BlockArt Selfdom

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BlockArt Selfdom

Change Record

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APPROVAL

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Dedication

I dedicate this work to my loved ones who have been my pillars of strength throughout this journey. To my family, whose unwavering support and encouragement have fueled my determination to pursue excellence. To my friends, whose uplifting presence and belief in my abilities have been a constant source of inspiration. To the mentors and educators who have imparted their knowledge and wisdom, shaping me into the person I am today. This work is a testament to the collective influence and impact of these exceptional individuals in my life, and I am forever grateful for their unwavering belief in me.

Acknowledgements

I am deeply grateful to my supervisor, ***Sir Muhammad Rizwan***, for their invaluable guidance and support throughout this project. Their expertise, insightful feedback, and continuous encouragement have been instrumental in shaping the direction and success of my research. I am fortunate to have had the opportunity to learn from their vast knowledge and experience. Lastly, I extend my heartfelt thanks to my family and friends for their unwavering encouragement and understanding during this journey. Their constant support has been a source of motivation and strength.

Executive Summary

NFTs (non-fungible tokens) can be used as student identity by creating a unique digital asset on a blockchain that is tied to a student's personal information. Each NFT can represent a student's identity and contain important information such as their name, roll number, and other relevant details. But many educational institutions store their information on servers, which can provide a certain level of security. However, there are still potential vulnerabilities to consider. For example, if an institution's server is hacked or compromised, sensitive information, including roll numbers and related data, could be accessed and potentially stolen. Additionally, there is always the risk of human error, such as accidentally exposing or deleting important data. In an effort to improve this process, some organizations are exploring the use of NFTs (non-fungible tokens) as a more secure and efficient way to represent student roll numbers and related information. NFTs are digital assets that are stored on a blockchain, making them unique, secure, and verifiable. By creating an NFT model for each student educational institutions can create a digital asset that is tied to the student and cannot be duplicated or tampered with. One major advantage of using NFTs is that they can be easily tracked and verified on the blockchain. This means that the authenticity and ownership of each student can be confirmed, providing a high level of security for both the institution and the student. Additionally, NFTs can be accessed through a mobile app or web portal, eliminating the need for physical Ids. This reduces paper waste and increases efficiency, as students can quickly access their information or data on their device without needing to carry around a physical card. Overall, replacing traditional Ids with NFTs can offer several benefits to educational institutions, including improved security, reduced waste, and increased efficiency. By leveraging the power of blockchain technology and digital assets, institutions can create a more secure and streamlined process for managing student data and related information.

Table of Contents

List of Figures

List of Tables

Chapter 1

Introduction

Chapter 1: Introduction

A radical innovation, blockchain technology has the potential to upend or perhaps replace current business structures that rely on third parties for trust. Through the publication of the Bitcoin whitepaper in 2008, the blockchain concept was initially revealed, and for the first few years, it was primarily employed as the technology underlying cryptocurrencies. Second-generation blockchains, such as Ethereum, were released in 2014 and enable for the programming and execution of software, or "smart contracts," on all participating blockchain nodes.[1] NFTs (non-fungible tokens) are a new technology that is rapidly gaining in popularity. They are essentially digital tokens that can have unique properties, making them perfect for applications such as online gaming or virtual assets. The non-fungible token market is expected to grow rapidly, to an estimated $22.6 billion by 2023. One of the main benefits of NFTs is the possibilityof using them to create blockchain-based smart contract applications. [2]

Explore the potential of utilizing NFTs (non-fungible tokens) as a transformative solution for student identity management in educational institutions. We highlight the limitations of traditional server-based systems and the risks associated with storing sensitive information.[3] By leveraging blockchain technology, NFTs offer a unique, secure, and verifiable digital asset for representing student identities [10]. We discuss the advantages of using NFTs, such as enhanced security, traceability, and accessibility through mobile apps or web portals. This project aims to demonstrate how the adoption of NFTs can improve efficiency, reduce waste, and provide a more secure and streamlined approach to managing student data and related information.

1.1. Background

In recent years, the use of blockchain technology has gained significant attention across various industries due to its potential to enhance security, transparency, and efficiency. One area where blockchain holds great promise is the management of student identities in educational institutions.[4] Traditional methods of identity management often rely on centralized servers that store sensitive information such as student roll numbers, personal details, and academic records. While these systems provide a certain level of security, they are not immune to vulnerabilities such as hacking, data breaches, and human errors [12].

The emergence of non-fungible tokens (NFTs) has opened up new possibilities for secure and decentralized identity management. NFTs are unique digital assets stored on a blockchain, ensuring their immutability and verifiability. Each NFT represents a distinct item or identity and cannot be replicated or tampered with, making it an ideal candidate for representing student identities [15].

The use of NFTs in the educational sector can address several challenges and limitations associated with traditional identity management systems. By leveraging blockchain technology, educational institutions can create a digital asset in the form of an NF T that is tied to a student's personal information, including their name and other relevant details. This NFT acts as a verifiable proof of identity, providing a high level of security and authenticity.

Moreover, the decentralized nature of blockchain ensures that student records and identities are not stored on a single server, mitigating the risk of a single point of failure. Instead, the data is distributed across the blockchain network, making it more resilient to attacks and unauthorized access. In the event of a breach, the tamper-proof nature of the blockchain ensures that any unauthorized changes can be easily detected and resolved.[5]

Additionally, the adoption of NFTs for student identities can lead to increased efficiency and reduced waste. Students no longer need to rely on physical IDs, as their NFT-based identity can be easily accessed through a mobile app or web portal. This eliminates the need for physical cards, reducing paper waste and streamlining the process of identity verification.

This project aims to explore the integration of NFTs and blockchain technology in the management of student roll numbers and identities within educational institutions. By implementing a proof-of-concept system, the project seeks to demonstrate the benefits of using NFTs for identity management, including improved security, verifiability, and efficiency. The project will also evaluate the practical challenges and considerations involved in the implementation and adoption of NFT-based identity systems in educational settings.

Through this research, we aim to contribute to the growing body of knowledge on blockchain technology and its applications in the education sector. By providing a comprehensive understanding of the benefits and challenges of NFT-based identity management, this project strives to pave the way for more secure, transparent, and efficient student identity systems in educational institutions.

