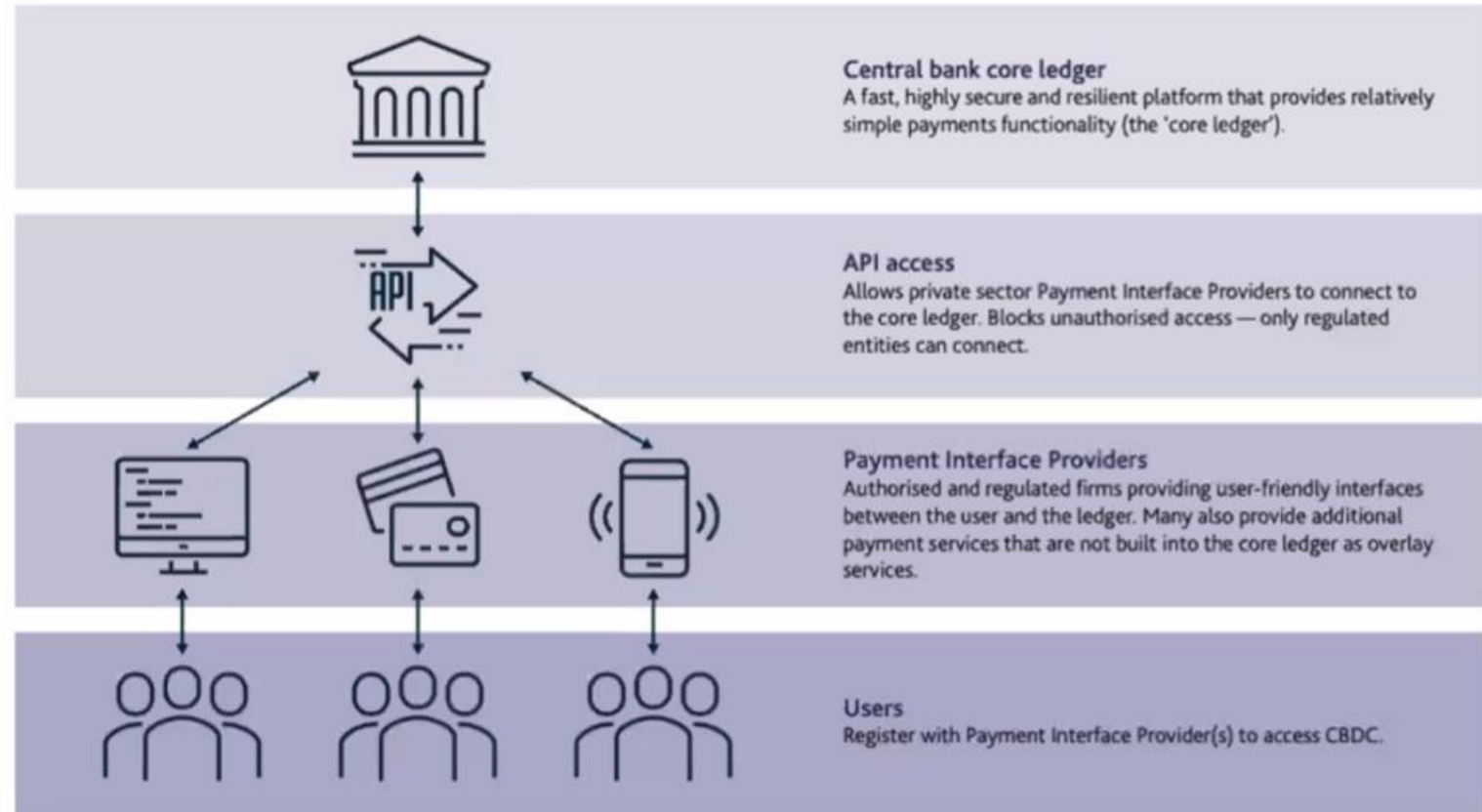
Many questions must be answered first

ARCHITECTURE

- Token or account-based?
- Centralized, decentralized or hybrid?
- Blockchain-based?
- Security protocol?
- Interoperability?

POLICY

- Issuance/Distribution?
- Supply & controls?
- Privacy & surveillance?
- Remuneration?
- Systemic risk?
- Social inclusiveness?
- Offline use?



