



Matrix World - A Programmable 3D Multichain Metaverse

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Abstract. Matrix World is a decentralized open virtual world that lets users interact with immersive 3D applications simultaneously running on different blockchains. The world consists of Lands, issued as Non-Fungible Tokens (NFTs), which permanently persist on blockchain networks such as Ethereum and Flow. Thus, Matrix Lands are tradable and transferable via blockchain networks and their owners retain complete control over the creations on their Lands. These Lands can be bound to a sandbox in the Matrix Network which has its own compute and storage resources. These resources allow landowners and creators to govern the visual appearance, inner properties, and lifecycle logic of the Land's creations, ultimately resulting in the production of an immersive 3D application that can operate in perpetuity in the Matrix World cyberspace. In Matrix World, users can take advantage of standard 3D open-world features such as building 3D architectures, hosting virtual meetings, exhibiting digital assets (e.g., NFTs), etc., along with more advanced functionality such as creating and hosting 3D decentralized applications (DApps) using Matrix's built-in creator services and computational resources. These DApps include 3D games and 3D marketplaces, among others. Our ultimate goal is to create unlimited possibilities and opportunities in the metaverse by eliminating the boundary between blockchains and building a next generation 3D open-world DApp platform on top of Matrix World.

Keywords: Blockchain · Metaverse · Query · 3D · Cyberspace

1 Introduction

The metaverse can be seen as an iterative network of three-dimensional virtual worlds, which are persistent online computer-generated spaces in which several individuals from disparate physical places can interact in real-time for work or play, as stated in [4]. [5] discusses in general how technologies have been enhanced and should be further developed to completely facilitate the functional

metaverse. Each field has advanced in its own right over the last few decades, gradually altering people’s lifestyles. The metaverse has recently gained popularity for two primary reasons: 1) as a result of the COVID-19 pandemic, and 2) as a result of the adoption of blockchain technology [9].

Speaking of open-world games, it is always inevitable to mention Minecraft [3]. Minecraft offers the freedom for players to build a customized 3D world. Additionally, it exposes powerful and robust backend interfaces that enable users to implement their own game or application in that universe. More significantly, it introduces the Bring Your Own Device (BYOD) concept to the game [2]. As a creator, you can purchase your own compute resources, namely a Minecraft server, to run your Minecraft-based minigame. The majority of blockchain-based 3D open-world platforms are inspired in some way by Minecraft, and we have already seen several well-implemented products [10]. Some of these products have concentrated on gaming and game creation, others have focused on 3D social networking and showcasing assets (NFTs), and some have offered a thin layer of 3D visualization while allowing the community to add additional extensions to enrich their ecosystems [6].

The availability of metaverse-related studies and surveys has increased over the past few years. However, none of the existing blockchain-based open worlds have demonstrated the same customization and user experience level as Minecraft. Despite its obvious potential, blockchain-based research is restricted, and its widespread adoption for many applications is not yet available [1]. In other words, none of the current blockchain-based 3D open worlds have provided a Turing-complete world capable of creating infinite possibilities. A 3D world built entirely on assets is not a real living Metaverse, but a new revolution is underway to enrich the community. The transition from a collection of separate virtual worlds to an interconnected network of 3D virtual worlds, or the Metaverse, depends on advancements in four areas: immersive realism, ubiquity of access and identification, interoperability, and scalability [4].

2 Proposed Programmable Multichain Metaverse

2.1 Programmable Objects

We breathe life into Matrix World’s objects by introducing the concept of programmable objects, known as Matrix Objects, that run on a canonical virtual machine called the Space Virtual Machine (SVM). The SVM keeps track of a group of Matrix Objects in one or more Lands and manages each object’s attributes, appearance, and lifecycle. Meanwhile, users can define custom functionalities to customize the behavior of these Matrix Objects. Using the Matrix Object and Scene Editor, authorized creators can easily program the actions of their Matrix Objects and create complicated 3D applications by combining multiple programmed/scripted Matrix Objects which can then interact with one another. As illustrated in Fig. 1, the ideal SVM enables hierarchical objects to operate jointly by following predetermined scripted operations. The requested SVM CPU and memory capacity dictates the maximum number of objects and

the complexity of application logic. At the same time, the Matrix Lands determine the virtual physical space in the Matrix World.

