Tokr: An open-source protocol for financing real world assets v0.1.0-beta.1

Calvin Cooper	Greg Miller	Jon Slemp
calvin@tokrlabs.xyz	greg@tokrlabs.xyz	jon@tokrlabs.xyz

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Abstract

In this paper, we introduce a standard for tokenizing real-world assets and develop an open-source protocol for decentralized real property finance. Representing real property ownership digitally as non-fungible tokens (rNFTs) enables market participants to frictionlessly exchange and finance real world assets programmatically on the Solana blockchain.

Protocol Website:
https://tokr.finance/

Documentation:
https://tokr.gitbook.io/tokr-main-docs/

Code:
https://github.com/orgs/TOKR-labs/repositories/

Contributors:
Alex Smith, Kevin Mack, Jonathan Nutt

Contents

1 Introduction

In the wake of the industrial revolution, philosopher and political economist John Stuart Mill predicted that capital-managed firms would be superseded by cooperative forms of enterprises, such as the labor-managed firm. [1] According to Mill, the free market itself would gradually and quietly transform from capital-ownership and capital-management in favor of cooperative associations. Over 150 years later, we are finally in that transition period. With the advent of blockchain technology, new cooperative forms of organizing have emerged, such as decentralized autonomous organizations (DAOs) and decentralized finance (DeFi) protocols. However, decentralized networks still face barriers to interact with the legacy market. New financial systems, legal frameworks, and business models are needed to bridge the gap between the on-chain decentralized world and the off-chain built world.

To that end, Tokr is a protocol for financing real-world assets on the Solana blockchain. In this paper, we introduce a system for tokenizing real property and establish an open-source platform for accepting real-world assets as collateral in decentralized finance.

Capital Markets are where savings and investments are channeled between suppliers (people or institutions with capital to lend or invest) and those in need (people or businesses seeking to borrow money or raise equity capital). [2] Private markets refer to investments in equity and debt of privately-owned companies. [3] Capital Markets seek to improve efficiencies by bringing capital suppliers together with those seeking funding, and provides a place for them to exchange value.

Tokenizing real property refers to the creation and issuance of non-fungible tokens (NFTs) that represent real property ownership. A protocol is needed for real property ownership to be digitally represented as NFTs in a way that counterparties can trust as collateral. This enables the frictionless exchange of real property and facilitates the formation of capital pools that algorithmically lend and/or invest in real-world assets using blockchain technology.

An open-source standard for tokenizing real assets promotes wide adoption and supports the interoperability and confidence needed for real property-backed NFTs (rNFTs) to be accepted as collateral by any DeFi protocol at scale.

The Tokr Protocol consists of composable modules that include the following:

a) Tokrizer: a dApp to certify and mint rNFTs by interacting with a Proof of Title and Proof of Value oracle,
b) Tokr Markets: markets that facilitate lending and borrowing with rNFTs as collateral, and the
c) Resolver: a system for risk mitigation and dispute resolution.

Tokr real property NFT (rNFT) Metadata Standards provide reusable frameworks for minting rNFTs and representing real property on-chain. Tokrizer is a process by which rNFT metadata is certified through a decentralized oracle network. This process results in the certification of Proof of Title and verification of Proof of Value. Tokr Markets incentivize asset tokenization and promote liquidity. This demonstrates how DeFi markets can programmatically lend using Tokerized rNFTs as collateral. The Resolver system mitigates the risk of loss and deters bad actors.

Lenders, investors, and buyers can trust that Tokrized rNFTs certified by Tokr DAO adhere to a Tokr Market Framework that ties them to real property ownership. Open-source metadata standards enable the global market to create rNFT marketplaces, trade rNFTs across centralized and decentralized exchanges, and accept rNFTs as collateral in DeFi markets.

Transparent, automated, digitally-enabled asset ownership, capitalization, and exchange unlock new potential in financial markets and the built world. Tokenized assets and securities provide the nuanced sophistication of traditional financial instruments with the added benefits inherent and unique to blockchain and cryptoasset ecosystems, such as instant transfer and settlement, 24/7/365 global markets, permissionless and programmable borrowing/lending, and disintermediation to reduce fees. Moreover, decentralizing real property finance eliminates barriers to entry, is anti-confiscatory, and expands access to ownership.

2 The Tokr Protocol

The Tokr Protocol establishes a uniform platform for tokenizing real property and establishes the trust needed for buyers, sellers, and capital providers to finance real assets using blockchain technology.

The Tokr Protocol is composed of three modules:

a) Tokrizer: Tokrizer certifies Proof of Title and verifies Proof of Value. This system ensures that rNFT ownership on-chain results in legal ownership and authority over the property off-chain, and establishes the collateral value of rNFTs. Each rNFT asset type requires its own category-specific Framework and Metadata Standard.

b) Tokr Markets: Tokr Markets are cross-collateral pools that enable rNFT holders to deposit assets and borrow capital from liquidity providers.

c) Resolver: Resolver is a decentralized arbitration platform and debt collection system that resolves conflict and mitigates risk due to loss of value, bad actors, and fraud.

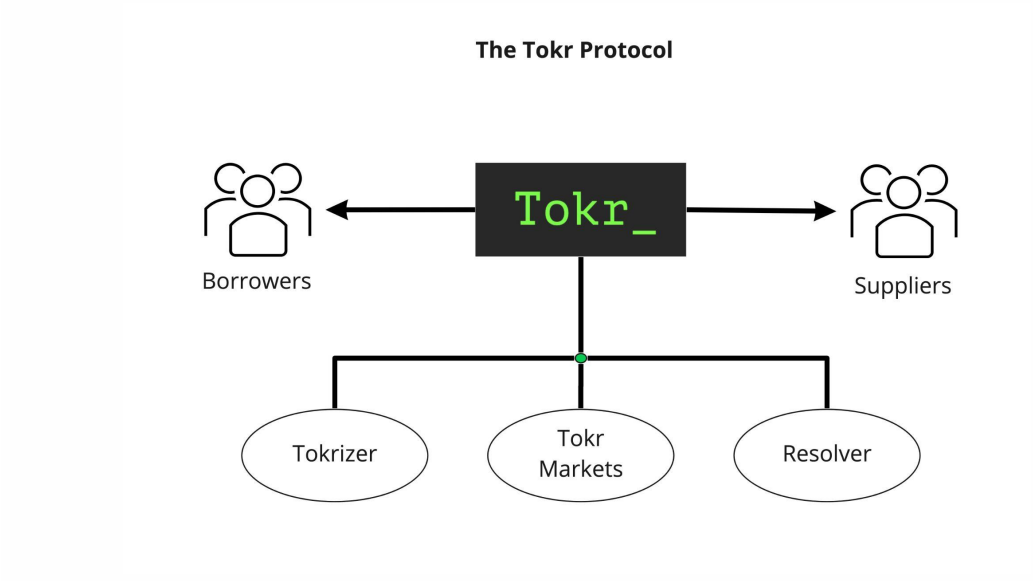

Figure 1 The Tokr Protocol

2.1 Tokrizer

Tokrizer is a process by which an rNFT is minted and receives certification of Proof of Title and verification of Proof of Value. This system ensures that rNFT ownership on-chain results in legal ownership of the property off-chain, and establishes the collateral value of rNFTs. Establishing the collateral value enables users to borrow funds from DeFi protocols programmatically using rNFTs as collateral. The Tokrizer process is composed of two primary functions:

1. Proof of Title certification
2. Proof of Value verification

Each function is performed by a decentralized oracle network within Tokr DAO whose sole purpose is to validate the information contained within the rNFT metadata standards of a given Tokr Market Framework (more details in section 2.2.1).