Source: <https://www.bankofengland.co.uk/paper/2020/central-bank-digital-currency-opportunities-challenges-and-design-discussion-paper>

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5. Stage II: Cybermediation

Which new business models will blockchain enable?

A blockchain allows **untrusted parties** to reach **consensus** on a shared digital history, **without a middleman**.

The promise of blockchain

Creating a trust machine

“A mysterious new technology emerges, seemingly out of nowhere, but actually the result of two decades of intense research and development by nearly anonymous researchers.

Political idealists project visions of liberation and revolution onto it; establishment elites heap contempt and scorn on it.

On the other hand, technologists – nerds – are transfixed by it. They see within it enormous potential and spend their nights and weekends tinkering with it.

Eventually mainstream products, companies and industries emerge to commercialize it; its effects become profound; and later, many people wonder why its powerful promise wasn’t more obvious from the start.

*What technology am I talking about? **Personal computers in 1975, the Internet in 1993, and – I believe – Bitcoin in 2014.***

(continued on next slide)

Marc Andreessen, Why Bitcoin Matters, The New York Times, 2014 ([link](#))

Creating a trust machine (cont.)

(continued from previous slide)

*[...] Bitcoin gives us, for the first time, a way for one Internet user to transfer a unique piece of digital property to another Internet user, such that **the transfer is guaranteed to be safe and secure, everyone knows that the transfer has taken place, and nobody can challenge the legitimacy of the transfer.** The consequences of this breakthrough are hard to overstate.*

What kinds of digital property might be transferred in this way? Think about digital signatures, digital contracts, digital keys (to physical locks, or to online lockers), digital ownership of physical assets such as cars and houses, digital stocks and bonds, & digital money.

All these are exchanged through a distributed network of trust that does not require or rely upon a central intermediary like a bank or broker. And all in a way where only the owner of an asset can send it, only the intended recipient can receive it, the asset can only exist in one place at a time, and everyone can validate transactions and ownership of all assets anytime they want.”

Marc Andreessen, Why Bitcoin Matters, The New York Times, 2014 ([link](#))

What applications can we build on blockchains?

