SINGAPORE MANAGEMENT UNIVERSITY

ISFS626 Tokenized Assets and NFTs

Group 5

Technology Insights and Future Prospects for Blockchain

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Contents

1. Abstract

The blockchain technology, although it is still in its' infant stage, is undergoing significant transformations, driven by market growth, technology innovation and evolving regulatory frameworks. Technological advancements, such as Layer 2 solutioning, are overcoming traditional scalability and efficiency challenges, enabling broader application with higher transactional volumes. The increased adoption of blockchain observed in various sectors, such as Banking and Finance, Event Management and Real Estate, has highlighted its growing market relevance. Meanwhile, the global regulatory environment is slowly becoming more supportive, offering clearer guidelines that enhance adoption which will eventually help to drive further innovation and investment in the blockchain space, positioning it as a key component in the future technology and finance.

2. Introduction

Bitcoin, as a cryptocurrency or decentralized digital money, was the first application of blockchain technologies in 2009. It was invented in 2008 by an unknown person or group of people using the pseudonym, *Satoshi Nakamoto*, who published a white paper entitled *"Bitcoin: A Peer-to-Peer Electronic Cash System"*. (Nakamoto, 2008)

Since then, the advancement of this technology has led to greater utilization of blockchain in various sectors, such as Banking and Finance, Event Management and Real Estate. Blockchain has also transformed numerous business applications, as organizations across the industries tap on the various key characteristics of blockchain, such as decentralization, transparency and immutability. (Al-Sulami, Ali, Ramli, & Lu, 2024).

In this paper, we intend to begin by outlining blockchain technology key features and its advantages. We will then explore the latest advancements, including Layer 2 solutions (Rollups). We will also cover the current market adoption rate, followed by the practical applications, such as Tax Compliance, Real Estate Tokenization and Event Ticketing. Lastly, we will share our team's perspective on why we believe that the adoption rate of blockchain technology will rise in the future.

3. Blockchain Technology

The concept of blockchain was first introduced in 1991 by Stuart Haber and W. Scott Stornetta (Figure 1), who developed a cryptographically protected chain of blocks to create tamper-proof, timestamped digital documents. In 2008, during the financial crisis, Satoshi Nakamoto published a paper that introduced Bitcoin, a peer-to-peer digital currency system. Bitcoin's blockchain solved the problem of double spending and became the foundation for future cryptocurrencies.

Since the release of bitcoin and cryptocurrencies back in 2008 when it was recognized as blockchain 1.0, blockchain has since evolved from blockchain 1.0 to blockchain 4.0 where it

incorporates blockchain with industry applications. Some of the examples of block chain 4.0 include Tax Compliance, Real Estate Tokenization and Event Ticketing.

The definition of blockchain technology is where the distributed ledger is distributed across a network of computers. Each transaction is recorded in a block, and it will be linked together in a chronological chain. Once a block is added to the chain, it cannot be altered or deleted. This will ensure the integrity of the data stored. Unlike the traditional database where it has a central agency called administrator. This administrator has complete control to access the information that is stored in the database.

There are three key elements of blockchain which are (1) distributed ledger technology, where the ledger is distributed in the participants network. (2) immutable records, where no participants can tamper or change the transaction after it had been recorded with the ledger. (3) smart contracts, where it defines the conditions for corporate bond transfers.

How Blockchain works

The steps of how a blockchain works first start with a transaction request initiated by a user on the network and the request will generate a new block to represent the transaction. Once the new block was created, it will distribute to every node in the network and the nodes in the network will validate the transaction by using Proof of Work (PoW) or Proof of Stake. (PoS). After the node is validated, the node will receive some reward such as cryptocurrency. The node will then add the block to the existing blockchain where it linked to the previous block. After it has linked the block, the transaction is complete.

There are multiple benefits of using blockchain technology. However, three of the benefits are identified as the most important among the rest.
1. Transparency: As the transaction block is shared with everyone in the network, all transactions become visible to all participants, creating a high level of transparency.
2. Security: Blockchain is extremely secure because it uses cryptography to protect data making it difficult to tamper with or forge records.
3. Traceability: The blockchain allows for the tracking of assets and transactions from start to finish which helps to reduce fraud and improve accountability.

