Unique Network Technical Paper

Summary

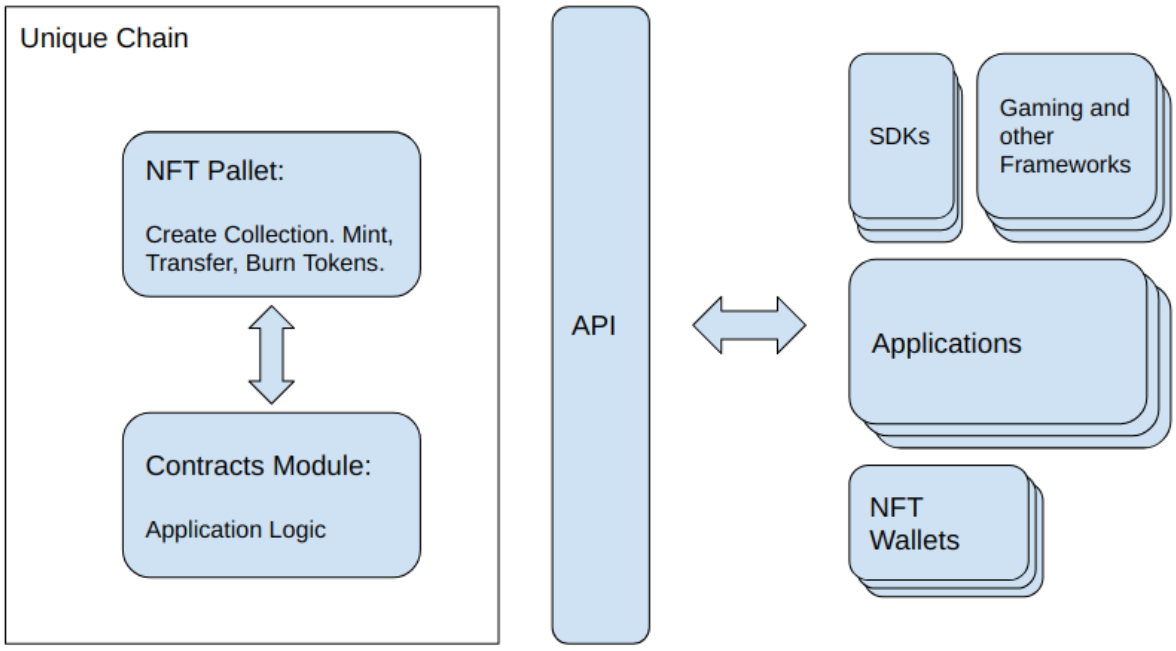
Unique Network blockchain in the Polkadot ecosystem can be seen as a foundation for standards and good practices serving for any software that uses or relates to NFT. The core components of Unique blockchain are:

- Token Pallets that handle NFTs, RTFs, and Fungible tokens
- EVM/Ethereum Smart Contracts

Like ERC-721 Ethereum standard [1] for smart contracts, NFT Pallet provides the base for creating collections of NFTs, minting tokens, managing their ownership, and much more. The smart contracts functionality is included to handle any application logic that is unknown at the time of chain design.

The Unique Network aims to provide the feature rich and flexible configuration experience to its users. This includes multiple authorization levels, economic models that enable freemium application marketing, miscellaneous administration options, advanced spam protection. The goal is to cover the broad spectrum of NFT applications' development needs and provide maximum flexibility at low to affordable cost.

Architecture



It is hard to overestimate the importance of Ownership [2] in human society. Ownership defines the exclusive rights and control over the property. This term originates at the very beginning of our civilization and serves as a basis for many notions such as freedom, money, crime, trading, giving, etc. English philosopher John Locke in his Two Treatises of Government work [3] argues that property even predates the existence of governments, hence it defines “live, liberty and estate”. Thus property, ownership, and rights are one of the most important mankind essentials. It is important for one’s solid realization of the universe to build a correct and precise model of ownership and rights.

Ownership implies a relation between an owned Entity and an Owner, the party that the Entity belongs to. In Blockchain networks the Owner is usually represented by an address: A hash [4] of a public key [5] of a blockchain account, associated with a human identity or not.

Defining the owned Entity, as well as rights, presents a more complex problem. In accordance with the ERC-721 standard, the NFT protocol is a very simple and basic description and storage of ownership information. It allows to create a Thing, a unique entity. The protocol allows creating an assignment between the unique Thing and the Owner address, as well as rights to transfer the ownership to another Owner and destroy the owned property.

This limited set of operations composes the base functionality of the NFT pallet. Purposefully it does not have any knowledge of application logic that may use the NFTs. In order to preserve the decentralized and trustless operation of NFTs, the smart contract functionality is included in the Unique chain so that application developers can implement their custom logic while exercising their user’s ownership rights over NFTs on the same blockchain.

In addition, the NFT pallet allows storing the NFT metadata in order to allow more authentic definitions of NFT items, while staying agnostic of this metadata format.

The Substrate framework [7] provides a robust and flexible WebSocket API allowing connections to the Blockchain to be established by its clients: NFT wallets, Games, Marketplaces, and other applications.

Feature Highlights

Collection Management

The Collection in Unique Network means a set of items united by a common purpose, as well as collection name and description, token prefix, and superior ownership. Generally, a collection would at least originally serve one application (e.g. a game or an art gallery) and possibly more as it evolves. The application developer would create the collection and become its owner. Ownership of collection means the full authority over all of its properties and NFTs, including the capacity to destroy the tokens and the collection or give up this authority by transferring the ownership to an address with an unknown private key. For example, an address of a smart

contract (incapable of further transferring or exercising the ownership rights) may be used, since the algorithm of creating smart contract addresses is well known and users don't control the process [6]. Once the authority is given up, the collection properties become locked, which may mean, for instance, that no more NFTs can be minted.

Another important right that collection ownership gives is administration. An administrator of collection is the account that has elevated privileges over common users, but slightly less than a collection owner. As such, only the collection owner can destroy the collection and add administrators. This permission level was mainly aimed to allow automated operations over collections, such as minting tokens on demand (in a server application in the protected environment). Should the administrator key be compromised, the owner can disable the compromised administrator account. Alternatively, administrator accounts can be used for manual collection management. Also, a smart contract can serve as a collection administrator to allow advanced decentralized application logic such as Claiming free SubstraPunks, for example [8].