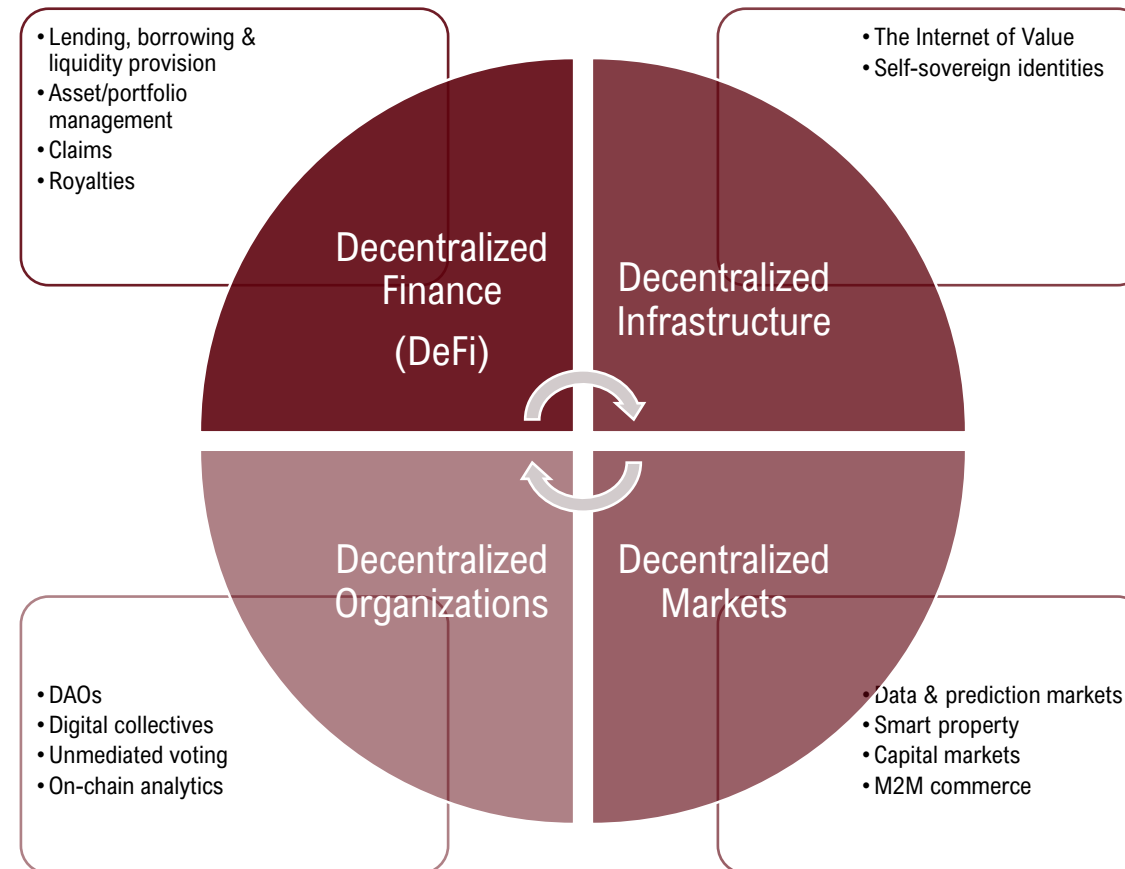
- As mentioned, blockchain technology will be responsible for all kinds of innovations
 - Some will be **incremental** offering marginal improvements on existing products or services.
 - Some will be **sustaining**, offering significant improvements that will shift the power dynamics within existing markets
 - Some will be **disruptive**, enabling new products and business models that will entirely disrupt existing markets
 - Some will be **radical**, enabling business models, and applications so novel, that lie beyond our current imagination
These novel applications and models will create entirely new markets and attract consumers previously thought unattainable
- **Type A: Blockchain for incremental and sustaining innovations, AKA the “boring stuff”:**
 - Many internet-based applications can (& will be) moved to blockchain-based systems.
- So, we will see:
 - *Supply chain management applications of blockchain*
 - *Health applications of blockchain*
 - *Energy applications of blockchain*
 - *xxx applications of blockchain (replace ‘xxx’ with the sector/domain of your choice)*
- These are generally called the “industrial applications of blockchain”
 - Some of these applications will be important, most will deliver only incremental improvements in productivity, cost or other KPIs.

What applications can we build on blockchains?

- **Type B: Blockchain for disruptive and radical innovations, AKA the “exciting stuff”:**
- We will increasingly see **native blockchain applications**
 - Things that could not have been build before blockchain
- **Disruptive innovations** will shake up the industries, and make former successful incumbents stumble:
 - Some aspects of DeFi
 - Some aspects of NFTs
 - Central Bank Digital Currencies (CBDCs)
- **Radical innovations** will entirely transform the landscape in ways that we cannot imagine. They will create entirely new products, markets, and consumer needs:
 - Decentralized Autonomous Organizations
 - Decentralized Infrastructure
 - Some aspects of Decentralized Markets
 - Some aspects of DeFi
 - Convergence of AI, IoT, Blockchain (more on that next week)
- We have only starting seeing the tip of the iceberg of such applications
 - Expect a wave of innovation, value creation and creative destruction of ‘old’ industries in the coming years

Some examples of the 'exciting stuff'

Native blockchain applications



1. Decentralized Finance (DeFi)

Creating money legos

- From lending/borrowing platforms to stablecoins and tokenized Bitcoin, the DeFi ecosystem has launched an expansive network of protocols and financial instruments
 - **Lending, borrowing & liquidity provision:** the most well-known DeFi protocols today enable algorithmic, autonomous interest rate setting by having smart contracts automatically match borrowers and lenders and calculate interest rates based on the ratio of borrowed to supplied assets.
 - **Asset & portfolio management:** expensive and fraught with risk, trade processing and settlement is a complex industry with lots of intermediaries (brokers, custodians, clearers, settlers, etc.), ready for DeFi disruption
 - **Claims:** Moving insurance claims management to smart contract-based systems (self executable and self enforceable transactions) will revolutionize the current system, which is largely manual, error-prone and fraud-laden
 - **Royalties:** Redesigning music and other royalty management schemes toward decentralized, self-executable systems, down to the level of their atomic elements.
- DeFi brings programmability, interoperability, transparency and self-custody in the management of financial assets and personal data
- Interestingly, the ultimate result of DeFi might be another source of centralization: making the world's global financial industry run atop a common software infrastructure
- We will discuss DeFi in detail in week 12