1.2. Motivations and Challenges

The motivations behind this project are driven by the need for enhanced security, verifiability, and efficiency in student identity management within educational institutions. By leveraging NFTs and blockchain technology, the project aims to create a system that provides a higher level of security against unauthorized access and tampering of student identities. Additionally, it seeks to establish a transparent and traceable framework to ensure the authenticity of student information. The project also addresses the challenges of traditional identity management systems, such as the reliance on physical IDs and time-consuming verification processes, by implementing NFT-based identities that offer improved efficiency and accessibility. However, challenges exist in terms of adoption, integration, scalability, sustainability, and ensuring privacy and data protection. By addressing these challenges, the project aims to develop a robust and effective identity management solution that can benefit educational institutions and their students.

1.3. Goals and Objectives

The goals of this project are centered around improving student identity management in educational institutions through the utilization of NFTs and blockchain technology. The primary objectives include enhancing security, verifiability, and efficiency while addressing the limitations of traditional identity management systems. By leveraging the unique properties of NFTs and the decentralized nature of blockchain, the project aims to create a secure and transparent system that protects student identities, ensures data integrity, and streamlines the identity verification process. Following are some of the features and goals of this project.

Features:

- NFT-based Identity Creation
- Secure Storage on Blockchain

- Tamper-proof Verification
- Mobile and Web Access

Goals:

- Enhanced Security
- Streamlined Identity Verification
- Improved Efficiency
- Increased Transparency and Verifiability
- Reduced Paper Waste

By achieving these goals and objectives, the project aims to contribute to the development of a robust, secure, and efficient student identity management system using NFTs and blockchain technology in educational institutions.

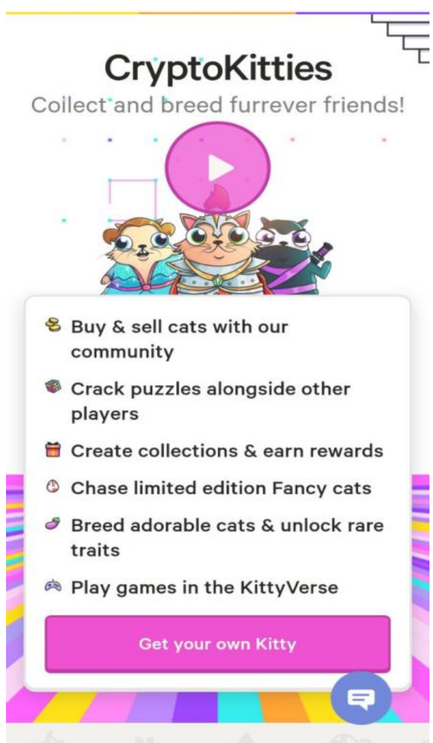
1.4. Literature Review/Existing Solutions

Through some literature review and research work, we came up with these observations:
NFTs are digital tokens that can't be copied because they use blockchain technology to prove who owns them. They are used to reflect digital and real-world assets like art and real estate, so they can be traded with a small chance of fraud. The job market is also changing because of digital change and the use of blockchain technology. There are already more people than ever working on NFTs, blockchains, and cryptocurrencies, but this will become more popular. blockchain-related jobs increased 118% from September 2020 to July 2021.
Traditional educational institutions face difficulties students to pay attention and be motivated, which is made worse by online learning. NFTs have been suggested as a way to reward students based on how they do on tests. They provide positive reinforcement by giving NFTs users bragging rights and special access. Even though the system works and saves money, it needs to be used by more people so that its real-world effects can be measured. NFTs have a lot of possible uses in a lot of different businesses, but they can't be used widely until problems and restrictions are fixed [6]. Systems for selling tickets for events are similarly plagued by issues including fraud and a lack of oversight of related activities. Non-Fungible Tokens (NFTs) have

been suggested as a solution to these problems because they give tickets distinctive, impenetrable identifiers and allow for improved transaction management [7]. Blockchain technology has the ability to disrupt markets that heavily rely onthird parties for trust [7].

It all started with the first NFT ever created, called Quantum, which was minted by Kevin McCoy on Name coin in 2014. But several other NFTs were launched on pre-Ethereum blockchains over the following years — for example, **Spells of Genesis** launched in 2015, and stands as the first-ever blockchain-based game.

The first NFT-based application to enjoy broad acceptance was a virtual online game called **Crypto Kitties** [8]. The game at one point used more than 70% of the transaction capacity of the Ethereum network, and in late 2017 the most expensive NFT, which signifies ownership of such a cat, was auctioned for more than $100,000 [8]. Over 100 comparable digital artefacts, including digital card games or unique original works of art, have been created by the community in the last year, and more are expected [8]. Even though it is questionable if digital objects have value outside of their ecosystem, NFTs can help with the tokenization of physical products like artwork [8].



Our work involves the storage of complete student data in NFTs. By utilizing blockchain technology, student information such as personal details, academic records, attendance, and other relevant data can be securely stored in a decentralized and tamper-proof manner. This ensures the integrity and immutability of the data, providing a reliable and transparent system for storing student information. Administrators play a crucial role in this process as they verify and manage the student data. Through the use of appropriate authentication and authorization mechanisms, administrators have the ability to access and validate the data stored in the NFTs. They can assign specific NFTs to individual students, ensuring the association between the digital identity and the respective student.

Teachers also have a role in this system as they can update student information, such as exam results and attendance records. This enables real-time monitoring of student progress and facilitates efficient communication between teachers and students. By allowing teachers to interact with the NFTs, the system ensures accurate and up-to-date student data.

From the student's perspective, the dashboard serves as a centralized hub where they can access and monitor their entire university progress. They can view their academic records, check exam results, track attendance, and access other relevant information. This provides students with a comprehensive overview of their academic journey and empowers them to take ownership of their educational progress.

The implementation of NFTs for storing student data represents a significant advancement in the digitization of education systems. It offers enhanced security, accessibility, and transparency compared to traditional methods of storing student information. By leveraging the capabilities of NFTs, educational institutions can streamline administrative processes, facilitate efficient communication, and empower students to actively engage with their educational journey [19].