Layer 2 Solution

Scaling solutions are essential for overcoming the scalability challenges faced by major blockchains. Figure 2 shows that Blockchains such as Bitcoin and Ethereum generally manage just 7 to 15 transactions per second (TPS), but Visa can process up to 24,000 TPS. To effectively compete with centralized systems, enhancing scalability is crucial. There are two main strategies to achieve scalability: enhancing the base layer or offloading tasks to an additional layer.

Improving the base layer is difficult because of the blockchain trilemma. Conversely, Layer 2 solutions offer an alternative by using external tools and methods to achieve scalability without directly altering the core blockchain.

Optimistic Rollups operate under the assumption that transactions are valid by default and submit them to the main Ethereum chain. They use a fraud-proof system that activates only if a challenge is raised. First, Optimistic Rollups trust the transactions and depend on other participants to verify their accuracy. However, if fraudulent activity is discovered, the transaction is reversed, and the validator involved faces a penalty.

4. Current Market Adoption

"Blockchain technology is advancing along the hype cycle to a place where enterprise organizations are now realizing meaningful results from it. There's a clear and growing demand in markets around the world, and opportunities abounds for organizations building enterprise-grade blockchain solutions" - (Casper Labs, 2023)

It is observed that organizations are universally bullish on blockchain adoption[1], with smart contracts as the leading topic that sparks the highest interest among the business leaders. With the introduction of smart contracts, we have noticed that the digital (on-chain) distribution platforms / channels have the capability to replace the intermediaries within the traditional linear relationship type of value chain[2], enabling a cost-saving opportunity for end-users (EY Parthenon, 2023). Furthermore, tokenization concept has also spurred and garnered interest to both investors and financial institutions as it helps to bring the following benefits[3]:

1. **Access to new capital / types of assets**: Tokenization can lower the minimum investment required to access certain assets, making them more accessible to a wider range of investors, particularly in private capital markets
2. **Increase liquidity:** Tokenization can increase liquidity in traditionally illiquid markets by allowing investors to buy and sell tokens on secondary markets.
3. **Enhance operational efficiency:** Tokenization can automate various tasks through smart contracts
4. **Fractionalization:** Asset tokenization can help to improve liquidity and allows for broader participation in the investment process
5. **Enhance Transparency:** Helps to build trust among investors and increase confidence in the market
6. **Reduced Cost:** By using smart contracts, transactions can be automated, reducing the need for intermediaries

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[1] Casper Labs 2023 survey results. Refer to appendix (Figure 3)
[2] Refer to appendix (Figure 4)
[3] Refer to appendix (Figure 5)

Recognizing the benefits of asset tokenization, many banks and financial institutions have begun to start off on proof-of-concept project since 2021. There are also notable banks, such as HSBC[4], VP Bank[5], Société Generale[6]; and financial institutions such as BlackRock[7] and Franklin Templeton[8], commercializing the tokenized real-world assets to the accredited investors. Figure 6 shows an end-to-end portfolio management & interoperability POC designed by JP Morgan, which can be used as a reference point when designing the structure and its ecosystem (JP Morgan, 2023).

As a result, the total value locked (TVL) in Decentralized Finance (DeFi) within the Real-World Assets (RWA) has seen a significant growth, from less than US$200 million in 2022, to the current valuation of US$6billion (CAGR 530%). Figure 7 shows the TVL within the RWA protocol. With the projection of tokenized total addressable market ranging between US$6 – US$16 Trillion by CitiGroup and BCG, and based on the existing market cap, the potential for growth in the tokenization space is immense, signaling a significant opportunity for investors and businesses to capitalize on this emerging market.

In the next few segments, we will explore the practical usage of incorporating blockchain technology to the following usage: Tax compliance, Real Estate Tokenization and Event Ticketing.

5. Practical Usage: Tax Compliance

As in other fields, government has explored blockchain technology to transform public administration and provide transparent and secure public services. Several implementations of this technology have been built and used by governments around the world, for example in building smart cities, identity management, e-voting, land registration, and supporting tax compliance.

In order to collect Value Added Tax, blockchain can be integrated with supply chain management models which involving manufacturers, suppliers, retailers, customers, and the government to input the data from all stakeholders regarding VAT-liable goods and services.