2. Decentralized Infrastructure

Creating the next WWW

- **The Internet of Value**
 - Blockchain enables a new kind of internet: from the internet of information to the internet of value
 - Even the basic internet architecture is ripe for disruption, with applications such as decentralized DNS
- **Self-sovereign identities (SSIs)** will use blockchain infrastructures to solve the identify fraud problem of the current internet
 - Disintermediating identity verification will create multi-source, multi-verifier digitally signed credentials that will ultimately use some form of zero-knowledge (ZK) proofs to verify identities.
 - Interestingly, SSIs may prove to be more relevant and commercially successful in identifying objects, not humans, on the Internet of Things (IoT).

3. Decentralized Organizations

Creating a new industrial economy

- Business
 - Smart contracts enable a wave of algorithmic governance, enabling new forms of industrial organization that supersede archaic hierarchical, human decision making forms of business
 - **Decentralized Autonomous Organizations (DAOs)**
 - New forms of spontaneous or semi-spontaneous organizations emerge, including **digital collectives**
- Institutions
 - **Unmediated voting** can provide a level of security and incorruptibility that might improve civic engagement and participation in democratic processes.
 - **On-chain analytics** redefine how due diligence, KYC/AML/CTF and other monitoring functions are done, thereby reinforcing trust building on decentralized systems

4. Decentralized Markets

Creating the commerce of the future

- **Data & prediction markets** enable transactions & price discovery for hitherto commercially unexploited (or, conversely, centrally overexploited) data points
 - Monetizing users' personal data in social media platforms & recommender systems
 - Creating industry-wide secure data exchange networks in healthcare and other sectors
 - Leveraging the wisdom of the crowds to create more efficient forecasting markets & developing oracles to connect blockchains to the outside world
- **Smart property:** from cars to homes, the economy of the future will be built atop an infrastructure of decentralized, blockchain-verifiable Internet of Things (IoT) infrastructure that will allow for digital property management and ownership transfer
 - Smart devices, appliances and sensors will all connect to the internet and use smart contracts to transact with one another and with humans.

4. Decentralized Markets (cont)

Creating the commerce of the future

- **Capital markets** will redefine the ways in which capital is invested
 - In terms of who can invest (democratizing access), but also on what can be invested (fractional ownership, new marketable instruments)
 - Early examples included ICOs, IEOs and STOs: changing the rules of capital raising of the industrial economy
 - **Tokenization** (fungible and non-fungible tokens, including personal tokenization) will extend the breadth, depth and reach of capital markets (*see next section*)