1.5. Gap Analysis

Current Status:

There are no specific projects that have implemented a system on a blockchain network with NFTs for each student, but there are projects that transform student documents into NFTs to enhance credential security and verification using blockchain technology Several universities, including Duke University, have expressed interest in NFTs, with Duke implementing them for its Master of Engineering in Financial Technology degree, offering educational credentials in the form of NFTs. This forward-thinking approach highlights the universities' recognition of NFTs' potential to enhance the verification and secure sharing of academic achievements [9].

Target:

The primary targets of our project are to develop a system integrated with blockchain technology, ensuring secure storage and verification of students, while also creating unique NFTs for each student to represent their educational achievements in a tamper-proof and decentralized manner.

Gap Analysis:

The current systems lack integration with blockchain technology and the creation of NFTs for each student, highlighting the gap in leveraging blockchain for secure credentials and introducing unique visual representations of achievements. Our project aims to bridge this gap by developing a system that combines blockchain technology, secure credential management and NFT creation, providing enhanced security, transparency, and unique digital representations of student accomplishments.

1.6. Proposed Solution

In the decentralized system we are developing, the objective is to store complete student details such as name, address, department, subjects, and more. To overcome the high gas fees associated with storing data directly on the blockchain [17], we plan to utilize the **InterPlanetary File System (IPFS)** for free storage on decentralized servers.

IPFS is a distributed file system that provides a peer-to-peer network for storing and retrieving data. It uses a content-addressable system where files are identified by their cryptographic hash, ensuring their integrity and immutability. Instead of storing the entire student data on the blockchain, we store the necessary information in the form of an NFT on the blockchain while storing the bulk of the data on the IPFS server.

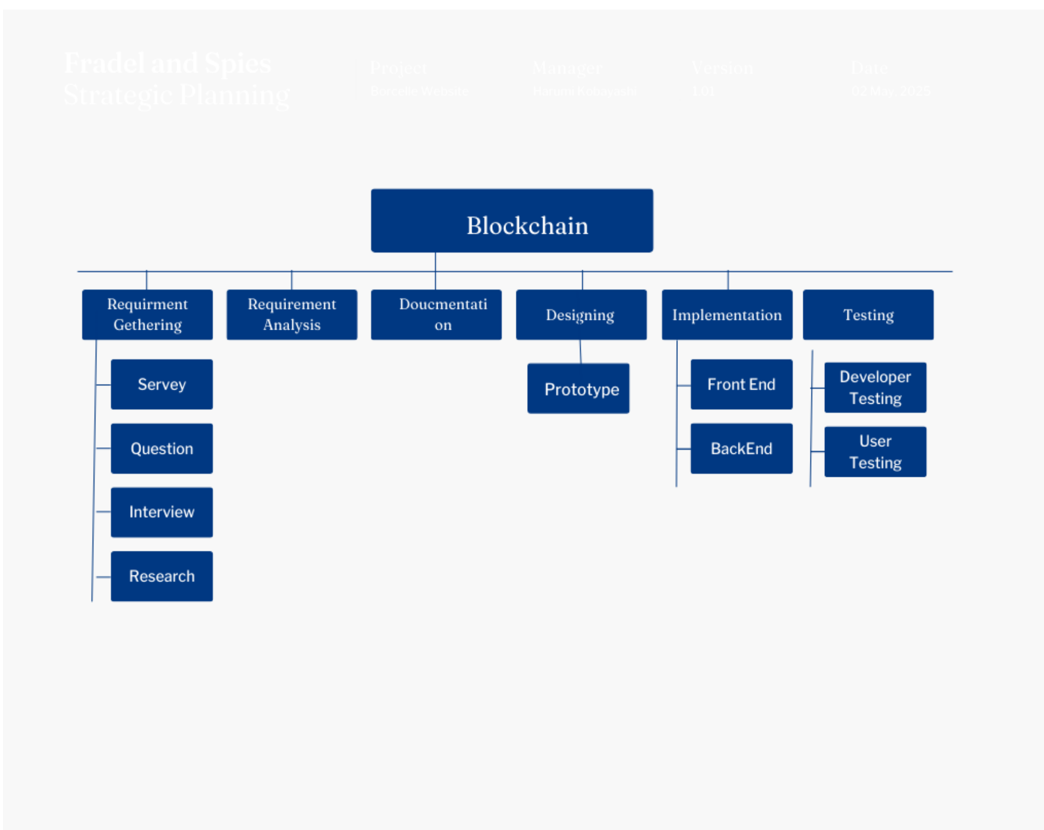
The process involves uploading the student data to the IPFS server, which assigns a unique hash to the uploaded data. This hash can then be stored within the NFT on the blockchain, serving as a reference to the actual data stored on the IPFS server [17]. When accessing the student data, the blockchain retrieves the IPFS hash from the NFT and fetches the corresponding data from the IPFS server, ensuring the integrity and availability of the complete student details.

By leveraging the IPFS server for storage, you can reduce costs associated with blockchain transactions while still maintaining the security and decentralization benefits of the blockchain [19]. This approach allows for efficient handling of student data, making it accessible through the blockchain while utilizing the free storage capabilities provided by the IPFS server.

1.7. Project Plan

We will create NFT's which will be developed using Smart contracts on Ethereum Blockchain in Solidity language. Every student has its own NFT and student own that NFT will always remain the Owner of that particular NFT. It is one of the Most Secure ways to maintain the actual identity.

1.7.1. Work Breakdown Structure

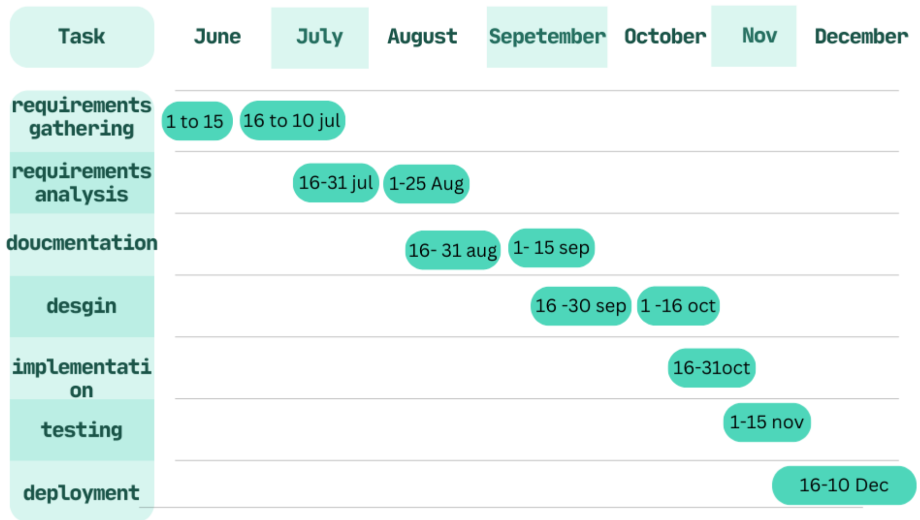


1.7.2. Roles & Responsibility Matrix

The purpose of roles & responsibility matrix is to identify who will do what.