2.1.1 rNFT Metadata Standard

Considering use cases of rNFTs being owned and transacted by individuals or entities (such as DAOs) as well as third party brokers/wallets/auctioneers, a standard dataset is necessary for any party to programmatically read and interact with rNFTs as well as understand and trust what they are purchasing and/or financing.

rNFT Metadata Standards specify the minimum information needed to describe the real property represented by the rNFT and provide basic functionality to create, track and transfer rNFTs. rNFT metadata standards will exist for a variety of asset types (such as real estate, private companies, art, etc.). Tokr DAO will be responsible for certifying new standards to accept other real property as collateral, such as public/private company stock, and amending existing standards as the protocol matures.

2.1.2 Proof of Title Certification

Proof of Title Certification is the process by which the Tokr protocol certifies the owner of the rNFT has legal rights of ownership and possession of the underlying property. This ensures rNFTs minted by the Tokrizer meet the due diligence requirements set forth by a Tokr Market Framework and meet the minimum specifications set forth by an rNFT Metadata Standard. This empowers all parties to review documentation submitted to substantiate that rNFTs are legally bound to real property ownership.

Initially, Proof of Title certification involves a decentralized network of human certifiers who are members of Tokr DAO. In the future, this process will remove human intervention through an automated decentralized Oracle network enabled by information found in trusted places such as state business filing records, county title records, etc.

2.1.3 Proof of Value Verification

Proof of Value Verification is the process by which the Tokr protocol promotes trust and transparency with respect to the collateral value of real property that has been certified and minted in accordance with a given rNFT metadata standard. Like Proof of Title certification, Proof of Value verification involves a decentralized network of Tokr DAO members.

For the initial implementation of Tokrizer, valuations are not calculated in real-time. Those seeking to mint rNFTs must submit supporting documentation to Tokr DAO to establish the current value of the property. Examples of acceptable documentation include third-party valuation issued by a licensed appraiser, an opinion of value issued by a licensed real estate broker, or the most recent at-cost value set by an arm's length transaction. Supporting documentation will be verified by the Tokr DAO.

Initially, the certification and verification processes will be centralized, but will progressively transition to decentralized control as Tokr DAO grows and matures. A decentralized system could involve randomly selected certifiers that review the application and certify or deny based on a consensus mechanism established by Tokr DAO. In the long term, it is the goal of Tokr DAO to replace decentralized human consensus with data feeds from public records and other trusted systems.

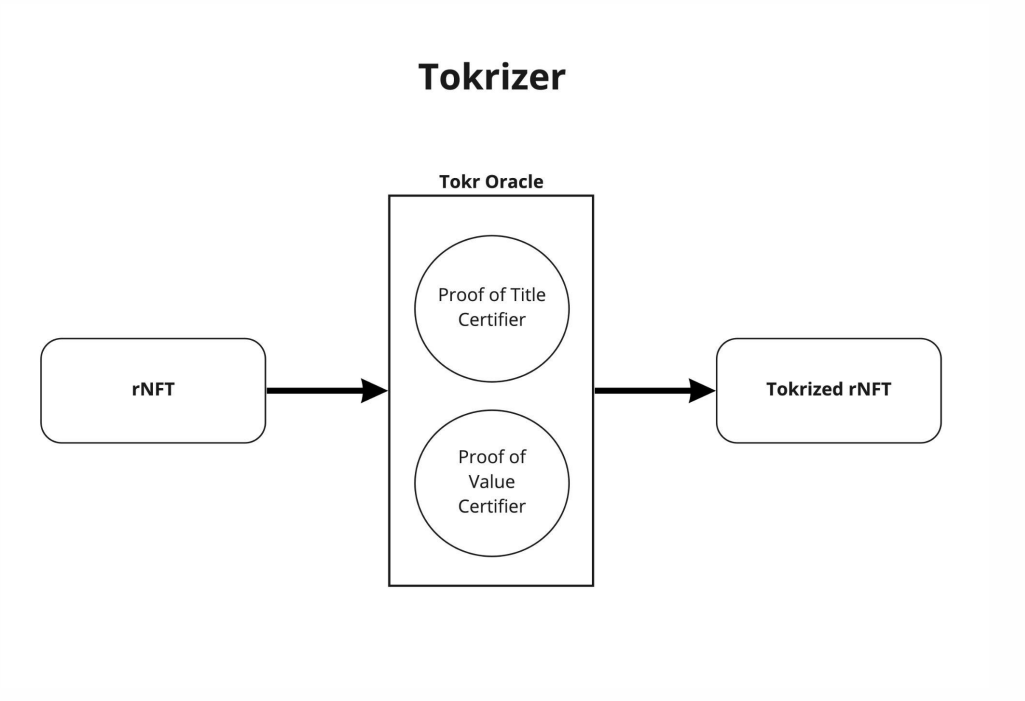

Figure 2.1 Tokrizer, rNFT Ownership Conveys Authority Over Real World Asset

2.2 Tokr Markets

The Tokr protocol enables permissionless and programmatic financing of real property through Tokr Markets. Tokr Markets accept as collateral any rNFT certified by Tokr DAO.

DeFi protocols such as Compound and Aave have proven the combination of smart contracts and over-collateralization mitigates counterparty risk and eliminates the need for intermediaries in the loan origination, closing, and repayment process. Overcollateralized lending frameworks now extend beyond fungible and semi-fungible tokens and have enabled further financialization of NFTs. Tokr Markets extend these paradigms to financing real-world assets using rNFTs as collateral.

