Navigating the Future of Finance

A Proof of Concept for Compliant Web3 Digital Securities Issuance

By ADDX

Author

Terence Yak Co-founder & Lead Blockchain Research Engineer



Abstract

The digital transformation of the financial industry is at a crucial juncture with the advent of blockchain technology and the rise of decentralized finance (DeFi). This whitepaper presents a detailed account of a Proof of Concept (PoC) conducted by ADDX, aimed at exploring the potential of permissioned DeFi protocols in the Web3 environment for the issuance of digital securities. At the heart of this PoC is the integration of Soulbound Tokens (SBTs) — a novel form of non-transferable digital tokens — to ensure compliance with regulatory frameworks while leveraging the inherent advantages of blockchain technology.

The PoC examines the feasibility of a self-service decentralized application (DAPP) that allows for the issuance, management, and transfer of digital assets within a regulatory-compliant framework. This includes a deep dive into the technical architecture of the protocol, showcasing the successful deployment of smart contracts on an Ethereum Virtual Machine (EVM)-compatible blockchain network. The whitepaper articulates the challenges and triumphs of embedding compliance mechanisms, such as Know Your Customer (KYC) and Anti-Money Laundering (AML), within the decentralized constructs of blockchain.

In this exploration, the PoC aligns with the Monetary Authority of Singapore's Project Guardian, sharing its vision for a secure and regulated DeFi ecosystem. A limitation of this PoC, however, is its focus on a single solution within the vast landscape of possibilities. The whitepaper concludes with a reflection on the learnings from the PoC and its implications for FIs considering their digital asset strategy. It emphasizes the need for ongoing innovation, robust technological infrastructure, and a regulatory-first approach to navigate the future of finance in the Web3 era. The ultimate goal is to present a scalable, interoperable, and user-friendly platform that can set the standard for compliant digital securities issuance and pave the way for future advancements in the sector.



Acknowledgements

This project owes a significant portion of its success and feasibility to the generous support provided by the Monetary Authority of Singapore (MAS) through the Financial Sector Technology and Innovation (FSTI) grant. We express our profound gratitude to MAS for recognizing the potential of our endeavour and for providing the necessary financial support to bring our vision to fruition.

The FSTI grant, a hallmark initiative by MAS, is designed to foster a culture of innovation and technologically driven solutions within Singapore's financial sector. By awarding us this grant, MAS has not only provided financial backing but has also affirmed the importance and relevance of our project in the evolving landscape of financial technology. This endorsement is instrumental in driving forward our objectives and in contributing to the innovative vigour of Singapore's fintech ecosystem.

The support from MAS through the FSTI grant has enabled us to leverage cutting-edge technology, enhance our research capabilities, and develop solutions that align with the dynamic demands of the digital finance world.

We hope that our work will contribute to the vision of MAS in establishing Singapore as a global hub for financial technology and innovation, and we look forward to continuing our collaboration in pushing the boundaries of what is possible in the digital finance landscape.



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01 | Executive Summary

Digital securities, a significant innovation in financial markets, have emerged as a key player in the blockchain revolution. They encompass tokenized versions of traditional financial assets, including stocks, bonds, and real estate, leveraging blockchain technology for issuance, trading, and management. This evolution offers numerous advantages such as increased liquidity, global accessibility, fractional ownership, and reduced operational costs, making private and illiquid assets more accessible to a broader range of investors.

As digital securities continue to reshape the financial landscape, one critical issue stands at the forefront of this evolution: on-chain compliance. Ensuring that transactions and issuances of digital securities adhere to regulatory standards on the blockchain, especially on decentralized public network, is not just a technical challenge, but a fundamental necessity for the legitimacy and long-term viability of this emerging market.

On-chain compliance is the embedding of regulatory requirements in the financial world such as KYC & AML into the blockchain itself. For instance, in Singapore, financial institutions engaged in transactions involving digital payment tokens (DPT) are required to adhere to the Payment Service Act¹. This entails conducting due diligence on customers, monitoring transactions, screening wallets, and maintaining diligent reporting and record-keeping practices. On-chain compliance is crucial for protecting investors and ensures that digital securities operate within the bounds of the law, safeguarding investor interests and maintaining market integrity.