WBS #	WBS Deliverable	Activity #	Activity to Complete the Deliverable	Duration (# of Days)	Responsible Team Member(s) & Role(s)
1.	Requirement Gathering	1	Survey, Question, Interview, Research	15	Hanzala, Noor, Hassan
2.	Requirement Analysis	2		10	Hanzala, Noor
3.	Documentation	3	UML, SRS	25	Hanzala, Noor, Hassan
4.	Designing	4	Front End Design and Application Design	30	Hanzala, Noor
5.	Implementation	5	Back End Implementation, Decentralized Application Development	45	Hanzala, Noor, Hassan
6.	Testing	6	Developer Testing and User testing	20	Hanzala, Noor
7.	Deployment	7	Deployment on live Server	30	Hanzala, Noor, Hassan

1.7.3. Gantt Chart



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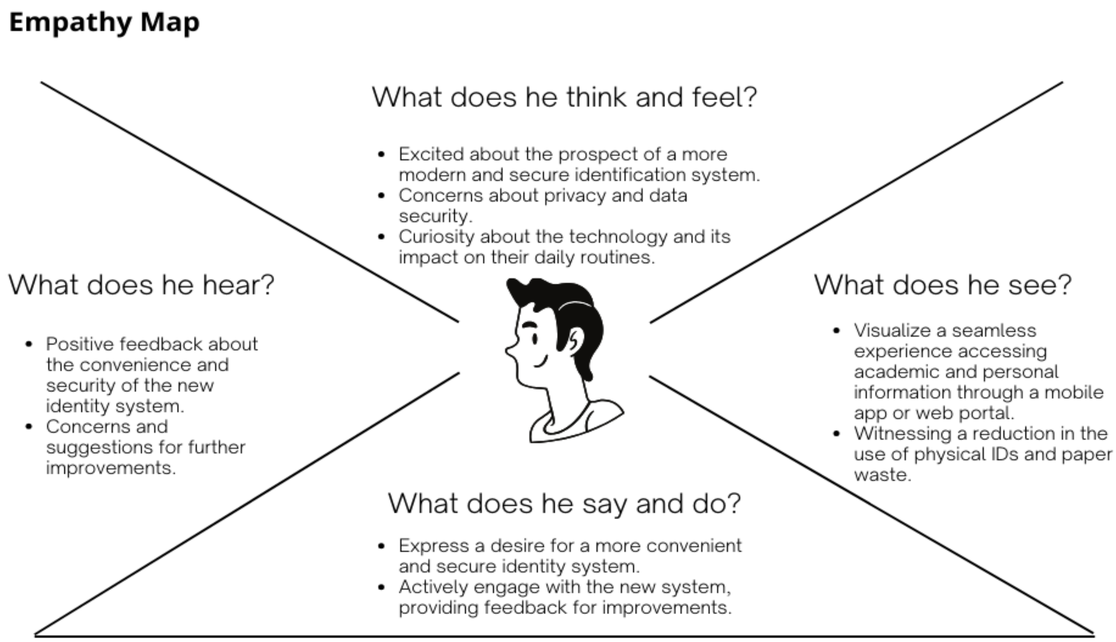
1.8. Report Outline

We will create NFT's which will be developed using Smart contracts on Ethereum Blockchain in Solidity language. Every student has its own NFT and the student own that NFT will always remain the Owner of that particular NFT. It is one of the Most Secure ways to maintain the actual identity.

1.9. Empathy Map



Chapter 2

Software Requirement Specifications

Chapter 2: Software Requirement Specifications

2.1. Introduction

2.1.1. Purpose

The purpose of this project is to revolutionize the traditional university management system by leveraging blockchain technology and Non-Fungible Tokens (NFTs). The project aims to enhance the security, transparency, and accessibility of student credentials, ensuring tamper-proof record-keeping and reliable verification. By creating NFTs for each student, the project intends to provide a visually captivating and unique representation of their educational achievements. The project's purpose is to modernize the university management system, improving the credibility and portability of student records, while embracing innovative technologies to enhance the overall user experience. Ultimately, this project strives to redefine how universities manage and authenticate student credentials in the digital age.

2.1.2. Document Conventions

2.1.2.1 Heading and Section Format:

- Main headings: Use bold or larger font size, left-aligned.
- Subheadings: Use smaller font size, left-aligned.
- Numbered Sections: Use decimal numbering (e.g., 1, 1.1, 1.2, etc.)

2.1.2.2 Font Styles and Highlighting:

- Use a standard font (e.g., Calibri) for the entire document.
- Use bold font for headings.

2.1.2.3 Language and Grammar:

- Write in clear and concise language, avoiding technical jargon or ambiguous terms.
- Use proper grammar, spelling, and punctuation throughout the document.
- Maintain a consistent writing style and tone.

2.1.3. Intended Audience and Reading Suggestions

When reading the SRS document, it is suggested to start with the Introduction section to understand the project's context, goals, and objectives. Proceed to the Scope section to grasp the system's boundaries and limitations. Review the Functional Requirements section to understand the major system functionalities, followed by exploring the Non-functional Requirements section for performance, security, and usability aspects. Readers can then focus on sections pertinent to their role or area of interest, such as User Interface Design, Security and Access Control, or External Interfaces. The System Features section provides a detailed description of each module or component, while the Project Plan section outlines the project timeline and deliverables. By following this suggested reading sequence, readers can gain a comprehensive understanding of the system's requirements and overall project scope.