Financing real-world assets is typically a time-intensive process. For instance, when financing real estate, a variety of stakeholders may be involved including senior lenders, mezzanine lenders, general partners, limited partners, intermediaries (such as broker-dealers, fund managers, and underwriters), and neutral third parties that reduce counterparty risk (such as title agencies and escrow agents). Instead of a series of intermediaries, the Tokr protocol uses blockchain technology to streamline the financing process, mitigate counterparty risk, increase transparency, and reduce the time and cost needed to transact within the traditional financial system.

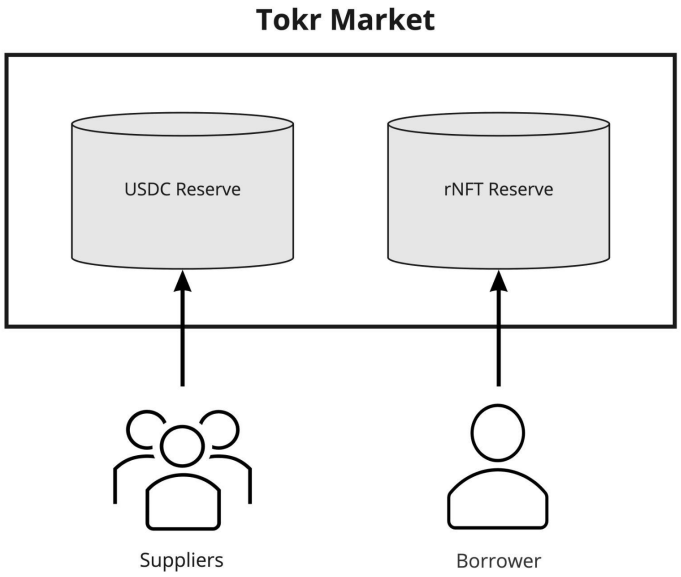

Figure 2.2 Tokr Markets

2.2.1 Tokr Market Frameworks

Each Tokr Market is governed by a Market Framework. Tokr Market Frameworks determine the types of rNFTs a Tokr Market accepts as collateral (i.e. real estate, company stock, etc.) and outlines the risk frameworks and interest rates a Tokr Market will programmatically lend against.

Each Framework includes configuration of the Tokr Protocol to certify Proof of Title, verify Proof of Value, mint and accept rNFTs as collateral, execute programs for deploying capital from Market reserves, and establish systems to mitigate risk.

First, for providers to accept rNFTs as collateral, Proof of Title and Proof of Value within a set Framework must be certified and easily reviewed. In the built world, a due diligence process is carried out by professionals to certify ownership and assess the value of property. Each asset class typically has standard due diligence processes. However, the process is cumbersome and redundant. Often, someone seeking to raise capital submits the same information to multiple capital providers in various different applications. Providing a standard streamlines the process of collecting the basic information and documentation needed to make an investment decision. As an open-source standard, the requirements for basic due diligence can evolve with the contribution of the market. No one entity owns the standards, but everyone can contribute to improving due diligence for the market. Further, by storing due diligence information as rNFT metadata, capital providers can automate due diligence processes and deploy capital programmatically using blockchain technology.

The Tokr Protocol and Tokrizing rNFTs doesn't replace due diligence and no one entity owns due diligence. The Tokrizer process simply streamlines the collection of due diligence so that Tokr Markets can programmatically lend or invest within predetermined risk parameters. Each Tokr Market elects to accept rNFT certification standards to streamline their due diligence collection process. In the future, Tokr Markets can elect to manually review the due diligence and require additional information, or simply programmatically invest without additional due diligence.

2.2.2 Supplying Assets

The Tokr protocol aggregates the supply of each user within a specific Tokr Market; when a user supplies a cryptoasset such as USDC to a capital reserve, it becomes a fungible resource. Markets are cross-collateralized by rNFTs held in unique Escrow Vaults within a Tokr Market (more details on Escrow Vaults in Section 4.3.2).

Suppliers deposit cryptoassets in the Tokr Market of their choosing and receive liquidity provider (LP) tokens that entitle the owner to an increasing quantity of the underlying Tokr Market reserve. As the Tokr Market accrues interest, distributions, and/or debt service payments, LP tokens become convertible into an increasing amount of the underlying Tokr Market reserve.

Unlike the collateral used in typical DeFi liquidity pools, rNFTs are not easily liquidated. Thus, the redemption of LP tokens is limited and v1 Tokr Markets can only be set up with a finite lifespan (similar to private debt and equity funds). In these cases, LP tokens issued by the liquidity pool can be redeemed after the predetermined period of time and once all outstanding loans have been paid or liquidated.

In the future, permissionless pools may be established with unique structures mimicking hedge funds, private equity funds, evergreen debt funds, and even money markets.

2.2.3 Supplier Incentives

Until now, DeFi liquidity providers have primarily used cryptoassets to generate yield from highly-correlated asset pools and cryptoasset money markets. Tokr Markets create an opportunity for liquidity providers to use their cryptoassets to generate yield from uncorrelated, off-chain assets and cash flows. This opportunity may provide a relatively stable yield to liquidity providers, and it also may promote a healthier relative risk-adjusted return for their portfolios. Additionally, suppliers receive these benefits while enjoying the option for liquidity by selling, exchanging, or transferring their LP tokens at any time.

2.2.4 Borrowing Assets

Unlike typical DeFi protocols where a user's collateral is a fungible asset, the Tokr protocol enables borrowers to deposit rNFTs that represent ownership in specific real property. Borrowers can deposit rNFTs as collateral and borrow funds from any Tokr Market that accepts their rNFT as collateral. A borrower's rNFT is held in an Escrow Vault unique to the rNFT and can only be withdrawn by borrowers when the terms of the loan have been met, or by lenders upon loan default and liquidation.

In order to initiate a loan, the borrower must certify that their rNFT can be used as collateral in a Tokr Market. Once validated that the borrower holds an acceptable rNFT, the borrower may deposit their rNFT into a Tokr Market as collateral which establishes a unique Escrow Vault and updates the borrower's collateral balance. The borrower can then originate and close on a loan against their collateral balance, locking their rNFT in the Escrow Vault in the process. If the loan terms are violated, the rNFT held by the Escrow Vault will be auctioned off to liquidators at a discount.

2.2.5 Borrower Incentives

Borrowers looking to finance real property are often met with high barriers to entry, inefficient intermediaries, high take rates, and undue bias in the traditional financial ecosystem. The shortcomings of this process are apparent and create negative outcomes and capital value. Tokr Markets provide an opportunity for borrowers to instantly obtain financing from a permissionless DeFi protocol. This opportunity not only establishes a more perfect market mechanism for financing real property, it also enables borrowers to more efficiently build, cashflow, exit, and repeat.