The benefits of implementing Blockchain for VAT collection are:

1. **Enhanced Transparency**: Blockchain creates an immutable and transparent record of all transactions which each transaction is recorded as a block on the blockchain.
2. **Real-time VAT Calculation:** since smart contracts are reusable and can be embedded within blockchains, the VAT calculation is conducted automatically and accurately.
3. **Efficient VAT Reconciliation:** due to the timely nature of all VAT calculations, any discrepancies can be promptly identified and resolved.

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[4] HSBC's Gold Token Goes Live for Retail Investors in Hong Kong.
[5] VP Bank: Digitization of assets
[6] Societe Generale issues a first digital green bond on a public blockchain
[7] BlackRock Launches its first tokenized fund, BUIDL, on the Ethereum network
[8] Franklin Templeton: Franklin OnChain US Government Money Fund (FOBXX)

4. **Reduced Administrative Burden:** The automation of VAT processes through blockchain technology simplifies operations for both businesses and tax authorities.
5. **Improved Compliance Verification:** The immutable nature of blockchain records simplifies the verification of VAT compliance.

Recognizing the potential benefits of blockchain in VAT collection, several countries have initiated pilot projects and implementations. Ghana, for example, has investigated using blockchain to improve compliance and streamline tax procedures. Brazil, a nation renowned for its intricate tax structure, has expressed interest in using blockchain technology to improve the administration of VAT. These nations seek to raise tax revenue, decrease tax evasion, and enhance overall economic efficiency by establishing an environment that is transparent and auditable for taxes.

Blockchain is adopted as well to enhanced Tourist VAT refund. This model comes from the Thai Revenue Department and builds on the idea of a supply chain by forming a consortium with other stakeholders like immigration offices, tourism ministries, and financial institutions. The creation of an extensive smart contract outlining each participant's duties and obligations is a key component of this strategy. This system seeks to expedite tourist refunds while maintaining compliance with tax regulations by automating the VAT refund process. This model can cut down on fraudulent claims, speed up processing considerably, and improve the traveler experience in general.

6. Practical Usage: Real Estate

Tokenization refers to a digital representation of an asset on a blockchain. Essentially, a real estate property is tokenized by dividing it into fractions and automating the operational process using smart contracts. The first step is to divide the property's value into smaller bits, depending on the property owner's choice. Then, the property can be purchased bit by bit through these tokens, either by many different investors or by one person.

The advantages of doing this in the real estate space are:

1. **Increased Liquidity:** Tokenization allows for fractional ownership of real estate, making it easier for investors to buy and sell smaller shares of properties thus allowing multiple people who earlier could not enter the property sector, to invest and reap benefits.
2. **Broader access to investment:** by breaking down the high-cost barrier typically associated with real estate investment, tokenization opens the market to a wider range of investors.

Drawbacks of tokenization of real estate:

1. **Regulatory and legal challenges:** The regulatory landscape for tokenized real estate is still evolving, governments and regulatory bodies across the world don't yet have a set framework on the rules to allow for tokenization of real estate.
2. **Market volatility and risk:** The underlying asset of real estate tokenization can be crypto currencies or other tokens which are subject to market volatility. This can introduce risks

for investors, especially those who are not accustomed to the fluctuations typical in digital asset markets. Additionally, the novelty of the market can lead to unforeseen issues and a lack of historical data for accurate risk assessment.

The application for this can be showcased by using an example, where 10 tokens that have been worth $100,000 each were used to tokenize, a property valued at $1,000,000. These tokens are provided through the listing company to investors. Different investors can buy different number of tokens depending on their ability.

After buying these tokens, each investor is entitled to earn a rental yield that is proportionate to the number of tokens they possess. For instance, if one token's rent income is $100 then a holder of four earns $400 while another who only has one will get $100. The proceeds are shared based on the number of tokens owned by every individual hence it has got a simple and transparent sharing mechanism.

This arrangement allows for freedom in selling or trading of ownership rights represented by tokens in secondary markets by the investors. At some point where one of them wants to become the sole owner of this property, he/she may decide to purchase the tokens from other shareholders. Subsequently after collecting all the coins including those appearing on listing company his/her name is exchanged for title deeds which must be burned as required under corresponding smart contract regulations.