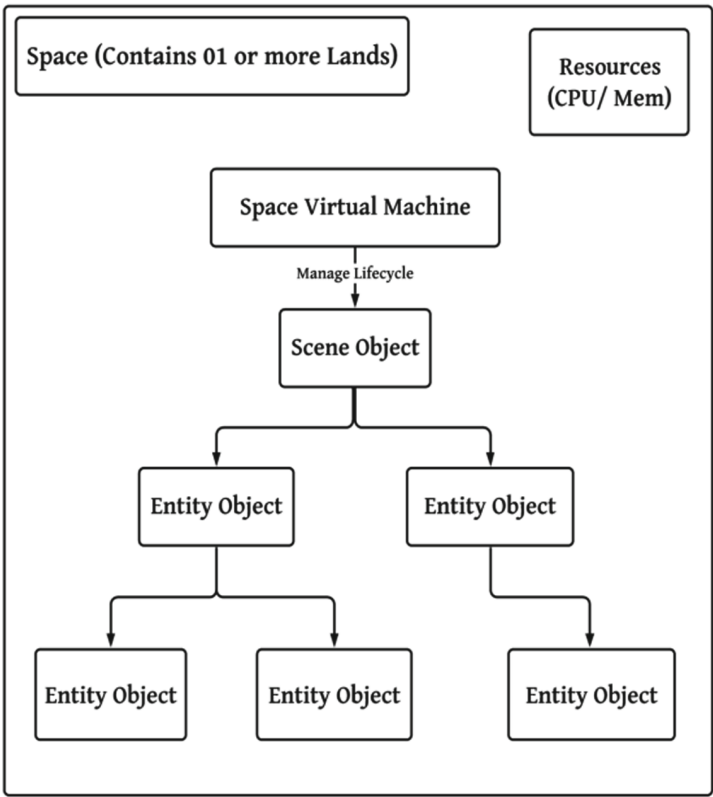


Fig. 1. Space virtual machine and the hierarchy of matrix objects

Additionally, multiple SVMs can connect to form a Matrix Network, as shown in Fig. 2. Each SVM is responsible for operating a Scene on a single Land or Space (a collection of merged Lands) that provides various features similar to a game server. Not only may creators construct 3D applications on a single SVM, but also cross-SVM for multiscene applications.

As defined earlier, Matrix World is a Turing-complete metaverse, which means that each object can be programmed as a living entity. Additionally, we provide developers and creators with tools and services to aid in the production of Scenes and DApps. Thousands of 3D applications will operate simultaneously in the form of fully programmable objects and will be decentralized. That is how Matrix World integrates apps into the actual metaverse.