2.2.6 Risk Frameworks & Liquidation

Tokr Markets are each structured with unique parameters that outline their terms and risk frameworks with considerations such as maximum LTV, maximum duration of loans, minimum APR offered, supported Market Frameworks (real estate, corporate stock, etc.), and collateral factors. These parameters are established during the creation of a Tokr Market which enables suppliers and borrowers to understand the terms associated with the market and facilitates instant and permissionless lending/borrowing.

2.3 Resolver

Resolver is a decentralized arbitration platform and debt collection system that resolves conflict and mitigates risk due to loss of value, default, bad actors, and fraud.

When interest, debt service, or distribution payments are not made to the Escrow Vault the health factor of the collateral position is impacted. When the health factor exceeds the maximum threshold acceptable to the pool, the collateral position is deemed to be in default and the Escrow Vault initiates a liquidation auction for the underlying rNFT collateral. Liquidators can bid on the rNFT to take possession of it at a discount. When payment is made by a Liquidator, they receive the rNFT from the Escrow Vault.

When implemented, the Resolver system will utilize a decentralized network of adjudicators to handle subjective disputes that can not be resolved by smart contracts alone. In addition, Tokr DAO will implement a system for debt collection that bids out the legal right to enforce ownership rights when challenged in the built world.

3 Initial Tokr Market: DAO Owned Real Estate (DORE) Framework

The DORE Framework establishes a Tokr Market Framework for DAO Owned Real Estate. The Framework maintains a library of legal documents and templates for binding real property title off-chain to rNFT ownership on-chain. Additionally, the Framework sets forth a metadata standard for real estate rNFTs and Tokrizer requirements including standards for Proof of Title and Proof of Value. Suppliers that participate in Tokr Markets that accept DORE rNFTs can accept rNFTs as collateral and programmatically lend to borrowers (real estate owners that have minted rNFTs).

Tokr DAO will initially establish a Tokr Market under the DORE Framework structured as individual funds with lifespans, caps, and redemption periods. After v1 launch, any user can establish a Tokr Market under its own framework and standards.

3.1 Initial Use Case: Debt Recapitalization

Tokr Markets using the DORE Framework will initially enable borrowers to obtain debt financing for real estate property they already own. Borrowers who would like to refinance or recapitalize an asset they already own can request to Tokrize their asset and, if certified, use their rNFT as collateral to obtain a loan from a Tokr Market.

3.2 DORE Library

The DORE Framework Library includes a template for creating legal entities that own real estate and sets forth standards to ensure that title to real property is owned in a way that legally binds it to an rNFT. Central to the model is a legal structure that ensures decisions made by the DAO have legal authority over real-world entities and assets represented by rNFTs.

Tokenizing real estate requires a legal framework that binds real-world assets to digital tokens issued on the blockchain. The DORE Framework sets forth a model for DAO formation,

the creation of limited liability companies (LLCs) established by DAOs (referred herein as LAOs), and single-member special-purpose vehicles (SPVs) whose sole purpose is holding title to real property (Figure 3.2.1).

The DORE Framework sets forth standards for SPVs that hold title to real property to organize and mint their membership interest in the SPV as an NFT. This is what we refer to as an rNFT—the digital representation of ownership of an SPV that has title to real property. If an rNFT is sold, the seller is transferring to the buyer ownership of the SPV and its assets which include title to real property (Figure 3.2.2). Thus, the DORE Framework is a standard for real property ownership and conveyance using digital tokens issued and transferred on the blockchain.

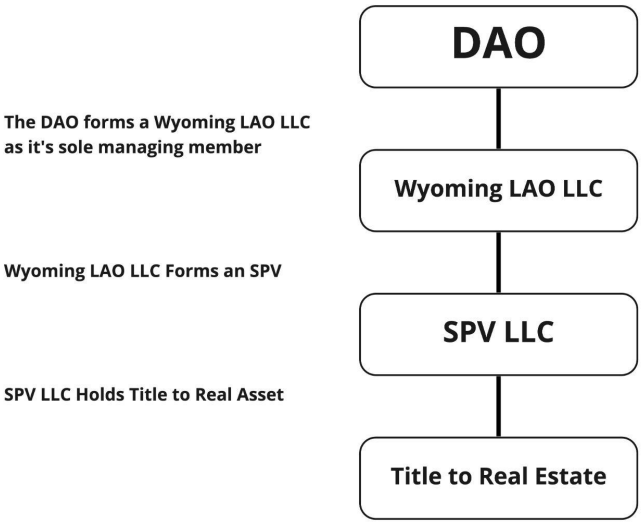

Figure 3.2.1 DORE Entity Framework

3.2.1 Forming a DAO

The DORE Framework sets forth standards that DAOs must meet to ensure the legal enforceability of rNFTs minted by the Tokr protocol. This starts with the formation of DAOs and the on-chain proposals that authorize the appointment of representatives to form the entities and take the actions required to acquire property and mint rNFTs. Tokr provides an application that streamlines the formation of DAOs and includes template proposals to meet the requirements set forth by the DORE Framework.

3.2.2 Forming a LAO

DAOs that form LAOs can be member-managed or algorithmically managed. The DORE framework utilizes a member-managed LLC structure. The Wyoming LAO LLC is governed by a single member, the related DAO, whose actions are governed by their governance programs.

3.2.3 LAO-Owned Title SPV

LAO-owned Title SPVs are legal entities created to fulfill the sole objective of holding title to real property. Structured as single-member LLCs, these SPVs can hold title recorded by government entities such as county recorders. Membership Interest in the SPV represents full ownership, governance, and control of the SPV. Membership Interest in the SPV can be easily transferred by a Membership Interest Purchase and Transfer Agreement that can be recorded digitally without the

need to interact with intermediaries such as county recorders. In essence, holding Title to real property in an SPV that is owned by a LAO enables the DAO to hold SPV ownership (and by extension Title ownership) and transfer ownership to other entities who purchase the SPV from the LAO. The purchase and transfer of SPV ownership can be facilitated and recorded on the Solana blockchain.

3.2.4 Transferring Ownership of SPV

Ownership of an SPV can be transferred by assigning ownership of the rNFT and signing an Assignment of Membership Interests Agreement on-chain. Template documentation (included in the DORE Library) and information in the rNFT metadata supports signing the Assignment of Membership Interests Agreement when a buyer purchases rNFTs on-chain from a seller. Future implementations of the Tokr Protocol will enable buyers and sellers to retrieve an HTML file that generates a signed copy of the Agreement. This can be downloaded as a PDF and used for legal and recording purposes in the built world.