7. Practical Usage: Event Ticketing

Like the use case of tokenization in real estate, another practical example is Tokenization of event tickets.

The problem faced by users who are wanting to buy event tickets today are:

1. **High fees:** A ticket, in its lifecycle goes through multiple people, multiple intermediaries adding to a lot of fees which is not transparent and unknown. For in demand events, this fee can far exceed the original cost of the event.
2. **Counterfeits:** A ticket sent over email, or messaging platforms has no way of authenticating if it's not counterfeit. Many malicious people occasionally alter the PDF files and scam people only for them to realize at the event.
3. **Scalping:** People with the intention of making money setup bots to buy tickets in bulk. After that they sell them at sky high prices to make their profits, impacting the customer who actually wants to go for the show.

We proposed a template on how blockchain can be used to solve these problems, the template involves 5 steps

1. **Smart contracts:** Develop smart contracts to manage ticket issuance, sales, transfers, and validation. Smart contracts automate the process, ensuring tickets are unique and tamper-proof

2. **Tokenization:** Convert each ticket into a unique token on the blockchain. This ensures that each ticket is immutable and traceable.
3. **Storage:** Tickets sold through platform and sent to the users' wallets
4. **Verification:** Use blockchains immutable ledger to verify the authenticity of tickets during resale. Each transfer updates the blockchain, maintaining an accurate ownership record.
5. **Validation:** Ensure real time validation of tickets at the event entrance. The system should check the blockchain to confirm the ticket has not been duplicated or tampered with.

Following these 5 steps as a high-level business process to develop blockchain based ticketing platform can reduce the problems that users face when purchasing these tickets.

8. Conclusion and Outlook

The future of blockchain technology is shaped by significant trends in global standardization and mainstream integration. As blockchain continues to gain traction, there is a concerted effort towards the development of global standards, exemplified by the initiatives of ISO/TC 307. This movement towards standardized regulatory frameworks is essential for ensuring interoperability, enhancing security, and fostering global trust in blockchain applications (ISO, 2016). Standardization will provide a consistent foundation for the widespread adoption of blockchain technology, facilitating cross-border transactions and collaborations in various industries.

Moreover, blockchain is becoming increasingly integrated into mainstream financial and business operations. Major corporations like IBM, Microsoft, and Amazon are leading the way by incorporating blockchain into their service offerings, providing Blockchain-as-a-Service (BaaS) platforms that enable enterprises to adopt and leverage blockchain technology with ease (Appinventiv, 2024). This integration signifies a shift from blockchain being a niche technology to becoming a critical component of modern business infrastructures, driving innovation in areas such as supply chain management, financial services, and digital identity.

In summary, the blockchain industry is poised for continued growth and innovation. With ongoing advancements in technology and the evolving regulatory environment, the outlook for blockchain is promising, with potential to significantly impact various industries and drive global economic change.

9. Appendix

History of Blockchain

CFTE

Stuart Haber and Scott Stornetta: cryptographically protected chain of blocks

Stefan Konst presents his cryptographic secured chain theory

Birth of Blockchain 2.0: uses other than means of exchange.