2.1.4. Product Scope

NFTS (non-fungible tokens) are a new technology that is rapidly gaining in popularity. They are essentially digital tokens that can have unique properties. The non-fungible token market is expected to grow rapidly, to an estimated $22.6 billion by 2023.

2.1.4.1 **Software Description:**

- This system is a comprehensive software solution designed to streamline administrative processes within a university.
- It provides a decentralized platform for managing student enrollment, course registration, grading, and document management.
- The system leverages blockchain technology and Non-Fungible Tokens (NFTs) to ensure secure and tamper-proof student credential verification.

2.1.4.2 **Purpose and Objectives:**

Purpose:

The software aims to improve operational efficiency, enhance data security, and provide a user-friendly interface for managing university activities.

Objectives:

- Decentralize administrative tasks to eliminate redundant processes and reduce paperwork.
- Enhance data security and integrity through the use of blockchain technology.
- Provide a user-friendly platform for students, faculty, and administrators to access and manage relevant information.
- Enable secure and transparent verification of student credentials through NFTs.

2.2. Overall Description

2.2.1. Product Perspective

The product specified in this SRS is a new, self-contained system designed to enhance student identification and information security within educational institutions. The project aims to replace traditional student cards with NFTs, providing a secure and decentralized digital system for storing student information. Students will use a user-friendly app to input their data, while teachers will have the ability to update records like marks or attendance. Administrators will assign NFT models to students based on predefined criteria. The system will integrate with existing infrastructure and prioritize scalability, usability, security, and compliance with data protection regulations.

2.2.2. User Classes and Characteristics

Students:

Students are the primary users of the product and will interact with it frequently. They may have varying levels of technical expertise and familiarity with blockchain technology. They require easy access to their digital identities, the ability to view and update personal information, manage their educational credentials, and interact with other features specific to their student roles.

Administrators:

Administrators are responsible for managing the system and overseeing its functionality. They possess higher technical expertise and have administrative privileges. They require advanced functionalities such as user management, NFT issuance and revocation, access control, system configuration, and generating reports. They have elevated security and privilege levels to ensure the smooth operation of the system.

Teachers:

Teachers will utilize the system to update student records, such as marks or attendance. They need secure access to student data and the ability to perform necessary administrative tasks efficiently. Teachers may also benefit from user-friendly interfaces that simplify the record-keeping process.

2.2.3. Operating Environment

Solidity: Solidity is a programming language specifically designed for writing smart contracts on the Ethereum blockchain.

JavaScript: JavaScript is a popular programming language that can be used for front-end development, back-end development, and interaction with blockchain networks through web3 libraries.

As for the choice of IDEs, here are a few options commonly used by developers:

Visual Studio Code: Visual Studio Code is a lightweight and highly customizable IDE that supports various programming languages and provides a rich set of extensions for blockchain development.

Remix IDE: Remix IDE is a web-based IDE specifically designed for Solidity smart contract development. It offers features such as syntax highlighting, code compilation, and debugging capabilities.

Truffle Suite: Truffle Suite is a development framework that provides a suite of tools, including Truffle IDE, for smart contract development. It offers features such as project management, smart contract compilation, and deployment automation.

Regarding laptop specifications, it is recommended to have a laptop with sufficient processing power, memory, and storage capacity to handle the development environment and associated tools. Here are some general recommendations:

Processor: A modern multi-core processor, such as Intel Core i5 or i7, or an equivalent AMD processor.

Memory (RAM): At least 8GB of RAM, although higher RAM capacity can improve performance when working with resource-intensive tasks.

Storage: Sufficient storage capacity, preferably an SSD (Solid State Drive), to accommodate the development environment and project files.

Operating System: The choice of operating system depends on the developer's preference, but popular options include Windows, macOS, and Linux.

These specifications can serve as a starting point, but it's essential to consider the specific requirements of the development tools and frameworks being used for the NFT-based student identification system and ensure the laptop meets or exceeds those requirements.

2.2.4. Design and Implementation Constraints

- User can access from any Pc or Mobile using internet connection.
- User can use right key and their login profile name to get attached to their profile.
- Admin create NFTs for each student by using Ethereum (ETH) through MetaMask.
- All data will be saved in real time in blockchain.

Blockchain Technology:

The implementation of the system on a blockchain network introduces the constraint of working with blockchain technology. This includes understanding the specific blockchain framework chosen for the project, integrating with the blockchain network, and implementing the necessary smart contracts and consensus mechanisms.

2.2.5. Assumptions and Dependencies

All the dependencies and assumptions that this project have are listed below:

- IPFS for Metadata uploading.
- React Js for Web Application.
- Figma for front-end.
- MetaMask wallet public key for transaction.

2.3. External Interface Requirements

2.3.1. User Interfaces

Our decentralized application's user interface is a simple one.

For the Student:

- Login/Registration
- Dashboard
- Profile Management
- NFT Student Card

1). Allowing students to create an account or log in using their credentials securely.

2). It should provide an overview of their information, such as their name, profile picture, and relevant details.

3). They should be able to update personal details, contact information, and profile pictures easily.

4). A dedicated section displays the NFT student card, which represents the student's identity and serves as a digital version of the traditional student card. The UI present the NFT card prominently, with relevant details like student name, photo, and unique identifiers.

For the Admin:

1). The UI provide a secure login/authentication process for administrators.

2). Admin has an option to mint NFT of requested student.

3). Admin can see the student details.

For the Teacher:

1). The UI provide a secure login/authentication process for Teachers.

2). Teacher has an option to update student marks and attendance.

3). Teacher can see the student result details.

2.3.2. Hardware Interfaces

In hardware interfaces for our Dapp, a user needs:

- PC (Windows OS or Mac OS).
- Android phone or tablet.
- 3G OR 4G internet connection.

2.3.3. Software Interfaces

Our Dapp is an easy-to-use. Dapp with the front-end designed on **Figma** with React Js for functionalities and on the backend, we have used **Ethereum blockchain** and **mySQL** database. In Ethereum blockchain, there are smart contracts integrated with our Dapp which are developed in solidity language **version 0.8.8**. Also, for property's image uploading we are using **IPFS server.**

2.3.4. Communications Interfaces

Our Dapp uses **Web3** and **ether** libraries for communication between our Dapp and Blockchain. Also, **IPFS** server for files communication. For data encryption **SHA-256** hash algorithm is used and for frontend **React Js** library is used.

