

BEYOND THE HYPE OF REAL WORLD ASSETS



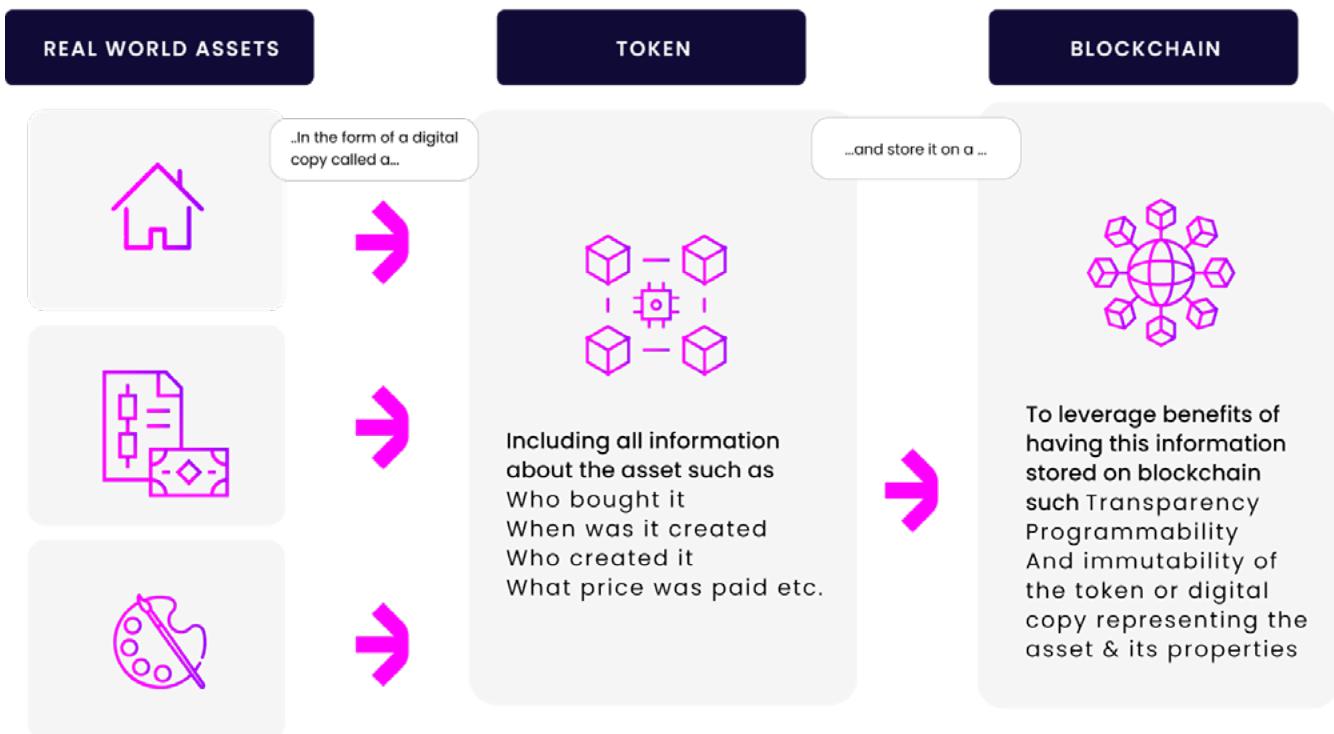
Outlier Ventures®

Storing digital copies (tokens) of real world assets on the blockchain is about to fundamentally change how we interact with everyday assets. Increasingly explored by the financial industry, we believe tokenization of real world assets will have an impact on every single industry as blockchain technology diffuses across society over the next decade.

**JASPER DE MAERE**

Research Lead at Outlier Ventures

Tokenization is the process of representing...



“I believe the next generation for markets, the next generation for securities will be tokenization of securities. Distributed ledgers will bring instantaneous settlement and change the whole ecosystem,”

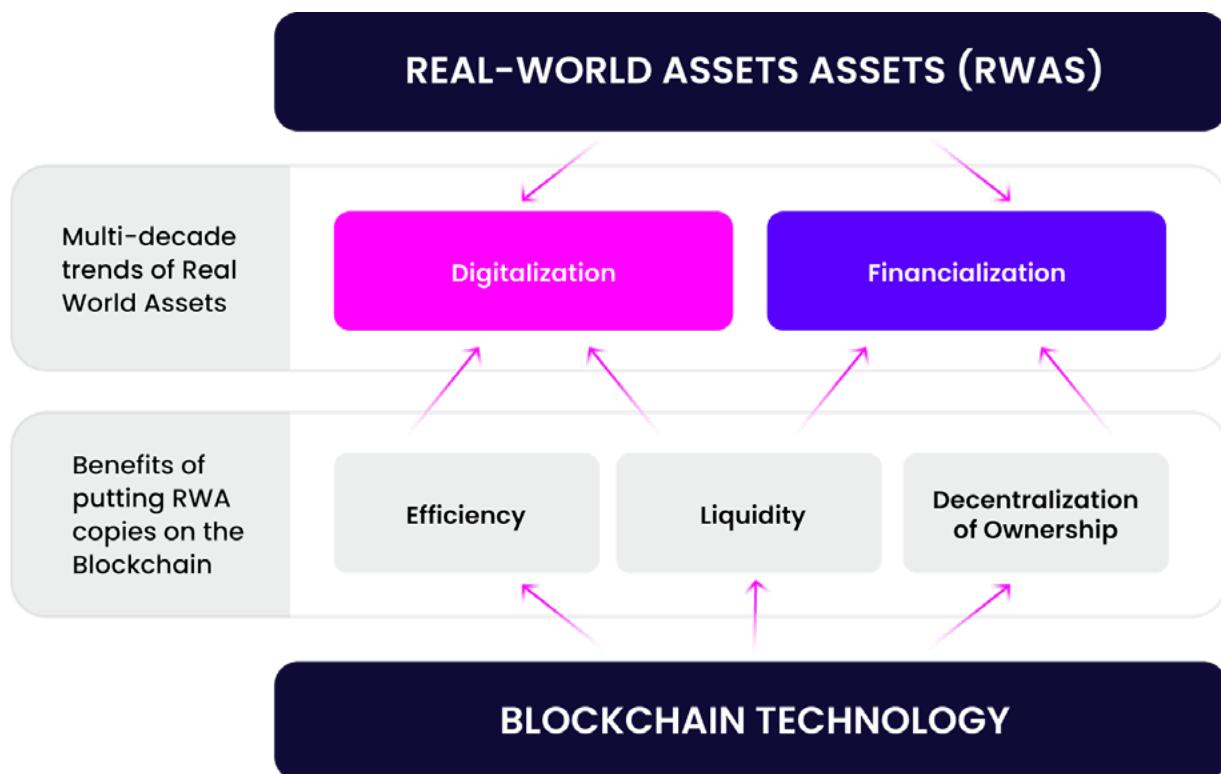
BlackRock CEO Larry Fink said during this year's New York Times DealBook event.

Tokenizing real-world assets (RWA) is anticipated to have significant transformative potential, spanning from investing and asset management to manufacturing, real estate, and even art.

The total addressable market (TAM) for RWA tokenization is estimated to reach between \$10 to 15Tr by the end of the decade and is attracting the eye of major institutional participants. We believe this is an underestimation.

Converting physical or intangible assets into digital tokens that can be traded on a blockchain can enhance the liquidity, accessibility, and efficiency of multiple asset types. There are already existing use cases, such as tokenized bonds. But this is a drop in the ocean compared to the flood of digitized assets that could move onchain, such as real estate, carbon credits and company assets such as inventory and intellectual property.

This study aims to provide founders and investors with a comprehensive understanding of RWA tokenization, an area we anticipate will have a significant impact over the next decade across multiple sectors.



A TALE OF TWO TRENDS

The tokenization of real-world assets (RWAs) has two major trends; digitalization and financialization. The former transforms physical assets into a digital format, while the latter endows them with financial instrument properties. Blockchain-based tokenization is accelerating these two trends, enabling innovations, such as token programmability.

AN OPPORTUNE TIME

Significant interest in RWA tokenization goes back as far as 2019. However, we believe there are key differences between the current environment and previous cycles. Institutional investors, hedge funds, and asset managers now drive participation, marking a shift from previous retail-led cycles. Today's sophisticated market participants are using advancements in blockchain scalability, security, and interoperability to pilot new tokenization projects. They are introducing these products to their clients, and shaping discussions around the evolving regulatory environment.

Robust regulatory frameworks are being introduced, fostering institutional involvement. One example of this is the UK's Electronic Trade Documents Act, which aligns seamlessly with blockchain applications for RWA tokenization. The synergy of progressive regulation, technological advancements, and enhanced transmission mechanisms, like Central Bank Digital Currencies (CBDCs) and stablecoins, marks a promising new era in the field of RWA tokenization.

UNRECOGNIZED POTENTIAL

We believe the total addressable market, TAM, for the tokenization of RWAs, is significantly greater than the current estimate of ~15Tr. by the end of 2030. Estimates fail to consider the potential increase in an asset's value post tokenization. A more accurate estimate should include new markets that facilitate healthy price discovery of tokenized assets. Also, tokenization can segregate an asset into different elements, creating separate, liquid markets for these elements, leading to further price discovery.

THE ULTIMATE ENDGAME

Without tokenization of RWAs, the computational capacity of blockchain based smart contracts is limited to the on-chain world. Through tokenization, off-chain or real world assets are brought into the realm of smart contract capabilities, extending the computational capacities of the economy. This movement is called the computational economy and is a new economic paradigm where Web3 technologies facilitate the development of a 'computable economy', which enables a significant increase in economic complexity and, from this, wealth. Tokenization of RWAs is a critical step in unlocking the computational economy, which we believe is the ultimate endgame of blockchain technology.

We appreciate there is a lot of information in this document to digest, that's why we provide two quick one-pagers.

REAL WORLD ASSET TOKENIZATION ONE PAGER

A TALE OF TWO TRENDS

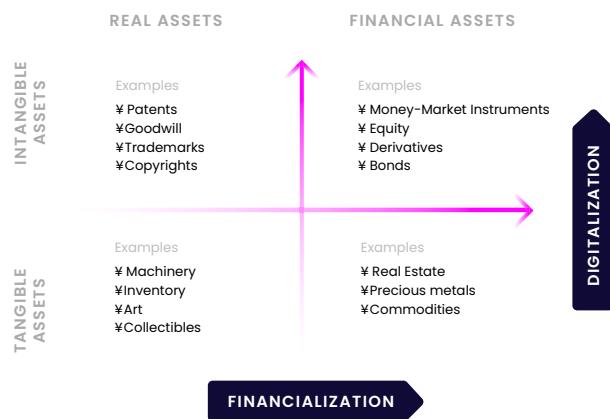
Tokenization of RWAs serves as a driver for the next leg of these two trends:

Digitalization of assets

The transformation of physical assets into digital formats or the migration of digital assets onto new infrastructure. Tokenization examples - inventory, supply chain assets, financial products,...

Financialization of assets

The process of turning any asset into a financial instrument. Tokenization examples - Data, intellectual property, in-game assets,...



BENEFITS

We believe through leveraging features of blockchain technology, **tokenization unlock three key benefits:**

Efficiency

Improves transparency, traceability, programmability... of the asset
Examples - Inventory management, trade finance, healthcare records

Liquidity

Allows assets to change ownership in a transparent and structured
Examples - Venture capital, fine art, collectibles, music, carbon credits

Decentralization of Ownership

Allows distribution of asset ownership in a transparent and structured way. Examples - Decentralized Physical Infrastructure, IoT.

BENEFITS

Efficiency

Financial Markets, Digital Identity, Public Sector, ESG reporting....

Liquidity

Tradability

Carbon Certificates, Collectibles, Art...

Decentralization of Ownership

Segregation

Intellectual Property, Trademarks, Digital Asset Rights, E...

Financial Assets

Private Markets, Property...

Real Assets

DePIN, Maas, AI, IoT

WHY NOW?

Almost five years after its initial hype, tokenization of RWAs is looking different. We identified three key reasons that give us confidence that it's different this time around.

- 1 **More mindshare & activity** - We see more mindshare and activity from a larger set of players who are actively trying out the technology.
- 2 **Tech stack & developer tooling** - We see improvement in the infrastructure and tooling required for tokenization of RWA.
- 3 **Legal & regulatory clarity** - We have seen regulatory improvement to cater for tokenization of RWA over the past years and only expect this to accelerate as more stakeholders openly express interest.

ADOPTION

< MATURITY

We see adoption playing out in the following sequence

1 Efficiency

Financial Markets, Digital Identity, ESC reporting,-

2 Tradability

Carbon Certificates, Collectibles, Art...

3 Decentralization of Financial Asset Ownership

Private Markets, Property.

4 Segregation

Intellectual Property, Trademarks, Digital Asset Rights...

5 Decentralization of Real Asset Ownership

DePIN, Maas, AI, IoT

WHY FINANCIAL ASSETS

We think there are **four main reasons** why the tokenized RWA narrative is so fixated on financial markets:

- 1 **Like a glove** - There is a strong fit for tokenization that facilitates and improves existing (i) processes, (ii) liquidity and (iii) the decentralization of ownership of financial assets.
- 2 **Lingo & founders-market fit** - Financial professionals looking for solutions, see above average value in tokenization because they are familiar with the concept of liquidity and deal with assets that are by definition decentralized of ownership.
- 3 **Digital representation** - Financial instruments are already largely digital, making them easier to tokenize.
- 4 **Massive value** - Financial assets make up 2/3rd of all assets globally.

CHALLENGES

The Oracle Problem is the most critical challenge for tokenized RWA. It relates to blockchains inability to access external data securely, hindering their decentralized nature.

We see two trends that are solving the oracle problem.

Innovation & Game Theory - We see evidence that innovative solutions with embedded game theory can align incentives between stakeholders to incentivize updated & correctly reflected tokenized RWAs.

Digitalization - We see digital transformation driving the shift from tangible to intangible assets. We believe over time, more and more tangible assets will be represented as intangible assets.

Lessons For Builders Pocket Guide

We hope that this boiled down one-pager can serve as a pocket guide which founders can use along their journey as they build out applications and infrastructure for real world asset tokenization

3 Key Benefits

Efficiency

Liquidity

BoO

One of the key objectives of our work is to encourage aspiring Web3 founders working across traditional industries to look around at the existing infrastructure and status quo and ask the question **"Is there possible room for improvement or disruption of the industry through the implementation of tokenizing assets?"**

As blockchain technology matures, founders need to pivot away from simply selling the technology. **For the next leg of adoption, founders need to sell the solution, not the technology. Having a deeper understanding of the real value of tokenization is the first step in creating a high value solution.**

Improves transparency, transaction costs, execution, reporting... of the asset across the value chain

Unlocking efficiency is the first step in the journey to put all assets on the blockchain. It will serve as the gateway for asset holders to migrate from centralized databases onto the blockchain.

- **The gateway** - We believe that efficiency will be the gateway driver that will incentivize asset holders to tokenize RWAs onto the blockchain.
- **Weave efficiency into the product** - If the product is dependant on RWAs that still need to move on-chain, we recommend embedding efficiency gains as a value proposition into the product. Efficiency is easily quantifiable and creates a tangible argument for asset holders to move on-chain.
- **Start with the inefficiency** - It is trivial but starting with what is most inefficient is a great way to find adoption. The opportunity cost of moving is low for an asset that is plagued with inefficiencies. There's less net benefits for asset holders already efficiently managing assets on chain.
- **Go more granular** - Efficiency is an all-encompassing term. A more granular understanding is needed of what can be made more efficient within the value chain.

Conclusion - We believe that efficiency is currently the main driver behind tokenization. It provides tangible evidence of the benefits of blockchain based assets. Efficiency needs to be woven into the product architecture. even if it's not the core value proposition.

Allows assets to change ownership in a transparent and structured way

Creating liquidity around an asset unlock hidden value of the asset. An asset is worth the most when it sits in the hands of those who want it the most Creating liquidity on a tokenized RWA marketplace is notoriously difficult. The following factors make it easier to bootstrap liquidity onto the platform:

- **Pent up demand from both sides** - there is a pent up demand from both sellers and buyers of the underlying asset to trade and create liquidity in the asset. It requires at least two parties to trade, so both sides need to be willing to step into the market.
- **Solving for more than just liquidity** - Liquidity itself is a difficult value proposition for tokenized products. We recommend combining liquidity with improvements in efficiency or potential decentralization of ownership of the asset. in the asset. It requires at least two parties to trade, so both sides need to be willing to step into the market.
- **Tokenizing existing vs creating entirely new market** - There are generally two types of tokenized RWA marketplaces that are created.
 - **Existing market** - Tokenizing RWAs that were already traded in other (non-tokenized) market places. Businesses need to solve more than liquidity problems. Efficiency gains or decentralized ownership need to sit at the centre of the strategy.
 - **New markets** - Tokenizing RWAs that were not traded in liquid markets. In case there is a pent up demand from both sides of the market to trade the asset, liquidity standalone is a great value prop. If not, efficiency gains or decentralized ownership need to sit at the centre of the strategy. If it is a completely new asset class created through tokenization (segregation), understand who demand and supply sides flow.
- **Move beyond price speculation** - We agree that asset price speculation is a great way to bootstrap trading volumes for the platform. However speculator interest is always short lived. In the long term the demand to be sustainable and based on something else than pure price speculation.

Conclusion - We believe that marketplaces purely aiming to create liquidity around specific assets are winner-takes-all models where the profitability model quickly turns into a race to the bottom as players compete to create their network effect. We recommend adding additional utility to the platform to create a stronger economic moat.

Decentralization Of Ownership

Allows distribution of asset ownership in a transparent and structured way

Decentralization of asset ownership is the true end-game in which ownership, participation and investment into all assets get democratized.

Understand the network effects - Businesses created around BoO rely heavily on network effects (nfx) and incentivization of participation of users who need to buy into the network and help support it. Nfx are notoriously difficult to create but create the strongest economic moat possible. Founders need to understand the dynamics at play and have a vision on how to build out their own network.

Why is decentralization needed - We are still discovering the true potential of decentralization of ownership but at the moment a lot of it has to do with either (i) capital formation or (ii) democratization of infrastructure.

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1

A TALE OF TWO TRENDS

TL;DR ~ We got you

Tokenizing is the process of creating a digital copy of any asset on the blockchain, generating benefits in (i) efficiency,(ii) liquidity and (iii) decentralization of ownership for the tokenized real-world asset (RWA).

Tokenization speeds up two existing, structural asset trends:

- **Digitalization of assets** - The transformation of physical assets into digital formats or moves digital assets onto new infrastructure to unlock even more benefits.
Asset Examples – inventory, supply chain assets, financial products...
- **Financialization of assets** - The process of turning any asset into a financial instrument by reengineering cash flows, investment opportunities and capital formation.
Asset Examples – Data, intellectual property, in-game assets,...

Note

For anything unclear, we have a [taxonomy](#) dedicated to tokenization of real world assets. Real world assets (RWAs) have been covered extensively in the past. Many, including OV, believe tokenization of RWAs is one of the killer use cases of blockchain and web3. Before continuing, let's clarify what we mean by RWAs and tokenization.

“Tokenizing is the process of creating a digital copy of any asset on the blockchain”

Simply said, tokenization is putting assets on a blockchain database. By creating a digital copy, or token, of a real world assets (RWA) on the blockchain, the record keeping capabilities of the blockchain can be used to improve and create. We believe there are three key benefits unlocked from tokenizing RWAs for that asset:

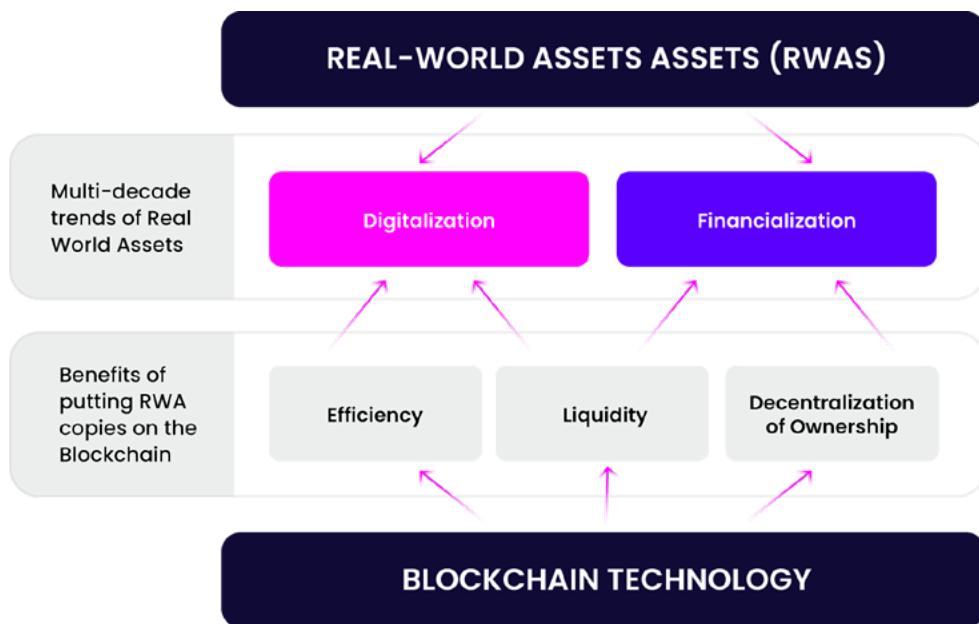
- **Efficiency** – Improves performance using “the least amount of inputs to achieve the highest amount of output.”
- **Liquidity** – Allows assets to change ownership in a transparent and structured way.
- **Decentralization of ownership** – Allows distribution of asset ownership in a transparent and structured way.