Financial Institutions grapple with the primary challenge of enforcing on-chain compliance especially when operating on decentralized public networks, a task that hinges critically on the accurate identification, authorization, and authentication of pseudonymous blockchain addresses. As the Web3 domain continues to expand, a variety of techniques have emerged to associate blockchain addresses with real-world identities, each presenting its own set of intricacies and possibilities. The upcoming section will explore these strategies, explaining their importance for the future of finance and highlighting why soul bound tokens are, in our opinion the preferred solution.

¹ https://www.mas.gov.sg/regulation/guidelines/ps-g02-guidelines-on-provision-of-digital-payment-token-servicesto-the-public



02 | Methods of on-chain compliance

Financial Institutions (FIs) operating on decentralized public networks face significant challenges, particularly in identifying, authorizing, and authenticating blockchain addresses. In the evolving Web3 world, several methods exist for linking blockchain addresses to real-world identities, each with its unique complexities and potential.

2.1. The Role of Self-Sovereign Identity (SSI)

One notable solution is Self-Sovereign Identity (SSI), which has garnered considerable attention in recent years. Innovations like PolygonID, Affinidi, uPort(Serto & Veramo), and Civic represent significant strides in this domain. SSI empowers users with direct control over their identities, leveraging advanced technologies such as zero-knowledge proofs. Despite its progress, SSI is still relatively new to many users and faces challenges in achieving widespread adoption. This hesitancy can be attributed to its technical complexity and the proliferation of varying solutions and standards, which can be overwhelming.

2.2. Addressing Access Control in DeFi Protocols

Beyond identification, FIs must effectively manage access control for blockchain addresses interacting with their DeFi protocols. This is often handled at the smart contract level, determining the permissions and actions a blockchain address can execute. Traditional methods like whitelisting or role-based access control offer a solution, but they often fall short in terms of user experience. Typically, users discover their access rights through trial and error or by directly querying the smart contract – a process that is neither user-friendly nor intuitive.

2.3. Introducing a More Intuitive Solution: Soulbound Tokens

A more user-centric and ecosystem-friendly approach is the use of Soulbound tokens. These tokens offer a seamless method for identifying, authenticating, and authorizing blockchain addresses. Soulbound tokens provide a clearer and more straightforward way for users to understand their access and permissions within a DeFi protocol. By embedding the necessary information within these non-transferable tokens, users can easily ascertain their status and access rights, enhancing the overall user experience and simplifying interactions within the DeFi ecosystem.



03 | Soulbound Tokens

Soulbound tokens (SBTs) may not be an entirely new phenomenon, having been first proposed in May 2022 by prominent figures including Vitalik Buterin, Ethereum's co-founder, in the paper "Decentralized Society: Finding Web3's Soul."² SBTs are a special type of non-fungible tokens (NFTs) that are inherently non-transferable. Unlike tradable NFTs such as Cryptokitties or Azuki, which can be bought and sold on marketplaces like Opensea, SBTs are designed to remain with a single owner. This quality makes them ideal for Financial Institutions to use as on-chain credentials, verifying the identity of a wallet address without the possibility of transfer.

SBTs offer FIs a robust mechanism for imposing on-chain regulations, but their benefits extend further. The NFT boom that started in early 2021 has resulted in widespread adoption of NFT standards such as ERC721 and ERC1155 across most major cryptocurrency wallets. As a result, any SBTs issued would be readily supported within the existing wallet infrastructure. Furthermore, NFTs have become a familiar concept to the general public, which could make the transition to using SBTs smoother. When evaluating other potential options for managing on-chain regulation, such as Self-Sovereign Identity (SSI) or whitelisting methods, SBTs stand out as the more pragmatic choice due to their compatibility and ease of adoption for both ecosystems and endusers.