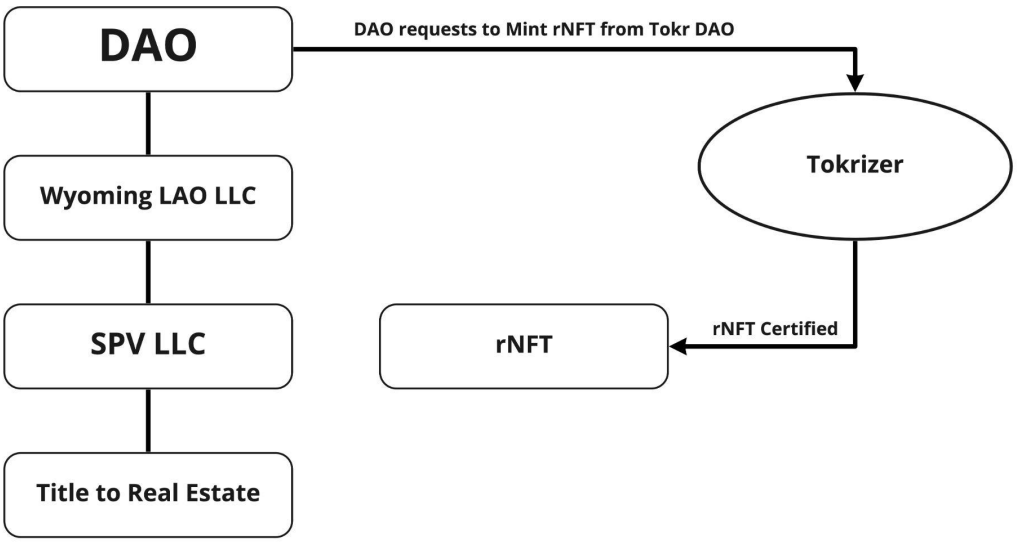

Figure 3.2.2 Digital representation of SPV ownership as rNFT

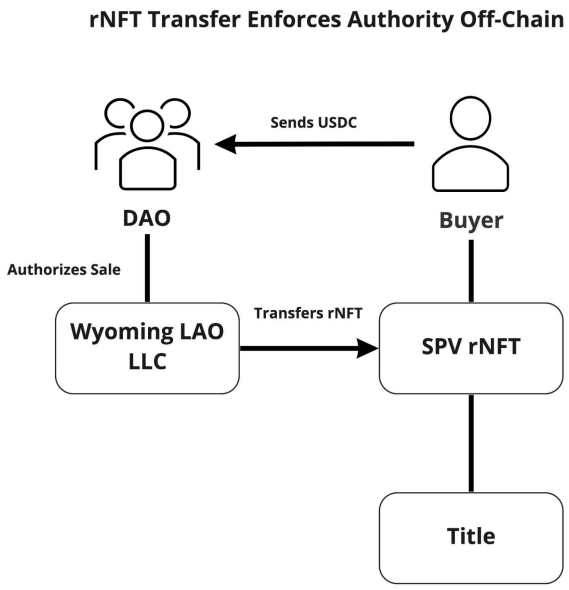

Figure 3.2.4 Transfer real property ownership off-chain by transferring rNFT and signing Assignment of Membership Interests Agreement on-chain

3.3 DORE Implementation

Tokrizer has been configured so that Proof of Title and Proof of Value meets the DORE Framework Standard. Certification by the Tokrizer application requires that title is held in real property by an SPV that is owned by a LAO that was formed by a DAO in accordance with the structure, rights and provisions set forth in the DORE Library. Deviation from the template documentation must meet the same ownership, control, governance, and protective provision requirements set forth in the template documentation. Current versions of standard documentation can be found in the Tokr Github repository linked here.

Example valid metadata and documentation that would result in certification by the Tokrizer application is included in Figure 3.3 below.


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in Brinkhaven, OH. This is a vacant lot situated in the Village of Brinkhaven, County of Knox in the State of Ohio. More particularly, the
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and time of the transfer of the rNFT. Buyer and Seller hereby acknowledge and agree that, by signing the smart contract to transfer this
rNFT for the consideration documented on the blockchain, each are effectuating the transfer of the Membership Interest described in the
Assignment of Membership Interest from Seller to Buyer upon the terms and subject to the conditions contained therein. \nThe Current Owner,
Tokr DAO, and any Tokr affiliates or contributors to the open-source software and systems involved in the Tokr Protocol and the minting of
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this rNFT hereby disclaim any representation or warranty relating to the sufficiency or adequacy of the title to the real estate owned by
the entity specified in the rNFT metadata, and, by purchasing this rNFT, you hereby acknowledge that you are not relying on any such
representations or warranties. Linked in the metadata is a copy of the Owner's Title Insurance Policy that was obtained at the time of
acquisition (or subsequently as amended in the metadata, if applicable). The metadata and documentation submitted as part of rNFT
certification and verification process is intended to make data collection easier to assist you in conducting your own due diligence. It is
strongly encouraged that you conduct your own research and additional due diligence as it relates to the sufficiency and adequacy of the
title to such real estate prior to acquiring this rNFT, which may include obtaining a title insurance policy. Any validations or
certifications made by the Current Owner or Tokr DAO and any affiliates or contributors relating to the rNFT do not relate to the title of
such real estate."
        }
    ]
}
```

Figure 3.3 DORE Metadata Standard

4 Protocol Implementation & Architecture

Tokr is a protocol for financing real-world assets on the Solana blockchain. The protocol establishes a foundation for permissionless and programmatic borrowing and lending using rNFTs as collateral assets. Trust is established in rNFTs as collateral assets through the Tokrizer certification and minting of rNFTs under standards and frameworks set forth by Tokr DAO.

4.1 DAO Tooling

Tokr DAO has launched a forked version of the SPL Governance framework and Realms UI that ensures DAOs can form in compliance with the DORE Framework giving authority of rNFT ownership over title to real-world assets. Tokr Labs has launched a dApp to form DAOs and operate in accordance with Framework standards. Initially, the DAO Tooling is configured to meet the DAO Owned Real Estate Framework. The Tokr DAO dApp can be accessed here.

4.2 Tokrizer v.0.1.0

Tokrizer is a dApp that facilitates the minting of rNFTs by certifying they meet the requirements set forth by their applicable asset Framework and verifies the collateral value of the asset. The Tokrizer programs are controlled by Tokr DAO.

The diagram (Figure 4.2) below depicts the process of minting an rNFT via the Tokrizer program. First, Tokr DAO receives a request to mint an rNFT. Once Tokr DAO confirms that the information submitted meets the Framework standards, Tokr DAO “certifies” by accepting the proposal to mint the rNFT. An instruction set containing validated metadata and the recipient’s address is packaged into a transaction, which is signed and subsequently executed by the Tokrizer program. Next, NFT mint accounts, associated token accounts (ATA’s) for the recipient, and a metadata account are created. Finally, the rNFT is minted and transferred to the recipient.

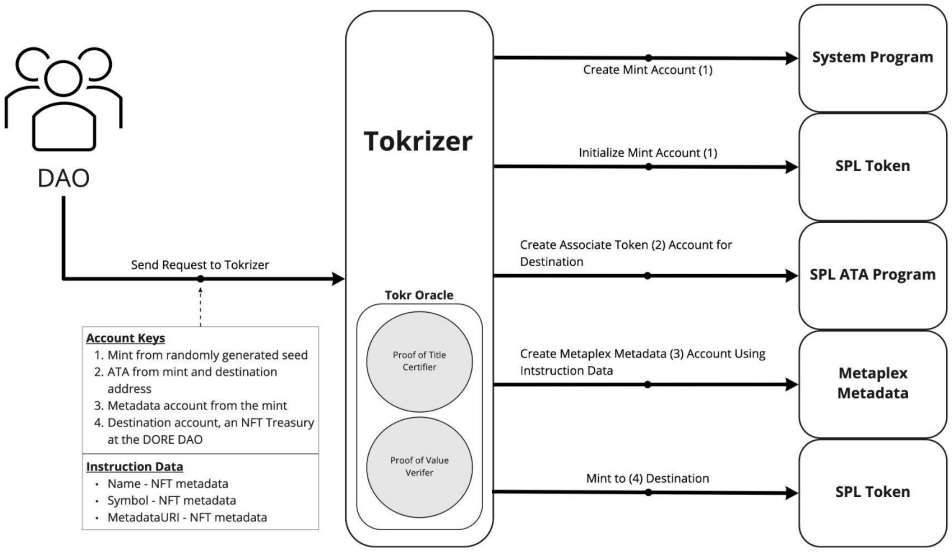

Figure 4.2 Tokrizer Program Architecture

4.2.1 rNFT Metadata Structure

Tokr builds on the Metaplex NFT standards for minting, visualizing, and exchanging NFTs. The Attributes required by the applicable Framework and rNFT Metadata Standard can be submitted with the rNFT mint request using the Tokrizer dApp.

To submit Material Agreements and Documentation, Tokrizer supports the storage of NFT metadata in Arweave, a decentralized file storage network. This is required for uploading documentation specified by the asset Framework for certification.

4.2.2 rNFT Mint Request & Certification

Users seeking to mint an rNFT must submit a request to Tokr DAO using the Tokrizer dApp. The request includes an application with the rNFT metadata and documentation to certify Proof of Title and verify Proof of Value. A user who wishes to mint an rNFT must submit the required information using Tokrizer, linked here.

Assuming the request meets the Framework requirements, the rNFT Metadata Standard, and sufficient Proof of Title and Proof of Value documentation has been submitted, Tokr DAO will mint an rNFT and deposit it into the user's account.