More on this [later](#).

Few have been successful at creating an all-encompassing framework for RWA tokenization. Based on our expertise in Web3, we have made an effort to formulate a framework for founders, investors and web3 enthusiasts to use as a guide to uncover the true potential of RWA tokenization.

We believe that tokenization of RWA feeds into two separate trends, making it difficult to understand its net benefits and impact. These two trends are i) digitalization of assets and 2) financialization of assets and are structural trends that have been playing out over the past decades.

- **Digitalization of assets** – The transformation of physical assets into digital formats or moves digital assets onto new infrastructure to unlock even more benefits.
- **Financialization of assets** – The process of turning any asset into a financial instrument by reengineering cash flows, investment opportunities and capital formation.



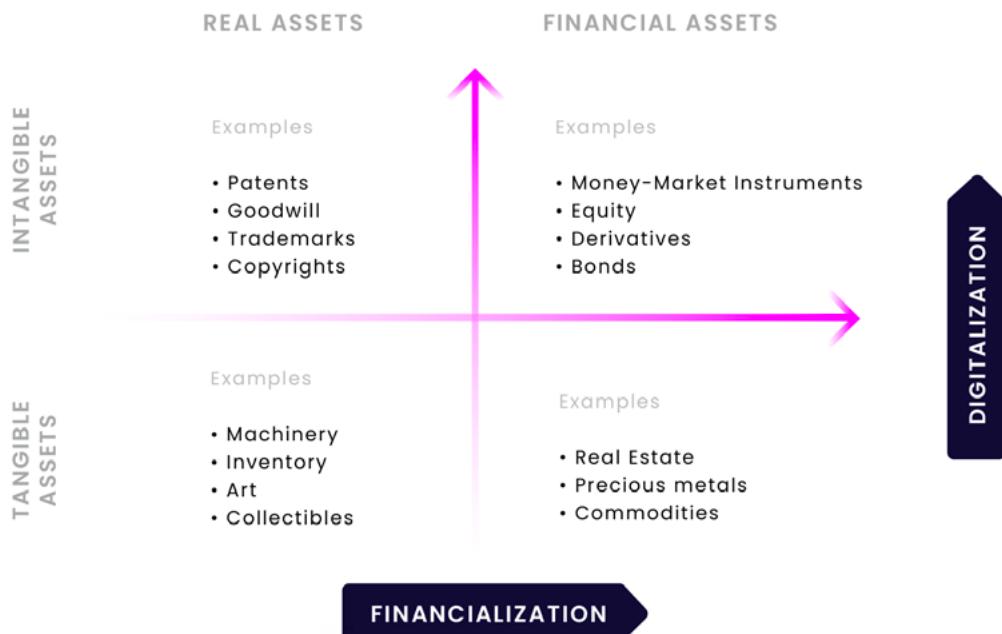
There are two dimensions that apply to each RWA. These dimensions are also associated with the two structural trends happening in RWAs today.

Digitalization – applies to tangible- and intangible assets

Financialization – applies to real- and financial assets.

For example, Patents = intangible real asset, Equity = intangible financial asset,

Machinery = tangible real asset

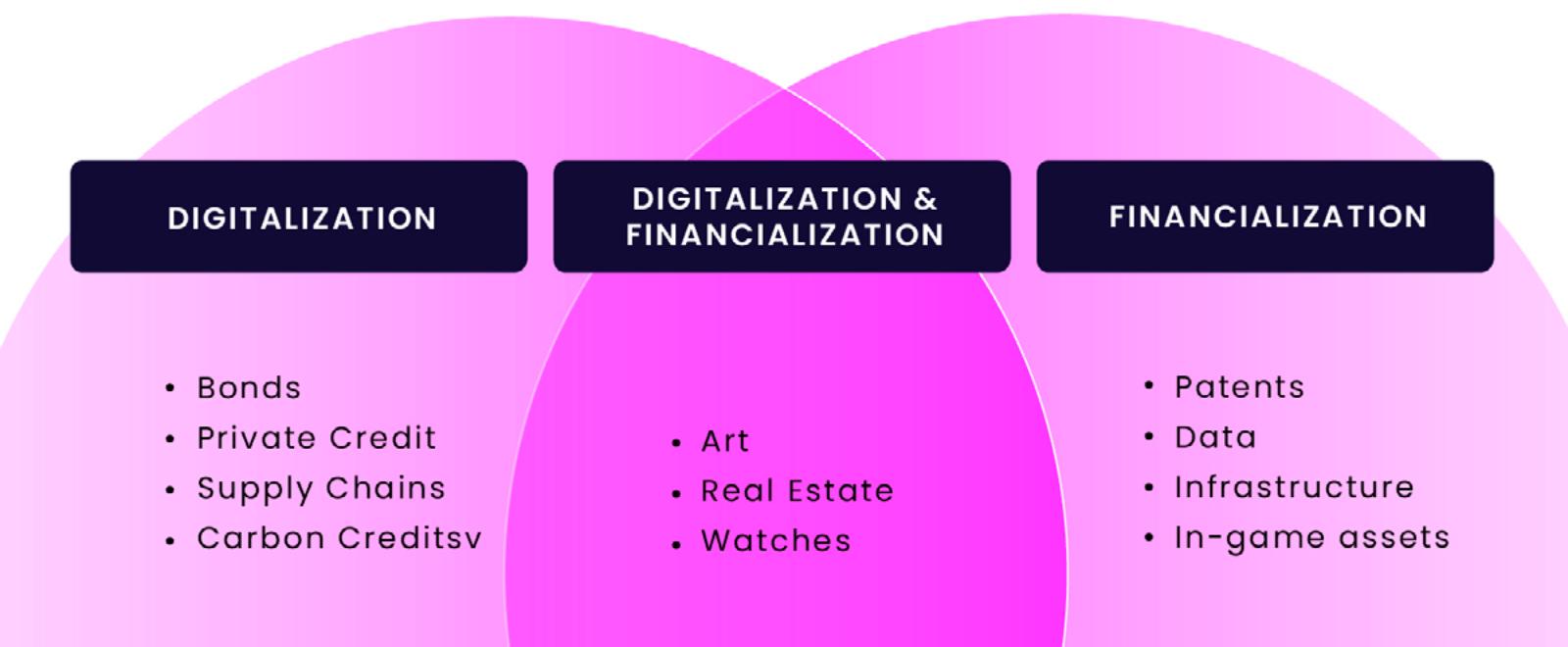


We believe that tokenization of RWA is accelerating both the financialization and digitalization of real world assets. As more assets are tokenized, we anticipate an increase in assets becoming intangible, and their transformation into pseudo-financial instruments. Later we'll go into much more detail on digitalization and financialization of RWAs. Below is a one liner on how tokenization of RWA and blockchain are accelerating these trends.

Digitalization – In the search for more efficiency, assets are becoming digital, and intangible, in nature as the process of tokenization unlocks more benefits that come with being represented in token format on the blockchain. Intangible assets can also still benefit from digitalization when moving to a different database or infrastructure, unlocking new benefits. With 75% of all data stored globally generated over the past 5 years, we believe the value in the digital world is about to exceed the physical world in the near future. Examples – inventory, supply chain assets, financial products,...

Financialization – The token representing the RWA asset is highly programmable with automatically executable actions embedded in the token's smart contract code. This allows for the easy and low cost reengineering of cash flows and investment opportunities and capital formation associated with real assets that were previously not considered to be financial instruments. Examples – Data, intellectual property, in-game assets,...

It is important to stress that digitalization and financialization are not mutually exclusive. There are assets, that when tokenized, can encompass both trends simultaneously. Below we categorize some assets to illustrate what type of assets generally fall under which trend



WHY NOW?

TL;DR ~ We got you

This is not the first time we've seen an upsurge in interest regarding the tokenization of real world assets. **Here are three key reasons why we believe this time is different:**

- More mindshare and activity from a larger set of players who are actively trying out the technology.
- Improvement in the infrastructure and tooling required for tokenization of RWA.
- Regulatory improvement to cater for tokenization of RWA over the past years and only expect this to accelerate as more stakeholders openly express interest.

There was an initial buzz of interest in the tokenization of RWAs in 2017 and 2018. So, why do we now see a renewed interest in the tokenization of RWAs? Some say this is purely a rotation of blockchain narrative as a result of the macroeconomic environment. High inflation and interest rates result in different types of financial products becoming attractive such as T-bills. They believe we are rotating back to tokenization because it's the most exciting way to fit blockchain technology into these different investment opportunities.

However, we believe this time really is different. Almost five years after its initial popularity, the narrative around the tokenization of RWAs has changed.

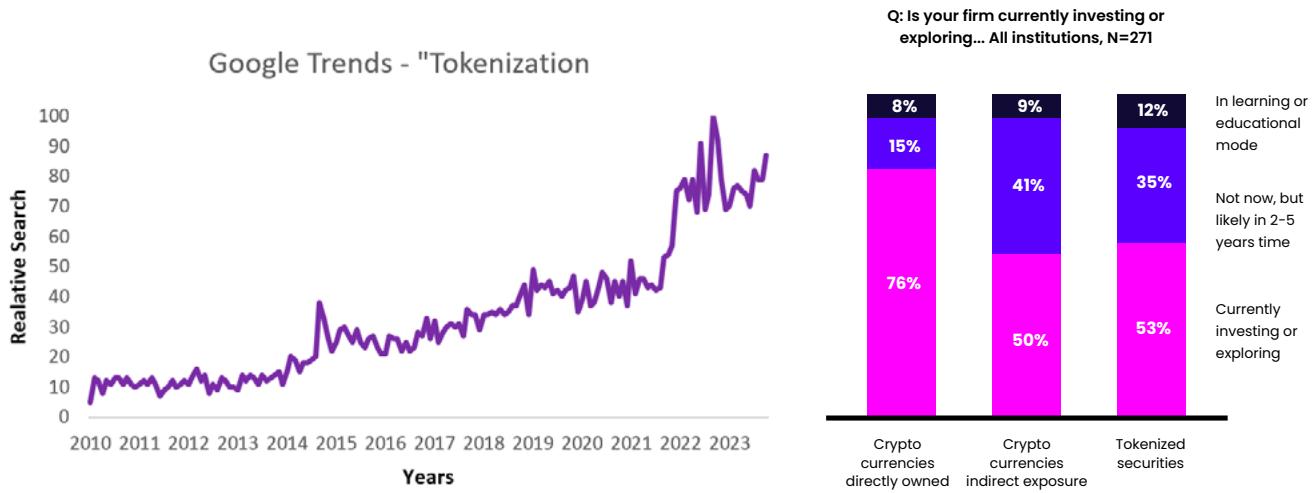
Below are three reasons that give us confidence that this time is different.

1. MORE MINDSHARE & ACTIVITY

We see more mindshare and activity from a larger set of players who are actively trying out the technology.

The 2019 and 2020 cycle was largely driven by retail investors and crypto enthusiasts. It was great to kickstart excitement on the prospects of moving real-world assets onchain. However, tokenization of RWAs is not an easy endeavor and in the first cycle interested participants did not have sufficient access to asset pools to kick-start the trend.

Today this looks vastly different. We see a growing interest from institutional investors, such as banks, hedge funds, pension funds and asset managers to tokenize RWAs. These entities have access to the asset pools and control the pace of adoption of tokenization of financial assets, which is the largest asset in the global economy, to a large extent. Seeing a growing recognition and appetite for the technology makes us very excited about the next wave of adoption.

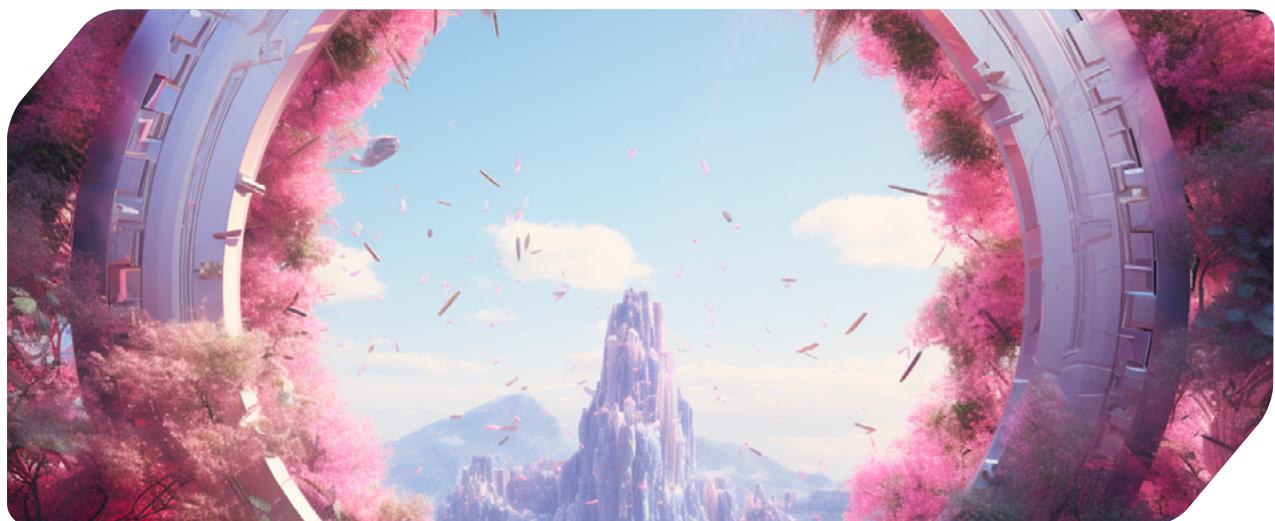


2. TECHNOLOGY STACK AND DEVELOPER TOOLING ON POINT

We see improvement in the infrastructure and tooling required for tokenization of RWA.

In recent years, the blockchain techstack has made significant advancements in scalability, security, and interoperability, reducing barriers to adoption in both permissioned and permissionless ledgers. Additionally, improvements in SDKs and tokenization standards have streamlined implementation processes for various stakeholders.

Alongside these native web3 infrastructure enhancements, established players are also embracing tokenization. Notably, major financial market infrastructures like DTCC, Clearstream, and Euroclear are launching tokenization pilot projects. While blockchain and RWA tokenization could potentially make these central counterparties obsolete through atomic securities settlement, they are still exploring opportunities and providing gateway infrastructure for their existing client base, making it easier for them to explore RWA tokenization. Besides infrastructure, these large incumbents are also driving the narrative and conversations with the regulatory authorities. [Industry paper: Advancing the digital asset era, together \(sept 2023\)](#) is a great example of this.



3. LEGAL & REGULATORY CLARITY

We have seen regulatory improvements aimed at catering for the tokenization of RWA over the past years and we expect this to accelerate as more stakeholders openly express interest in the area.

The most crucial factor for widespread adoption of tokenized RWAs is regulation. Positive developments are occurring in most jurisdictions, except the US, which is facing a political deadlock on crypto regulation. Exciting advances in digital asset regulation, such as MiCA and the UK's final proposals, provide institutional investors with confidence to explore this technology. A robust regulatory framework remains the primary requirement for institutions to implement large-scale asset tokenization. Alongside crypto regulation, we also observe improvements in regulations for general digital assets, which are often overlooked but are essential for RWA tokenization, with the UK's Electronic Trade Document Act, ETDA, serving as a prime example.

UK – The Electronic Trade Documents Act (20 Sept 2023) – The law changes a traditional paper bill of lading into a digital asset, eliminating the need for physical signatures and replacing them with digital signatures. This transformation is akin to the way stock certificates have become electronic and can be traded on stock exchanges and accessed through mobile brokerage apps. The law is not limited to specific technologies but it caters very well to blockchain and unlocks the legitimate use of tokenized RWA in trade.

Mechanism of Transmission

The tokenization of financial securities, a topic of increasing interest, is being facilitated by regulatory clarity regarding transmission mechanisms (CBDCs, Stablecoins,...) to settle transactions. In 2017, the tokenization of financial assets faced challenges due to the absence of a regulated, blockchain-based medium of exchange to use for onchain settlement of transactions. With the ongoing exploration and rollout of Central Bank Digital Currencies (CBDCs), financial institutions now have the missing piece of the puzzle in place.

Ranking of top three pain points with respect to your current digital asset custodians - #2 is legal

- 1 Product feature set**
 - 2 Legal and regulatory framework**
 - 3 Consolidated view and management of traditional and digital assets**
- Security-related certifications, e.g., SOC 1/2 and measures**
- Risk and compliance framework**

Source: BNY Mellon, Survey result of 271 institutional Investors



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THE RWA VALUE PROPOSITION

TL;DR ~ We got you

We believe RWAs can unlock key features such as transparency, tradability and divisibility by being represented through a digital token on the blockchain.

Leveraging these key features leads to **three key benefits for the tokenized RWA** which finds implementation across different use cases. The three benefits are:

- **Efficiency** – Improves performance using “the least amount of inputs to achieve the highest amount of output.” (Improves transparency, transaction costs, execution, reporting... of the asset)
- **Liquidity** – Allows assets to change ownership in a transparent and structured way.
- **Decentralization of ownership** – Allows distribution of asset ownership in a transparent and structured way.

The benefits of tokenization of real-world assets lie in the benefits of using the digital token to represent the underlying asset on the blockchain. In doing so, holders of the token can access the benefits of blockchain innovations. Essentially, tokenizing assets marries the value of real-world assets with the dynamic features of blockchain.

We believe that blockchain technology has key features which can be leveraged by real world assets through the process of tokenization. A combination of features are then used to unlock what we believe to be the three key benefits of having RWAs on the blockchain. These key benefits each have a strong value proposition and are driving the adoption of tokenization of RWAs across different industries.

UNLOCKED FEATURES OF RWAS THROUGH TOKENIZATION

Through tokenization, we believe there are key blockchain features that RWAs unlock by being represented through a digital token on the blockchain. These key features are:

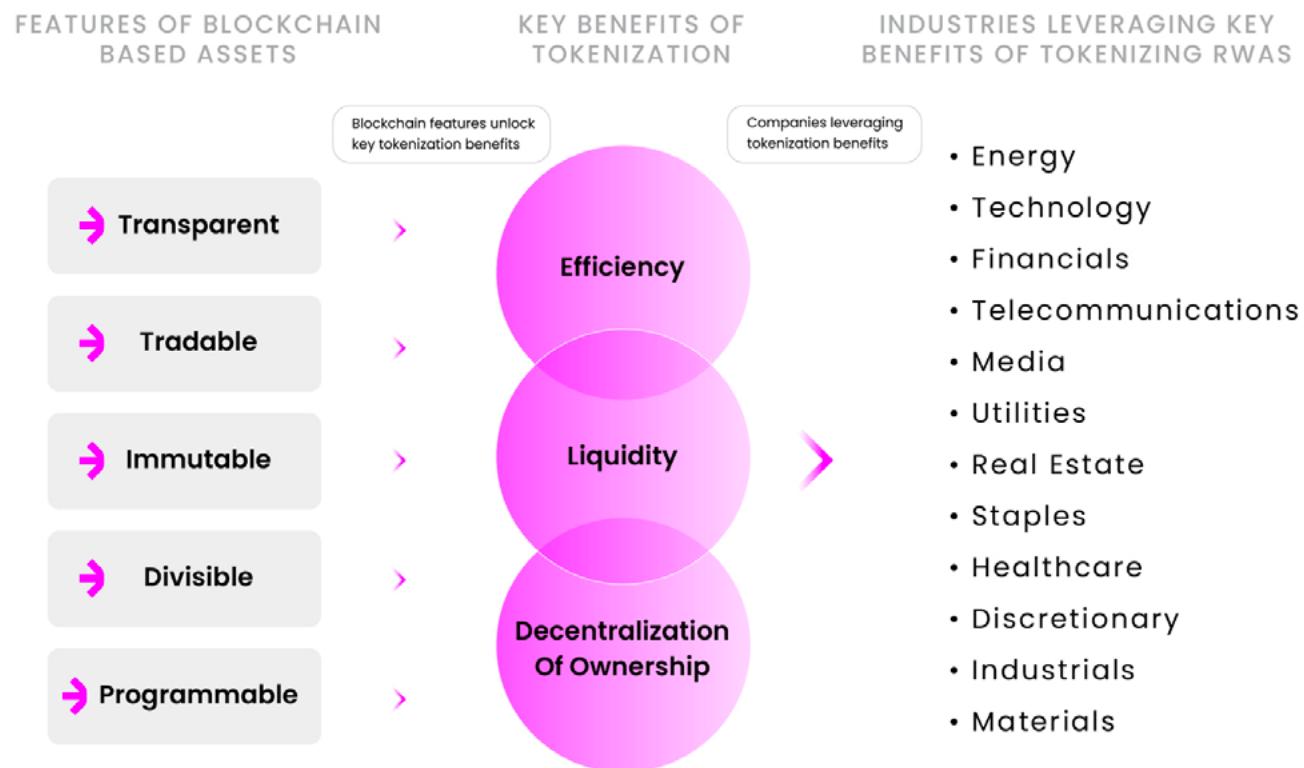
- **Transparent** - The blockchain is a transparent ledger where all participants can verify transactions, enhancing trust and accountability.
- **Tradable** - Blockchain enables the creation and exchange of digital assets that can be easily bought, sold, or traded on various platforms.
- **Immutable** - Data stored on a blockchain is nearly impossible to alter or delete, ensuring the permanence and security of recorded information.
- **Divisible** - Blockchain allows assets to be divided into smaller, tradable fractions, making it possible for more people to invest in and own a portion of valuable assets.
- **Programmable** - Blockchain smart contracts enable automated and self-executing agreements, allowing predefined rules to be coded into the blockchain for various applications and processes.