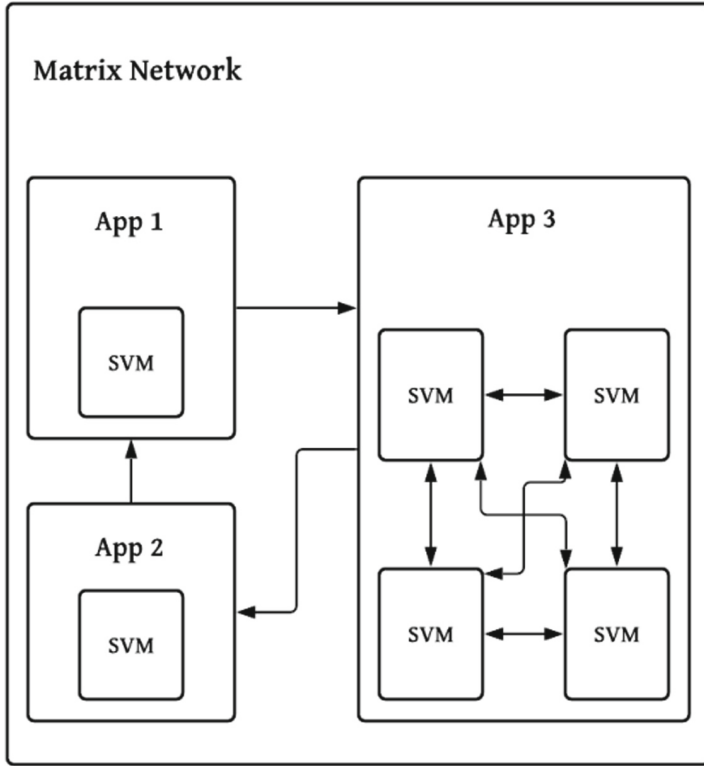


Fig. 2. Applications in matrix network

2.2 Multichain Connectivity

The Matrix World technology facilitates the maintenance of identities across several blockchains. The system currently supports Ethereum and Flow, but it can easily be expanded to incorporate new blockchains as its persistent and consensus layers. Moreover, creators can also connect Matrix Objects to external smart contracts running on multiple blockchain networks. For instance, game developers and content creators can build a 3D Uniswap ATM by crafting its appearance and defining the action that invokes Uniswap’s swap function in Ethereum. Furthermore, they can place such an ATM in a virtual NBA Top Shot museum that features a 3D video gallery powered by the Flow network. In addition to blockchain networks, Matrix World can also connect to external services. In the first instance, we propose integrating NFT marketplaces on multiple blockchains such as OpenSea, Rarible, MyNFT, as well as storage protocols like IPFS and Arweave, and streaming services such as Twitch and YouTube. To this end, creators can directly connect to the aforementioned services using both programmable 3D objects and API endpoints. Notably, the entire system is designed to be extensible, allowing for the continuous addition of new

services to enrich the world. Matrix World's multichain connectivity enables the creation of unique immersive social networks. Users can experience a world with unlimited possibilities by connecting to multichain DApps and other resources. Matrix World will bolster interoperability among multichain DApps and streamline communication across several metaverses.

2.3 Architecture

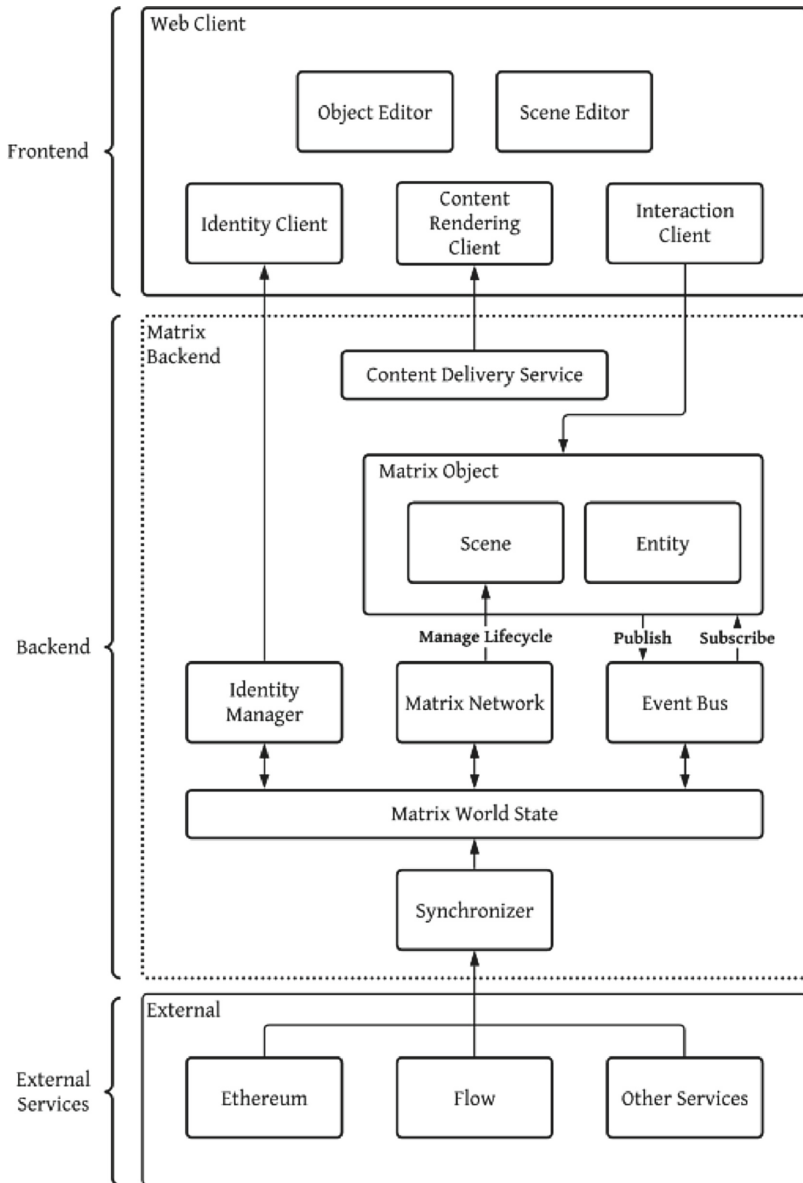
The Matrix World system is illustrated in Fig. 3, which consists of 3 layers: Frontend, Backend, and External Services.