Operating NFTs

Once the collection is created, its owner can mint tokens that belong to this collection. The minting process is an atomic operation of creating an NFT item, setting this item's immutable metadata and its owner. After the item is created, it becomes an owned truly unique token. The owner of the NFT can transfer it to another address, destroy it, set the mutable token metadata, or, like with collections ownership, give up their authority by transferring to an address with an unknown private key.

Collection Properties

Metadata Schemas

One important property of a collection is the Off-chain Schema. This schema describes the metadata that is associated with each token and can be accessed by the token ID. It can be an image or a more complex and structured data. For additional protection of token authenticity, the off-chain metadata hash can be recorded in the immutable token metadata.

Besides the off-chain schema, it is possible to set the similar schemas for mutable and immutable NFT metadata that are stored on-chain.

The main purpose of the off-chain and on-chain schemas is allowing the standardised definition of application specific token data. Even though the Unique blockchain does not utilise this knowledge, 3rd party NFT wallets may do, so the whole NFT ecosystem will benefit from off-chain schema by having a common way to access and display token features.

White Lists

Depending on the application design and requirements, the collection may be accessible for a wide audience or for a restricted and private group of accounts. In the latter case, a white list access mode may be enabled to restrict capabilities of owning and transferring tokens by only accounts included in the white list.

Private and Public Minting

The Collection owner may choose to allow non-privileged users to mint tokens in their collection by enabling the public minting mode. Combined with the White Lists, this could be a powerful tool for applications that require their users to be able to create their own tokens, such as art galleries, some games or applications for collectors.

Economic Models

As Pedro Armelin (UX Designer) says in his article [9], mass adoption of blockchain technology is largely dependent on UX. An average Internet user would not have any of the following:

- Knowledge of cryptography or blockchain
- Crypto exchange trading experience or even an account
- Understanding of gas fees

For many gamers owning an NFT does not mean anything more than just seeing an image associated with this NFT in the “My Account” section of the WEB page or in the game application and being able to use it in the game or transfer it to another user.

A DMV officer would not need to know anything more than the identity of a person who owns a vehicle with a certain VIN number (represented by an NFT). Any more details will be perceived as extraneous and obstructing the smooth user flow.

This obstruction in the UX presents a large adoption problem and is being tackled by blockchain software engineers in different ways.

Ethereum

Gas is the “biggest blocker for people starting to use dApps”, says Carsten Munk in his Medium article “Is frictionless Ethereum (and dApps) usage possible” [10]. Every person needs to have a minimum of Ethereum to pay for 21k gas in their wallet before they are able to run any transaction. One way to attack this problem is subsidising the gas cost when the user address is known. Another solution is Gas relay for contract calls, as described in EIP-1077 [11] that requires the user signing a message as a proof of intention to execute the transaction.

Either solution requires additional infrastructure to be deployed on top of the Ethereum network, in most cases centralized.

EOS

The EOS system resources [12] are limited, like in any blockchain, but EOS presents an interesting economic model for freemium applications: RAM must be purchased, but it is only purchased one time and remains with the application permanently. In order to execute a transaction, application users would be required to purchase CPU and Network bandwidth, but only if they are willing to use a high amount of these resources in a short period of time, otherwise they are accumulated at some low rates in the user's account and allow executing free transactions at a small rate limit.

While this model is more native to the blockchain (EOS), it has significant limitations. Besides high RAM prices (which are formed on the open public RAM market and cannot be controlled by EOS miners/stakeholders), it does not provide much flexibility in terms of transaction throughput and complexity. Should the contract owner decide to subsidise a more expensive transaction or more transactions per unit of time than default, they will be driven to fall back to custom solutions similar to what engineers implement in Ethereum.

Unique Network

Unique Network is going to offer several gas fee models for its users in order to provide as much flexibility as possible to adapt to miscellaneous marketing strategies of application developers and remove UX friction for the newcomers.

The gas fee model is configured separately for each Collection or a smart contract. Every Collection and smart contract has a fee model assigned to it, which determines how its transactions are paid, and the developer can choose the fee model that better suits their application. Initially the fee model is configured to a default one and can be updated later at any time and as many times as needed.

Currently there are two models implemented: The default "User paid fees" model when the transaction sender pays all gas fees, and the "Pay as you go" model when collection or smart contract owners enable sponsoring for certain transaction types for their users. The spam protection for this model will be explained in the next paragraph.

Spam protection

Network fees are the important security factor that prohibits malicious players from abusing the network resources, as well as protect the network from being overwhelmed by good applications. Changing mechanisms of transaction commissions requires special caution. In case of sponsored fee models, the sender and transaction fee payer may be different entities, which may create an attack surface if spam protection was not in place.

Spam protection prevents uncontrolled depletion of sponsor funds. The Network applies rate limits to sponsored transactions. An NFT token transfer can only be sponsored one time per an interval of time. In the case of a smart contract call, the rate limitation is more challenging because the sender or client identification cannot be easily established: The key pairs to send

transactions can be generated as easily as generating a short random sequence of bytes (a private key). The transaction subject (like NFT ID) does not generally exist because smart contracts are aimed to express custom application logic. So the second layer of protection is required: White lists. In order to securely sponsor the smart contract transactions, the application will need to establish a registration procedure, which adds the user's address to the white list.

Configuring rate limits is one of the upcoming features of the Unique Network that will increase the flexibility of sponsored modes. Also, advanced economic models are included in the roadmap that will allow the collection and contract owners to provide free transactions in exchange for locking funds.

Contract Ownership

Like collections and NFTs, smart contracts in Unique Network are also owned. The ownership is atomically assigned at the moment of contract deployment, so the contract is owned by the address that deployed it. Later on the owner can configure fee sponsoring for that contract.