Blockchain is not alone in enabling digital transformation

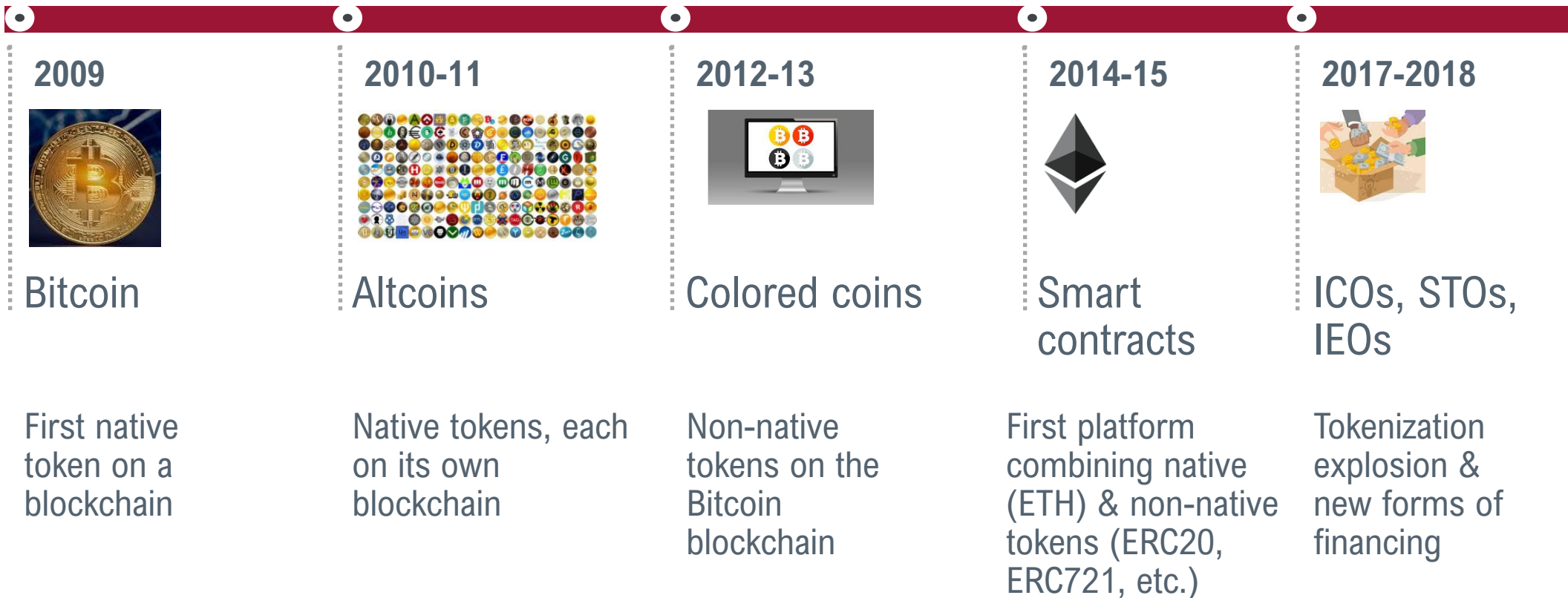
- The previous are examples of decentralization disruption enabled by blockchain **only**
- But, blockchain is not the only infrastructure technology reaching maturity and commercial exploitation potential in our times
- When blockchain combines with other transformative technologies, the scope of possible applications changes dramatically
 - More about this convergence next week (session 11)

Distributed Ledgers (Blockchain)	Artificial Intelligence	Internet of Things
Robotics	Augmented/Virtual Reality	3D Printing
Molecular nanotechnology	New materials	Energy storage
Autonomous Vehicles	Synthetic Biology	Quantum computing

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6. Tokenization

Everything up to now has ultimately been about tokenization



The next phase of digitizing physical assets

- **Tokenization** is about using DLTs to prove one's ownership of real-life **assets** or **rights**
 - **Physical assets:** securities, real estate, art, etc.
 - **Digital rights:** license rights, access rights, intellectual property rights, future income rights, etc.
- **Benefits**
 - Tokens are trivially created, stored, traded
 - Liquid, global markets can be created for almost everything – including **fractional ownership**
- **Challenges**
 - Generally, not decentralized: **intermediaries will ALWAYS be needed** for non-native assets
 - Legal recognition

How does tokenization work?