THREE KEY BENEFITS THAT TOKENIZATION BRINGS TO RWAS

By tokenizing assets and leveraging features of the blockchain, assets and its users unlock three key benefits from tokenizing assets. We believe each of these benefits stand alone and have a strong enough value proposition to be rational for tokenizing real world assets.

- **Efficiency** – Improves performance using “the least amount of inputs to achieve the highest amount of output.” (Improves transparency, transaction costs, execution, reporting...)
- **Liquidity** – Allows assets to change ownership in a transparent and structured way.
- **Decentralization of ownership** – Allows distribution of asset ownership in a transparent and structured way.



EFFICIENCY

Value Proposition

Tokenization of RWAs unlocks efficiencies for the assets that are represented on a blockchain. RWAs stored on a blockchain database improve the transparency, integrity and cost efficiency of handling these assets.

Biggest Challenge

We identify some key challenges related to leveraging RWA tokenization for efficiency:

- **Consortium** – Most efficiency is generated when different entities across the same value chain synchronize through a consortium. There is difficulty in convincing companies who are not fully economically aligned to collaborate and share information of tokenized RWAs.

Examples

Below some examples of how RWAs are tokenized in order to unlock asset efficiency:

- **Inventory Management** – Streamlined racking of inventory from source to destination.
- **Trade Finance** – Reducing paper & central server based documentation, improving efficiency, security & accessibility of transactions.
- **Healthcare Records** – Improve transparency & traceability of medical records across stakeholder (ie. Patients, hospitals, pharma & insurance).

LIQUIDITY

Value Proposition

Tokenizing real-world assets (RWAs) with the key focus to improve their liquidity. It enhances transparency, integrity, and cost efficiency in handling assets. This makes buying, selling, and trading RWAs more accessible and cost-effective.

Biggest Challenge

- **Liquidity Splintering** – Lack of standardization of tokenization practices and marketplaces leads to fragmentation of liquidity across multiple trading venues, making it difficult and expensive to trade assets.

Examples

Below some examples of how RWAs are tokenized in order to unlock asset liquidity:

- **Private Assets** – Creating liquidity in a previous highly illiquid market, allowing investors to enter and exit at more flexible times in the investment cycle.
- **Fine Art, Collectibles & Music** – Consolidating liquidity across a fragmented market with previously poor transparency and centralized market makers.
- **Carbon Credits** – Bringing liquidity to new assets, allowing them to be transparently traded on blockchain-based marketplaces.
- **Data** – Creating a liquid market around data allows the asset to be monetized by other stakeholders than those who store it, which is currently what is happening in the data economy.

DECENTRALIZATION OF ASSET OWNERSHIP

Value Proposition

Tokenization of RWAs enables the coordinated decentralization of ownership of these assets. The onchain representation of RWAs provides an efficient and low-cost method for tracking ownership fractions across various parties. Through its low costs and scalability, blockchain facilitates the decentralization of ownership in scenarios where previously high costs made decentralized ownership economically unfeasible.

Fractionalization, which allows digital assets to be easily divided into fractions (%) of itself, plays a pivotal role in tokenized RWAs' ability to decentralize asset ownership. By dividing assets into smaller portions or fractions of itself, it democratizes access to these assets and creates new ways for capital formation.

Biggest Challenge

- **Regulation of ownership** – Bearer ownership, where possession of a tokenized asset signifies ownership, is reemerging in blockchain. Unlike the centralized financial system, blockchain's decentralized nature requires a supranational framework for bearer ownership. This ensures smooth fractionalization of ownership, avoiding reliance on central entities. There are also token embedded rules that need regulation to become enforceable.

Examples

Below are some examples of how RWAs are tokenized in order to unlock decentralization of asset ownership:

- **Decentralized Physical Infrastructure (DePIN)** – a decentralized approach to constructing and maintaining various physical infrastructure elements, offering participants compensation and ownership through token incentives, enabled by blockchain and widespread internet connectivity.
- **Machinery-As-A-Service** – a new service model for industrial appliances where machines are rented rather than purchased. In this model, the lifecycle of these machines is managed by a network of specialized entities. Blockchain serves as the rails to coordinate between these entities.

OTHER COMMON CHALLENGES

Besides the specific challenges related to the key benefits, there are overarching challenges with tokenization of RWA. Below are a few key challenges:

- **Network Effect** – Blockchain-based applications, by their very nature, rely on network effects. With RWA, a network effect of users is needed to turn efficiency, liquidity or decentralization of ownership into a viable value proposition that convinces new users to tokenize RWAs and populate the shared blockchain. If a company is the first to move on a decentralized blockchain, there is little advantage and it's simply operating an expensive, inefficient database. As more players come and share data in a trustless way, it becomes more attractive to join. But someone needs to be first...
- **Oracle Problem** – Difficulty when reflecting a digital asset that represents a tangible RWA. There is a requirement for a secure and reliable way to ensure the data input (token) reflects the state of the real-world asset. (more details on this [later](#)).
- **Tokenization Standards** – Standardizing the tokenization of real-world assets is essential for ensuring compatibility, regulatory compliance, and investor trust in blockchain-based finance. However, the decentralized nature of blockchain and the need to address legal and technical challenges make achieving universal standards a complex task. Overcoming these challenges is crucial.
- **Infrastructure** – RWA tokenization requires data, the digital copies of the assets, to be migrated from a centralized data infrastructure to a blockchain based infrastructure. Companies and projects are still looking for the best way to tackle this challenge. Existing companies looking to integrate blockchain technology need to secure daily operations while changing the data infrastructure. It is effectively like changing the engine of a car engine while driving at full speed.

EFFICIENCY

Examples

- Healthcare records
- Supply chain assets
- T-bills & money market
- Inventory management

LIQUIDITY

Examples

- Private assets
(venture capital, private equity)
- Fine arts, collectibles, music
- Carbon credits
- Data

DECENTRALIZATION OF OWNERSHIP

Examples

- Machine-As-A-Service
- Decentralized Physical Infrastructure
- IoT

2

WEB

3

THE COMPUTABLE ECONOMY

The computable economy is a new economic paradigm where web3 technologies facilitate the development of a ‘computable economy’, which enables a significant increase in economic complexity and, from this, wealth. This critical transition will occur when this institutional computation can be extended from on-chain assets to off-chain real world assets.

The vision of the Web3 Computable Economy, is explored by Boson Protocol Founder – Justin Banon and blockchain economist – Prof. [Jason Potts](#), hinges on the evolution of economic complexity and wealth through history. The vision is that the economy is a complex adaptive system, where wealth correlates with the complexity and diversity of its components. This complexity has grown through innovations like language, writing, and the scientific method, each propelling us from tribal societies to modern economies.

In this context, Web3 technologies, particularly blockchain-based smart contracts, are pivotal. They’re seen as the next major institutional technology, potentially catalyzing a new era of computable economic order. These smart contracts are fundamental to achieving a Computable Economy, as they allow for programmable commerce layers that can significantly enhance economic complexity and diversity.

This new economy aims to unlock exponential wealth and address major sustainability and existential challenges, contributing to the long-term survival of our species. The crux of this vision is the integration of all assets, including offchain real-world assets (RWAs), into the Web3 economy. This integration requires ‘hard tokenized’ assets, which assure strong, cryptography-enforced ownership claims without the need for intermediaries. Such hard tokenization of RWAs is essential for running deterministic economic programs, thereby enabling a computable economy.

Boson Protocol ([more here](#)), a decentralized protocol which enables the trust-minimized, automated execution of off-chain actions, is the foundational Decentralized Trust Layer for Real World Assets, and enables the trust-minimized tokenization and exchange of any real world asset.

3

THE TOTAL ADDRESSABLE MARKET

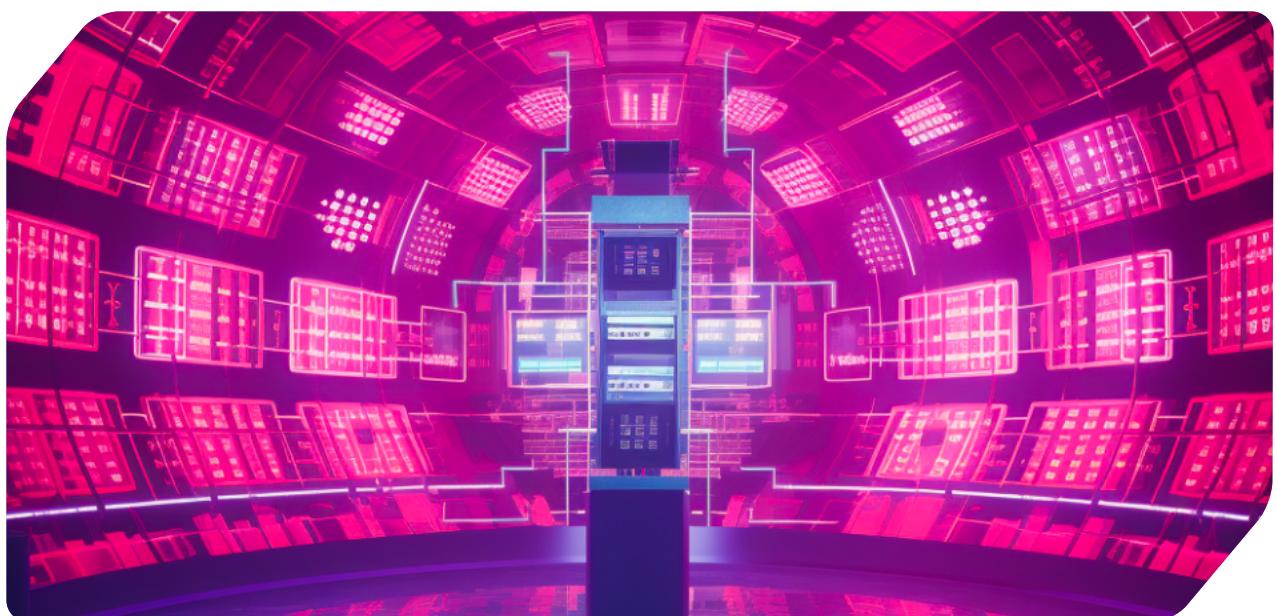
THE TOTAL ADDRESSABLE MARKET

We believe that the potential for tokenizing RWAs is underappreciated. Upon examining the methodology used to assess the impact of RWA tokenization, we have identified some missing elements.

The standard method for estimating the total addressable market of tokenized assets involves assessing the value of all potentially tokenizable assets and projecting a percentage that will be tokenized over time. While we find the approach reasonable, it is incomplete. This methodology does not account for the appreciation in asset value that is unlocked by creating liquid markets around these assets.

The value of an asset is defined by a combination of intrinsic value (based on future financial cash flows) and market value (what buyers are willing to pay for it). Through tokenization, markets are created around existing and new assets, allowing more price discovery, leading to an appreciation of the value as there is new price discovery of previous illiquid assets.

We believe there are two drivers behind the appreciation of the market value of assets as a result of tokenization.



THE RIGHT HANDS

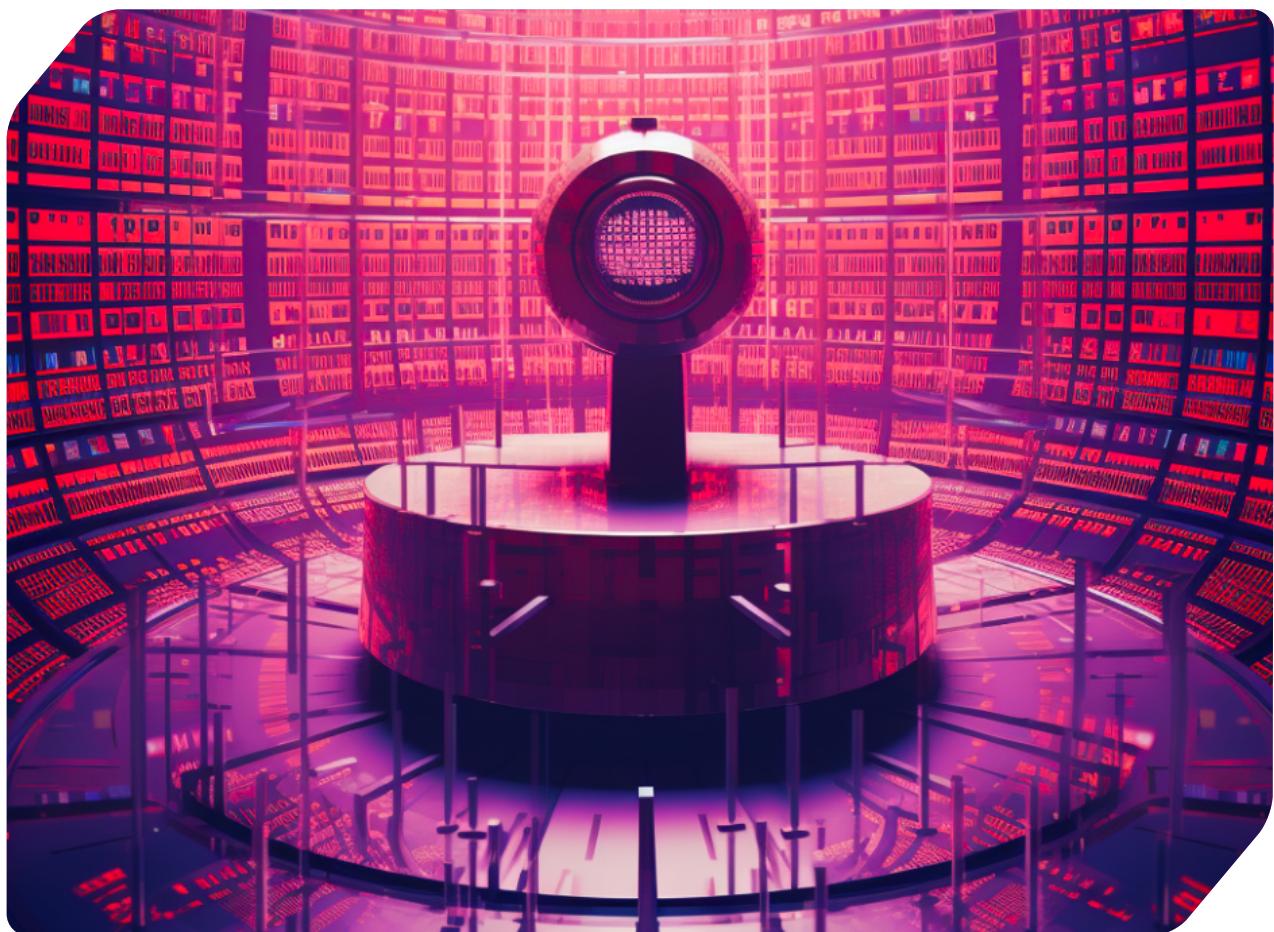
Benefits of tokenizing existing assets are undervalued. As discussed in the benefits, tokenization of RWAs facilitates liquidity and the decentralized ownership of assets. It allows for assets to be transferred to those who value the assets the most, leading to an uplift of its intrinsic value. In practice tokenization & the creation of liquid markets enables the transfer of assets to those who value them most, increasing the value of the asset. Much like a liquidity premium, tokenized assets are likely to experience an increase in their value.



ACCESS NEW ASSETS

Valuation uplift of segregated or newly created assets is not taken into account.

As discussed in the section on [segregation](#), tokenization allows asset holders to efficiently split up their assets into sub-categories of their assets (for example, separating the carbon certificate rights from a forest and trading these as two separate assets). We believe this opportunity is not captured in any of the TAM projections. Specific rights or aspects of an asset can now be isolated and traded separately from the original asset. This leads to an appreciation of that part of the asset as it unlocks new economic opportunities and can sit in the hands of those who value it the most.





4

THE TOKENIZATION TECH STACK

THE TOKENIZATION TECH STACK

TL;DR ~ We got you

There are generally three layers in the tokenization technology stack.

- **Standards** – Define how assets and ownership are represented
- **Infrastructure** – Enable tokenization and provide surrounding infrastructure rails
- **Applications** – Provide utility to the holders of tokenized assets

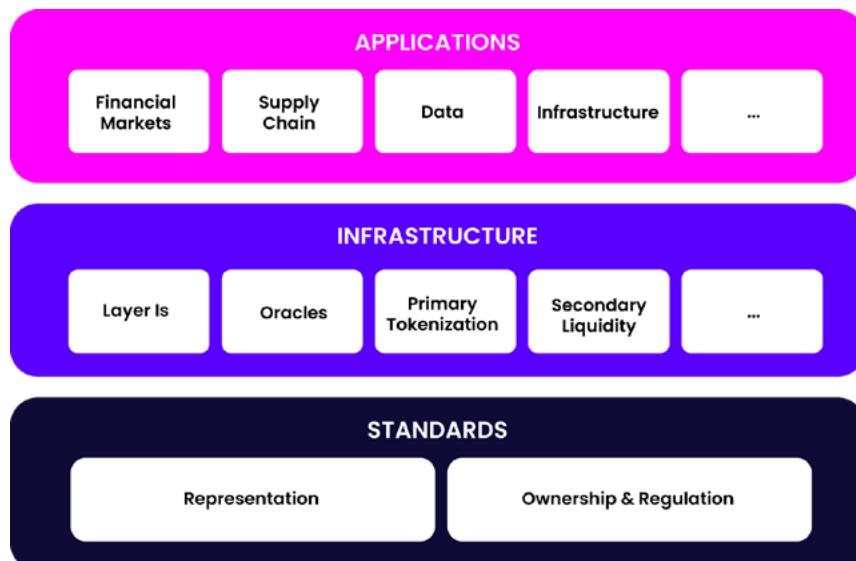
As tokenization finds wider adoption in the next cycle we anticipate changes in the way they are currently defined and built out. As the technology landscape changes, we believe that founders involved in building infrastructure and applications should maintain flexibility and agility. Different components of the existing stack may emerge as more preferred or effective than others

It is widely accepted to assert that the technology stack supporting the tokenization of RWAs consists of three distinct layers.

Applications – Provide utility to the holders of tokenized assets

Infrastructure – Enable tokenization and provide surrounding infrastructure rails

Standards – Guide the programmability of the token



STANDARDS

Standards are necessary to channel programmability of tokens. Tokenization standards break further down in two equally important categories. Both are prerequisites to a healthy and functioning RWA tokenization ecosystem.

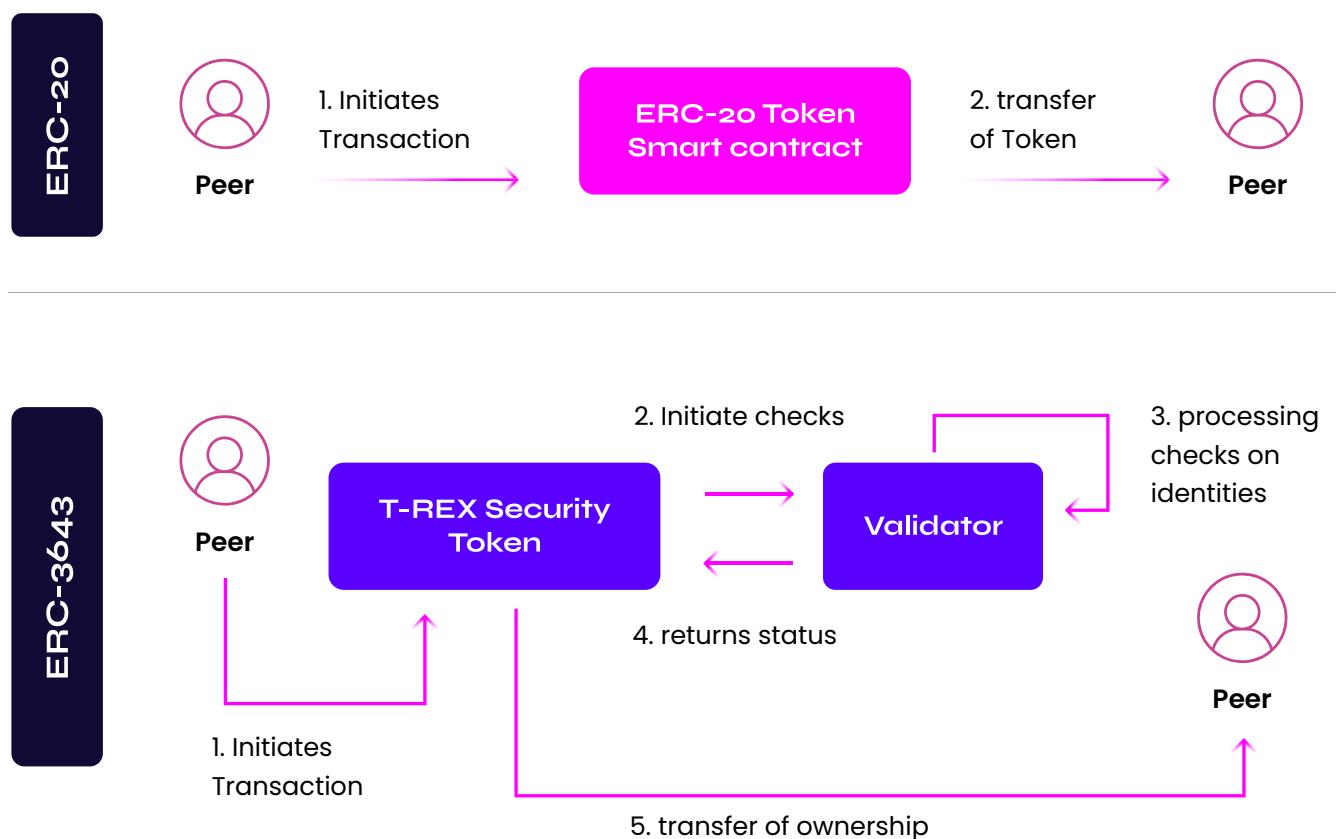


REPRESENTATION

Like any other software technology, when not centrally issued or created, it is important to have widely accepted standards to ensure interoperability between tokens issued by different players or different ecosystems.