1991 — 1998 — 2000 — 2008 — 2014 — 2020

Nick Szabo working on 'bit gold,' a decentralised virtual money

Satoshi Nakamoto releases a white paper defining the model for a blockchain

DeFi applications surpass $1B in TVL

Figure 1: History of Blockchain

Numer of transactions per second (TPS) of selected providers

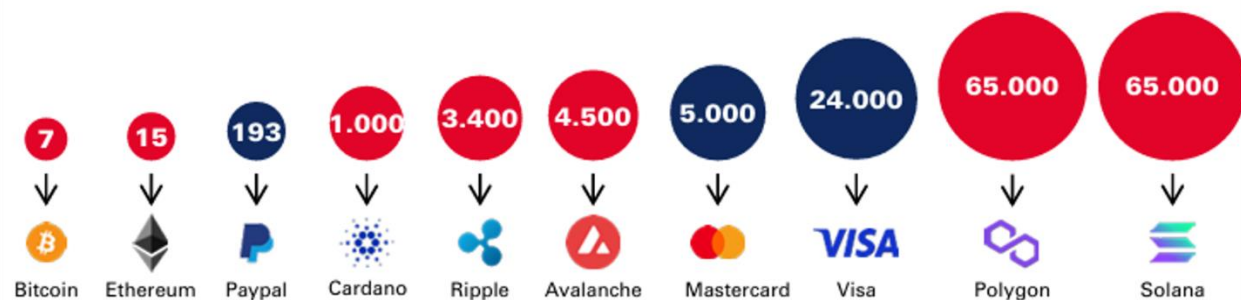| 7 | 15 | 193 | 1.000 | 3.400 | 4.500 | 5.000 | 24.000 | 65.000 | 65.000 |
| Bitcoin | Ethereum | Paypal | Cardano | Ripple | Avalanche | Mastercard | Visa | Polygon | Solana |

Figure 2: Number of Transactions Per Second (TPS) for selected provider
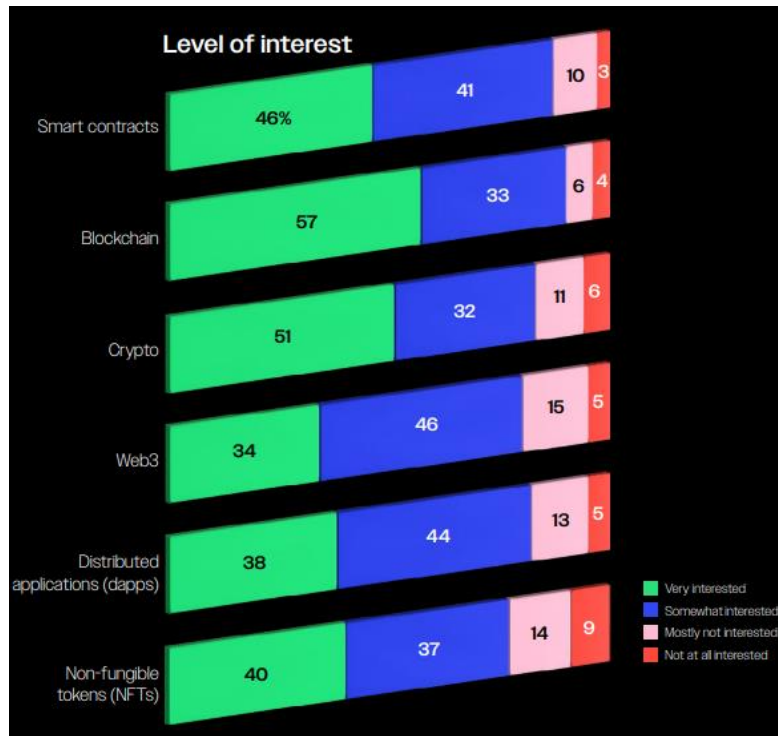
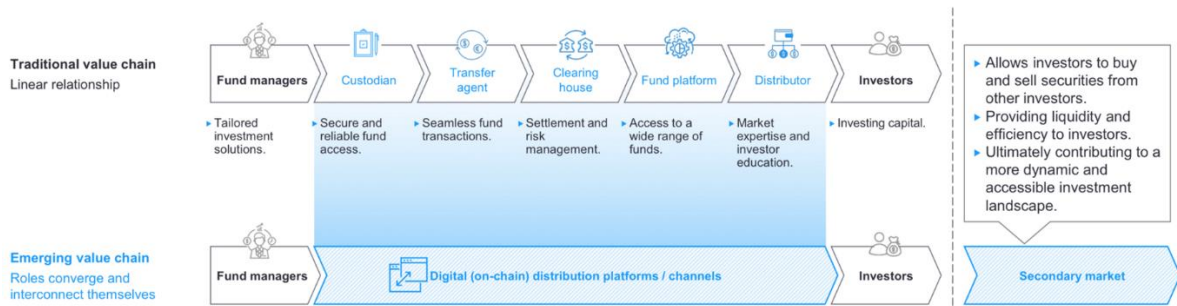*Figure 3: Business Owners level of interest*