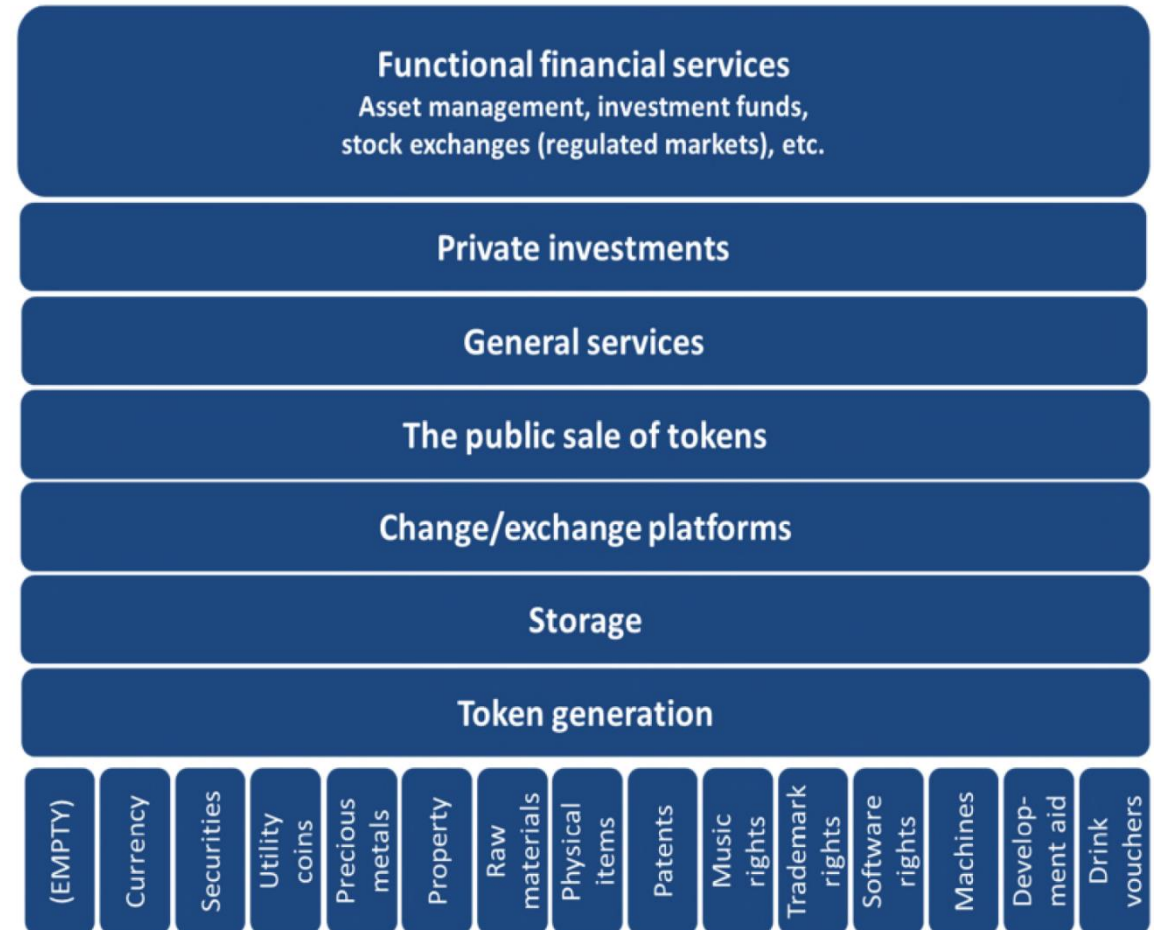
An alternative classification

- Tokens can be thought as **containers**
- A token can be:
 - Either **loaded** with a **right** that represents a real-world **asset**
 - Or not – a token container can also be empty (**native asset**)



Decentralization does not destroy intermediaries; it replaces them

- New **intermediaries** needed for all non-native assets
 - Token **generators**
 - Token **issuers**: disclosure requirements and investor protection
 - Token **validators**: know who owns tokens and can legally enforce represented rights and obligations
 - Token **custodians**
 - Token **exchange service providers**
 - Token **identity service providers**
 - etc



Example of new mediation/registration requirements

Lichtenstein Blockchain Act (2020)

- The Lichtenstein Blockchain Act foresees no less than **ten** different roles (& associated registration/licensing requirements):
 - Personal requirements
 - Organizational requirements
 - Minimum capital requirements
 - Internal control mechanisms
 - Due diligence requirements (KYC, AML, CTF)