Fees Payable with ERC-20, Ethereum, or Even Valuable NFTs

One of the coming soon perks of using the flexible economic models is the capability to pay fees directly with the Application's own Fungible (a.k.a. ERC-20) token minted within the Unique Chain. Once the exchange rate between Unique and the application token can be established, the application will be allowed to switch to paying fees with its own token. Combined with Ethereum, Bitcoin, and other bridges, this feature opens the wide range of possibilities to inter-operate between networks, since theoretically any value (not even limited to Fungible tokens, but also Re-Fungible) transferred from over the other networks, can be used for transaction fee payment.

Re-fungible and Fungible Modes

Re-fungibility is an important step towards building real life models of ownership rights. Often a unique item may be owned by multiple entities in different proportions. The examples of such shared ownership are abundant: Timeshares, co-ownership of art, fractional car ownership, etc. For that purpose Unique Network provides the special mode of Collection: Re-Fungible. The Re-fungible token can be minted and then partially transferred to multiple owners. Read more about the re-fungible standard in Standards and Interoperability section.

Fungible collection mode is targeted at the same set of use cases as ERC-20 tokens: Any non-unique and divisible resource can be represented as a Fungible token. While these use cases are not the prime focus of Unique Network, many applications need this functionality in parallel to the NFT. The examples include: Non-unique game resources (such as game money), rating points in applications with social networking capabilities, voting tokens, etc.

Notes on Standards and Interoperability

Despite abnormally high transaction fees, at the present moment Ethereum still dominates the NFT space: According to Etherscan.io [14], there are over 7500 NFT smart contracts deployed with a daily number of transactions going over 7000, the number of minted tokens being over 1,000,000 and the number of holders being in the hundreds of thousands unique owner addresses. The most popular NFT standards in Ethereum space are currently ERC-721, and ERC-1155 [13]. Nonetheless, the other blockchains also hosted a few NFT projects. As such, Bitcoin provides the Counterparty protocol [15]. EOS released the recommended standard for NFT smart contract [16], which is similar to ERC-721.

The Interchain NFT and Metadata Standardization [13] conducted extensive research of NFT token and their Metadata standards. Unique Network aims to comply with this interchain standard and deliver the network protocol that is applicable to and able to describe a wide range of NFT formats known in order to prewire the NFT interoperability for most if not all known NFT standards, which is explained in detail further.

ERC-721

ERC-721 [1] is the most popular NFT standard that serves as a base for many standards inheriting its properties. It provides capability to mint, burn, and transfer tokens. The methods such as allow and transferFrom enable withdrawing tokens on owner's behalf. It is also possible to include random data in the transfer transactions and perform safe transfers that verify that the receiving party (a smart contract) is capable of receiving the NFT token and can handle it by executing a *onERC721Received* call-back method.

All these features are or will be covered by the basic functionality of NFT Pallet, which is in the core of Unique Network.

Also, the ERC-721 standard describes the *ERC721Metadata* metadata standard, which includes collection name, token symbol, and token URI. Collection name, description and symbol (token prefix) are the properties of any Unique collection, and token URI can be set as a part of the Off-chain schema.

Token supply as well as BalaceOf parameters also translate one to one to Unique collection parameters: number of created tokens and balance.

ERC-1633

Refungible standard [20] is covered by Re-Fungible mode in Unique NFT Pallet. See Re-Fungible and Fungible Modes section for more detail.

ERC-1155

ERC-1155 standard [17] mainly adds batch operations on top of ERC-721. This functionality is not directly changing the data formats for NFT, but is a convenient way to automate and optimize operations on multiple NFTs. Also, even though the batch minting is not explicitly included in ERC-1155, Unique implements this feature as well, and will implement batch transfer operations.

ERC-994 and ERC-998

Delegated NFT [18] and Composable NFT [19] add the relationship layer, e.g. “NFTs are arranged in a federated, tree-like format”. In order to stay efficient while accommodating this functionality, Unique Blockchain will add a pallet that will allow to create directed labeled interconnections between NFTs. The NFT Relations section explains the relationships between NFTs in more detail.

ERC-809 and ERC-1201

Ownership is a capacious term, which serves as an umbrella for many rights that authorize entities for many different actions. Due to this reason, it is important to create the framework capable of providing granular definitions and enforcements for these authorizations.

Renting of NFT described in standards ERC-809 [21] and ERC-1201 [22] are only a small subset of such authorizations, which will be covered under Advanced Ownership Structure, see the corresponding section below.

Counterparty

Simple yet flexible Counterparty standard [15] adds the capability similar to ERC-721 to Bitcoin protocol, as well as ERC-1633: Fractional Ownership or Re-Fungible.

OpenSea Metadata Standard

Opensea is one of the first and most popular NFT trading platforms in Ethereum space that developed the NFT Metadata standard [23] aimed to help describe and visualize all NFT properties that deal with NFT trading and exchange. OpenSea indexers collect on-chain and off-chain data, so that the API can provide the aggregated data about a single NFT token to its clients in one RESTful request.

While aggregation is helpful for the purposes of the API, we think it is still important to separate schemas to on-chain and off-chain, since it does not limit schema flexibility, but provides additional structure at low cost. Besides this separation, the Unique metadata schemas are fully compatible with OpenSea standard, since they do not restrict schema format and, in fact, one of

the recommended formats for the metadata schema is JSON, which is the same as OpenSea API provides. Additionally, Unique network is capable of storing the mutable metadata on-chain in order to support the decentralized application logic, which is also covered by mutable on-chain metadata schema.

Examples of data that is provided by both OpenSea and Unique metadata schemas include, but are not limited to image URLs, token name and description (which we recommend to be stored off-chain in order to preserve system resources and lower application expenses), miscellaneous key-value pairs stored in JSON format.

Tezos TZIP-16

Tezos TZIP-16 [24] standard was created to serve a broader purpose of describing the smart contract metadata, which is not necessarily limited to NFT smart contracts only. It separates schemas into on-chain and off-chain and allows to define each with a JSON string, which is natively supported in Unique chain.

Unique Metadata Schemas

Standardization is important in order to set the grounds for interoperability between multiple chains, but also is flexibility. Unique Network sets the goal to support many standards to stay interoperable and at the same time flexible enough to accommodate new schema standards as they appear. Thus, the Network does not restrict the schema to any format, but allows to select the format out of existing known standards to the moment: ERC-721, OpenSea, or Tezos. The NFT wallets will be able to read the schema version that is stored on-chain and display the NFTs appropriately.