Frontend: The frontend of Matrix World is a public-facing web or mobile client. It contains: 1) The Identity Client, a multichain identity client that users will use to log in and get authorized to access Matrix World's services via their blockchain credentials (cold wallet or hot-wallet services). 2) The Content Rendering Client, a WebGL-based client that renders the visual appearances of 3D Matrix Objects in the browser. 3) The Interaction Client, the client responsible for interacting with Matrix Object models managed by the Matrix Network. The Matrix Network routes the signal to a specific SVM to perform the update in the backend.

Backend: The backend is responsible for two major data workflows, as shown in Fig. 3. The first is synchronizing the data from external services like blockchain networks (Ethereum [11] and Flow [12]) and other centralized services (e.g., OpenSea [8]). These data will be collected in the Matrix World state and aggregated events will flow to the Event Bus and be subscribed to by the frontend clients. The second workflow consists of the instructions input from the frontend. These data will stream into the Matrix Network, update the world state, and trigger external service calls.

A Matrix Object is the minimal unit of Matrix World as illustrated in Fig. 4. It has default properties, such as its physics, textures, 3D transformations, and attached NFT media. Creators can also define custom attributes for Matrix Objects via scripts or the Editor UI. Matrix Objects are programmable so that the user can define their lifecycles and action functions. Action functions will be triggered when an interaction signal is sent from the client and lifecycle functions will be triggered when the Matrix Object's state changes. These functions can have multiple purposes like updating the 3D visuals, transforming and making payments, invoking another Matrix Object's action, and performing external calls. Matrix Objects can also subscribe to events from the Event Bus.

The Space Virtual Machine (SVM) is a sandbox server that manages all of the Matrix Objects' states and lifecycles for a specific Matrix Space (Fig. 1). Its computation and storage resources are equal to the sum of the resources of its Lands. Matrix is currently hosting all SVMs ourselves, but we plan to release self-hosted SVMs for landowners for decentralized land management and DApp hosting.

**Fig. 3.** High-level architecture

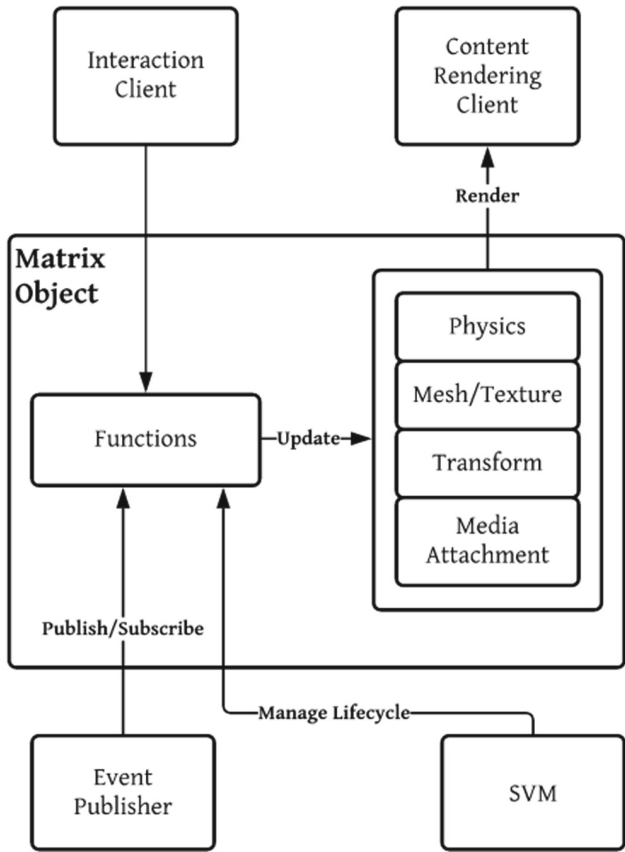


Fig. 4. Matrix object

The Matrix Network is a distributed network consisting of applications built on top of SVMs (Fig. 2). Landowners can build their DApps by running SVMs bound to their Spaces. This design is inspired by Ethereum and allows all SVM public functions to call each other. Our goal is to make the Matrix Network a 3D DApp platform