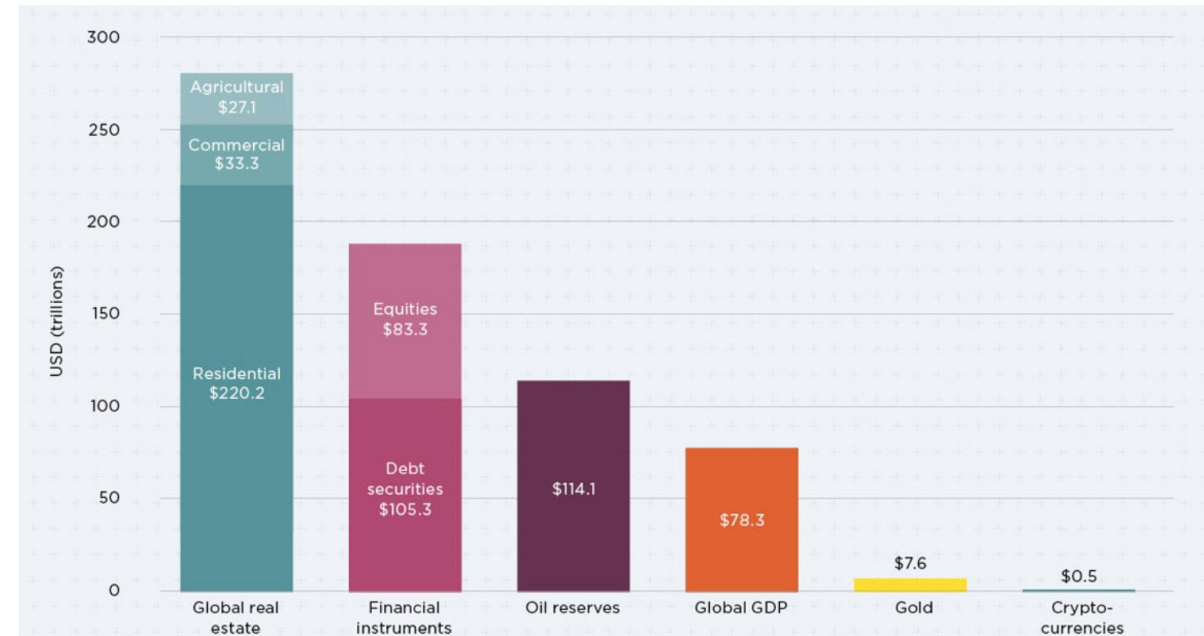
	Token Generator	Token Issuer	TT Key Depository	TT Token Depository	Physical Validator
Registration Duty	✓	✓ *	✓	✓	✓
REQUIREMENTS					
Personal Reliability (bankruptcy and criminal law)	✓	✓	✓	✓	✓
Organizational Suitable business structure and appropriate written internal proceedings and control mechanisms	✓	✓	✓	✓	✓
Minimum Capital	✗	Token ≤ 5 Mio = 50k Token > 5 Mio = 100k Issuance > 25 Mio = 250k	100k	100k	Varies depending on value of the property being guaranteed max. CHF 250'000
Special internal control mechanisms	✓	✓	✓	✓	✓
Licensed as Trustee	✗	✗	✗	✗	✗
SUPERVISORY FEES					
Minimum Fee		CHF 500	CHF 500	CHF 500	CHF 1'000
Fee	CHF 250	0.25% of CHF equivalent value of money received during issuance	0.25% gross revenue received from services provided.	0.25% gross revenue received from services provided.	0.25% gross revenue received from services provided.
Maximum Fee		CHF 100'000	max. CHF 100'000	max. CHF 100'000	max. CHF 100'000
DUE DILIGENCE ACT APPLICABLE					
	✗	✓	✓	✓	✓

Use Case I: Tokenizing Real Estate

Securitizing a physical asset

- Today's real estate markets are slow, expensive and monolithic
 - Property **owners** cannot monetize part of their property
 - Property **investors** need large amounts of capital
 - Real estate **markets** are inefficient and illiquid; transactions are rare and price discovery is broken

Global real estate universe in comparison



Real estate as the the next stock market

- **Platforms/Exchanges** that bring together property owners and investors
 - Each property is split into blockchain-based tokens that securely represent ownership of a fraction of the asset
 - **Owners** enlist (part of) their property and monetize it by selling tokens
 - **Investors** acquire tokens and receive rental income while they hold them; they will also benefit from asset appreciation
 - The platform operates as property manager; income and expenses are securely & transparently recorded & distributed on the blockchain

Real estate as the the next stock market

- Benefits:
 - Owners can sell ownership rights to arbitrary percentages of their property.
 - Investors can acquire property ownership rights anywhere in the world, with minimum capital and expenses.
 - Liquid and efficient markets for global real estate will be created.