2.4. System Features

The system features of the product are organized based on the major services it provides. These features can be categorized and structured according to use cases, modes of operation, user classes, object classes, functional hierarchy, or any logical organization that best suits the product. This allows for a comprehensive representation of the functionalities and services offered by the system, ensuring a clear understanding of its capabilities.

- Signup. (User)
- Login. (Admin/User)
- MetaMask wallet integration with App. (Connect Wallet)

- NFTs minting of students. (Admin)
- Submit request to mint NFT. (Student)
- View Student's NFTs.
- View Student's NFTs details.
- Update a Student (NFT) on Ethereum.

2.4.1. User/ Signup and Login:

2.4.1.1. Description and Priority

This is the first step and the most crucial part. Without Signup and Login, the user will not be able to use application. So, it is on the highest priority to have a proper login system.

2.4.1.2. Stimulus/Response Sequences

The User will open the application on browser. On opening the application, the user will be redirected to signup Page where he has to put his credentials and after that to login page. In case of successful login, the user will be redirected to the next options screen.

2.4.1.3. Functional Requirements

The requirements for this feature are that the user should signup through valid credentials and then login through these same credentials securely.

2.4.2. NFT minting of Students:

2.4.2.1. Description and Priority

The process of NFTs minting of students is done by admin itself. The whole work of NFTs minting is based on a smart contract.

2.4.2.2. Stimulus/Response Sequences

The admin will create NFT through a form where they will fill the form by the details of student including profile photo, name, address, phone number and other essential information. After that he will confirm the creation and for transaction process MetaMask wallet application will open to confirm transaction, the transaction has the total cost mentioned containing the fees gas as well. After confirmingthe transaction, the NFT will be minted.

2.4.2.3. Functional Requirements

REQ-SF2-1: The admin must login with valid credentials.

REQ-SF2-2: The admin needs to connect it's MetaMask wallet with the app for transaction.

REQ-SF2-3: The admin must have enough number of Ethers (incl. gas fees) for transaction.

REQ-SF2-4: The student details must be valid to be converted to an NFT.

REQ-SF2-5: After a successful transaction the student's NFT will be minted.

2.4.3. NFT Storage and Management:

2.4.3.1. Description and Priority

Proper storage and management of NFTs representing student identities are crucial for secure handling of student information, requiring robust storage mechanisms, access control, and retrieval methods to ensure data integrity and availability. Prioritizing NFT storage enhances administrative processes, safeguards sensitive data, and contributes to the overall effectiveness and reliability of the student identity system.

2.4.3.2. Stimulus/Response Sequences

Users initiate storage requests for NFTs representing student identities, which are securely stored and associated with student information. The system enables retrieval, updates, and backups, enforcing access controls to maintain security and integrity of the NFTs.

2.4.3.3. Functional Requirements

REQ-SF3-1: NFT Storage and Retrieval.

REQ-SF3-2: NFT Backup and Archival.

REQ-SF3-3: NFT Access Control and Security.

2.4.4. Mobile/Web Access:

2.4.4.1. Description and Priority

Mobile and web access is a crucial functionality that prioritizes the accessibility and usability of the student identity system, enabling users to conveniently retrieve and manage student information through mobile applications or web portals. By focusing on intuitive interfaces, responsive design, and seamless connectivity, educational institutions empower users to efficiently access and interact with student data anytime and anywhere, enhancing the overall user experience.

2.4.4.2. Stimulus/Response Sequences

During Mobile/Web access, users authenticate themselves through valid credentials, allowing them to retrieve student information and initiate updates. The system responds with smooth and responsive data presentation, validating user authority, and providing error messages for network or server issues, ensuring a reliable and user-friendly access experience to student data anytime, anywhere.

2.4.4.3. Functional Requirements

REQ-SF4-1: User Authentication and Authorization

REQ-SF4-2: Seamless Mobile/Web Interface

REQ-SF4-3: Responsive Design and Compatibility

2.5. Nonfunctional Requirements

2.5.1. Performance Requirements

Response Time:

1. The system should respond to user requests for student identity information within 0.001 seconds to ensure a seamless user experience and avoid user frustration.

2. NFT verification should be performed within 0.001 seconds to provide quick and efficient validation of student identities.

Scalability:

1. The system able to handle a growing number of students and NFTs without a noticeable degradation in performance.

2. The system support number of users accessing their student identity information simultaneously without performance bottlenecks.

Data Retrieval:

1. The system retrieve and display student identity information within seconds when requested by the user.

2. When searching for a specific student's information using their roll number, the system should provide the result within seconds.

Real-Time Updates:

When a student's information is updated, such as a change in roll number, the system should reflect the updated data all relevant interfaces.

2.5.2. Safety Requirements

Our Dapp will be highly secured as we are using the latest, fastest and most importantly the safest technology **'Blockchain'**. The system provides reliable backup and recovery mechanisms to protect against data loss or corruption in case of hardware failures or other incidents.

2.5.3. Security Requirements

All the data in blockchain in stored in hash form (SHA-256). So, it is a very secured method of storing data. Also, as the data is immutable so it is not hackable or unalterable. Also, the user needs to give its public and private of wallet for transaction. So, everything is safe and secured. For database server, the password should be saved in encrypted form. Email and password will be required from user to login with. The application should use MySQL authentication for verification of the user login. The application should check the input is valid or not.

2.5.4. Usability Requirements

Who: Users of the student identity system

What: Require a user-friendly interface, accessibility features, efficient performance, customization options, comprehensive help and documentation, and support for internationalization and localization

When: During the interaction with the system

Where: Within the student identity system

Why: To enhance user satisfaction, ease of use, and overall usability, ensuring a positive user experience, accommodating users with different needs, providing efficient system performance, and facilitating customization and personalization options.

2.5.5. Reliability Requirements

The reliability requirements of the system are to ensure that any faults do not lead to system failure.

2.5.6. Maintainability/Supportability Requirements

Firstly, as it's blockchain based so the chances of system failure are very minimum but still in case of any system failure, our Dapp can be maintained within 15 minutes practices.