Across ecosystems we've seen the creation of standards. Most well known are the ethereum ERCs. The most well known are ERC-20 and ERC-721 which are useful but have a very general purpose. As applications and use cases become increasingly complex and problems like "[the oracle problem](#)" get tackled, more complex, specific purpose standards arise.

Amongst those we take ERC-3643 as a quick example of how token standards can tackle the issue of control, transfer and recoverability of the token.



Source: Tokeny

On 15 December 2023, the ERC-3643 [passed the final stage](#) of the Ethereum improvement proposal (EIP) process. This is the first formal tokenisation standard formally adopted by Ethereum. It's a significant milestone and solidifies RWA tokenisation as a trend within the ecosystem.

We expect an increase in token standards to go through the proposal process as the number of RWA use cases increases. Within this trend we expect two separate movements. On one side, there are the niche ERC standards tailored to specific use cases. On the other hand there will be the creation of general purpose ERC proposals like the [ERC-7208](#) (onchain data containers). We believe there will be a balance between general purpose ERC standards for the most generic RWA tokenisation use cases supplemented by specific-purpose standards for new or niche use cases.

In short, we are very excited by the activity and enthusiasm we see around tokenisation ERC standards as they form the backbone for how RWAs are represented and structured on the blockchain.

Ownership & regulation

Tokens have programmable rules embedded. These rules need to be enforced to have any use. Regulation surrounding the ownership of assets is a prerequisite for the rules embedded into any token to become enforceable by law. Without regulation, embedded rules into the token such as ownership rights are hard or even impossible to enforce.

A common example is the regulation surrounding bearer assets. Bearer asset regulation is a framework governing the ownership of an asset. In its simplest form, it assumes that the holder of the asset is also the legal owner. This regulation was used in the past for financial assets (bonds, equity, etc.) but became irrelevant when financial markets adopted a custodianship structure to facilitate trading activities and create borrowing/lending opportunities. Today, with Web3 wallets, bearer asset regulation becomes important again.

INFRASTRUCTURE & SDK

Infrastructure and tooling serves as the foundation that allows RWAs to be digitized and integrated onto a blockchain, thereby leveraging the technology's benefits. This involves processes from creation to storage and trading, where high-integrity infrastructure is essential to give applications the confidence to represent assets onchain.

Up until now, tokenization infrastructure has been of a general-purpose nature. Our current infrastructure is designed to be application-agnostic, enabling the construction of applications on top of it, regardless of the industry or application type. However, we anticipate a shift in this trend, with early signs already emerging in financial markets (tZERO, Securitize,...). **As tokenization of assets becomes more prevalent, applications will likely become more specialized, necessitating a more robust and tailored infrastructure to support specific applications.**

APPLICATIONS & MARKETPLACES

The applications layer is where the real utility of tokenizing RWAs is realized. These applications utilize one or more key benefits of tokenization in their business models, bringing the value proposition to life and enabling users to reap the benefits.

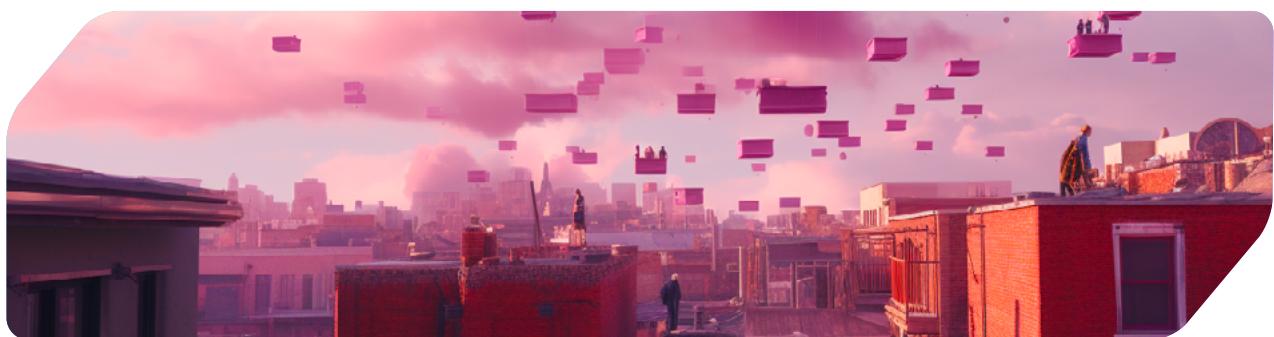
Currently, most applications adopt a 'tokenization-first' approach. This means they prominently feature the technology stack used in their product descriptions. However, **we anticipate a shift in this trend in the next cycle. As the technology matures, applications are expected to focus more on highlighting the benefits rather than the technology itself.** End users should not need in-depth knowledge of blockchain technology to understand an application's value proposition. We foresee that tokenization will become more abstracted, leading to a scenario where the adoption of these applications is driven solely by the tangible benefits they offer to users.

MONOLITHIC TO MODULAR

“Blockchain technology’s architecture is undergoing rapid evolution. Initially characterized by monolithic, specific-purpose infrastructure, there is now an accelerating shift towards modularity in tokenization infrastructure.”

This shift is spurred by the rapid expansion of tokenization, which is being applied to an increasingly diverse range of asset classes. As blockchain-based tokens emerge as a universal link between traditional and digital assets, the underlying tech stack is evolving to support this variety.

This move towards a modular architecture aims not only to enhance interoperability but also to spur innovation, enable customization, and foster a seamless ecosystem. In such an ecosystem, various assets – from real estate to intellectual property to financial instruments – can be efficiently represented, traded, and managed. **As the technology landscape changes, we believe that founders involved in building infrastructure and applications should maintain flexibility and agility. Different components of the existing stack may emerge as more preferred or effective than others, necessitating adaptability in their approaches.**



5

WHAT ARE WE EXCITED ABOUT?

TL;DR ~ We got you

We have pinpointed several areas within the tech stack where we eagerly anticipate seeing innovative developments in the near future

Infrastructure

- As requirements and complexity grow, the shift is moving from general-purpose to specific-purpose infrastructure.
- There is a need for infrastructure improvements to facilitate the onboarding of buyers of tokenized assets, particularly in emerging asset markets.
- Improvements in cross-chain capabilities are necessary, as interoperability is essential for providing token holders with a frictionless experience when navigating across the ecosystem.

Applications

- **Efficiency** - We see a lot of short term potential in unlocking efficiency gains through tokenization and believe this is the gateway argument to get many assets represented on blockchain.
- **Liquidity** - We are excited to see markets created around new asset classes that previously did not enjoy liquid markets. This will unlock financial value embedded in assets which currently don't sit in the hands of those who value it most.
- **Decentralization of ownership** - We are excited about new business models that will spawn out of the reengineering of asset ownership. Particularly around capital formation and breaking down capital requirements to participate in capital intensive businesses like Telecommunication, Utilities, Energy and Manufacturing.

It is widely accepted to state that there are three distinct layers in the technology stack that supports the tokenization of RWAs.

- **Standards** - Define how assets and ownership are represented
- **Infrastructure** - Enable tokenization and provide surrounding infrastructure rails
- **Applications** - Provide utility to the holders of tokenized assets

We see exciting developments across infrastructure and applications.

INFRASTRUCTURE

We believe there's still a long way to go on the infrastructure until we reach the tokenization end-game.

For the section below we look through the lens of mainly financial asset tokenization with a short-term adoption horizon.

Over the past five years we have seen significant improvements on the technical side to facilitate tokenization. We've seen L1 scaling, wallets, token standards (ERC20, ERC721, ERC3643, ERC2222, etc)... We believe that the general purpose tokenization infrastructure is maturing. As tokenization use cases grow more complex we expect innovation and founder attention to move from general purpose to use case specific tokenization infrastructure. **We are seeing a move from general purpose to use case specific tokenization infrastructure.**

We continue to see a bottleneck on the demand side of tokenization. While there are plenty of opportunities to tokenize and fractionalize asset classes, we see many verticals struggling to make a liquid market around these tokenized assets, even for assets that already have an existing liquid market. We believe the opportunity for founders now lies in building out infrastructure to onboard buyers.



We believe the opportunity for founders lies in building out infrastructure to onboard buyers. Below a few that excite us:

- **DAO Treasury Tooling:** Tools that allow DAOs to make quick decisions and execute to manage and diversify treasury through tokenized assets.
- **Risk management & assessment tooling:** Traditional investors, while interested in the yields offered for example by T-bills, struggle to assess required risk premia for tokenized products. Onchain indexing tools help investors quantify risk.
- **Regulation-first onboarding tools:** Regulatory compliance is still a bottleneck and there are structures in place to be compliant. These structured solutions should be bundled and abstracted away through tooling.
- **SDKs for complete tokens:** With tokenization we often see the asset being represented as tokens with the terms & conditions simply added as PDF. If we want to move from “dumb” to “smart” tokens we need tooling for users to embed the data into the token. We appreciate it also requires regulation for these rules to become enforceable.

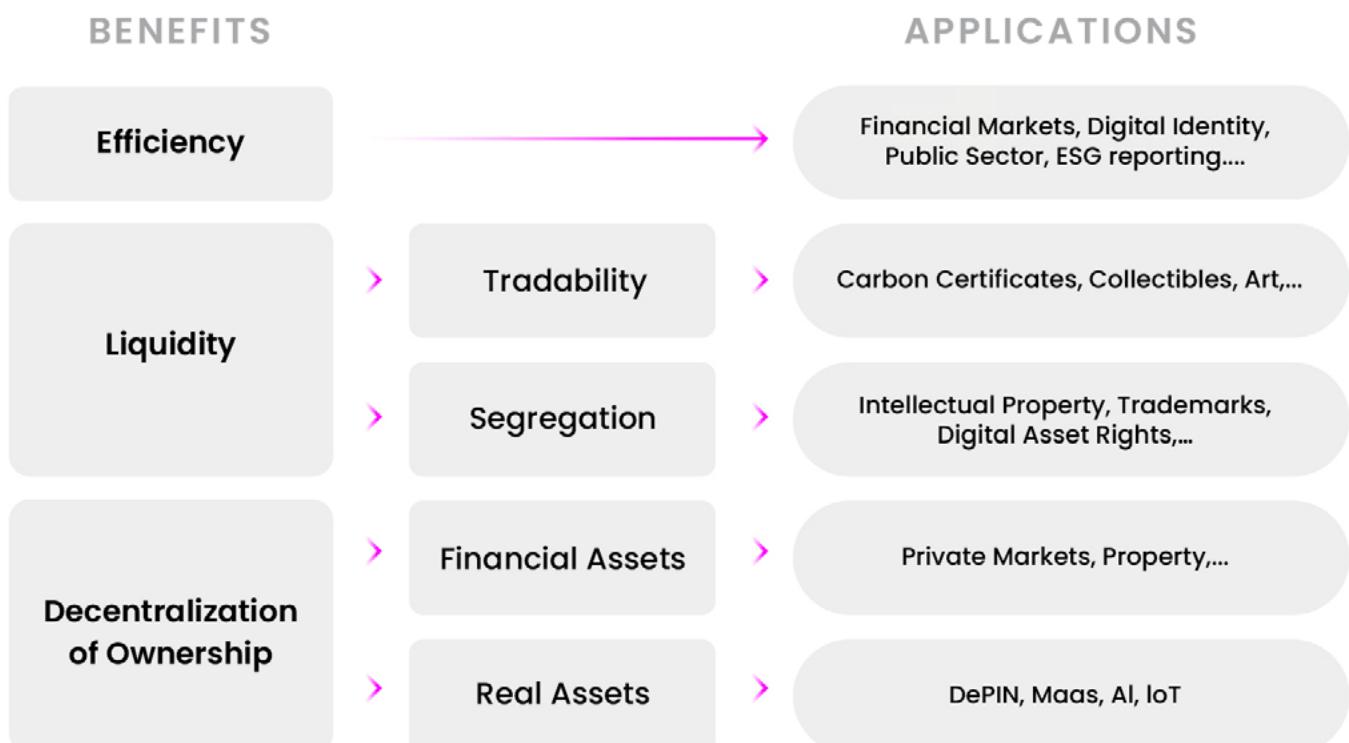
We are of the view that we are moving towards a multichain reality as blockchains are going from monolithic, general purpose ledgers towards modular and vertical- or app specific builds. This is especially true in financial services where we currently see tokens rolled out on both permissioned and permissionless blockchains.

We believe X-chain interoperability for tokenized assets should be built out. Some examples here are: Data feeds, Liquidity aggregators, Oracles

APPLICATIONS

For this section we'll look at the overall tokenization space and its opportunities. While we believe there are a lot of applications for financial assets, we feel like they are well documented and want to use this section to inspire and explore tokenization across industries.

Rather than structuring the applications according to the end-market, we structure them according to the benefits they create. We previously discussed the three key benefits of tokenization. To pair them up with applications, we further split up liquidity and decentralization of ownership. Below and overview of the benefits and examples of applications.



EFFICIENCY

Tokenization can unlock benefits between stakeholders that operate on the same value chain but are not aligned through the same economic incentives. We believe efficiency is the gateway argument to move assets onchain.

- **Sustainability reporting** – blockchain can be used to track carbon emissions across value chains
- **Financial markets** – infrastructure and processes of financial markets are completely different across asset classes. Tokenization can unify practices across asset classes.
- **Digital identity** – tokenizing and storing personal data in a web3 wallet allows individuals and legal entities to control the information flow and digital footprint.

LIQUIDITY

Despite facing challenges, we believe that establishing a liquid market through tokenization can aid in unlocking the financial value embedded within assets that are currently inefficient to trade.

For the use cases that interest us the most, we break liquidity further down into two sections; tradability, and segregation.

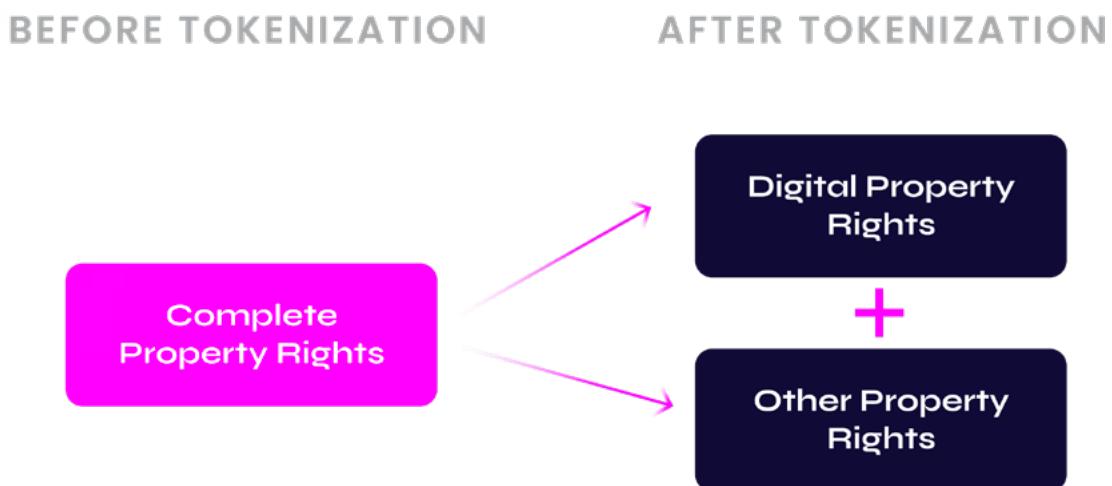
Tradability – Tokenization has the potential to create a market for assets which were previously “over-the-counter” (OTC).

- Carbon Certificates – Combining efficiency and liquidity here, blockchain traded carbon certificates improve efficiency (transparency, reporting,...) and liquidity in a previously inefficient market.
- Collectibles – Tokenization brings efficient, low cost tradability to a market that was previously over-the-counter.

Segregation – Tokenization has the potential to create completely new assets by tokenizing and financializing specific elements of assets, reengineering cash flows in assets and making a market around these assets.

Example: digital property right (PRDs) – The separation of Property Digital Rights from overall property rights. These rights are defined as the right to control and monetise the physical asset in augmented reality and metaverses. The ownership is tokenized and can be fractionalised and openly traded. (see [Darabase](#)).

By defining the rights and creating a liquid market for Property Digital Rights, Darabase expects a 2% markup on the global property value over time. The mark up stems from the underutilisation of the Property Digital Rights because of the lack of a simple system for registration, ownership and tradability.



Other examples are markets around intellectual property, trademarks, etc

We expect to see more of this segregation of asset rights as tokenization diffuses across industries.

The difficulty of creating liquid markets

RWA tokenisation alone is not creating liquid markets around assets. Instead it is lowering the barrier of entry to create these markets by improving transparency, costs,... when changing ownership of the underlying assets.

Creating liquid markets around previously inefficiently traded markets is powerful but notoriously difficult. **Liquidity occurs when there is a strong, sustainable desire to trade the asset from both the supply and the demand side of the market.**

There are a lot of idiosyncratic reasons for players to step into the market however we believe that there are two types of assets that traditionally have been successful in driving sustainable demand to trade from both sides:

- **Volatile Assets** – Assets with inherent volatility of their intrinsic value. These assets, because of how they are valued or the information that is available to do so, see fluctuation in their perceived intrinsic value. As a result, the changes in the price (IV) of the asset is constantly rebalancing the desire for the supply and demand side of the market.
Example – financial products like publicly traded equity and fixed income,...
- **Non-durable assets** – Assets that have a finite shelf life. By having assets that need to be replaced and produced as they are consumed, there is a sustained dynamic of supply and demand to trade the underlying asset. On the opposite, if the asset has an infinite shelf life, there is no need for buyers to step back into the market after they bought it initially (apart from price speculation, re Volatile Assets).
Example – Soft goods, perishables, consumables, FMCG, Disposable Items,...

DECENTRALIZATION OF OWNERSHIP

Decentralization of Ownership is the key, beneficial innovation that most closely aligns with the Web3 narrative. We believe the applications of this benefit vary, depending on the type of asset where ownership becomes decentralized.

Financial Asset Ownership

The applications for financial assets revolve around capital formation and the ability to get access to;

- **Private Markets** – previously hard to access VC and PE investment opportunities become accessible through fractionalization of the investment vehicles.
- **Property** – Property ownership in the US now takes up ~60% of disposable income, crowding out the middle class from ownership. Tokenization can restructure property ownership.

Real Asset Ownership

The decentralization of this asset type also concerns capital formation, but with vastly different implications. We believe capital intensive industries will be impacted the most. Traditionally, capital intensive industries are inaccessible due to the high initial investment required. Through decentralization of ownership of real assets, the barriers to entry to these industries can be lowered, and their existing business model challenges reduced, leading to more efficiency..

- **Decentralized Physical Infrastructure (DePIN)** – Compute, telecommunication, storage, utilities, etc
- **Machine-as-a-service** – if interested, recommend [this](#)
- **Democratization of Artificial Intelligence** – Distribution of AI capabilities through partial ownership of infrastructure & computational capacity.
- **Internet of Things** – Redistribution of asset ownership structure to unlock full potential of IoT and smart cities.



6

HOW DO WE SEE ADOPTION UNFOLDING?

OVERALL ADOPTION

There are many moving parts but we believe there are two prerequisites to any adoption of tokenized assets.

- **Regulation** - A regulatory framework for this new asset class is critical. Not only is there no way for token holders to comply but without regulation there is no way to enforce the embedded terms and conditions linked to the token.
- **Product demand** - while partially tied to regulation, there needs to be a clear demand from buyers for tokenized products. We are at a point where infrastructure build out is outpacing demand. We need demand for these services to start picking up.

We lay out our framework of adoption based on the different applications that leverage the key benefits as discussed above. **The framework is a result of weighing up the short term opportunities with the hurdles that need to be cleared before we can see widespread adoption.**



We are excited about all five pockets of tokenization adoption but believe there is a sequence in which we will see applications leveraging these benefits maturing. We think efficiency is the lowest hanging fruit. We see users becoming convinced of the efficiency gains associated with the tokenization of RWAs by the face value benefits alone. These benefits will also serve as the gateway for other use cases as more assets get represented onchain.