In the forthcoming section of the whitepaper, we will provide a detailed examination of ADDX's proof of concept, in which we experiment with SBTs and smart contracts. This exploration aims to uncover the technical underpinnings necessary to facilitate a compliant lifecycle for digital securities native to Web3, operating on a public and permissionless blockchain such as Ethereum. Our analysis will delve into the intricacies of implementing these technologies to meet the stringent requirements of regulatory compliance in the digital securities domain.

² Weyl, Eric Glen and Ohlhaver, Puja and Buterin, Vitalik, Decentralized Society: Finding Web3's Soul (May 10, 2022). Available at SSRN: https://ssrn.com/abstract=4105763 or http://dx.doi.org/10.2139/ssrn.4105763

04 | Proof Of Concept: Web3 Native Digital Security Issuances

For the PoC, we sought to investigate the practical applications of SBTs within a regulatory framework, particularly their potential use by regulated financial institutions on a public, permissionless blockchain. We demonstrate this by using an realistic scenario of an FI — ADDX in this instance—that would like facilitating compliant, web3-native digital security issuances.

The intention behind using this scenario is twofold. First, to help those in the industry understand the complex details of setting up and running their own smart contract protocols in a way that follows the rules. Secondly, to spark a broader discussion on the strategic considerations for FIs venturing into digital assets. Among the critical questions we aimed to address were:

- a) **Smart Contract Protocol Design:** What are the pivotal considerations for FIs when architecting smart contract protocols, ensuring they align with regulatory requirements and business objectives?
- b) **KYC Enforcement:** How can an FI ensure that only KYC-verified participants engage with its protocol, thus maintaining a compliant user base?
- c) **Authorized Issuance:** Particularly for the case study on digital security offerings, what safeguards can ensure that only approved entities are able to launch primary issuances?
- d) **Transfer Restrictions:** What are the strategies for enforcing compliance in digital security transfers, ensuring that they are limited to accredited or 'qualified' investors, as per relevant regulatory criteria?
- e) **Post-Issuance Oversight:** Once the digital securities are issued, how can an issuer retain regulatory oversight and control over these assets to adhere to ongoing compliance mandates?

Through this exploration, our goal is to provide a foundational understanding for industry stakeholders contemplating their digital asset strategies, emphasizing the operational, regulatory, and technical considerations pivotal to a compliant integration into the digital economy.



4.1. Proposed Use Case

ADDX's envisioned scenario for compliant Web3-native digital security issuances entails the deployment of a permissioned DeFi protocol, specifically an asset tokenization platform, on a public blockchain. The design of this protocol includes strong regulatory safeguards to facilitate the lawful issuance of digital securities. Aimed at the Web3 space, this initiative would be accessible via a decentralized, easy-to-use application(otherwise known as a DAPP), empowering users to issue and purchase digital securities on their own.

For the proposed scenario, ADDX will be responsible to issue SBTs to verified users of its protocol. To participate, users must complete the KYC process through ADDX, which includes submitting their wallet address. As a regulated FI, ADDX is tasked with conducting thorough due diligence on both the clients and their respective wallet addresses. This due diligence is achieved by employing established cryptocurrency compliance practices, such as Know Your Address (KYA), encompassing transaction monitoring and wallet screening. SBTs are then issued to the wallets that have been cleared through KYC and KYA processes. Only wallet addresses with an SBT issued by ADDX will gain access to the platform's permissioned DeFi issuance protocol.



4.2. Architecture Overview

Figure 1. Architecture Overview

The above diagram illustrates the technical architecture designed for the proposed use case, highlighting several essential elements to be developed for the prototype: the ADDX SBTs, the ARTS issuance protocol, and the user-facing DAPP. For the purposes of this PoC, the prototype and its associated smart contracts will be implemented on the testnet of an Ethereum Virtual Machine (EVM)-compatible blockchain.