2.4 Services

Convenient Tooling for Creators: We intend to release a collection of tools that will enable anyone to construct 3D objects in Matrix World. The first tool will be a cloud-based What You See Is What You Get (WYSIWYG) model editor that allows users to alter a 3D model’s geometry, material, lighting, and shaders [7]. Along with the model editor, we also plan to include a Scene editor, which will allow creators to import the numerous 3D objects they have built into a Scene or directly use other external resources to ramp up and augment

a Scene. Apart from handcrafting models from scratch, the we are also working on an automated tool that will enable users to generate Scenes using pre-defined blueprint templates. Additionally, creators can offer their blueprints to Matrix World’s marketplace to accelerate the building process for other players while also monetizing their works.

NFT Ecosystem: Matrix World will offer users convenient functions to import NFTs into the metaverse. These functions will allow users to directly import 2D images, 3D models, videos, audios, and other multimedia NFTs into the 3D world. All imported NFTs will be transformed into Matrix Objects with original appearances (e.g., a 2D image will be transformed into a 3D picture with a frame).

Since each of the NFTs imported into Matrix World becomes a Matrix Object, creators can program the loaded NFTs to make them more functional. For instance, if the creator is a game maker, he or she can construct playable characters for a mini-game using Loot NFTs and create a mini-game using these characters. On the other hand, if the creator is an artist that knows about programming, he or she can convert a static image into animation by applying a dynamic animating filter.

Apart from importing existing NFTs, Matrix World is capable of creating NFTs from Matrix Objects. As a result, Matrix World will have a first-party 3D marketplace that will connect to Ethereum and Flow marketplaces. With a few clicks, users will be able to easily publish NFTs from Matrix Objects.

3 Case Study

3.1 Immersive 3D DApps

Matrix World’s development tooling and programming language will allow users to develop immersive 3D applications. Creators can define 3D objects’ shapes, attach materials and textures, create lighting, add transformation functions, attach scripted and AI-based behaviors, make payments, invoke external services, etc. The players can go into the 3D NFT buildings to check details such as textures. They can finish shopping in the immersive marketplace without external links, bring the NFT home, and use an auto construction code pack to see the NFT building auto-build on their Land.

3.2 Programmable NFTs

Matrix World allows users to directly import 2D images, 3D models, videos, audios, and other multimedia NFTs into the 3D world with convenient functions. Each imported NFT will be transformed into a Matrix Object with an original appearance (e.g., a 2D image will be transformed into a 3D picture with a frame). Since all of the NFTs imported into Matrix World become Matrix Objects, creators can program the loaded NFTs to make them more functional.

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3.3 Cross-Chain Socializing and Trading

Matrix World is a metaverse space that connects multiple blockchain networks and services. It provides a place for different players from various blockchain networks to gather and meet.

1. Cross-Chain Conferences and Meetings: Matrix World's public social facilities and buildings can authorize people with identities from different blockchain networks to attend meetings and conferences. We believe cross-chain communications will be more productive than single-chain ones.
2. Cross-Chain Advertising: Brands that want cross-chain influence will find Matrix World to be the best fit for them. They can attract potential customers from multiple blockchain networks by posting advertisements in Matrix World's multichain visible public area.
3. Cross-Chain Trading: The Matrix World will develop a mechanism to allow cross-chain trading and payment to increase the liquidity of the assets (e.g., NFTs and in-game objects) in the Matrix World.

4 Conclusions

Matrix World is an open virtual world that empowers users to build 3D immersive applications on top of different blockchains. The world is made up of Lands, which are issued as Non-Fungible Tokens (NFTs). In Matrix World, users can build 3D architectures, host virtual meetings, exhibit NFTs, as well as create their own 3D decentralized applications using Matrix World's built-in computation resources. Matrix World is designed as a 3D DApp platform. The Matrix Network consists of a number of SVMs, each of which is responsible for running a Scene on a specific Land that offers various functionalities. Matrix World will provide creators with development and automation tools to facilitate Scene and DApp development. We hope that in the future, thousands of 3D applications will operate concurrently on Matrix World's DApp platform.

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