For context, we are very excited about verticals like decentralized physical infrastructure but believe this will be the last vertical to mature. We believe DePIN is arguably one of the most disruptive applications of tokenization, however there are more significant hurdles that need to be cleared before we see widespread adoption.

FINANCIAL ASSET ADOPTION

Financial instruments is an asset type that will see most adoption during this cycle. Recently we've seen a large slew of headlines coming from financial institutions around tokenization. We believe that there's much more brewing under the surface amongst asset managers, banks, exchanges and other TradFi players.

We are excited about all facets of tokenization but expect new headlines around financial assets to pull in founders, innovators and investors as they see this as an opportunity with short term catalysts and massive potential. Below we formulate how we think adoption will happen over the short to medium term.

We provide an [overview](#) below of the current state of financial asset tokenization.

ALL ABOUT T-BILLS

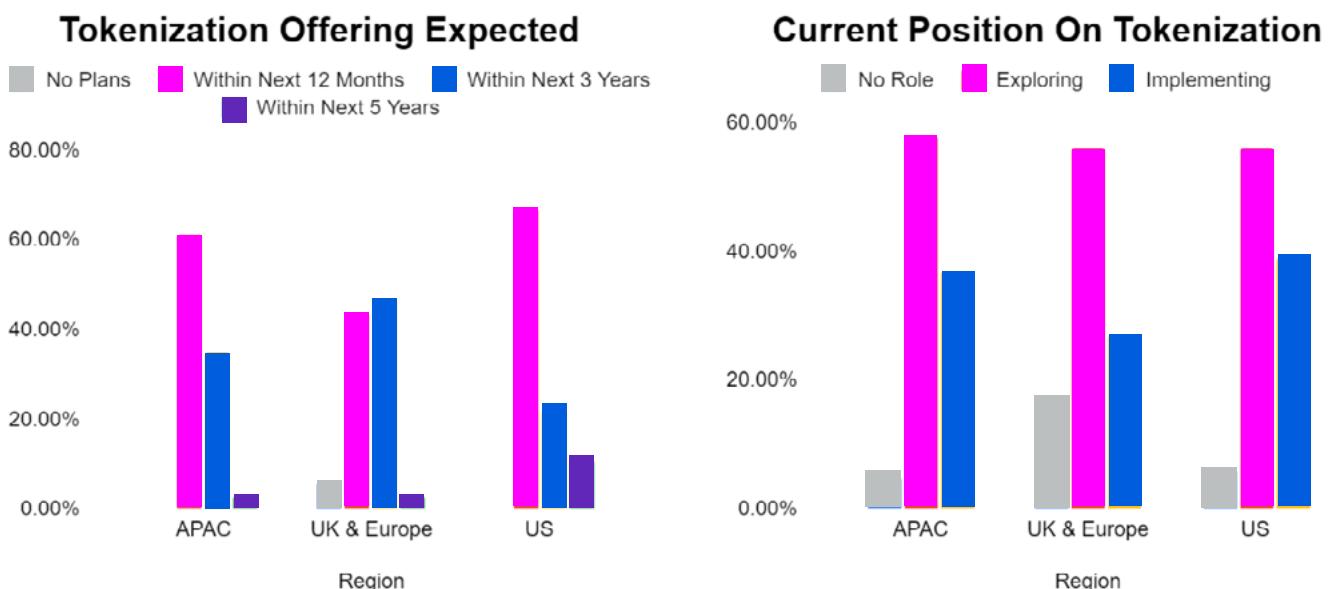
Tokenized T-bills thrive in the current environment of rising interest rates, initially as a low-volatility, regulator-friendly proof-of-concept, and now as attractive yield-bearing assets for crypto players. Their tokenized nature boosts capital efficiency, especially for trading firms. Their wide appeal, from startups preserving capital to sophisticated investors seeking yields, has been key to their success as they serve a very wide audience.

We believe that T-bills are an excellent entry point for financial institutions venturing into tokenization. They provide an opportunity to engage with a simple, straightforward, and familiar financial product on the ledger, allowing institutions to become acquainted with this new approach before exploring more complex offerings like DeFi and other onchain products.

SECONDARY LEDGER

We are seeing initiatives from asset managers to start tokenizing their fund offering. Looking under the hood, these asset managers are using blockchain as a second ledger. The tokenized funds are still traditionally managed, the value of the fund is just tokenized and distributed to the investor who can add it to their wallet to track the underlying value. The tokenized fund is a representation of the value held by the investor but not a representation of a claim to ownership over the fund.

We believe as financial institutions roll out tokenization, we'll see more of this approach where they opt to use blockchain as a secondary ledger where the token is just a representation that can be held in users' web3 wallets. This phase will last until financial players are more comfortable with the technology and integration risks and costs go down.



Source: [Calastone](#)

RISK PREMIUM

We are currently seeing a mismatch between the supply and the demand side of tokenized financial assets. From a technology point, much is already in place to tokenize. The bottleneck currently sits on the demand side as outside of T-bills, there is very low demand for tokenized products, especially from non-crypto native institutions.

We believe this has to do with assessing the risk premium required for buying into products represented on chain. As blockchain is still at an early stage in its life cycle, there's a natural risk associated with accessing products sitting on the blockchain. Investors are still assessing what investment return they find acceptable to take on the additional technology risk in order to access the investment. **We believe tokenization infrastructure and application providers need to have high integrity and need to operate with the highest degree of integrity and educate investors to help them get comfortable assessing this risk. Without the education, investors won't be able to make the risk assessment.**

THE WAY FORWARD

There are a lot of moving parts, however we think the adoption of tokenization of existing financial assets is driven by a simple formula. Adoption from the demand side for tokenized assets will happen if:

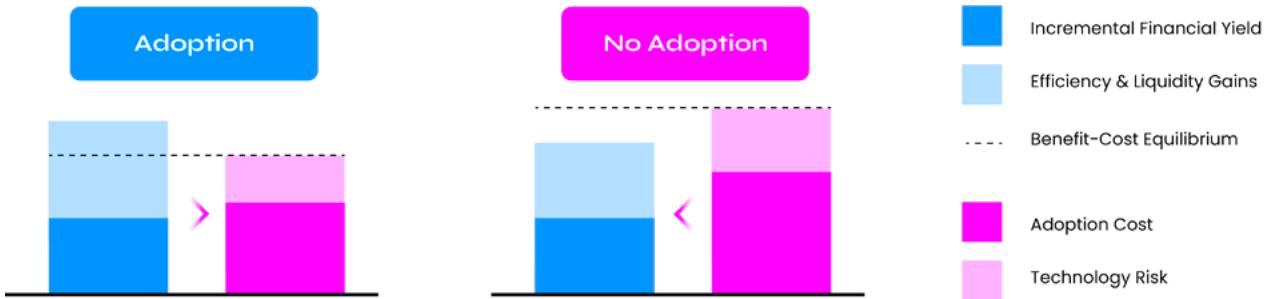
BENEFITS

COSTS

$$\text{Incremental Financial yield + Efficiency \& Liquidity Gains} \geq \text{Technology Risk + Adoption Cost}$$

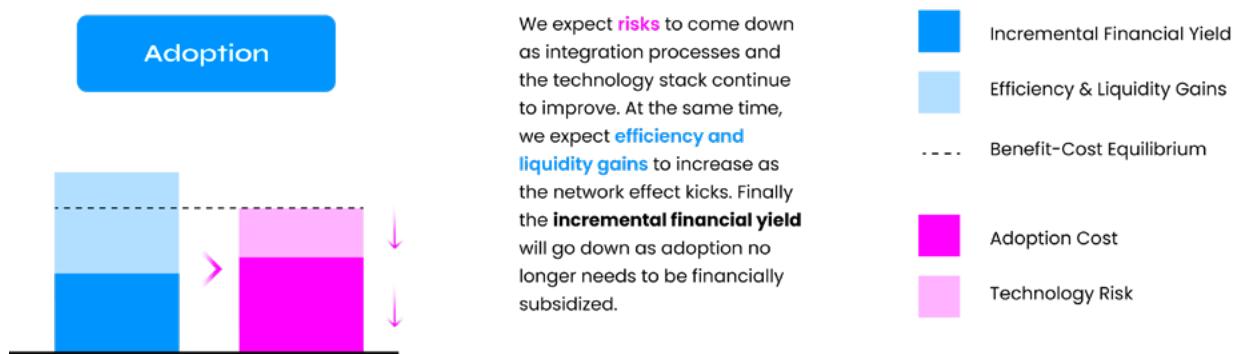
- **Incremental financial yield** – Yield from holding the product on chain on top of what it would offer if it was simply represented offchain.
- **E & L Gains** – The benefits beyond financial gains of holding the asset onchain.
- **Technology Risk** – The risk associated with holding the asset onchain.
- **Adoption cost** – cost associated with infrastructure, compliance, associated with onchain.

ADOPTION FRAMEWORK



T-bill adoption is driven by the financial yield and feels like an anomaly which, as discussed, is largely driven by higher risk-free rates. T-bills are unique because financial yield is subsidizing adoption. We see this as an unsustainable approach for wider adoption across all financial products. We believe adoption this cycle will be driven by technology risk and adoption costs coming down further as we see pilot programs and regulatory clarity.

EXPECTED ADOPTION



For new financial products that only came into existence because assets were put on blockchain (for ex. DeFi), the equation is quite different. It basically boils down to whether or not the new product is catering to a segment of underserved users of financial products that benefit from this new product offering. If that's a yes, in combination with regulation and reasonable integration requirements, there'll be adoption.

We believe founders need to understand the moving parts in the adoption rationale of potential buyers of tokenized assets. They also need to understand what is important from a product perspective, it's likely not exclusively about financial upside.



7

DIGITALIZATION OF ASSETS

DIGITALIZATION OF ASSETS

Over the past two decades, since the dawn of the personal computer, we have been witnessing a structural trend called “digital transformation”. A trend which has given rise to a parallel digital world that increasingly mirrors our physical reality unlocking substantial benefits. This digital evolution includes the concept of a “Digital Twin,” which represents virtual counterparts of physical objects from the real world and has gained prominence in various industries. With 75% of all data stored globally generated over the past 5 years, we expect the digital realm to exceed the physical in terms of size and number of assets in the not so distant future.

We believe Tokenization of real world assets (RWAs) on blockchain is playing a central role in this next leg of the digital transformation. Blockchain serves as a trust protocol bridging the physical and digital realms by enabling the identification and connection of physical objects with their digital counterparts, leveraging trust, distribution, and value features.



8

FINANCIAL ASSETS

A key feature of financial assets is that they are the assets used in financial markets. An area where tokenization of RWA is most discussed and seeing relatively strong traction. We provided a definition of financial assets earlier, to make it even clearer, below is a non-exhaustive list of key financial assets.

Cash, Deposits, Stocks, Bonds, Mutual Funds, ETFs, Derivatives, REITs, Money Market Instruments, Private Equity,...

THE LOW HANGING FRUIT

The financial industry is currently at the forefront of blockchain-based asset tokenization. Tokenization is expected to revolutionize the way financial assets, such as stocks, bonds, and real estate, are represented and traded digitally. We also believe that there are strong use cases for blockchain integration & tokenization within finance.

We think there are four main reasons why the tokenized RWA narrative is so fixated on financial markets: Financial Asset Ownership



1. LIKE A GLOVE

There is a strong, natural fit between the key benefits of tokenizing RWAs and the financial industry. The industry strongly benefits from efficiency, liquidity and decentralization of ownership. Below a quick recap why we believe this:

Efficiency - There are many areas where efficiency in financial markets is important. First, it's an industry with a lot of regulatory requirements and reporting. Secondly, efficiency is important because it impacts resource allocation, investor confidence, fairness, and economic stability of financial markets.

Efficient markets ensure that asset prices accurately reflect available information, promoting informed decision-making and economic stability, although real-world markets are rarely perfectly efficient due to various factors. Looking at market infrastructure across different asset classes, it's hard to call financial markets efficient. There are different trading, clearing, custody, regulatory,... requirements across asset classes. Tokenization and blockchain-based financial markets can make these processes homogenous across asset classes, unlocking synergies and efficiencies, adding value to all stakeholders.

Liquidity - Financial assets switch hands regularly as these assets are used to invest, hedge, collateralize and perform other financial activities. Switching hands often, liquidity is a critical part of financial assets and the markets surrounding it. Improving liquidity of existing markets with proven liquidity is desirable.

Decentralization of Ownership - Many financial assets naturally have decentralized ownership for two main reasons:

- Diversification allows investors to spread risk, reducing exposure to individual assets, and improving portfolio stability.
- Certain investments necessitate pooling of assets from multiple participants to successfully raise capital, contributing to risk mitigation and enabling access to larger opportunities.

As illustrated, there is a strong fit for tokenization that facilitates and improves existing (i) processes, (ii) liquidity and (iii) the decentralization of ownership of financial assets.

2. LINGO & FOUNDERS-MARKET FIT

Founder-market fit is the idea that founders who have personal experience and a deep understanding of the problems and challenges within a specific industry are more likely to come up with innovative and effective solutions. We believe that financial professionals looking for solutions see above-average value in tokenization because they are familiar with the concept of liquidity and deal with assets that are, by definition, decentralized of ownership.

Understanding these concepts, financial professionals are quicker to recognize the sometimes intricate value propositions of tokenization across their industry. This contrasts with founders seeking to address issues in sectors such as healthcare or media, where a deep understanding of liquidity and decentralized ownership is less prevalent, for example.

3. INTANGIBLE ASSETS & DIGITALLY REPRESENTED

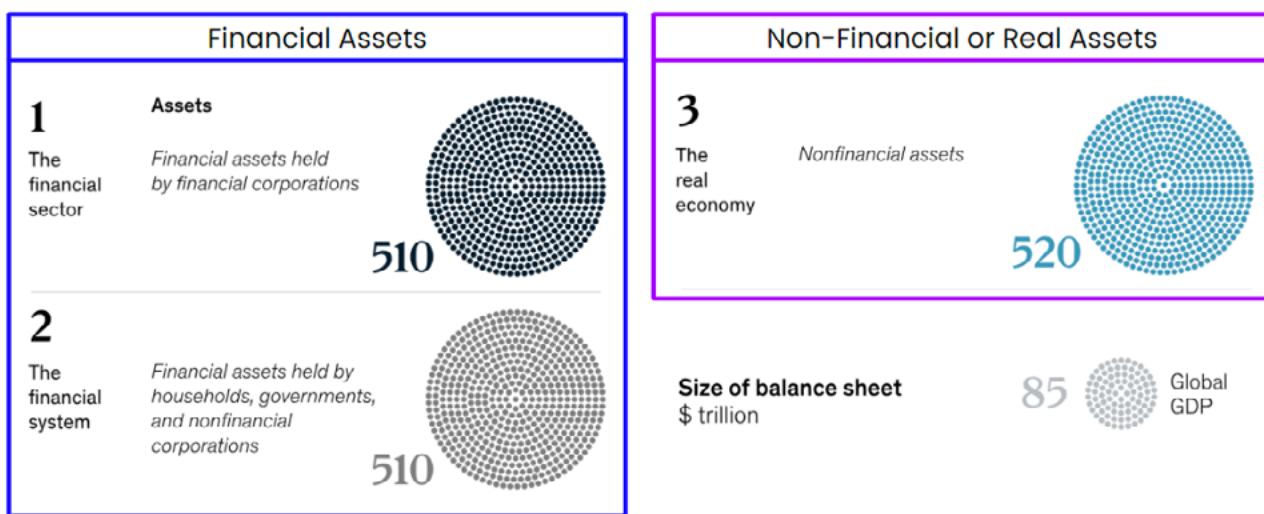
Financial assets are more intangible in nature because they represent legal and financial rights. They lack a physical form, and are valued based on market dynamics, rather than any inherent physical attributes.

For reasons we'll discuss more extensively later, intangible RWAs are easier to tokenize. In financial assets specifically there's the additional factor that many of these assets already have a "digital twin" sitting in a database. Migrating that twin onto a blockchain database is a significantly easier lift than tokenizing physical, real world assets.

4. MASSIVE VALUE

When examining global assets, we observe that financial assets constitute two-thirds of all assets internationally. Split equally between assets held by financial institutions and non-financial institutions (including governments and households), this is the largest and most distributed type of asset out there. This makes for a widely addressable market for tokenization with a lot of different use cases across efficiency, liquidity and decentralization of ownership where tokenized RWAs can add value.

When examining global assets, it becomes evident that financial assets constitute two-thirds of the total. These financial assets are evenly divided between those held by financial institutions and non-financial entities, including governments and households, making them the largest and most widely dispersed asset category. This wide presence of financial assets creates a massive addressable market for tokenization, offering numerous use cases related to efficiency, liquidity, and the decentralization of ownership. Tokenized RWAs (Real World Assets) can significantly enhance value across these areas.



Source: McKinsey

We'll dive deeper into what is happening with tokenization of financial markets.

SO WHAT IS HAPPENING IN FINANCIAL MARKETS?

Originally around 2017, the focus of tokenization of real world assets was on the digital representation of illiquid, physical assets such as collectibles, real estate, commodities and art, etc. In 2020, the DeFi summer showcased an alternative financial system with financial instruments mirroring those of traditional finance. This inspired financial institutions to start playing around with private and more recently public blockchains to deal in financial products.

As financial institutions started committing resources towards tokenization of RWA we've seen much of the innovation of tokenization of RWA gravitate towards financial applications as the industry started putting actual resources towards exploring use cases. Currently, the financial sector is the most advanced in terms of tokenization and the integration of blockchain technology to harness its potential.

So far, the adoption of tokenized RWAs and the technology supporting this trend has been driven by existing crypto users, rather than newcomers. However, traditional financial giants like Franklin Templeton and Wisdom Tree are showing interest in the tokenization of RWAs, indicating potential for DeFi to expand. The tokenization of RWAs has gained momentum in 2023, pushing their market values to record levels. The changing macro environment and ongoing demand from both crypto veterans and newcomers will shape the sector's future.



We believe tokenization will continue to be an important part of the narrative over the next couple of years. We also see other tailwinds that will accelerate the adoption over the next few years:

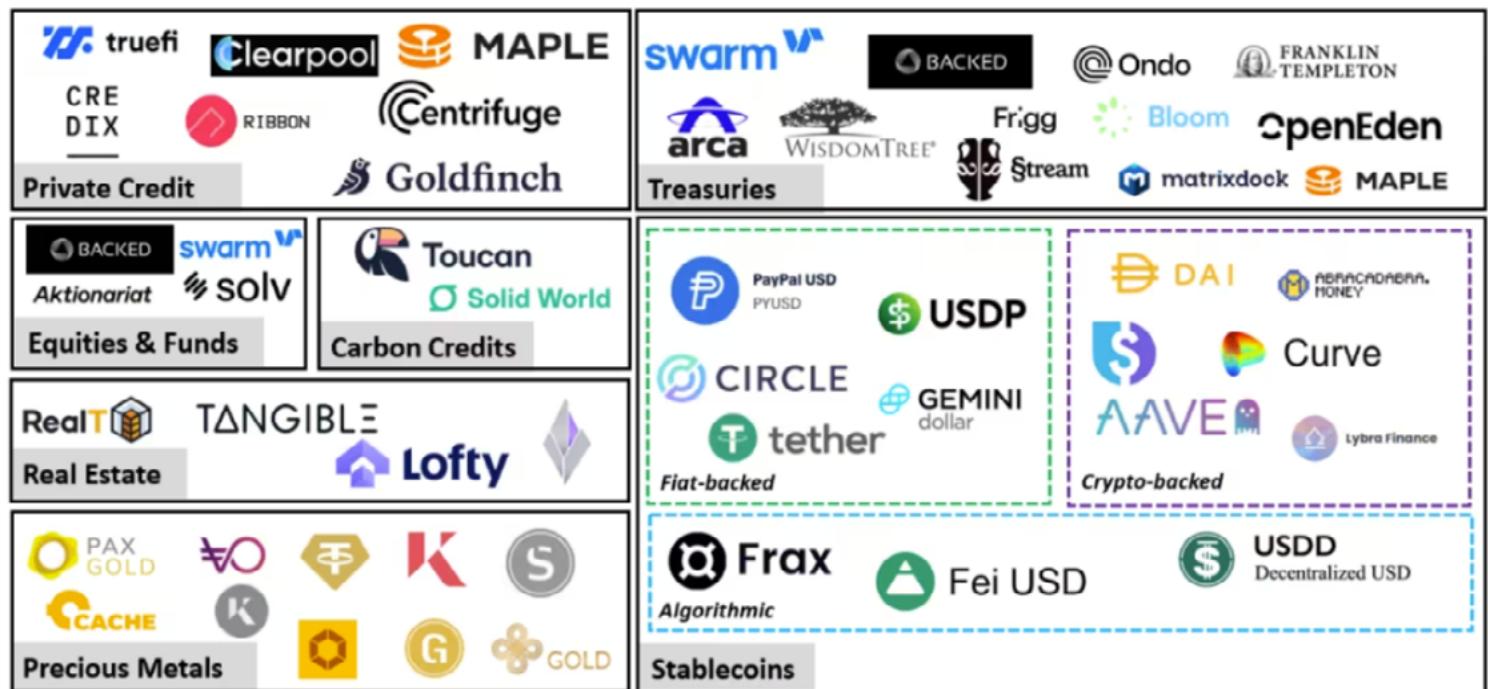
- **High cost of capital** – Higher risk-free rates expose the true cost of capital inefficiency during trading execution. Over the past 18 months, the cost of inefficient clearing, trading & financing of activities has gone up exponentially, incentivising financial institutions to look for solutions.
- **Roll-outs** – Many large financial institutions have committed to building their own tokenization platform. While we don't see this as the end-state, this should accelerate the population of financial instruments onto a blockchain.
- **Race to the bottom** – Concerning sales & trading, asset management and other business lines have been under cost pressure over recent years because of the increasing regulatory burden and challenger banks/fintech coming of age. As tokenization is explored more seriously, we think financial institutions will truly recognize its scaling and cost benefit potential.