Figure 4: Value Chain Transformation

Tokenization is better suited for inefficient and illiquid assets that are easy to authenticate, such as real estate, which are currently inaccessible to most investors
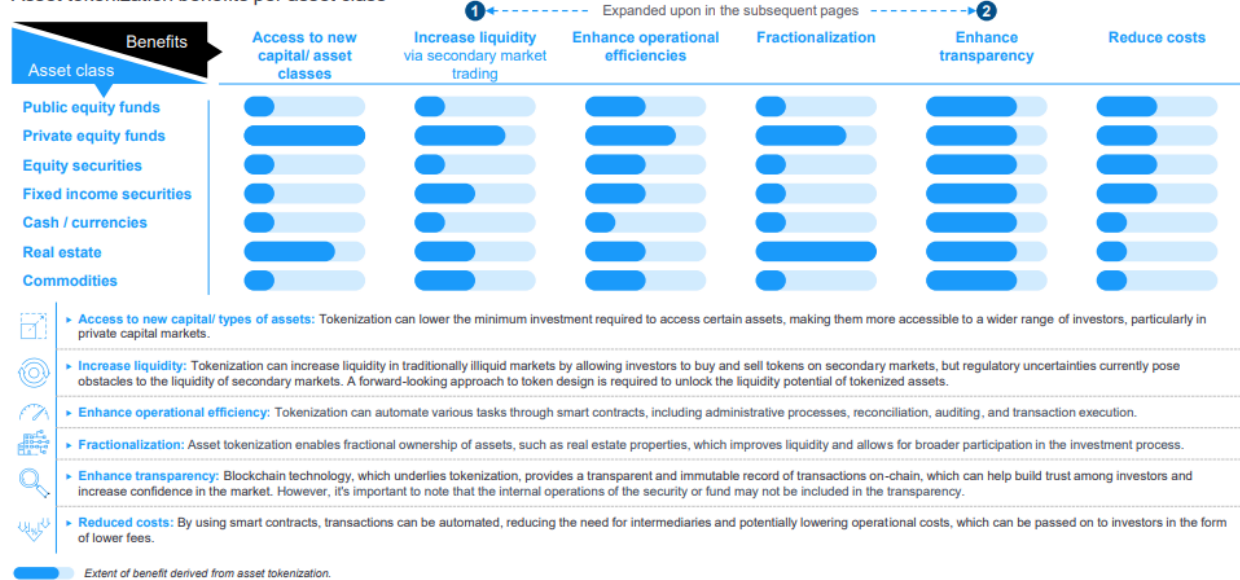
Asset tokenization benefits per asset class

Expanded upon in the subsequent pages

Asset class \ Benefits	Access to new capital/ asset classes	Increase liquidity via secondary market trading	Enhance operational efficiencies	Fractionalization	Enhance transparency	Reduce costs
Public equity funds	●		●	●	●	●
Private equity funds	●●	●	●●	●	●●	●
Equity securities	●	●	●●	●	●	●
Fixed income securities	●	●	●●	●	●	●
Cash / currencies	●	●	●●	●	●	●
Real estate	●●	●	●●	●●	●●	●
Commodities	●	●	●	●	●●	●

▸ **Access to new capital/ types of assets:** Tokenization can lower the minimum investment required to access certain assets, making them more accessible to a wider range of investors, particularly in private capital markets.

▸ **Increase liquidity:** Tokenization can increase liquidity in traditionally illiquid markets by allowing investors to buy and sell tokens on secondary markets, but regulatory uncertainties currently pose obstacles to the liquidity of secondary markets. A forward-looking approach to token design is required to unlock the liquidity potential of tokenized assets.

▸ **Enhance operational efficiency:** Tokenization can automate various tasks through smart contracts, including administrative processes, reconciliation, auditing, and transaction execution.

▸ **Fractionalization:** Asset tokenization enables fractional ownership of assets, such as real estate properties, which improves liquidity and allows for broader participation in the investment process.

▸ **Enhance transparency:** Blockchain technology, which underlies tokenization, provides a transparent and immutable record of transactions on-chain, which can help build trust among investors and increase confidence in the market. However, it's important to note that the internal operations of the security or fund may not be included in the transparency.

▸ **Reduced costs:** By using smart contracts, transactions can be automated, reducing the need for intermediaries and potentially lowering operational costs, which can be passed on to investors in the form of lower fees.