Consensus and Tokenomics

Consensus

The Unique Network will use PoA consensus until it becomes Kusama and/or Polkadot parachain. After that it will use the Relay chain consensus, as any Polkadot parachain does, and off-chain mechanisms for Collator incentivisation, which is important for decentralization, prevention of censorship attack [26], and improving the user experience due to reducing node latency for client responses.

Unique Token

Unique Token is the Unique Network token that is used for several purposes:

- Transaction rate limiting and DDoS protection in form of transaction fees
- Network Services
    - Application data storage rent
    - Advanced features of the network
- In-app payments through payable smart contract methods
- App promotion program
- Paid Rate Limits

Inflation

Inflation in Unique Network is used as a mechanism of development, R&D, marketing, operations, and other on-going expense funding in early stages of the network with decreasing inflation rate over the first 10 years. The initial year will start with inflation rate of 10% annual and will decrease by $\frac{2}{3}$% every year until it reaches 4% annual in the year 10, at which level it will stay thereafter. As a result of inflation, the Unique tokens will be minted on every block so that the total number of minted tokens during the year will approximately (to the rounding precision) equal to the inflation rate multiplied by the Unique token total supply at the beginning of the year. The table below shows the inflation rate in detail:

Year	**Annual Inflation Rate**
1	10 %
2	$9\frac{1}{3}$%
3	$8\frac{2}{3}$%
4	8 %
5	$7\frac{1}{3}$%
6	$6\frac{2}{3}$%
7	6 %
8	$5\frac{1}{3}$%

9	$4\frac{2}{3}\%$
10+	4 %

Network Services

Application Data Storage Rent

Applications may need to store their state such as game scores or state of the game, marketplace and such. Nonetheless, storing the application data in smart contracts may be inefficient and expensive due to per byte transaction/storage fees. Providing a special pallet for these needs may open the doors for optimized storage. In exchange, the pallet may require the application to deposit a certain amount of Unique Network token while the data is stored and release this deposited token when the data is disposed of. The tokenomics of such deposits will be designed so that storing the data is by orders of magnitude less expensive than storing in smart contracts, yet it is economically unsensible to store too much data, e.g. it will require locking the world supply of Unique token in order to store 1TB of data in the chain state.

Advanced Network Features

Unique Chain will be geared with a number of advanced features that will improve the performance of dApps. These include advanced spam protection, off-chain workers that provide indexing or integration with IPFS, import of NFTs from Ethereum Network, register identities and more.

App Promotion Program

This program is designed with the goal to motivate the application developers to join the Unique network, and to attract token holders to the newly made applications, which in turn will attract many end users. The application developers who are newly joining the network will be granted a transaction fee stipend that allows them to execute a starting number of free transactions. The range of this number is yet to be determined. This number of free transactions may be significantly increased, if the application is backed by *Application Promoters (individual token owners)* and their usage will be limited from a 6 to 12 months period of time. Transaction fees during the stipend period will be paid from the Unique Network accounts funded by Unique Network Treasury. After the period expires, the application developers may choose to continue sponsoring their users' transactions or ask their users to pay fees.

The program requires certain funds (Unique tokens) to stay in program circulation. The amount of required funds is proportional to the number of joining application developers and the

popularity of their applications. Unique Network will provide funds to be utilized in the program initially, but in order to involve the community, the program also invites *Application Promoters* who may lock their Unique tokens with the goal of promoting a certain dApp in exchange for incentivisation. Once Promoters' funds are locked to support an application and the promotion begins, the transaction fees of the application start to be paid from these funds and accumulate in the Treasury account. The Promotion continues until funds are depleted or the lock period expires. After the promotion ends, Promoters receive their unlocked funds and a percentage of the accumulated commissions proportionally to their locked funds (as we assume there will be more than one Promoter). Also, promotion has a long term effect for Promoters: They continue receiving a smaller percentage of transaction fees related to this application for the application lifetime (proportionally to their participation in the application promotion). Details of this program are to be defined by the launch of Unique main net.

Paid Rate Limits

When clients connect to a public archive node, sometimes it is necessary to read large amounts of on-chain data in a short period of time. Even though reading data is permissionless, the certain rate limits will be normally applied to equalise the opportunity for all clients, but it is always possible to dedicate additional cloud resources to boost the connection performance for applications that require additional bandwidth. Payment for boosting of rate limits can be one of the applications of Unique Token.

R&D Roadmap

The research and development in Unique will be a continuous process with a measurable result of miscellaneous PoCs and further implementation in MainNet or ecosystem tools in case if the corresponding research project succeeds.

NFT Wallet

The R&D roadmap has a production-level NFT Wallet that will enable a non-technical audience to create NFT and ReFungible collections, as well as Fungible tokens and perform major operations on them such as transfers.

This wallet implementation will be considered a white label reference implementation with an open source code that will be useful for both dApp and wallet developers.

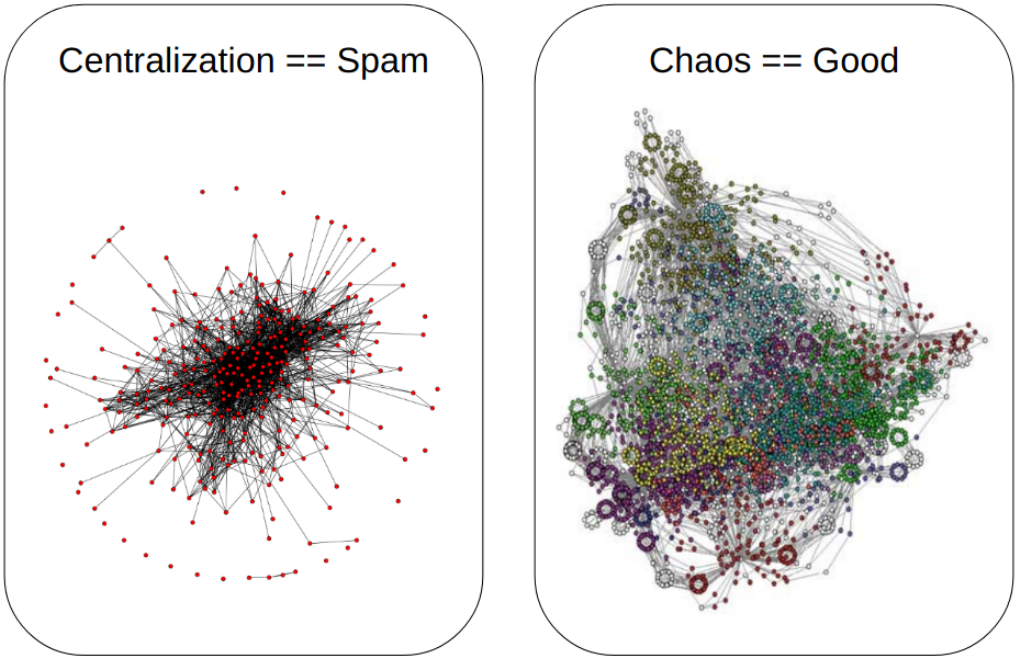
A PoC of the wallet has been operational since August 2020. See SubstraPunks Marketplace section for more details.