Over the past years, the focus has shifted from putting illiquid assets onchain to tokenizing instruments with existing liquid markets. As the mindshare and expertise around tokenization increased, so did the realization that migrating assets onchain is not that simple. We believe that is why the focus has shifted back to liquid instruments. That way financial institutions and players could focus on the technical aspect of tokenization without having to worry about bootstrapping liquidity in an entirely new market.

Today the focus of incumbents is on tokenizing Treasury bills, money market instruments, repos, etc. Startups and challengers are generally more adventurous in tokenizing as they don't have existing network effects to rely on to bootstrap liquidity. We'll explore some of the biggest verticals and explain what we're excited about:

OVERVIEW

The efforts of tokenized financial assets are mapped out nicely. Below an overview of the different efforts happening. Further in the thesis we'll dive into a few important verticals.



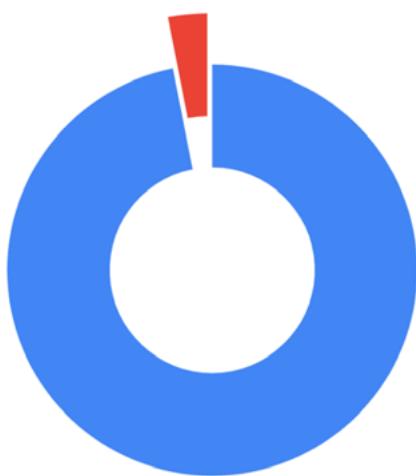
Source: Galaxy Research

STABLECOINS

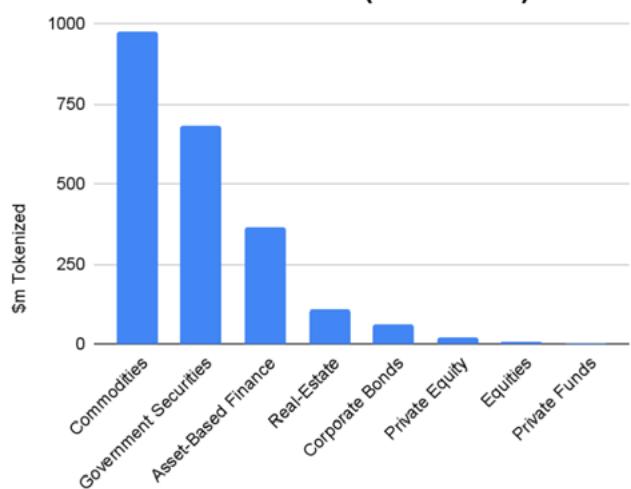
We begin this section by focusing on the largest and most established of tokenized RWA, stablecoins. With this type of digital asset, each token represents underlying fiat currency which is represented on-chain by the stablecoin. Stablecoins play a critical role for traders in the crypto ecosystem. Stables facilitate liquidity, and leverage in the system, serving as an intermediary onchain asset and reserve. They allow investors and traders to remain onchain when liquidating tokens or other asset positions.

Fiat-backed stablecoins have been around for almost a decade. Most of the time, these stables are tokenized versions of the unofficial global currency, the US dollar. With use cases in dApps, on CEXs and DEXs, fiat-backed stables continue to see strong adoption and product-market fit. Currently ~96% of all tokenized assets are fiat-backed stablecoins and we expect them to remain dominant for at least the short- to medium term future.

Fiat-Backed Stables as % Of Tokenized Assets



Tokenized Assets (Ex-Stables)



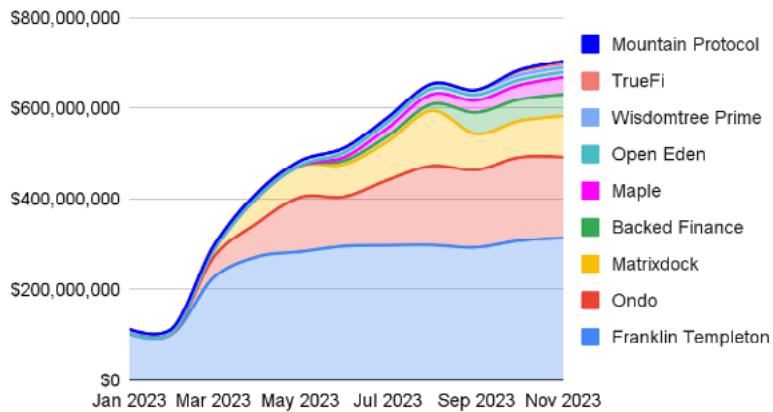
Source: Dune analytics, 21.co

TREASURIES & BANK ISSUED DEBT

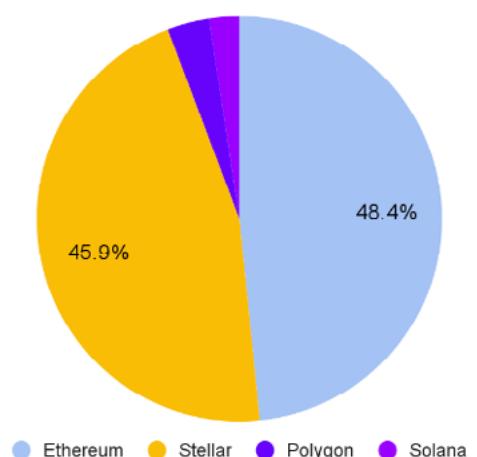
As of November 2023, tokenized treasuries and debt instruments have a total value of \$704m. The debt is mainly issued by the top 3 issuers, Ondo Finance (\$OUSG), Franklin Templeton (\$FOBXX), and Matrixdock (\$STBT) which have issued a combined \$583m of tokenized debt or ~82% of the total debt issued onchain.

2023 has been a year where tokenized debt finally came online through the effort of traditional financial institutions moving over and Web3 native protocols seeing capital inflow from investors. Since the year commenced, the amount of tokenized debt instruments has increased sixfold.. 2023 is a year where the risk-free rates of central banks increased significantly, narrowing the risk-premium received by investors choosing tokenized-debt. Despite the narrow risk-premium we saw strong inflows of tokenized debt. We believe this is evidence of (i) the strong appetite from investors to have more transparency through tokenized debt and (ii) a healthy risk tolerance towards blockchain-based financial products.

Tokenized Treasuries Market Cap By Protocol



Market Cap By Network



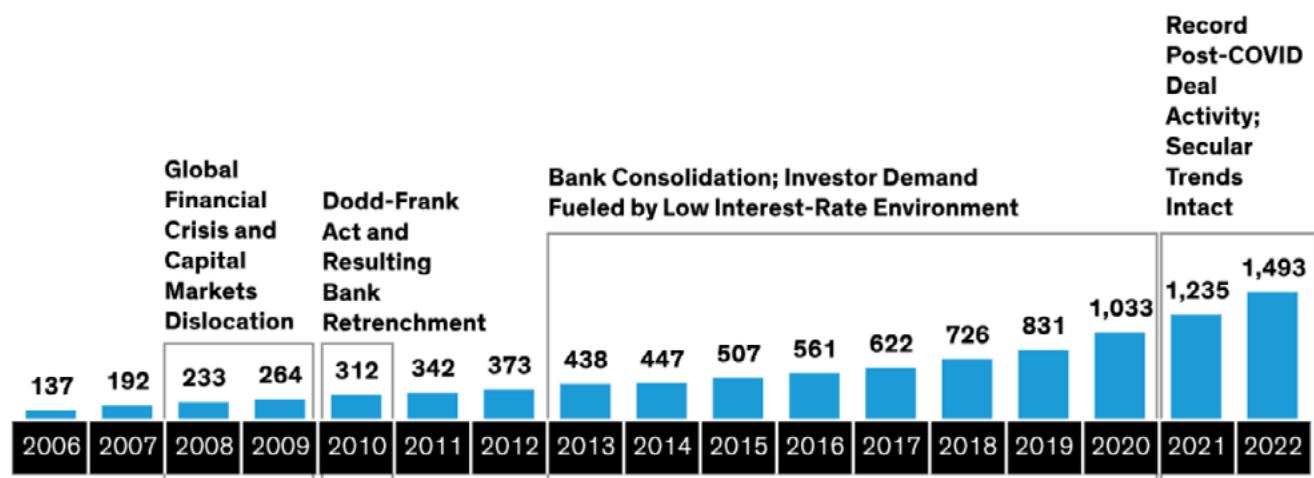
Source: RWA.xyz (excluding stUSD tokenized treasury)

PRIVATE CREDIT

Over the past decade we've seen a surge in demand for private credit. The trend toward private credit is fueled by investors seeking higher yields, diversification, and stability in a low-interest-rate environment. Regulatory changes and a demand for flexible lending options have made private credit attractive. Its low correlation with public markets also appeals to institutional investors. Due to a higher-for-longer interest-rate environment, private debt should decline in popularity as risk-premia shrink vs risk-free debt. Despite this, investors maintain a healthy appetite for private credit, underpinning a strong structural trend.

Leaps and Bounds: Private Credit's Rapid Growth

Private Debt AUM (USD Billions)

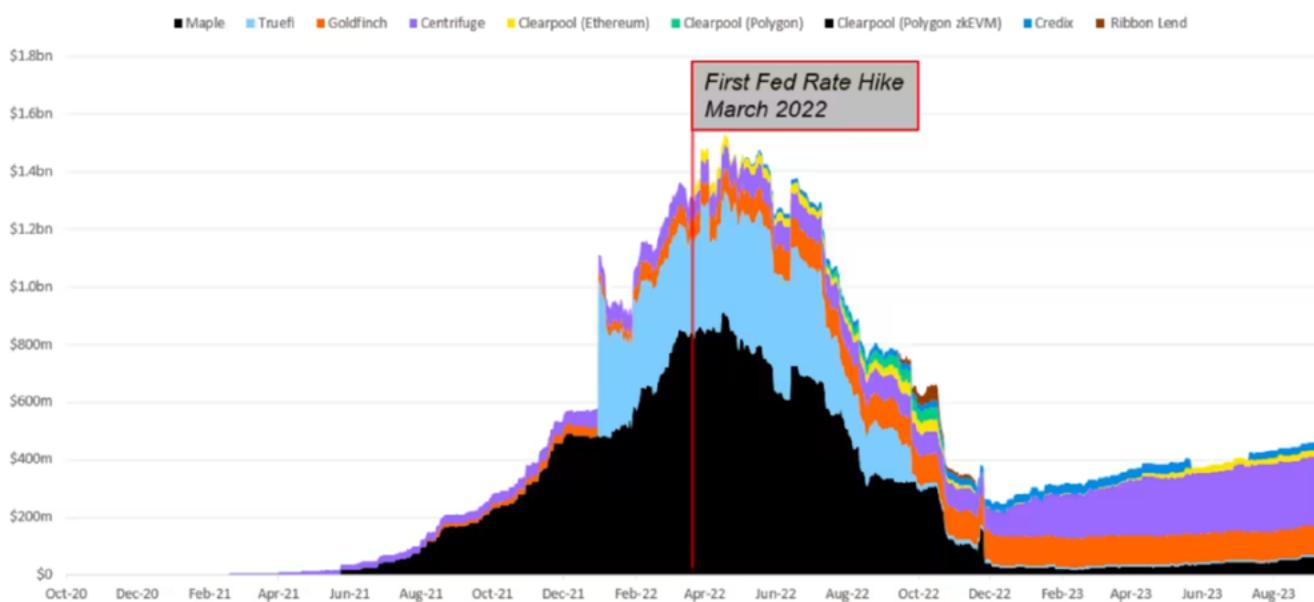


For illustrative purposes only. There can be no assurances any strategy or investment objective will be met with comparable conditions, or any investment objectives will be achieved.

As of August 17, 2023

Source: Preqin, Alliance Bernstein

Looking at tokenized private credit, we see that the rate hikes have a significant impact on the \$m active private credit loans. From its peak in May, of approximately \$1.5B, onchain private debt (\$m) is down 65%. This has mainly been driven by the decline in \$ from Maple and Truefi who peaked shortly after the Fed's first rate hike in March 2022. The total \$ of active loans troughed around the start of this year at ~\$250m and has bounced since back to \$460m mainly driven by the successful issuance of Centrifuge. Another strong performer has been Clearpool albeit from a very low base.



Source: DeFi Lama, Galaxy Research

The first Fed rate hike coincided with the start of the latest crypto bear market. We believe the strong decrease in \$m locked in onchain private debt is a double whammy of (i) rates increasing, making private debt less attractive and (ii) the overall crypto market cooling off. Since then we note a recovery (almost 2x) from the lows despite a relatively unattractive market environment. We believe this also points towards a structural positive trend in the space, defying gravity. As investors get comfortable with onchain exposure and infrastructure such as institutional grade wallets & on/off ramps improve, we expect private credit to remain a strong driver of RWA tokenization as transparency and efficient execution are much sought after by new and seasoned private credit investors.

9

REAL ASSETS

Beyond The Hype of **REAL WORLD ASSETS**

TL;DR ~ We got you

The trend we call “financialization of real assets” is brewing under the surface.

Tokenization allows the reengineering of cash flows, ownership and investment opportunities associated with the ownership of assets.

We believe that the trend of “Finance as a culture” will drive the demand to reengineer cash flows and investment opportunities as individual asset owners are increasingly looking to optimize for ways to fully optimize asset utility.

While it's not the entire asset that needs to be tokenized, there can be dissociation of the real asset and their cash flows, ultimately minting previously inaccessible financial assets.



THE FINANCIALIZATION OF REAL ASSETS

In recent years, driven by advancements in technology and education, a notable trend towards the financialization of real assets has emerged. Financialization signifies the growing influence of financial markets, instruments, and motivations in the management and utilization of real assets within the broader economy. This trend has expanded liquidity and investment opportunities, particularly in real assets, where financial returns and cash flows traditionally played a lesser role in value proposition.

We believe that tokenization will play a critical role in the next leg of financialization of these assets by unlocking efficiency, liquidity and decentralization of ownership for these assets. We see tokenization bringing liquidity and decentralization to cash flows associated with these real assets. While previously hard to disassociate these cash flows from the real asset due to transparency and efficiency issues, tokenization offers a technology solution, opening up real assets to financialization. This is a movement which will ultimately make them real and financial assets at the same time, similarly to what is already happening to real estate.

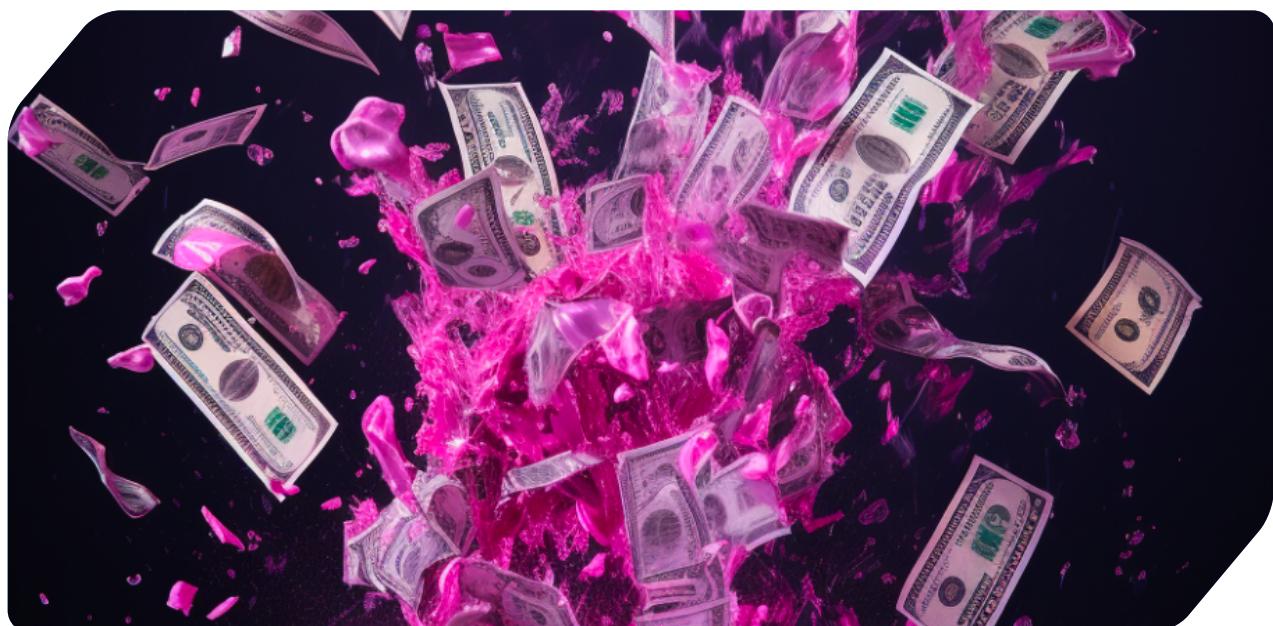


RE-ENGINEERING OF CASH FLOWS & INVESTMENTS

We see tokenization as a new building block in financial engineering that brings a higher degree of modularity, unlocking new financing & investment opportunities. We expect tokenization to have a significant impact in the outreach of financial markets. Through tokenization, financing and investing of assets can happen more bespoke and transparent, depending on the needs of the stakeholders and the underlying asset.

Today, real estate is a prime example of the financialization of real assets. Still sitting as this hybrid asset between financial and non-financial assets, we believe real estate is just the tip of the iceberg in the trend of financialization. We believe as tokenization begins to see widespread adoption, we'll see more tangible and intangible real assets use tokenization to invest & distribute cash flows to:

1. Decentralize ownership over these assets by fractionalizing the tokenized assets.
2. Tokenize cash flows generated by these assets.



INVESTMENTS

Tokenization unlocks new ways for capital formation that can be used to finance the creation of new real assets like machinery and infrastructure. Where assets were previously financed through bonds of private credit, tokenization and its ability to decentralize ownership unlocks new ways of financing real asset creation.

By converting real, tangible or intangible assets into digital tokens on a blockchain, the barriers to entry for individual investors are lowered, allowing a more diverse group of participants to engage in crowdfunding. This democratization of investment means that projects, whether they're in real estate, startups, or creative ventures, can access a global pool of potential backers. Tokenization offers fractional ownership, enabling investors to own a portion of an asset, also leveraging efficiency and transparency of the blockchain for distributing and managing the tokens. Overall, asset tokenization creates a new form of crowdfunding where token holders could have legal claims (condition to legislation) to the dividends and cash flows generated.

Tokenized private credit & debt is not the only way that tokenization changes project financing. On the equity side, we believe that through the distribution of ownership, tokenization also unlocks a way of financing that closely resembles traditional equity financing but on a smaller scale but while still being efficient and transparent.

CASH FLOWS

At a high level, the process of tokenization has the transformative potential to re-engineer and redistribute cash flows in various economic domains. As mentioned before, tokenization of RWAs unlocks overall efficiency, liquidity and decentralization of ownership. Compared to the traditional cash flow model tied to ownership. Tokenization allows for the restructuring of this traditional model in new ways. Below we'll unpack how these three key benefits unlock the re-engineering of cash flows:

- **Efficiency:** Increased transparency and automated smart contract execution allows the re-engineering and distribution of the cash flow.
- **Liquidity:** Tradability of tokenized RWAs and tokenized cash flows allow for an efficient and transparent primary- and secondary market to be created around these assets.
- **Decentralization Of Ownership:** Fractionalization of tokenized RWAs and tokenized cash flows allows for distribution and democratization of access to these cash flows.