```
let destinationAccount = new PublicKey(String(form.destinationAddress));

let mintSeed = (Math.random() + 1).toString(36).substring(2) + (Math.random() + 1).toString(36).substring(2);
const [mintKey, mintBump] = await getMintPda(wallet!.publicKey!, mintSeed);

const metadataKey = await getMetadataPda(mintKey);

const ataKey = await getAtaPda(destinationAccount, mintKey);

const data = Buffer.from(borsh.serialize(
    TokrizeSchema,
    new TokrizeArgs({
      name:  String(form.name),
      symbol: String(form.symbol),
      uri: String(form.metaDataUri),
      mint_seed: mintSeed,
      mint_bump: mintBump
    })
));


const instruction = new TransactionInstruction(
{
    keys: [
        {pubkey: wallet!.publicKey!, isSigner: true, isWritable: true},           // payer
        {pubkey: destinationAccount, isSigner: false, isWritable: true},          // NFT destination
        {pubkey: wallet!.publicKey!, isSigner: true, isWritable: true},           // NFT creator
        {pubkey: mintKey, isSigner: false, isWritable: true},                     // Mint Account to create
        {pubkey: metadataKey, isSigner: false, isWritable: true},                 // Metadata account to create
        {pubkey: ataKey, isSigner: false, isWritable: true},                      // New associated token account for destination
        {pubkey: TOKEN_PROGRAM_ID, isSigner: false, isWritable: false},           // SPL token program
        {pubkey: TOKEN_METADATA_PROGRAM_ID, isSigner: false, isWritable: false},  // Metaplex token program
        {pubkey: SystemProgram.programId, isSigner: false, isWritable: false},    // SPL system program
        {pubkey: SYSVAR_RENT_PUBKEY, isSigner: false, isWritable: false},         // SPL rent program
        {pubkey: ASSOCIATED_TOKEN_PROGRAM_ID, isSigner: false, isWritable: false} // SPL ata program
    ],
    programId: TOKR_PROGRAM,
    data: data
}
);
```

Figure 4.2.2.1 Tokrizer Program Execution

Figure 4.2.2.1 shows how to construct instructions needed for the execution of the Tokrizer Program as part of a Solana Governance Proposal. This instruction set is signed and executed by Tokr DAO, resulting in a Tokrized rNFT. This instruction set is referenced in Figure 4.2 as the data being sent to Tokrizer.

```
let creator = Creator {
    address: *creator.key,
    verified: true,
    share: 100 as u8
};

let _result = invoke_signed(
    &create_metadata_accounts_v2(
        *metadata_program.key,
        metadata_key,
        *mint_input.key,
        *payer.key,
        *payer.key,
        *payer.key,
        name,
        symbol,
        uri,
        Some([creator].to_vec()),
        0,
        false,
        false,
        None,
        None
    ),
    accounts,
    &[&[b"metadata", metadata_program.key.as_ref(), mint_input.key.as_ref(), &[metadata_bump]]]
);