NFT MarketPlace

Similarly to a wallet reference implementation, the open source marketplace will be built and shared with the community for similar and better solutions to be built with Unique. The main function of the Marketplace is to allow safe and trustless exchange and trading of non-fungible or re-fungible assets.

The marketplace MVP has been built and is operational since November 2020. See SubstraPunks Marketplace section for more details.

Advanced Spam Prevention



One can build the model of the network of transactors as a directed graph. Ideal graph structure is yet to be identified in further R&D activities, but most likely it is going to be chaotic or some other high-entropy structure rather than ordered because in the ideal decentralized application peers transact with each other randomly (from the macroscopic point of view). Miscellaneous machine learning algorithms may be applied to detect clusters or other types of deviations from high-entropy in this directed graph [25] in order to detect spam or attacks.

Bridging To Other Networks

Trustless transfers from other blockchain networks are an important step in mass adoption of the Unique Chain. It is as important to convert existing NFT assets to Unique as attracting new users and minting new collections and tokens. Building dedicated NFT bridges that allow transferring NFT tokens from Ethereum, EOS, Bitcoin, Flow and other networks to (and back from) Unique Chain are an important milestone for the Unique Network. Technically we see the

implementation of such bridges similar to bridges designed for transferring fungible values: By locking assets on the parent chain and minting the respective asset on the Unique Chain. Double spending will be prevented by security of the original chain (e.g. Ethereum smart contract that locks an NFT), and interoperability will be guaranteed by the correct identification of the assets, which, according to Interchain NFT and Metadata Standardization [13], will include ID of the originating chain, ID of the collection, and ID of the token on the originating chain. The process of transferring assets back to the chain of origination may be implemented in reverse: Burning (or locking) of the NFT token in the Unique Chain and releasing of the matching asset in the chain of origination.

Unique Chain collators or other incentivised parties may be responsible for operating the NFT bridges under the risk of being slashed in order to guarantee the bridge security.

The Re-Fungibility is an exciting option that is arised from having NFT bridges: If sharing of the ownership is desired, a previously non-fungible token may be made re-fungible once transferred to Unique Chain through a bridge. As such, a valuable asset (e.g. a CryptoPunk worth $1,200,000) may be split between multiple owners and even traded using a traditional exchange trading model with bid and ask order book for a more accurate price discovery.

Since the bridge is an important technical component for Unique, a PoC of a bridge has been implemented in the scope of SubstraPunks Marketplace project in order to de-risk the further development.

Interoperability with Ethereum

Interoperability with other blockchains does not have to be limited by transferring value through bridges. Unique also aims to become compatible with Ethereum smart contracts by means of including the EVM and Ethereum pallets with Frontier RPC API to enable interaction with the chain using the MetaMask, Truffle, and other Ethereum tools, similarly to other parachains [27]. This is an important feature for applications that will plan to transition from the Ethereum network to Unique chain. Ethereum smart contracts can be deployed in the EVM pallet just like they were deployed on the Ethereum blockchain. Our R&D is working on making the interaction of these smart contracts with NFT Pallet as transparent as possible and minimise any smart contract changes required for such interaction.

Another important feature for existing Ethereum users will be emulation of ERC-721, ERC-20, and other Ethereum standards through RPC calls. These RPC endpoints will enable transparent use of native Unique Network capabilities in Ethereum tools in the same manner as Frontier, i.e. Metamask, Truffle, Web3 libraries, etc. The dApp developers and publishers will be able to seamlessly convert their user bases to Unique with zero learning curve for their users.

Enabling NFT Exchanges and Auctions

A number of DEX smart contracts were deployed in Ethereum network many of which completely replicate each other or implement a well known exchange protocols such as 0xcert [28] or HydroProtocol [29]. NFT space has also seen multiple implementations of exchange functionality such as OpenSea [30] or Worldwide Asset Exchange [31]. NFT Collectible games sometimes implement their own auctions, like CryptoKitties [32]. Despite the abundance of protocols, the NFT exchange functionality may be as simple as implementing an escrow and a few types of auctions. Unique Network is planning to include the NFT Exchange pallet that provides basic yet efficient functionality for decentralized exchanges. This functionality may include acquiring tokens from holders by means of Approve + TransferFrom mechanism (see ERC-721 standard [1]), implementing plain exchange of NFTs between NFT and other assets holders, which may also include exchanging value using the XCMP protocol between parachains, as well as miscellaneous auction types such as bidder-driven, time-driven, etc. Should the marketplace require any more additional functionality, the NFT Exchange pallet will offer the integration with smart contract functionality, where the marketplace developers will be able to implement all requirements as needed.

NFT Relationships

Describing entities often implies the interactions or relationships between them. The relationships describe how objects form more complex real world structures. For example, a neighborhood may contain several streets, which contain houses, which contain rooms, etc., all together forming a tree-like structure of real estate objects. Episodes in a series are related to each other in the sense of fixed order in which they come after each other - that is modeled by the linked list.

In order to model the real life relationships between objects we looked at the prior art that has already been researched and is proven to work well for most of the software data models: Unified Modeling Language. According to UML.org [33], there are several major types of the relationship: Association, composition, aggregation, generalization (inheritance) and realization. Unique Network NFTs will utilize these types of relationships, as well as additional relationship properties (such as direction and weights, for example) with the goal to enable application developers to create data models to the required complexity.