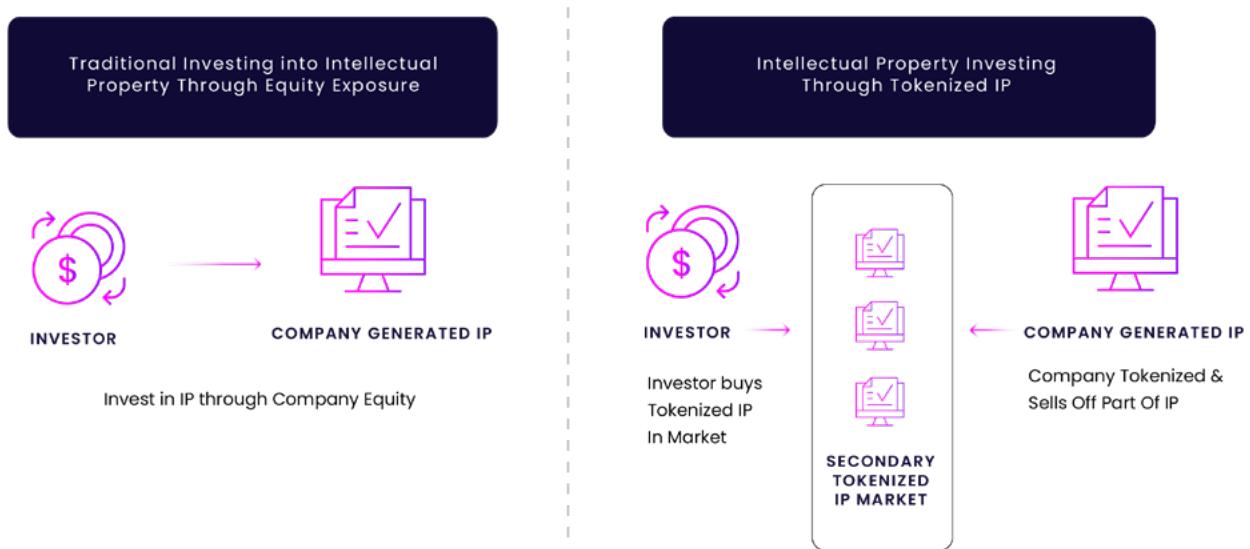
EXAMPLE – INTELLECTUAL PROPERTY

We'll look at a simplified example of how tokenization can redistribute the ownership and claim on cash flows generated by intellectual property from an investor's point of view.

Intellectual Property Rights (IPR) grant individuals or groups exclusive rights to their inventions for a specified period. Tokenizing IP enables the division of patent ownership into smaller parts, facilitating its distribution among multiple parties in the open market. By allowing companies that generate R&D to sell it down to recuperate investments and generate working capital, etc.

Those interested in IP can invest directly in it, which is then distributed across various companies. In the past, investors wanting to invest in a specific IP, like a new technology, had to invest in the company holding those IP rights. Tokenizing IPs provides a novel avenue for investors to access innovative concepts, enabling direct IP investments without the need to purchase diluted equity in the holding company.

The realm of Intellectual Property is characterized by substantial regulation and limited transparency. There are legal obstacles, and ideally, a supranational regulatory framework would be in place. Nonetheless, blockchain technology is expected to enhance the efficiency of IP management for both companies and individuals.



Licensing of intellectual property is a mature business practice. However, through tokenization, IP can now be distributed to interested investors in a transparent and efficient way, lowering the hurdles for other types of monetization strategies of real assets. We believe applications of tokenization of IP specifically will happen in R&D heavy industries such as Biotech, Software & Semiconductors.

WHY HAS THE FINANCIALIZATION OF REAL ASSETS NOT HAPPENED YET?

The answer lies in the cost associated with creating and executing these highly tailored set ups of ownerships and cash flows. Traditionally there's a large overhead cost associated with tailoring legal aspects of asset ownership. To allow scaling and reduce costs per unit, we have been working with standardized templates.

The tokenization of RWA, leverage transparency and automated smart contract execution changes this. Automated execution and programmability of tokens allows for costs to come down. Where use cases of (i) redistribution of cash flow and ownership or (ii) segregation of asset rights were previously not economically viable, tokenization of RWA makes these scalable and lowers costs.

So while there have been initiatives in the past such as home sharing in the 2000s, the administrative overhead and poor transparency rendered these economically unviable. Tokenization offers an alternative which can scale these business models at low costs. We advise aspiring founders across industries to look at current practices of asset ownership across industries and ask if the cash flows and ownership of these assets is already optimally distributed (for ex. [Machinery-as-a-service](#))



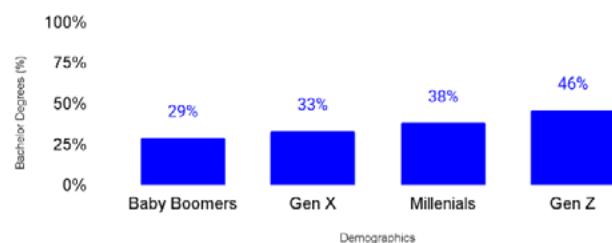
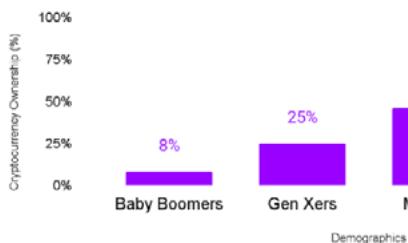
FINANCE AS A CULTURE & ASSET OPTIMIZATION

“Finance as a culture: The shared beliefs and behaviors surrounding financing matters in society”

We believe that we are entering a period of stronger finance as a culture. Starting in 2019 with trends as wallstreet bets and “Finfluencers”, we have witnessed a strong demand from individuals to take investment exposure. We believe this trend will only get stronger propelled by two key drivers:

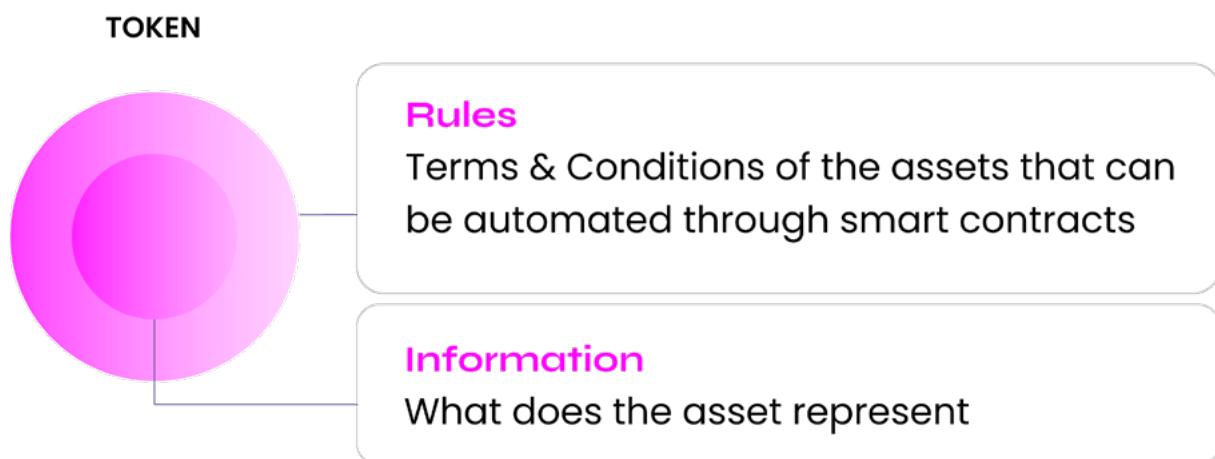
- **Investment access** – Individuals have unprecedented access to investment opportunities across an increasing spectrum as asset classes. Tokenization of RWAs will only improve access and increase the number of investable assets.
- **Financial Literacy** – Financial literacy is at an all time high, driven by the quality and accessibility of education. We think Millennials & Gen Z, the best-educated generations ever, will be big drivers of finance as a culture.

Financial literacy and access are becoming a social status. It empowers individuals to make informed financial decisions and build wealth. In today’s increasingly complex and interconnected world, being financially literate is seen as a sign of intelligence and responsibility, increasing one’s social status.



COMPLETE TOKENIZATION

We believe it is critical for RWA tokens to be a complete representation of the asset. The digital representation as a result of tokenization of RWAs is highly programmable. A great benefit of tokenization, apart from representing the asset onchain is the ability to tie rules to the asset.

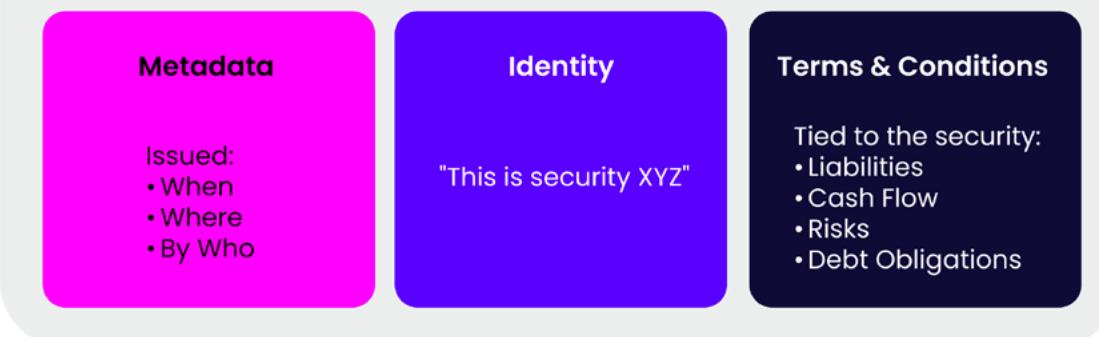


Many of the early stage tokenization projects are focused on creating a representation of the actual asset and putting it on the blockchain. This is a great start, but very basic. To realize the full potential of tokenization, the token must encompass all attributes of the asset, including liabilities, cash flows, terms and conditions, risks, debt obligations, and so forth, all of which should be directly embedded in the token.

Rules added to tokenization of assets allows for the creation of, for example, [programmable money](#). While not in scope and controversial in Web3, in short, the rules allow for money to have built-in mechanisms to incentivise or specify financial behavior.

In the exhibit below you see the three key components (identity, metadata and terms & conditions) of information embedded into financial assets.

FINANCIAL ASSET FEATURES



Currently, tokenization of financial assets lacks innovation. Most tokenized financial assets merely create a digital representation of the underlying asset, referred to as the asset's "identity" and the "metadata". The token is exclusively employed to monitor alterations in ownership on the blockchain. Although this method takes advantage of the blockchain's transparency, immutability, and tradability, we find it to be uninspiring.

The "Terms & Conditions" of the financial asset are simply embedded in the token as a PDF attachment. This means that cash flow calculation, liability settlement and other actions still require human intervention to be processed. Making "terms & conditions" of the asset machine-readable and executable is not only a missed opportunity, it also creates massive risk. If tokenization goes mainstream and users assume full automated execution, because it "sits on the blockchain", users will grow complacent and neglect terms & conditions, posing risk to the tokenized financial system.

The key hurdle still is regulation. There's a lack of a robust framework that addresses legal obligation tied to token embedded terms & conditions. Despite implementation being possible from a technical perspective, regulators need to address machine execution of the rules embedded in the token if we want to unlock the true value of tokenization of RWAs.

We believe the true value of tokenizing financial assets is unlocked by including all its features, rights and obligations into the smart contract. Allowing it to be executed automatically. We appreciate this requires smart contract standards and legislations but we believe this to be a huge opportunity for tokenization providers. Providing even low level automation across all asset features makes the RWA tokenization value proposition exponentially more attractive for incumbents who still need convincing of the opportunity.

10

CHALLENGES

CHALLENGES

TL;DR ~ We got you

The Oracle Problem

The Oracle Problem is the most critical challenge for tokenized RWAs. It relates to blockchains' inability to access external data securely, hindering their decentralized nature. It becomes a challenge when blockchain applications, including tokenization of real-world assets, require accurate real-world data, particularly for tangible assets like real estate and collectibles.

Solution

We see two trends that are solving the oracle problem.

1. **Innovation & Game Theory** – We see evidence that innovative solutions with embedded game theory can align incentives between stakeholders to incentivize updated & correctly reflected tokenized RWAs.
2. **Digitalization** – We see digital transformation driving the shift from tangible to intangible assets. Assessing changes in features of intangible, digital assets is significantly easier than tangible assets. We believe over time, more and more tangible assets will be represented as intangible assets.



IT'S NEVER EASY

Previously in the note we already discussed some of the problems specifically with tokenization. Below a quick recap of the most important ones.

- **Consortium** – Most efficiency is generated when different entities across the same value chain synchronize through a consortium. There is difficulty in convincing companies who are not fully economically aligned to collaborate and share information of tokenized RWAs.
- **Liquidity Splintering** – Lack of standardization of tokenization practices and marketplaces leads to fragmentation of liquidity across multiple trading venues, making it difficult and expensive to trade assets.
- **Regulation of ownership & digital assets** – Bearer ownership, where possession of a tokenized asset signifies ownership, is reemerging in blockchain. Unlike the centralized financial system, blockchain's decentralized nature requires a supranational framework for bearer ownership. This ensures smooth fractionalization of ownership, avoiding reliance on central entities. There are also token embedded rules that need regulation to become enforceable.
- **Network Effect** – Blockchain-based applications, by their very nature, rely on network effects. With RWA, a network effect of users is needed to turn efficiency, liquidity or decentralization of ownership into a viable value proposition that convinces new users to tokenize RWAs and populate the shared blockchain. If a company is the first to move on a decentralized blockchain, there is little advantage and it's simply operating an expensive, inefficient database. As more players come and share data in a trustless way, it becomes more attractive to join. But someone needs to be first...
- **Tokenization Standards** – Standardizing the tokenization of real-world assets is essential for ensuring compatibility, regulatory compliance, and investor trust in blockchain-based finance. However, the decentralized nature of blockchain and the need to address legal and technical challenges make achieving universal standards a complex task. Overcoming these challenges is crucial.
- **Infrastructure** – RWA tokenization requires data, the digital copies of the assets, to be migrated from a centralized data infrastructure to a blockchain based infrastructure. Companies and projects are still looking for the best way to tackle this challenge. Existing companies looking to integrate blockchain technology need to secure daily operations while changing the data infrastructure. It is effectively like changing the engine of a car engine while driving at full speed.

A more technical issue that tokenization is faced with is the oracle problem.

THE ORACLE PROBLEM – TOKENIZING TANGIBLE ASSETS

In its most strict definition, the blockchain oracle problem refers to the challenge of securely and accurately bringing external data into a blockchain's isolated environment. It is a problem related to the challenge of bringing and updating data about assets in the real (non-digital) world onto the blockchain in a correct and trustless way.

Blockchain networks are designed to be decentralized and trustless, which means they rely on the information and transactions recorded on the blockchain itself. However, there are many real-world scenarios where blockchain applications need access to data or information that exists outside the blockchain, such as stock prices, weather data, or the outcome of a sporting event. This also applies to the tokenization of real world assets. The challenge is to ensure that changes in features of the real-world asset are also reflected correctly in the digital twin (token) even after being minted. The oracle problem is particularly a concern for tangible assets such as real estate, art, collectibles, etc.

Without solving the oracle problem, it is not possible to have a truly trustless, computable economy driven by blockchain based smart contracts that execute and automate many of the mundane transactional activities in the real economy.

SOLUTION TO THE ORACLE PROBLEM

Many see the oracle problem as something insurmountable, rendering a large part of the RWA tokenization value proposition useless. We fully appreciate the complexity and challenges that the oracle problem brings. However, as technology optimists we believe there are two key drivers that will help us overcome this challenge:

- **Innovation & Game Theory** – We see evidence that innovative solutions with embedded game theory can align incentives between stakeholders to incentivize updated & correctly reflected tokenized RWAs.

- **Digitalization** – We see digital transformation driving the shift from tangible to intangible assets. Assessing changes in the features of intangible digital assets is significantly easier than assessing changes with tangible assets. We believe over time, more and more tangible assets will be represented as intangible assets.

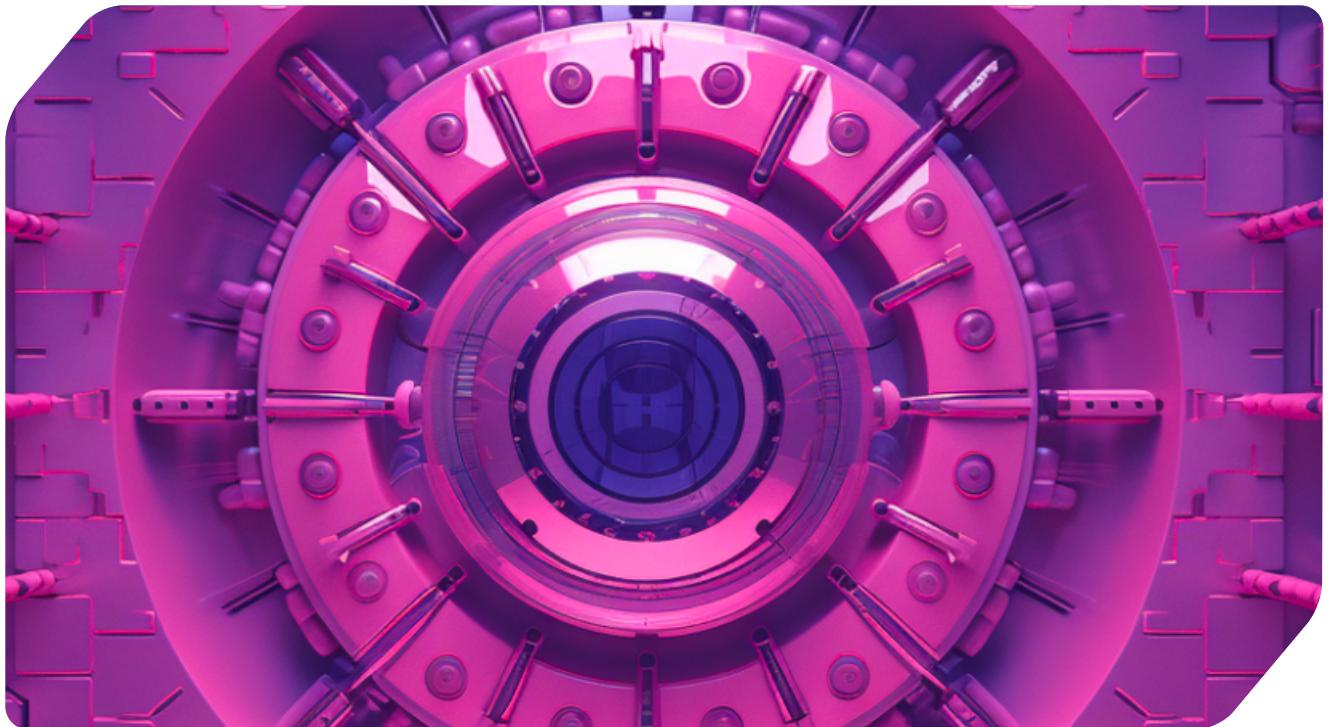
INNOVATION & GAME THEORY

Innovations and game theory are vital for ensuring that tokenized real-world assets accurately mirror their real-world counterparts on the blockchain. By incorporating incentive-driven smart contracts, reliable governance systems, secure oracles, and interoperable protocols, these innovations promote transparency and trust, aligning incentives to prevent discrepancies in asset representations. Below are some ways and innovations of how these issues can be resolved:

- **Tokenization Standards:** Developing standardized tokenization protocols and smart contracts that embed game-theoretic mechanisms can help ensure that tokenized assets accurately represent their real-world counterparts. These standards can specify how assets are verified, transferred, and governed within the blockchain ecosystem.
- **Proof of Reserve (PoR):** Implementing PoR mechanisms on the blockchain can provide cryptographic proof that the assets backing the tokens are held in reserve. Game theory can be used to design incentive structures that encourage the custodian or issuer of the tokens to maintain accurate reserves.
- **Oracles with Incentives:** Embedding game-theoretic incentives in oracles can help ensure that the data used for tokenized assets is accurate. Oracles can be designed to stake tokens as collateral and face financial penalties for providing incorrect data, encouraging them to act honestly.
- **Decentralized Governance:** Implementing decentralized autonomous organizations (DAOs) or governance systems for tokenized assets can use game theory to ensure that decisions about the assets, such as transfers or changes in ownership, are made collectively and transparently.

- **Smart Contracts with Dispute Resolution:** Smart contracts can embed game-theoretic dispute resolution mechanisms. If a dispute arises regarding a tokenized asset, a game-based approach can be used to reach consensus among the involved parties, providing a fair and transparent resolution.
- **Interoperability and Cross-Chain Solutions:** Innovations in interoperability and cross-chain solutions can ensure that tokenized assets maintain their integrity when moving across different blockchain networks. Game theory can help create incentive structures for these interoperability protocols to maintain accuracy.
- **Continuous Auditing:** Innovations in continuous auditing technologies can ensure that the assets backing the tokens are regularly verified. Game-theoretic mechanisms can be employed to incentivize auditors to maintain their integrity.
- **Decentralized Identity and Reputation Systems:** Blockchain-based identity and reputation systems can be employed to track the trustworthiness and performance of entities involved in tokenized assets. Game theory can help design incentives for good behavior and penalties for misconduct.
- **Market Mechanisms:** Designing decentralized exchanges and secondary markets for tokenized assets that incorporate game-theoretic market-making algorithms can help maintain fair and accurate pricing.
- **Community and Ecosystem Incentives:** Encouraging active participation and vigilance within the tokenized asset community through gamified rewards and governance structures can help keep the system accountable.





EXAMPLE – FINANCIAL SECURITIES

The transition of financial securities, such as bonds and equity shares, from tangible, physical assets to intangible, digital assets was propelled by a combination of factors. Traditional securities exchanges shifted to electronic trading platforms, central securities depositories dematerialized paper certificates, regulatory changes accommodated electronic trading, and technological advancements allowed for secure online trading. More recently, blockchain and distributed ledger technology have added a decentralized and tamper-resistant dimension to digital securities management. Financial intermediaries and investor demand played pivotal roles, with the latter seeking convenience and efficiency in trading and managing digital assets. This transition has improved market accessibility and efficiency but also raised new challenges, such as cybersecurity and regulatory compliance.