Extent of benefit derived from asset tokenization.

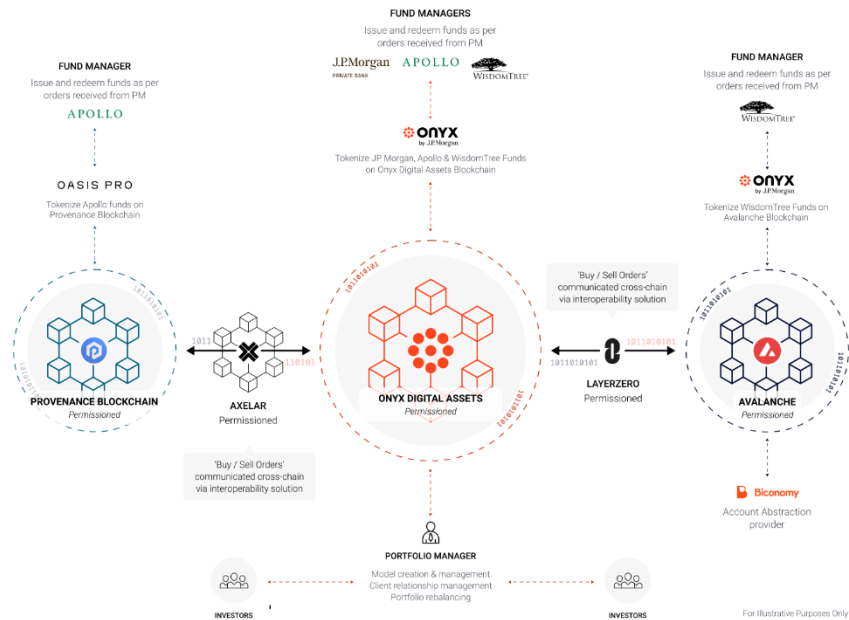*Figure 5: Overview on the benefits for tokenization*

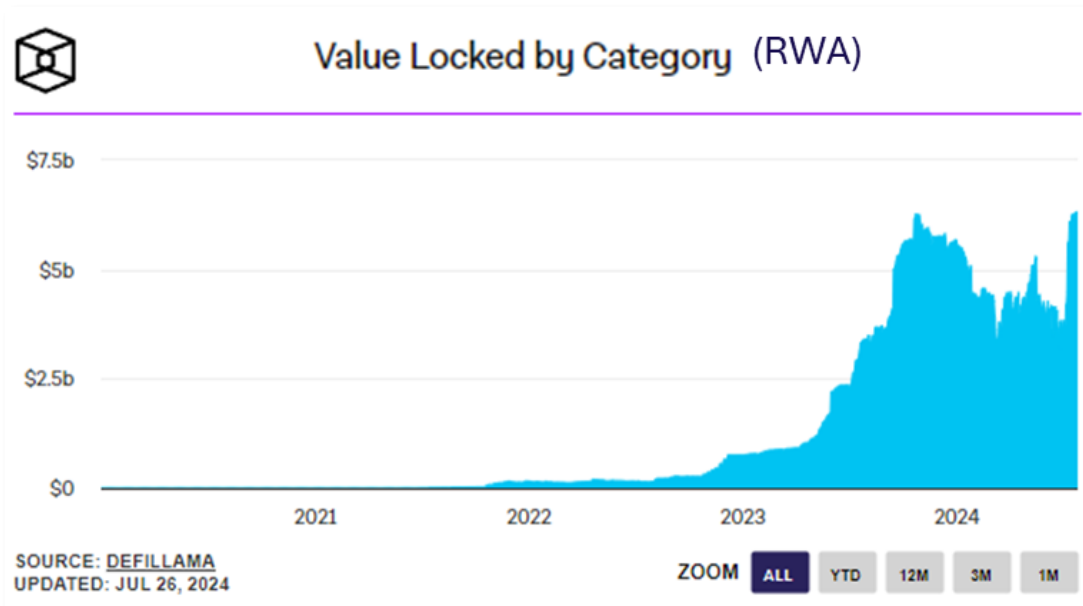*Figure 6: Overview of the end-to-end portfolio management & interoperability*

Figure 7: Total Value Locked (RWA)

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