4.2.1. ADDX Regulated Token for Securities (ARTS)

To ensure that its digital securities remain compliant throughout their lifecycle, ADDX is developing a proprietary token standard known as ARTS, depicted as component 6 in Figure 1, which embeds compliance features and regulatory rules directly within the token's architecture. ARTS will build upon the widely-recognized ERC20 standard to ensure compatibility within the broader ecosystem. It will incorporate mechanisms to ensure that only holders of ADDX's (SBTs) are authorized to receive ARTS tokens, enforcing transfer restrictions. Figure 2 provides a highlevel representation of the validation process governing ARTS token transfers.



Figure 2. ARTS Transfer Validation

To fulfil the KYC requirements, users must establish their status as accredited investors, as only such individuals will be eligible to receive an ADDX SBT. This ensures that, from a compliance standpoint, the transfer of ARTS tokens is confined to accredited investors or those who meet other defined criteria necessary for regulatory adherence.

Moreover, the ARTS smart contracts will be equipped with control features that enable the issuer, which may be ADDX or another entity, to oversee and regulate the digital securities postissuance. Control functions such as minting and burning allow for the adjustment of ARTS supply, while controlled transfer capabilities provide the issuer with the authority to address transactional issues, including dispute resolution and rectification of fraudulent activities or recovery from the loss of private keys.

4.2.2. ADDX SBTs

There will be 2 ADDX SBTs, depicted as component 5 in Figure 1, that will be issued, an ADDX Issue SBT and a ADDX Invest SBT. An ADDX Issue SBT will be issued to a verified issuer, while an ADDX Invest SBT will be issued to a verified investor. Both SBTs will be based off the ERC721 standard. ADDX will develop both SBTs and deploy them to the relevant test network.

4.2.3. ARTS Issuance Protocol

The ARTS issuance protocol, depicted as component 4 in Figure 1, is a collection of smart contracts developed to facilitate the compliant issuance and lifecycle management of ARTS tokens. The smart contracts are engineered to handle: i) configuration of the protocol, ii) access control of the protocol, iii) upgradeability of the protocol, iv) integration with ADDX SBTs, v) issuance logic (i.e. sale duration, fund raise currency, sale states, sale access) & vi) ARTS creation logic. For the scope of this PoC, the focus of the protocol has been narrowed to the initial phases of subscription, minting, and distribution.

Through the protocol, issuers can launch primary offerings of ARTS, while investors can directly contribute using their Web3 wallets. Following a successful offering, ARTS tokens will be minted and allocated to the offering's participants, and the funds raised will be transferred to the issuer. The design of the ARTS protocol ensures that only issuers with an ADDX SBT can commence ARTS offerings. Similarly, only investors with an ADDX SBT can engage in these offerings and, if successful, receive ARTS tokens.



Figure 3. Primary Offering of ARTS facilitated by the ARTS protocol

Referring to Figure 3, the steps involved in the ARTS issuance process are outlined as follows, with the assumption that the ARTS token has been established, the issuer is verified and possesses an ADDX Issue SBT, and the investor is similarly verified with an ADDX Invest SBT:

- 1. The issuer initiates a primary offering through the ARTS Protocol.
- 2. The ARTS Protocol then creates a dedicated smart contract to oversee the offering.
- 3. Investors take part in the offering by transferring funds to the designated ARTS offering smart contract.
- 4. When the primary offering concludes successfully, the smart contract ensures that:
 - a. ARTS tokens are created and allocated to the investors' wallets.
 - b. The capital accumulated during the offering is transferred to the issuer's wallet.



4.2.4. User Facing DAPP

The DAPP, depicted by components 1,2, & 3 in Figure 1, will be the interface for both issuers & investors to easily interact with the ARTS issuance protocol. Users will be able to connect their web3 wallet to the ARTS protocol via the DAPP. The DAPP will also demonstrate NFT based token gating which leverages the different ADDX SBTs issued to control views and accesses on the application level.