Blockchain will do to real estate investing what the Internet did to stock investing

Use Case I: Tokenizing Real Estate

An overview of changes

Issue	Reality before tokenization (now)	Reality after tokenization
Liquidity	Markets are geographically restricted and illiquid	Access to investors and liquidity globally
Price discovery	Price discover broken, limited by geography and lack of organized markets	Access to global data and prices. Transparent because of blockchain.
Efficiency	Transactions slow and expensive	Transactions more akin to trading stocks
Exchange	Transactions are private and no organized exchanges exist	Organized exchanges, more akin to other organized markets
Ownership	Real estate owners usually own and can resell 100%, 50%, 30% of property. Lower remunerations are rare.	Real estate micro-ownership. Investors can own fractions of a percentage of real estate

Creating real estate exchange markets

- **Alice** owns a Frankfurt property valued at €200,000
 - Tokenizes the property into 100,000 tokens, each valued at €2
 - Alice needs liquidity of €20,000, so she enlists 10,000 tokens in the platform, effectively putting 10% of the property for sale
- **Bob** wants to invest in Frankfurt properties, but his total capital is only €5,000
 - Obviously, he cannot buy any property in the city!
 - But, he can acquire 2,500 tokens of Alice's property (or may even diversify across properties)
 - Since he effectively now owns 2.5% of the property, Bob receives 2.5% of the property's rental income, as long as he holds the tokens
 - Bob may decide to sell his tokens in the secondary market. The price of the token will fluctuate to indicate the movement of real estate prices in Frankfurt and the particular property

Tokenizing future income streams



People need funding at their early or middle career stages to pursue their goals

Athletes need support for training, equipment, traveling.

Artists need to produce/promote their work, go on tour.

Students need to finance their studies.



Financing options are limited:

Loans (Debt)

What if talent could issue equity?

Tokenizing ownership of one's future incomes



Platforms that tokenize career prospects (future incomes) using blockchain



Enable investors to fund talent, investing on their future achievements and income



Enable talent to build up careers and/or insure against future risks



Markets that bring together investors and talent can be created

How would this work?

A simple example

-  Alice is a promising tennis player at her early career stages
-  She needs \$100,000 for equipment, training, traveling to tennis tournaments
-  She signs up at the platform, builds her profile, signs a contract with the platform; 100,000 tokens (each valued at \$1) are issued
-  Tokens are sold to investors. Alice receives \$100K, while investors get the rights to 30% of her future income for a fixed period
-  Alice invests the funds on professional training and participation in events around the world
-  After a few years, Alice has developed into a professional player earning \$300,000 a year
-  Of this income, 30% (i.e. \$90K annually) is distributed to token holders via the blockchain platform
-  Investors receive income (dividends) and can sell tokens, which will fluctuate in value according to income/maturity

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7. Conclusions

Blockchain is the next step in digital transformation

- Blockchains are a revolutionary foundational technology
 - They are the next Internet layer: allowing for **decentralized flow of value** (instead of just information)
 - They will unleash a wave of creative destruction in the (old) internet economy, replacing current intermediaries with new ones
- As a foundational technology, blockchain can be applied (almost) everywhere
 - But, the really exciting applications are going to be the **native** ones (i.e. those that cannot exist without a decentralized infrastructure)
 - These include **decentralized finance, decentralized infrastructure, decentralized organizations and decentralized markets**
- **Tokenization** is the next blockchain frontier
 - Tokenizing physical assets, like real estate
 - Tokenizing virtual assets, like future income streams

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8. Further Reading

Further Reading

- [Crypto Startup School](#): The course videos from a16z's Crypto Startup School, held in the spring of 2020. All videos are great learning resources, but the ones titled 'Crypto Networks and Why they Matter' and 'Applications: Today & 2025' are highly relevant to this session
- [Thoughts on Tokens](#): Written in 2017 (while the ICO bubble was still forming), it is very interesting to examine how the author's thoughts on tokens have matured since
- [Tokenisation and fractionalisation – A ten year vision](#): Reflections on tokenization from Consensus 2020
- [Liechtenstein Blockchain Act](#): How a small country has pioneered blockchain legislation by explicitly addressing tokens in its laws
- [Everything you always wanted to know about CBDCs \(but were afraid to ask\)](#): A non-technical primer on CBDCs.

Tip: Clicking while pressing Ctrl key opens a new tab in Chrome browser on non-Apple devices



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Questions?

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