Advanced Ownership Structure

The ownership gives exclusive rights over one’s property, but in the blockchain world it is not frequently asked what having these exclusive rights means. Some obvious options are the ability to transfer the ownership to another entity and to destroy the property. But some real world examples demonstrate that more options are needed to describe the use cases that Unique Network may face:

- *Lending and Borrowing* implies the capability to temporarily transfer some property ownership rights to another address
- *Right to display* given to a third party grants the permission to (exclusively or not) use the property for display purposes. For example, to an art gallery to display the art, for the video streaming service to playback videos, or to a Web site to use graphical images
- *Deed of trust* or right to sell or act in some other ways on behalf of the owner is often used in the real estate, personal or business situations

Many more examples can be given including the highly customized structure of permissions transferred by the owner to miscellaneous third parties. Smart contracts and integration with IPFS for legal document storage may be used to express and enforce the agreements both technically and legally.

Off-chain Workers for Indexing

In Substrate terminology, Off-chain Workers are services running in the background that represent a non-obligatory part of blockchain protocol. The running nodes may voluntarily choose to execute off-chain workers in order to provide additional service to the network and their clients.

One of the use cases for the off-chain workers is miscellaneous indexing (Chapter 8, Views and Indexes of Database Systems: The Complete Book [35] explains in detail what are database indexes and what they are helpful for). Off-chain indexes improve user experience and at the same time preserve decentralization of the network. Unlike centralized indexers (such as Etherscan [14] or Polkascan [34]), off-chain indexer is a part of the network and can be executed by any node, so the result of their work is duplicatable and verifiable and is protected to certain extent from the censorship.

Another advantage of off-chain indexers is the common RPC API exposed by the public node. This API is well known and integrated by Parity and ecosystem projects with many technological stacks such as JavaScript, Python, C++, C#, etc, which is a major step in mass and enterprise adoption.

XCMP Application Layer Protocol

Cross-chain Message Passing [36] in the Kusama and Polkadot ecosystem is an important piece connecting parachains to each other. Two blockchains connected to the relay chain (e.g. Kusama), will be able to exchange arbitrary messages between each other. Nonetheless, application layer protocols are needed in order to implement actual use cases. For example, one of the generic protocols is being developed at the moment for NFT Bridges [40] in the scope of Web3 Grants Program.

Unique will have more features than a standard bridge provides, which we would like to be usable by other parachains. A custom Unique application layer protocol on top of XCMP will

enable other parachains to fully engage with Unique and, if needed, use its rich functionality fully.

One of the example applications for XCMP is related to DeFi and consists of bridging NFTs between multiple parachains for trustless borrowing using NFT and ReFungible assets as a collateral. Another example is trustless ReFungibility of other networks' NFTs (e.g. a CryptoKitty) to implement split ownership.

The cooperation with other parachains is not limited to DeFi use cases only. Unique can be used by gaming or government parachains in order to store complex NFT items or bundles or provide NFT or ReFungible tokens to be temporarily displayed in a digital Art Gallery.

Game Development Frameworks Integrations

It is important to provide robust tooling for game developers. Integration with Unique Framework [38] and Unreal Engine [39] will enable approximately 90% of game development studios in using Unique blockchain. The major challenges of these integrations consist of understanding the underlying use cases and abstracting the blockchain development from game development making the former fully transparent for the engineers with zero experience in the blockchain domain.

Application State Storage

Data availability requirements dictate the necessity to store certain most important application data on-chain. The examples may include, but not limited to turn based games state or user account data. The former reflects the particularly interesting use case of decentralizing user accounts, authentication, and authorization. On the one side this use case largely overlaps with Advanced Ownership NFT structure allowing even more flexibility of how NFT and Refungible assets are owned and used, but on the other side, it presents the capability to better manage the application audience: Create it, easily on-board and transition users between applications securely and without a need to register and/or install new tools.

TestNet 1.0

Between August 2020 and March 2021, a live TestNet 1.0 was running the early version of Unique Chain. The TestNet 1.0 was capable of basic NFT functions such as creating collections, minting, transferring and burning NFT and Re-Fungible tokens. The network also supported Ink! smart contracts that integrate with NFT functionality.

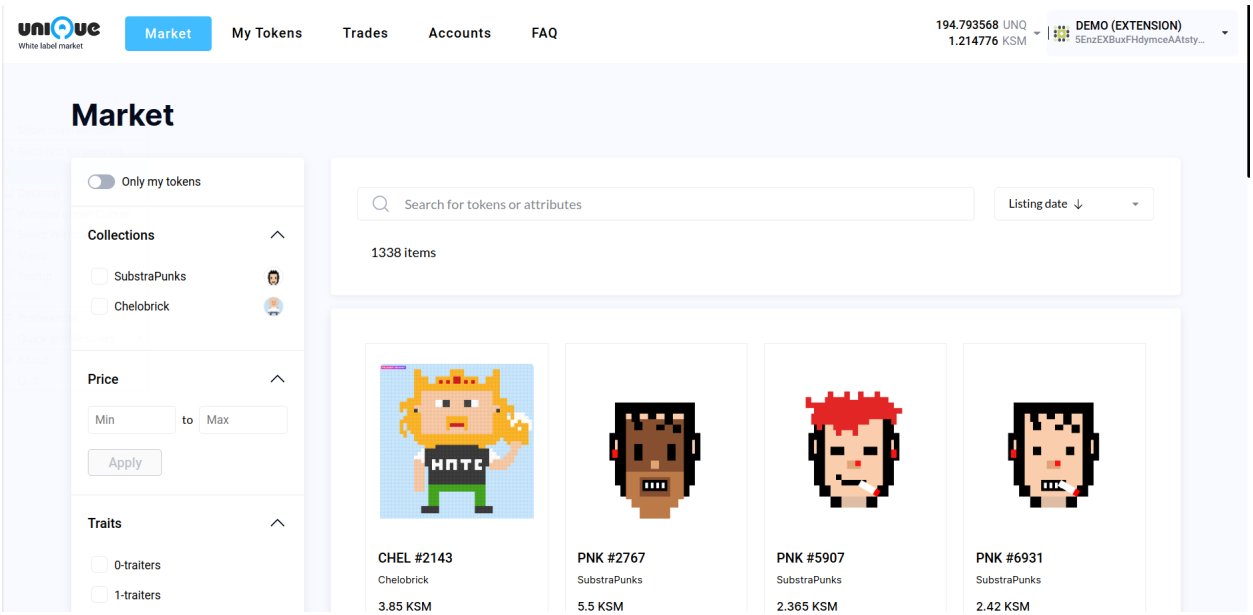
TestNet 2.0

In March 2021 we launched TestNet 2.0, a more advanced version of the Unique Chain. It is based on the newer (stable) version of Substrate, supports smart contract sponsoring, and

allows collection owners to give up rights to destroy the collection. Also it has some advanced collection limits.