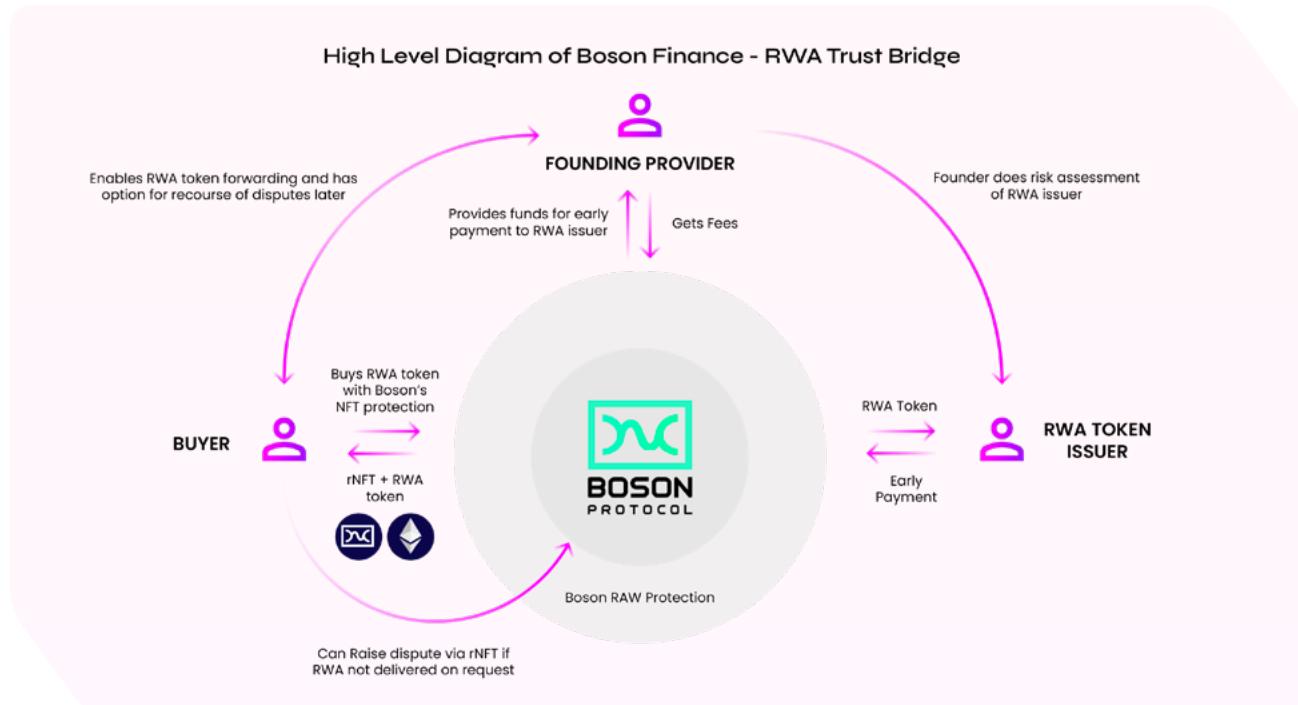
Similar to financial securities, we believe that as we see more financialization of real assets, more infrastructure will be put in place to make these assets naturally more intangible, making it easier for homologation between the real world assets and its token.

BOSON PROTOCOL – THE DECENTRALIZED LAYER FOR RWAS

Boson is an example of a world class protocol set to solve the oracle problem. It is a decentralized actuator oracle. That is, a decentralized protocol which enables the trust-minimized, automated execution of off-chain actions; which in turn can be seen as a general purpose solution to the physical asset oracle problem. As such, Boson Protocol is the foundational primitive for a trust-minimized tokenization and exchange of any real world asset.

Currently the protocol is built to fit for decentralized commerce, the Boson team is currently in the R&D phase to solve the problem of trusted RWA tokenization in finance. To extend trust-minimized guarantees to the Buyer of finance real world assets, Boson is being extended to create a permissionless, trust-minimized exchange layer on top of custodial and regulated protocols. This means that if the custodial protocol fails to redeem the asset, for whatever reason, the tokenized asset bearer can get their money back. Yet, the asset exchange can still be fully regulated, providing a bridge between decentralized trust and regulatory compliance.

Below the high level diagram of Boson Finance. Through embedded game theory, Boson can create trustlessness when dealing with tokenized RWAs.



Process Flow

- 1** Funding Provider assesses the risk of a trusted RWA tokenization platform, without having to actually sign any contractual agreements with it or even make any notifications.
- 2** Funding Provider sets assurance fees (for a specific range of amount-asset-time).
- 3** Buyer initiates the purchase by committing funds for the RWA token + Boson Protocol's rNFT production into the escrow.
- 4** Funding provider then immediately releases the pre-payment towards the RWA Token Issuer.
- 5** RWA Token Issuer, having received the payment, sends the RWA token to the Buyer via the Boson RWA protection wrapper at which moment the wrapper attaches rNFT protection to it.
- 6** Should Buyer choose to redeem the RWA token for its underlying asset, two paths can happen.
 1. If RWA delivery succeeds, then the rNFT is left to expire.
 2. If RWA delivery fails, then Buyer invokes Boson RWA protection by redeeming the rNFT and raises a dispute. Boson Protocol handles this dispute and if upheld. Buyer receives the money back. As this is a loss for Funding Provider, it can later attempt a legal recourse with the RWA Token Issuer.
- 7** En route Funding Provider collects fees for its contribution.

Solutions like Boson protocol as a critical piece in unlocking the computable economy as discussed.

11

TAXONOMY OF RWA TOKENIZATION

TL;DR ~ We got you

Amidst narrative creep and vague definitions, we define our taxonomy of real-world asset (RWA) tokenization.

Tokenization of RWAs

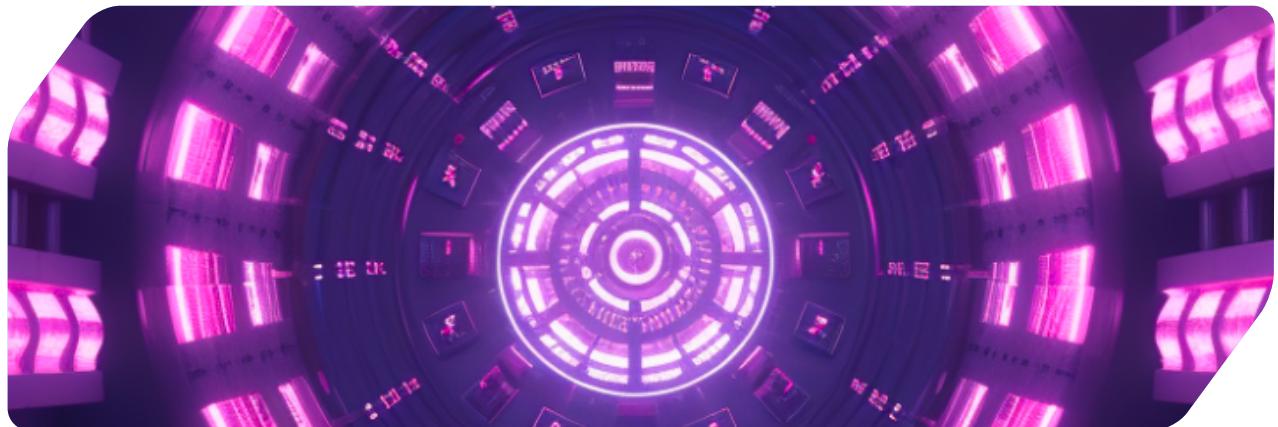
The process through which a digital twin of a real world asset is created and populated on the blockchain in the form of a digital token or NFT.

RWA = Unique combination of:

- Tangible <> Intangible
- Real <> Financial

Tokenization is the process through which a digital twin of a real world asset is created and populated on the blockchain in the form of a digital token or NFT.

The process of tokenization populates the blockchain (which is a database) with “digital copies” of RWAs.



ASSET TYPES

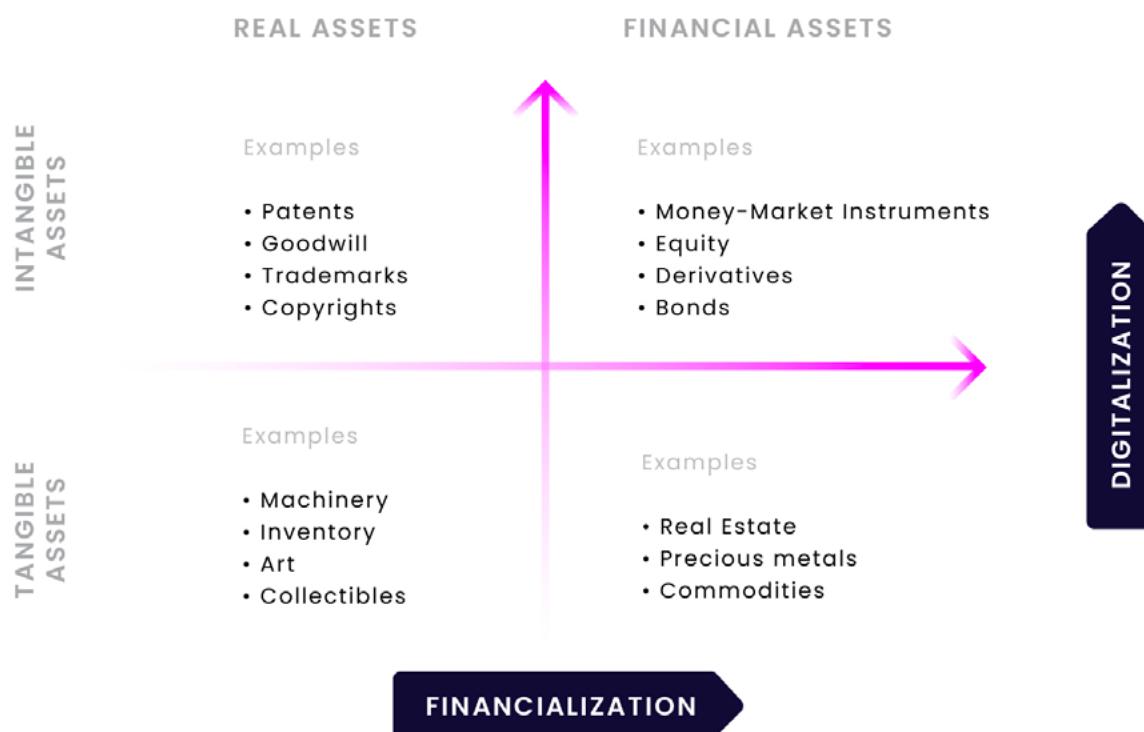
We believe there are two dimensions to each real world asset (RWA). Every asset that can be tokenized is a combination of both and faces different challenges based on where it sits on this spectrum.

- Tangible Assets <> Intangible Assets
- Real Assets <> Financial Assets

We believe there is value to be unlocked through tokenization across both spectrums of the different dimensions of these assets. What is why we are convinced that the tokenization opportunity applies to:

All tangible- & intangible assets

- All real- & financial assets



Note – Some assets such as real estate are considered hybrid where based on the subcategory of the assets, we call these hybrid assets.

TANGIBLE & INTANGIBLE ASSETS

The first dimension we discuss is tangible vs intangible assets and applies to the trend of digitalization. Sometimes it is also hard to definitively categorize some asset types as they can be both. In general it should be clear on what asset class we're dealing with.

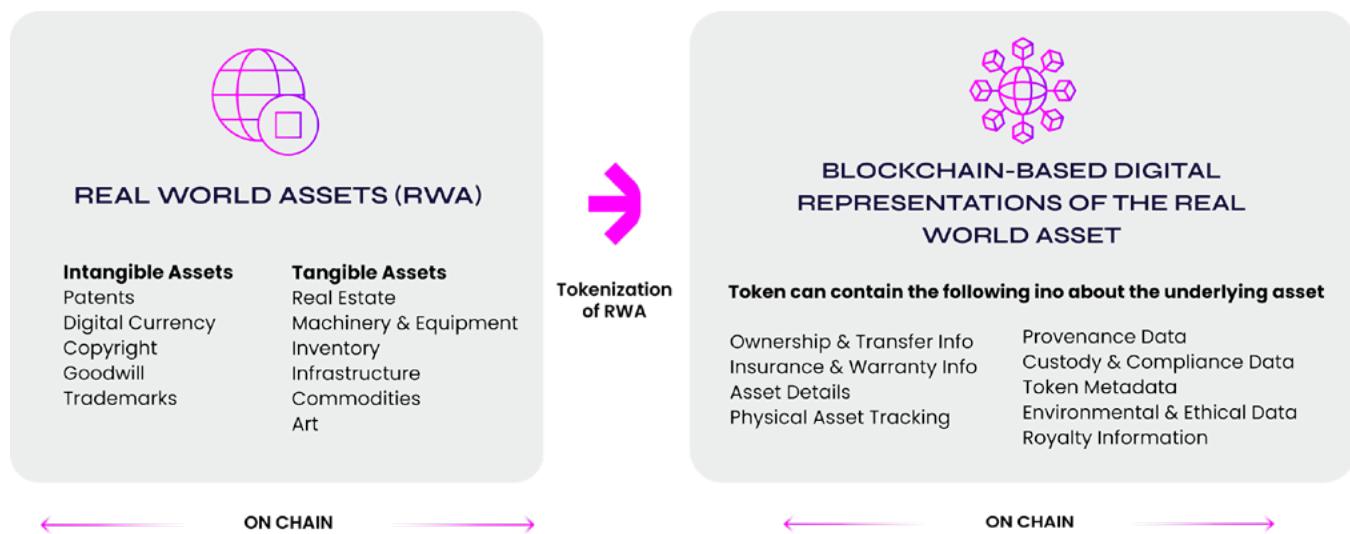
Tangible Assets

Assets that are physical and can be touched/felt. They have physical shape and form as well as intrinsic and economic value.

Intangible Assets

Assets that are not physical in nature. These have no shape or form despite having intrinsic and economic value.

Note – It is important to note that the distinction between tangible and intangible assets is not always clear-cut and this can change over time as we'll see below



Over the past years, as RWAs in vogue, we have seen its definition broadening. Originally, tokenized RWAs applied to tangible assets that were generally not yet reflected by a digital copy on any type of database. Over time, RWAs started including intangible assets such as financial securities as it became more widely recognized that there was also a large potential for intangible assets. Today, tokenization of RWAs implies dealing with tangible and intangible assets.

REAL- & FINANCIAL ASSETS

The second dimension is real vs tangible assets and applies to the trend of financialization. There are some assets that can be both, depending on other factors. In that case we call them hybrid but generally speaking the distinction is clear.

Financial Assets: A type of asset that signifies a claim on future cash flows, earnings or wealth. These assets are mostly intangible in nature.

Real Assets: A type of asset that holds inherent value and is employed in the creation of goods and services, generating income through their utilization. These assets are tangible and intangible.

Characteristics	Financial Assets	Real Assets
Tangible or Intangible	Mostly Intangible	Tangible & Intangible
Intrinsic Value	No**	Yes
Used to produce other assets	No	Yes
Value derived from?	Underlying Asset	Physical properties & intangible qualities
Liquidity	More Liquid	Less Liquid

** Financial assets have no intrinsic value because they do not produce any goods or services on their own

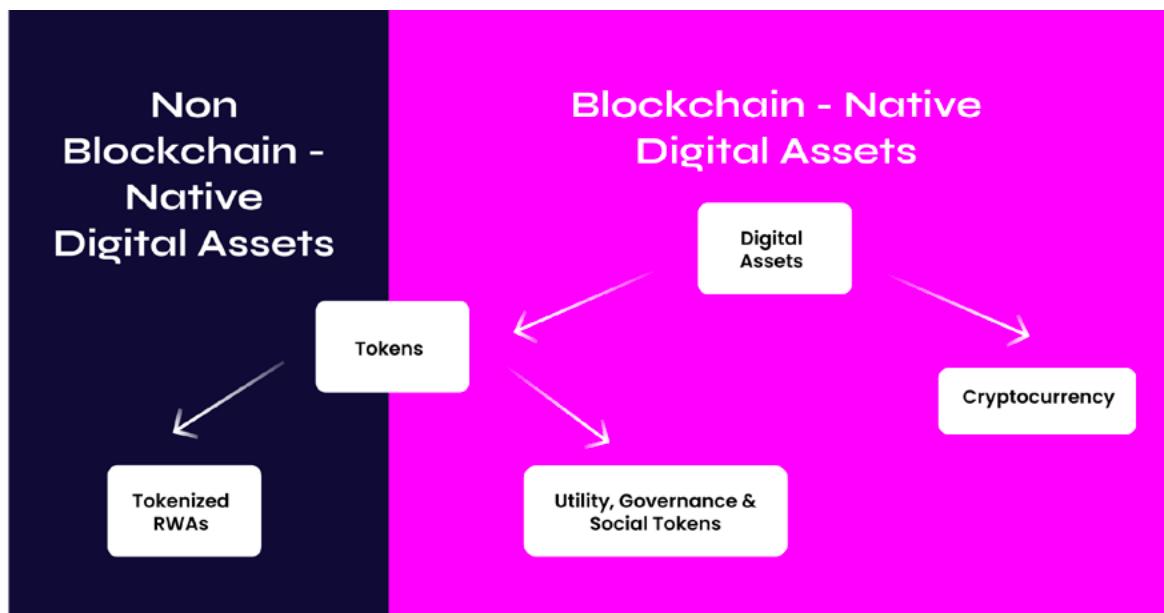
RWAS WITHIN DIGITAL ASSETS

Many investors, founders and users are underestimating the sheer value tokenization of RWA brings to the entire onchain digital assets universe. Often this stems from a poor understanding of what digital assets are made up of. In short there are crypto and non-crypto native assets represented on the blockchain.

- **Crypto-native assets:** digital assets created and existing solely within a blockchain ecosystem.
- **Non-crypto native assets:** digital assets created as a representation of other assets.

We see tokenized assets as:

$\text{Tokenized RWA} = \text{Total Digital Assets} - (\text{Cryptocurrency} + \text{Utility Tokens} + \text{Governance Tokens})$

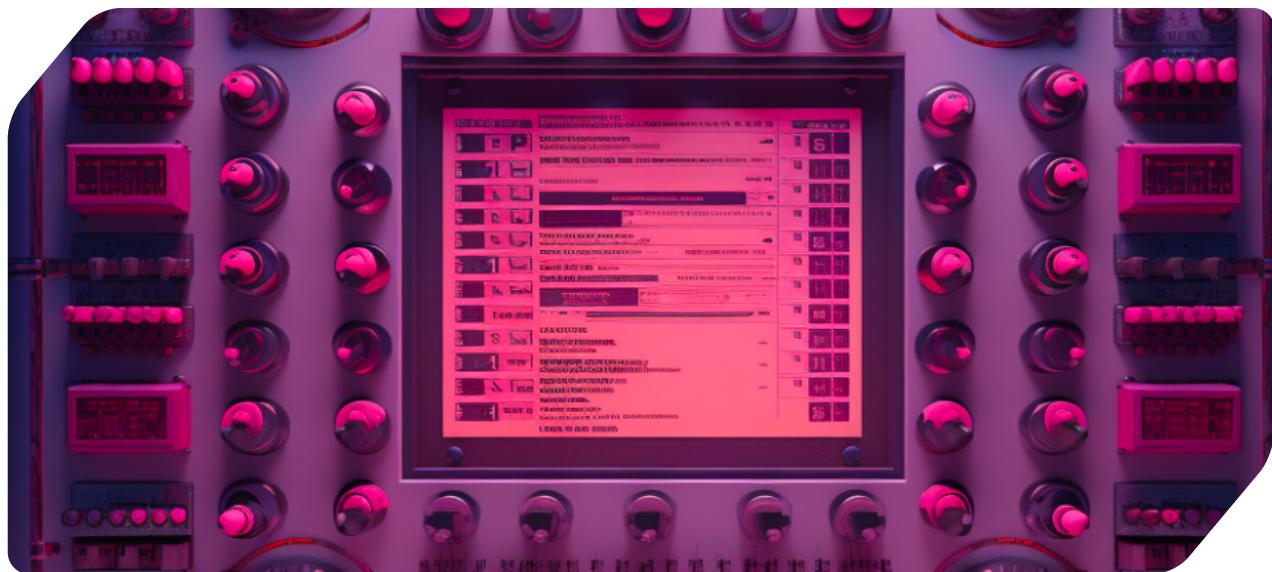


Even more simplified, we look at the value of tokenized assets as all value accrued on the blockchain minus the [total market cap](#) (excluding fiat-backed stables).

NOTHING NEW

The concept of “tokenization” stretches far beyond the advent of modern technology. In the 16th century, the British empire, confronted with a scarcity of small coins, saw an innovative solution emerge. Local merchants and municipalities began creating their own tokens from materials such as copper, lead, and tin. These were not just rudimentary coins but represented a solution to a pressing problem, streamlining trade and minimizing the risks associated with handling precious assets.

Fast-forward to our times, and we see the term “token” often associated with the digital realm, particularly blockchain technology. Now, these tokens digitally represent both tangible and intangible assets on decentralized ledgers. Their modern incarnations come with benefits that their historical counterparts couldn’t offer. As we bridge the historical concept of tokens with the capabilities of blockchain, we’re witnessing a transformative shift across global industries. This fusion not only streamlines operations but also challenges and reshapes our very notions of asset ownership and exchange in the digital age.



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