From a technical perspective, there are 3 main components that is required for a DAPP: the user interface, the indexer & node provider. The user interface, our front end, was crafted using the React framework with TypeScript. We incorporated WalletConnect³ to ensure seamless interaction with various Web3 wallets, enhancing the application's flexibility. For efficient data retrieval from the blockchain, we integrated with TheGraph⁴, an indexing provider that streamlines data display on the user interface. Finally, for the execution of user transactions, we employed Alchemy⁵ as our node provider, enabling reliable transaction broadcasting on the network.

4.3. Key User Flows

This section will illustrate using screenshots of the PoC built how the envisioned proposed selfservice DAPP that allows the issuing Web3-native digital securities compliantly with SBTs. We will detail the following use cases: i) Default views of a user ii) unauthorized users without SBTs are restricted from performing or viewing SBT-restricted actions within the DAPP iii) An issuer generating and managing their ARTS, iv) An issuer initiating a Web3 native primary offering of ARTS, v) An accredited investor participating in a primary offering of ARTS.

³ https://walletconnect.com/

⁴ https://thegraph.com/

⁵ https://www.alchemy.com/



4.3.1. Default Views

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Figure 4. ARTS Dashboard, before login

Figure 4 provides a snapshot of the user interface prior to wallet connection, illustrating that balance details are not visible until the user's wallet is linked. Given that the system's components are EVM-compatible, the DAPP interface is versatile and can operate on various EVM-compatible chains. This choice of blockchain can be easily made by the user from the DAPP's top right-hand corner, with the current default set to the Ethereum chain.

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	Figure 5. Connect a wallet			Figure	6. Wallet Connected	

The user will be able to connect his wallet as shown in Figure 5 & 6 above. After the user connects his wallet, he will be able to view his currency balances & available ARTS balances on the interface as shown in Figure 7 below.



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Figure 7. Dashboard after user connects wallet

4.3.2. Unauthorized Users

Users who do not possess ADDX SBTs will encounter restricted access on the DAPP interface. Specifically, those without the ADDX Invest SBT will be unable to enter the investment portal, and similarly, those lacking the ADDX Issue SBT will be barred from using the issuer portal. This restriction is an example of the earlier mentioned 'token gating' feature of the DAPP, which controls access based on the possession of specific SBTs. This is illustrated in Figures 8 & 9 below.

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4.3.3. Issuer generating & managing their ARTS

An issuer who has completed the onboarding process with ADDX and received an ADDX Issue SBT can access the issuer portal. To initiate a primary issuance, the issuer must first deploy the token. Once the token is deployed, they can then manage the ARTS. To open up the primary offering to investors, the issuer must create a security token offering (STO) for the ARTS. These interactions are in Figures 10 to 13.

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Figure 10. Issuer with ADDX Issue SBT

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Figure 11. Issuer Deploys a ARTS



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Figure 12. Issuer can manage the ARTS

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Figure 13. Issuer creates an STO for the ARTS



4.3.4. Investor invest in an STO

After an issuer creates an STO, investors who have completed the KYC process with ADDX and hold the ADDX Invest SBT will gain the ability to view and invest in the STO through the investment portal. For the purposes of this PoC, we have demonstrated that investments be made using the native blockchain currency, such as ETH, as well as USDC, to emphasize that regulated STOs should accommodate the network's inherent token while also supporting widelyrecognized stable coins, offering a more stable investment option compared to other, more volatile cryptocurrencies. These interactions are shown in the figures below.

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Figure 14. Account with ADDX Investor SBT



Figure 15. Investors who underwent KYC can view STOs listed by issuers





Figure 16. Investor can invest into the STO

05 | Lessons Learnt

5.1. Aligning Blockchain and Regulatory Compliance

The PoC has underscored the technical complexity involved in aligning blockchain functionality with the stringent requirements of regulatory compliance. Fls must account for the dynamic nature of regulations and ensure that smart contracts are designed with the flexibility to adapt as regulations evolve. This calls for a robust framework where compliance is not just an added feature but a foundational aspect of the blockchain architecture.