Showcase: UNQNFT Marketplace

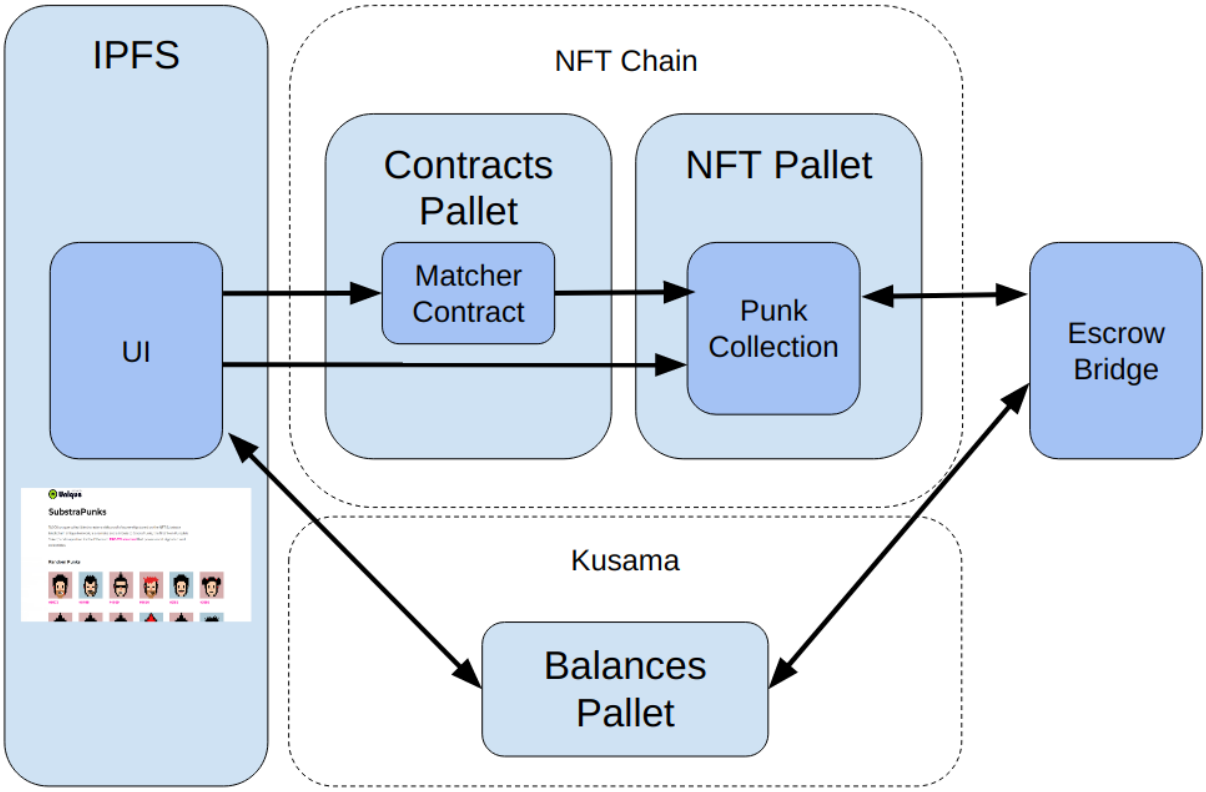
https://unqnft.io/



Initially designed for Hackusama [37] demonstration purposes, the Substrapunks game was welcomed by the crypto community and received a high level of popularity. The 10,000 NFT characters were all claimed in a few days and shortly after peer-to-peer trading began for valuable assets such as ETH and KSM. After one case of scamming, the quick decision was made to build an on-chain marketplace PoC to facilitate safe trading, explore the possible dApp architectures, experiment with miscellaneous types of loads, and discover and overcome possible problems in a developer-friendly environment.

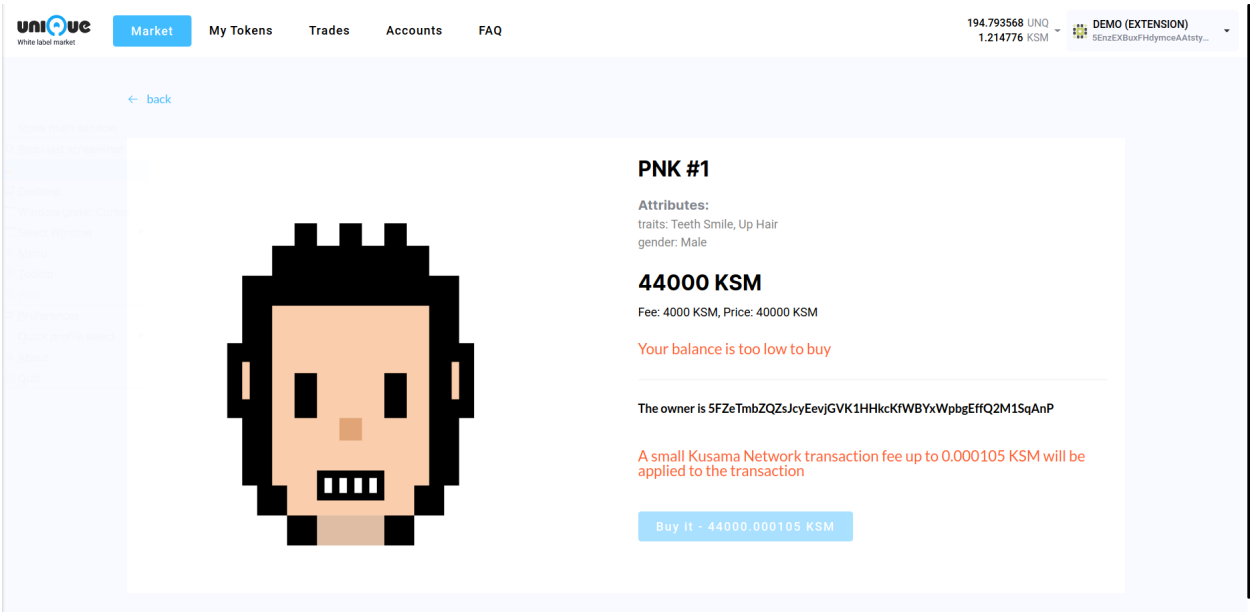
The first version of marketplace was launched in November 2020, it was updated in March 2021 with a new version that functions continuously since then. In March 2021, the total amount of sales reached over 3200 KSM (1,300,000 USD) with the average NFT sales price of approximately 2.22 KSM, and last week average price of 5.09 KSM which calculates to market capitalization of SubstraPunks of roughly 20,000,000 USD.