let _result = invoke(
    &mint_to(
        &spl_token::id(),
        mint_input.key,
        token_ata_input.key,
        payer.key,
        &[&payer.key],
        1 as u64
    )?,
    accounts
);
```

Figure 4.2.2.2 Tokizer Program Creates Metaplex Metadata Account

Figure 4.2.2.2 shows the Tokrizer program creates the Metaplex Metadata account using the name, symbol and URI as well as mints the rNFT. Successful execution of the above program results in a Tokrized rNFT that is sent to the account requesting certification. This snippet is referenced in Figure 4.2 as the 4th execution step.

4.3 rNFT Market Pool 1

Anyone who wants to accept rNFTs as collateral can establish a Tokr Market with their own Frameworks, risk parameters, and strategies.

We introduce the rNFT Market Pool 1 to demonstrate how a permissionless Tokr Market will function. rNFT Market Pool 1 (MP1) will be an initial implementation of a Tokr Market that accepts rNFTs as collateral and programmatically lends funds. We demonstrate how suppliers (and borrowers) can interact directly with the Tokr Market, earning (and paying) interest, without having to negotiate terms such as maturity, interest rate, or collateral with a peer or counterparty.

4.3.1 LP Tokens

Supplying liquidity to a Tokr Market results in the minting and distribution of LP tokens representing the Supplier's pro-rata share of a market reserve. LP tokens are fungible, unique to each Tokr Market reserve, and enable suppliers to sell or transfer their position without removing liquidity from the system.

Interest, debt service payments, and/or distributions received are added to a market's reserve without minting new LP tokens. This accrues value to LP tokens in a way that distributes a proportional share of all fees, debt service, and distributions collected to Suppliers.

Given the closed-ended fund structure of initial Tokr Markets, pricing of LP tokens on a secondary market or a DEX will be simple to facilitate based on the Tokr Markets lending framework and collateral assets, and liquidity can be achieved if a willing buyer exists.

4.3.2 Escrow Vaults

The Escrow Vault (EV) is an rNFT-specific reserve within a Tokr Market. EVs provide several key functions in the loan origination and closing process, but most importantly they mitigate counterparty risk. Once the Tokr protocol confirms a borrower has a Tokrized rNFT, the borrower may deposit their rNFT as collateral in a Tokr Market. This establishes an EV unique to the rNFT and borrower which enables the borrower to obtain a loan against their collateral asset. When a loan is originated, the EV locks the borrower's collateral and disperses the loan proceeds to the borrower's account. The rNFT may be retrieved from the EV only when the loan has been repaid by the borrower or the collateral position has been liquidated due to default. Additionally, the EV tracks the borrower's debt service payments, collateral factor, and initiates a liquidation auction when necessary.

A single Tokr Market can lend to multiple rNFTs, each held in unique EVs within the Tokr Market. EVs must be fully funded by a single Tokr Market reserve and cannot be funded by multiple Tokr Markets. When a Tokr Market reserve funds multiple EVs, the market reserve receives the aggregate yield from all of their associated EVs, and Suppliers are entitled to their pro-rata share of the yield generated by the activities of the market in addition to their principal balance.

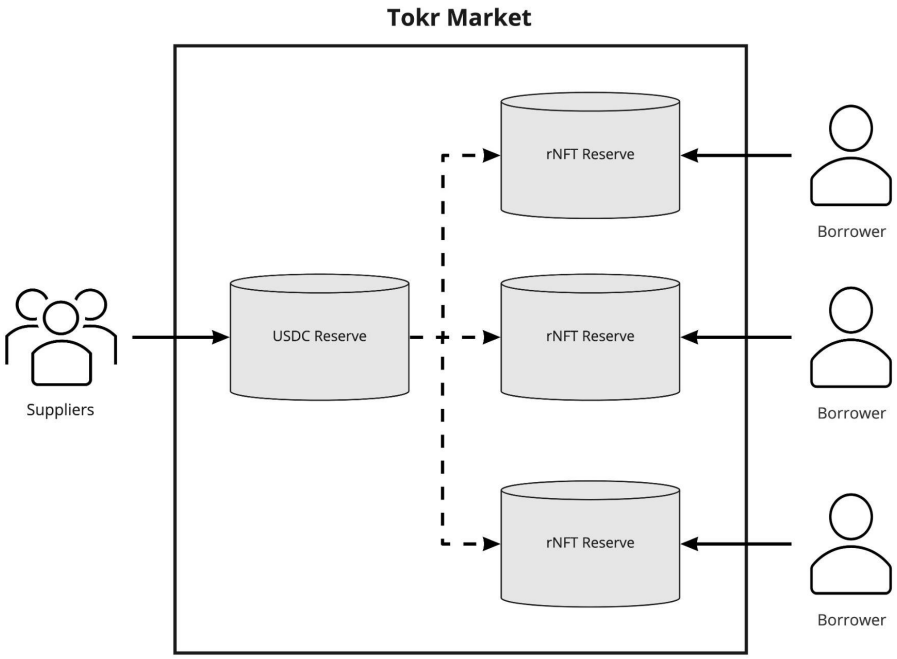

Figure 4.3.2 Multiple Escrow Vaults Held within a Single Tokr Market

4.4 Fractional rNFT

Tokr supports fractional ownership of rNFTs to enable various use cases, such as fractional equity ownership of real estate by members of any DAO that owns real property. The current implementation of Tokr Protocol utilizes the Metaplex Token Vault standard for minting fractional shares to distribute partial ownership of rNFTs.

rNFT owners (such as a DAO) can deposit their rNFT in a Token Vault. Initially, the vault is in an Inactive state. It is in this state that rNFTs can be added, and fractional shares can be minted into the fractional treasury. Once the vault is Activated, the vault is closed, and the vault authority can no longer mint new fractional shares. Fractional shares minted during initialization represent partial ownership of the vault and therefore represent fractional ownership of the rNFT in the vault.

In order to sell the rNFT, the fractional shares of the vault must be redeemed by paying off all outstanding fractional shareholders of the vault. Once redeemed, the vault will move to the Combined state, the vault authority will regain control of the rNFT, and the vault can move to the Deactivated state.

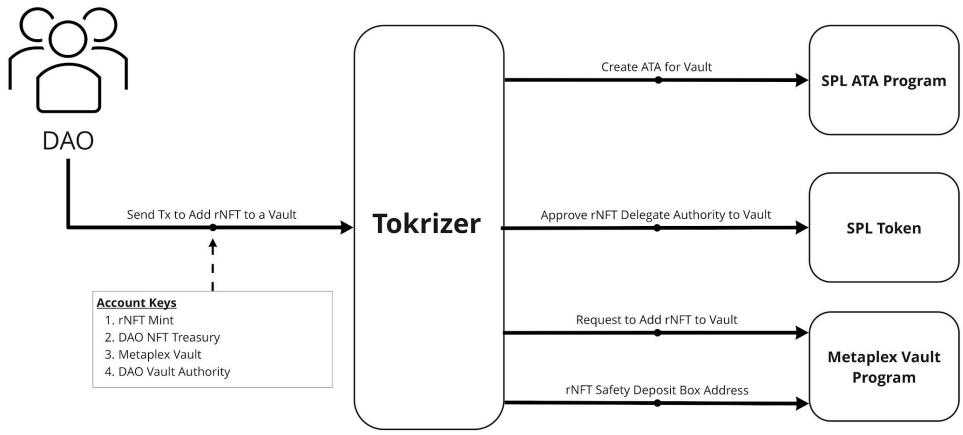

Figure 4.4.1 Contract Flow to Add rNFT to Vault