5.2. User Interface and Interaction

A key takeaway is the significance of the user interface (UI) in bridging the gap between sophisticated blockchain operations and user interactions. FIs need to invest in UIs that demystify blockchain complexities, presenting users with intuitive and seamless experiences. This encompasses everything from wallet connections to transaction confirmations, ensuring that users feel confident and secure at every touchpoint.

5.3. Smart Contract Functionality and Security

Furthermore, the development and deployment of smart contracts form the backbone of any digital asset strategy. FIs must ensure these contracts are not only functionally comprehensive, addressing aspects like token minting, transfer restrictions, and asset management, but also secure against potential vulnerabilities. This necessitates rigorous testing and auditing before smart contracts are brought into production.

5.4. Token Gating with SBTs as an Access Management Tool

Our PoC revealed token gating with SBTs to be an effective technical tool for managing access within a DAPP. FIs should consider the implementation of such mechanisms to enforce compliance and control user access based on their status, such as KYC verification or accreditation level.

5.5. Multi-Currency Support and Financial Integration

FIs must contemplate the technical implications of multi-currency support within their platforms. Our PoC demonstrated the feasibility and benefit of incorporating both native blockchain currencies and stable coins, suggesting that FIs should prepare for integrations that cater to a global and diverse investor base.



5.6. Network Scalability and Interoperability

The ability of the DAPP to function across various EVM-compatible chains is not just a technical feature but a strategic necessity for FIs looking to remain agile in a multi-chain future. This interoperability must be factored into the initial design to prevent future rework and ensure seamless cross-chain transactions.

5.7. Onboarding Processes and KYC Integration

The onboarding of users is a critical juncture that FIs must navigate with precision. The integration of KYC processes within the blockchain poses technical challenges that require careful consideration to balance regulatory compliance with user convenience.

5.8. Post-Issuance Control and Oversight

Managing digital assets post-issuance remains a significant technical and operational consideration. FIs must implement mechanisms that allow them to maintain oversight and control over digital securities, ensuring they can manage the total supply and facilitate corporate actions if necessary.

06 | Conclusion

The Proof of Concept (PoC) undertaken by ADDX has been a pivotal exploration into the realm of Web3, focusing on compliant, digital security issuances. It has successfully demonstrated the viability of using SBTs within a permissioned DeFi protocol to enforce regulatory compliance and facilitate secure and efficient digital transactions. Through the development of a user-friendly DAPP, the PoC has effectively showcased the potential for seamless integration of complex blockchain operations with intuitive user experiences.

Key to this exploration was the technical execution, which confirmed that well-structured smart contracts, robust user interfaces, and stringent access controls are non-negotiable components in deploying a compliant digital securities platform. The ability to support multi-currency transactions and maintain cross-chain interoperability has positioned the prototype as a forwardlooking model adaptable to the evolving blockchain landscape.

As we conclude this PoC, it's pertinent to recognize its alignment with the Monetary Authority of Singapore's (MAS) Project Guardian. This initiative by MAS seeks to explore the potential of asset tokenization and DeFi while ensuring that these innovations occur within the boundaries of regulatory compliance and risk management frameworks. Our PoC parallels the objectives of Project Guardian, contributing to the collective understanding of how traditional financial institutions can navigate and harness the advantages of DeFi.

The learnings from this PoC serve as a compass for future endeavours in the digital asset space, particularly for institutions seeking to engage with blockchain technologies responsibly. It reinforces the importance of regulatory-first approaches, which Project Guardian advocates for, ensuring that innovation does not outpace the guardrails set for financial stability and integrity.

In essence, the PoC stands as a testament to the potential for transformative financial solutions that can emerge when regulatory compliance is embedded into the fabric of blockchain innovation. It paves the way for future projects under the guidance of MAS and sets a benchmark for the industry, demonstrating that with the right blend of technology and regulation, the promise of Web3 can be realized in a safe, secure, and compliant manner.

About ADDX

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