Marketplace PoC Architecture



The Marketplace was built as a decentralized application with no backend and a minimal Escrow Bridge server application. It consists of four components:

1. The frontend UI hosted on IPFS. It consists of several static HTML5 pages powered by JavaScript. The scripts on this page integrate with NFT Chain by means of Polkadot{.js} browser extension and PolkadotJS API.
2. SubstraPunks NFT collection created in NFT Pallet with 10,000 minted NFTs. Each NFT has the unique ID and on-chain properties that determine the look of the character.
3. Matcher smart contract that stores current market state and matches incoming bids from the UI against existing ask offers. This contract is written in Ink! 2.1, the extension framework for creating smart contracts with Rust.
4. Escrow Bridge: The trusted account that serves as a mediator between buyers and sellers.



This marketplace is one of the first (if not the first) decentralized apps that is also acting as a bridge between multiple networks in the Kusama ecosystem. One of the greatest challenges building it was the design of a multi-blockchain transaction UX workflow. The process of selling an NFT consists of four steps that include two transactions on two different networks, and over 10 major branches of workflow going in an erroneous path, all correctly handled by the UI in a stateless and interruption stable way.

References

[1] Ethereum EIP-721, https://eips.ethereum.org/EIPS/eip-721
[2] Property and Ownership, https://plato.stanford.edu/entries/property/
[3] John Locke, 1689/90. Two Treatises of Government
[4] Knuth, D. 1973, The Art of Computer Science, Vol. 3, Sorting and Searching, p.527. Addison-Wesley, Reading, MA., United States
[5] Rivest, R.; Shamir, A.; Adleman, L. (February 1978). A Method for Obtaining Digital Signatures and Public-Key Cryptosystems. Communications of the ACM. 21 (2): 120–126.
[6] The Ink! Smart Contracts, https://substrate.dev/docs/en/knowledgebase/smart-contracts/
[7] Substrate, https://substrate.dev/docs/en/
[8] SubstraPunks Game, https://ipfs-gateway.usetech.com/ipns/QmaMtDqE9nhMX9RQLTpaCbogg7bqkb6Gi67iCKMe8NDpCE
[9] Pedro Armelin, UX is key to driving mass adoption, https://uxdesign.cc/ux-is-a-key-to-driving-mass-adoption-of-blockchain-b0f4d40f376c
[10] Carsten Munk, Is frinctionless Ethereum (and dApps) usage possible, https://medium.com/zippie/is-frictionless-ethereum-dapp-usage-possible-a9cd5b01b835
[11] Gas Relay for Contract Calls, https://eips.ethereum.org/EIPS/eip-1077
[12] EOS Core Concepts, https://developers.eos.io/welcome/latest/overview/core_concepts
[13] Interchain NFT and Metadata Standardization, https://internft.org/
[14] Etherscan, https://etherscan.io/tokens-nft
[15] Counterparty, https://counterparty.io/
[16] EOS NFT Standard, https://github.com/unicoeos/eosio.nft
[17] ERC-1155, https://eips.ethereum.org/EIPS/eip-1155
[18] Delegated NFT, https://github.com/ethereum/EIPs/issues/994
[19] Composable NFT, https://github.com/ethereum/EIPs/issues/998
[20] Re-fungible, https://github.com/ethereum/EIPs/pull/1633
[21] ERC-809, https://github.com/ethereum/EIPs/issues/809
[22] ERC-1201, https://github.com/ethereum/EIPs/issues/1201
[23] OpenSea Metadata Standard, https://docs.opensea.io/docs/metadata-standards
[24] Tezos TZIP-16, https://gitlab.com/tzip/tzip/-/blob/master/proposals/tzip-16/tzip-16.md
[25] C.M. Bishop, Pattern Recognition and Machine Learning, Springer – Verlag New York, 2006.
[26] Temporary Censorship Attacks in the Presence of Rational Miners, https://ieeexplore.ieee.org/abstract/document/8802377
[27] Moonbeam Blockchain, https://docs.moonbeam.network/
[28] 0xcert Exchange Protocol, https://0xcert.org/
[29] Hydro Protocol, https://hydroprotocol.io/
[30] OpenSea Exchange, https://opensea.io/
[31] Worldwide Asset Exchange, https://wax.io/
[32] CryptoKitties, https://www.cryptokitties.co/
[33] UML, https://www.uml.org/
[34] Polkascan, https://polkascan.io

[35] Database Systems: The Complete Book. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer D. Widom
[36] XCMP, https://wiki.polkadot.network/docs/en/learn-crosschain
[37] Hackusama, https://hackusama.devpost.com/
[38] Unity Framework, https://unity.com/
[39] Unreal Engine, https://www.unrealengine.com/
[41] NFT Bridge Protocol, https://github.com/w3f/Open-Grants-Program/blob/master/applications/NFT_Bridge_Protocol_for_NFT_Migration_and_Data_Exchange.md