```
let _result = invoke(
  &create_add_token_to_inactive_vault_instruction(
      *token_vault_program.key,
      *safety_deposit_box.key,
      *token_ata.key,
      *token_store.key,
      *vault.key,
      *vault_authority.key,
      *payer.key,
      *transfer_authority.key,
      1 as u64,
  ),
  &
      safety_deposit_box.clone(),
      token_ata.clone(),
      token_store.clone(),
      vault.clone(),
      vault_authority.clone(),
      payer.clone(),
      transfer_authority.clone(),
      token_program.clone(),
      system_program.clone(),
      rent_program.clone(),
  ]
);
```

Figure 4.4.2 Tokrizer Program Final Request to add rNFT to a Vault

The above snippet (Figure 4.4.2) from the Tokrizer program shows the final request to the Metaplex Vault Program to add an rNFT to a Vault.

5 Governance & Tokenomics

The Tokr protocol will follow a progressive decentralization model. Tokr Labs will begin with centralized control of Tokr DAO and the Tokr Protocol, and over time, will transition to complete community and stakeholder control. Building on the SPL governance model and implementing custom purpose-built programs, the Tokr protocol will be governed by Tokr DAO.

Tokr DAO is permissionless to join, its governance token will be implemented using a vote escrow token (veToken) model that will be made available to the community. Governance tokens will be valueless, with no economic benefit or right to cash flows. However, members of the DAO that hold governance tokens will be able to propose and execute changes and complete upgrades to the protocol if sufficient approval votes are met. Early on, changes to the protocol will require steep quorums to mitigate execution risk and rogue actors. This quorum will be relaxed over time as Tokr DAO and the Tokr protocol have demonstrable decentralization and the protocol becomes hardened through use.

The Tokr governance token will play a utility role in executing the protocol's programs, facilitate decentralized governance, and incentivize adoption (e.g. liquidity mining, staking). When implemented, Tokr's governance token will be used as a form of payment in the rNFT certification process, which will require payment to Tokerize rNFTs and check for certification when originating debt or equity financing.

Early members of the Tokr community will play an important role in shaping the token go to market strategy once the protocol has achieved sufficient adoption and decentralization for utility of the token.

6 Future Use Cases & Limitations

6.1 Future Use Cases

6.1.1 Equity Financing

Creating an Escrow Vault to receive equity financing will require initiating an Equity Financing Request. This will involve depositing an rNFT and submitting financing documents such as a pro forma, offering memorandum, and/or business plan to a decentralized Underwriting network. Underwriters review financing requests and approve or deny these requests based upon a predetermined risk framework. Once a financing request is approved, the Underwriters submit their response to the EV which generates a request from the Tokr Market to send the financing proceeds in USDC to the vault. This creates an obligation of the user to repay these proceeds, make cashflow distributions, and/or payout proceeds of a sale pro-rata in order to retrieve their rNFT from the EV. The rNFT is held in the EV to give the Tokr Market involved a first lien on the real estate asset in the event of a default.

6.1.2 Proof of Value Oracle

Decentralized Oracle networks enable the creation of hybrid programs, where on-chain code and off-chain infrastructure are combined to support advanced dApps that can react to real-world events and interoperate with traditional systems. [4]

The Proof of Value Oracle will be a price feed that stores the most recent valuation of a property and estimates the real-time value of an asset. The oracle can make this information available to anyone seeking to understand the current value of an rNFT in real-time. The oracle could provide a risk score and incorporate financial reporting by borrowers, on-time payment information, market, and other information.

6.1.3 Other Asset Types

The Tokr protocol establishes a foundation for Tokr Markets that can be applied to asset categories other than real estate. We chose to first focus on real estate, but intend to expand into other use cases such as financing private companies and factoring receivables. Each asset type will have its own framework and standards for the rNFT minting process and will be customized to fit the nuances unique to each use case.

6.2 Limitations

Tokenizing real property for use in DeFi markets introduces risks not associated with cryptoassets, including but not limited to subjective matters of value, human error, and legal disputes that can arise from operating in the built world. A robust dispute resolution, arbitration, and debt collection protocol (herein referred to as the Resolver) is needed to maintain the trust needed for a scalable DeFi market to form, backed by real property ownership. Additional legal and regulatory considerations must be explored, some of which are identified in the Disclosures & Disclaimers section contained herein.

Additionally, this whitepaper and initial Tokr implementation do not enable rNFTs to be fractionalized when they are deposited to EVs for loans. That means that rNFTs can either be fractionalized or they can be used as collateral assets in Tokr Markets, but not both at the same time. Further, this limits the ability to raise equity and debt financing at the same time using rNFTs as collateral. We will iterate to improve the approach and will address this in subsequent versions of the whitepaper.

7 Summary

- Tokr creates decentralized private equity and debt markets for financing real-world assets.
- The Tokr protocol certifies that rNFTs represent real property ownership and verifies the collateral value of rNFTs.
- Stakeholders can trust that recording the transfer of rNFT ownership on-chain results in the transfer of real property ownership off-chain.
- Buyers and sellers can instantly exchange real property ownership without costly intermediaries such as brokers and agents.
- Users can supply tokens such as USDC to earn interest on-chain with real property as collateral off-chain, without traditional intermediaries such as banks, brokers, or fund managers.
- Users can instantly borrow USDC by supplying real property (off-chain) as collateral, represented digitally as rNFTs (on-chain), without onerous underwriting processes required by traditional intermediaries such as banks, brokers, or fund managers.

References

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Tokr DAO (including affiliates, core developers, members and contributors) does not provide legal advice. The DORE Framework (and any Framework standard set forth or adopted by Tokr) is a template that can be used to demonstrate real property ownership is tied to rNFTs and submit due diligence to streamline the data collection process. However, every stakeholder is encouraged to seek their own counsel and conduct their own due diligence.

The Tokr DAO, any Tokr affiliates or contributors to the open source software and systems involved in the Tokr Protocol and the minting of rNFTs disclaim any representation or warranty relating to the sufficiency or adequacy of the title to property owned by entities specified in any rNFT metadata, and, by purchasing a rNFT, users acknowledge that they are not relying on any such representations or warranties. Linked in the metadata are copies of documentation submitted by owners seeking to prove ownership and demonstrate the value of real property. The metadata and documentation submitted as part of the rNFT certification process is intended to make data collection easier to assist stakeholders in conducting their own due diligence. It is strongly encouraged that any party seeking to assess the value of rNFTs conduct their own research and additional due diligence as it relates to the sufficiency and adequacy of the title and value of such property prior to acquiring a rNFT or accepting it as collateral, which may include obtaining a title insurance policy (in the case of real estate) or may include other appraisals and diligence as the buyer/lender sees as appropriate.