2.5.7. Portability Requirements

The system will be portable as long as the hardware/ software requirements met. The minimum OS could be windows 10 while the system can also run on windows 11 and any upcoming OS of windows in the future.

2.5.8. Efficiency Requirements

The system ensures efficient and timely access to student roll number information through the NFT-based solution, minimizing retrieval delays and optimizing data processing. Additionally, the project focus on scalability and resource optimization to handle a large number of students and streamline student identity management processes.

2.6. Domain Requirements

The system should meet the database requirements for secure and efficient data storage.

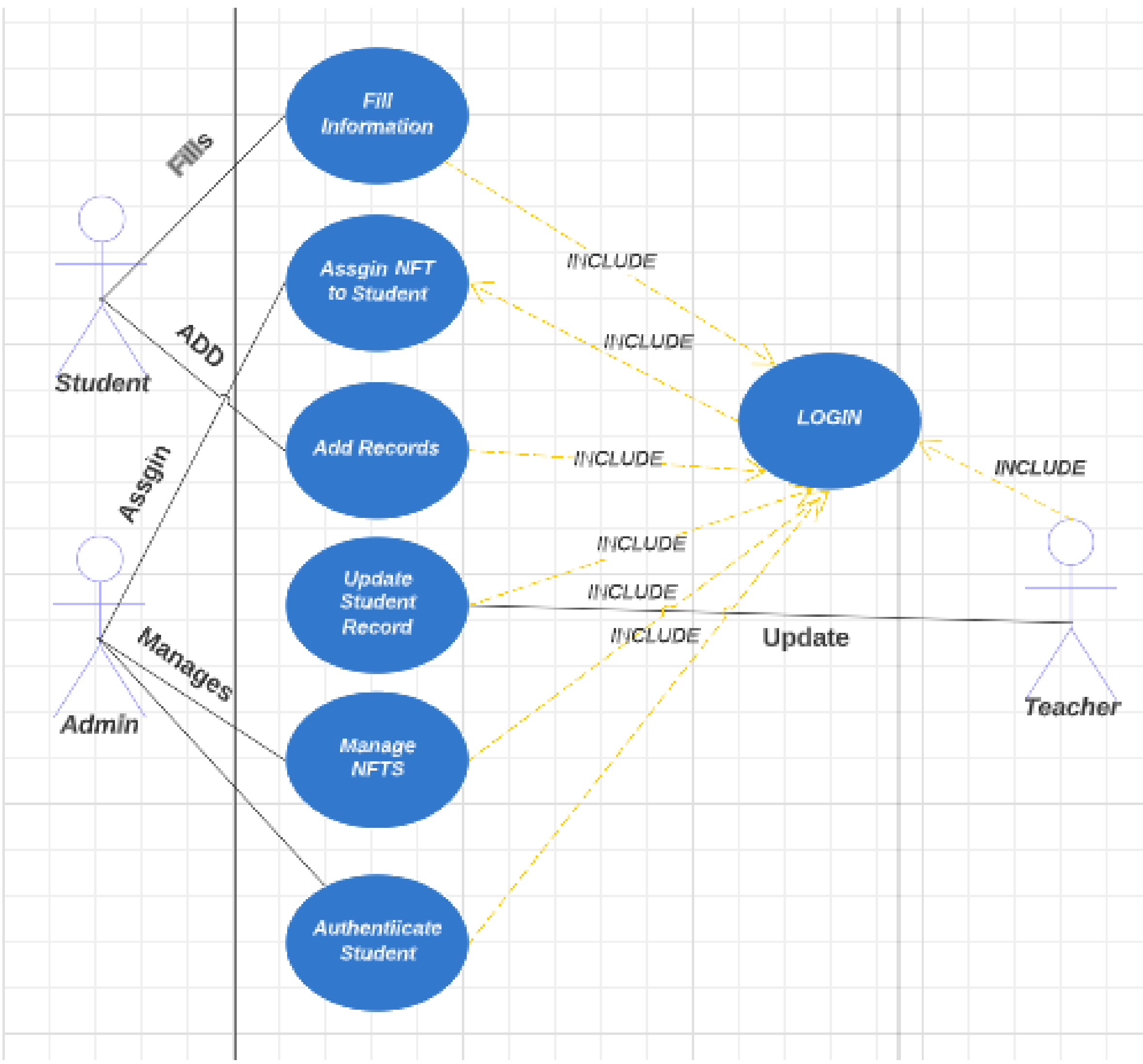
Chapter 3

Use Case Analysis

Chapter 3: Use Case Analysis

This chapter is all about the roles and functionalities of the system and its actors in the use case form. All the primary and secondary actors with respect to their responsibilities. We have made a use case diagram in which we've properly defined each and every functional and nonfunctional requirement according to the respected id or levels. In the use case given below explains the relation between actors and their functionalities.

3.1. Use Case Model



3.2. Use Cases Description

Fill Student Information: The student fills in their personal and academic information using the Dapp.

Assign NFT to Student: The admin assigns an NFT to a student.

Update Student Records: The teacher updates the student's records, such as marks or grades.

Manage NFTs: The admin manages the creation, mint, assignment, and tracking of NFTs.

Authenticate Student: This Dapp verifies the student's identity during the login process.

Actors:

Student: Interacts with the Dapp to provide personal and academic information.

Admin: Assigns NFTs to students and manages NFT-related operations.

Teacher: Updates student records, such as marks or grades.

Use Case Connectors:

"**fills":** Connects the Student actor to the Fill Student Information use case.

"**assigns**": Connects the Admin actor to the Assign NFT to Student use case.

"updates": Connects the Teacher actor to the Update Student Records use case.

"manages": Connects the Admin actor to the Manage NFTs use case.

"authenticates": Connects the Student actor to the Authenticate Student use case.

Components:

Student Dapp: The application used by students to provide their information, interact with NFTs, and authenticate themselves.

NFT Management: Manages the creation, assignment, and tracking of NFTs.

Student Records: Stores and manages the student's academic records, including marks, grades, and other relevant information.

Authentication System: Verifies the student's identity during the login process.

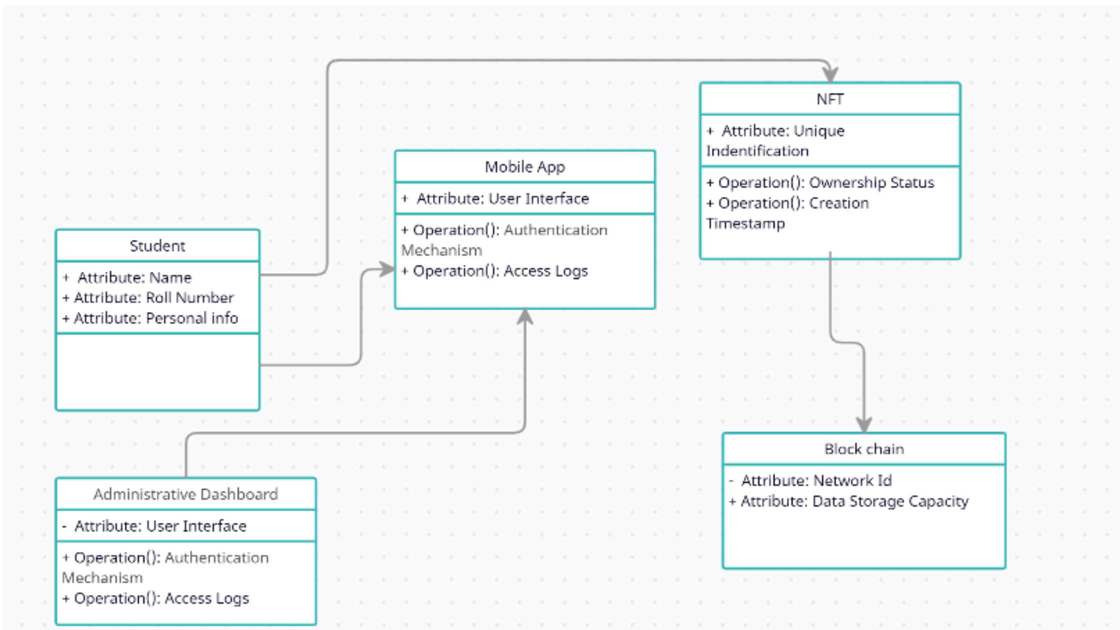
Chapter 4

System Design

Chapter 4: System Design

In this chapter we have covered all the diagrams that are needed for system design like architecture diagram, entity relationship diagram, class diagram, deployment diagram, collaboration diagram, activity diagram and state transition diagram etc.

4.1. Domain Model



4.2. Entity Relationship Diagram with data dictionary

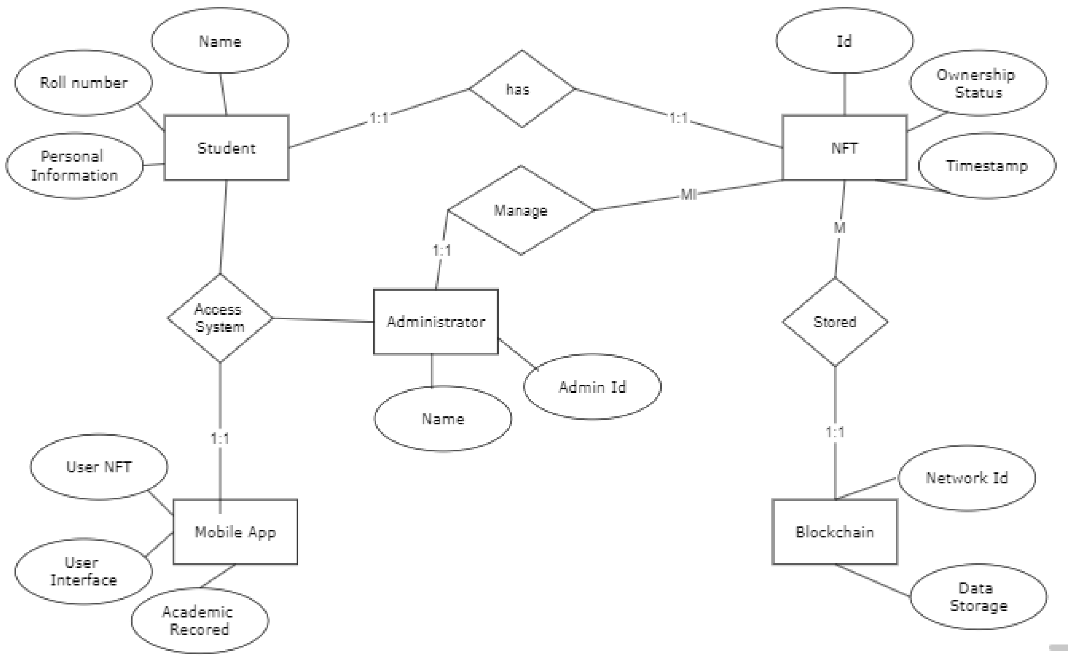


Table Entity: Student

Attribute	Data Type	Data Format	Field Size	Description
Student ID	Integer	N/A	4 bytes	A unique identifier assigned to each student.
Name	String	Text	100 characters	The name of the student.
Roll Number	String	Alphanumeric	10 characters	The unique identification number assigned to the student.

Personal Information	String	Text	Varies	Additional details about the student, such as address, contact information, and date of birth.

Table Entity: NFT (Non-Fungible Token)

Attribute	Data Type	Data Format	Field Size	Description
NFT ID	Integer	N/A	4 bytes	A unique identifier associated with the NFT.
Student ID	Integer	N/A	4 bytes	A reference to the student the NFT is tied to.
Creation Timestamp	DateTime	YYYY-MM-DD HH:MM:SS	N/A	The timestamp indicating when the NFT was created.
Ownership Status	String	Text	20 characters	A flag indicating the ownership status of the NFT (e.g., active, revoked).

Entity: Mobile App/Web Portal

Attribute	Data Type	Data Format	Field Size	Description
Interface ID	Integer	N/A	4 bytes	A unique identifier for the mobile app/web portal.

Design	String	Text	Varies	Details about the visual design and layout of the interface.
Functionality	String	Text	Varies	Describes the features and capabilities of the mobile app/web portal.
Authentication Mechanism	String	Text	Varies	The method used to authenticate users accessing the system.

Entity: Blockchain

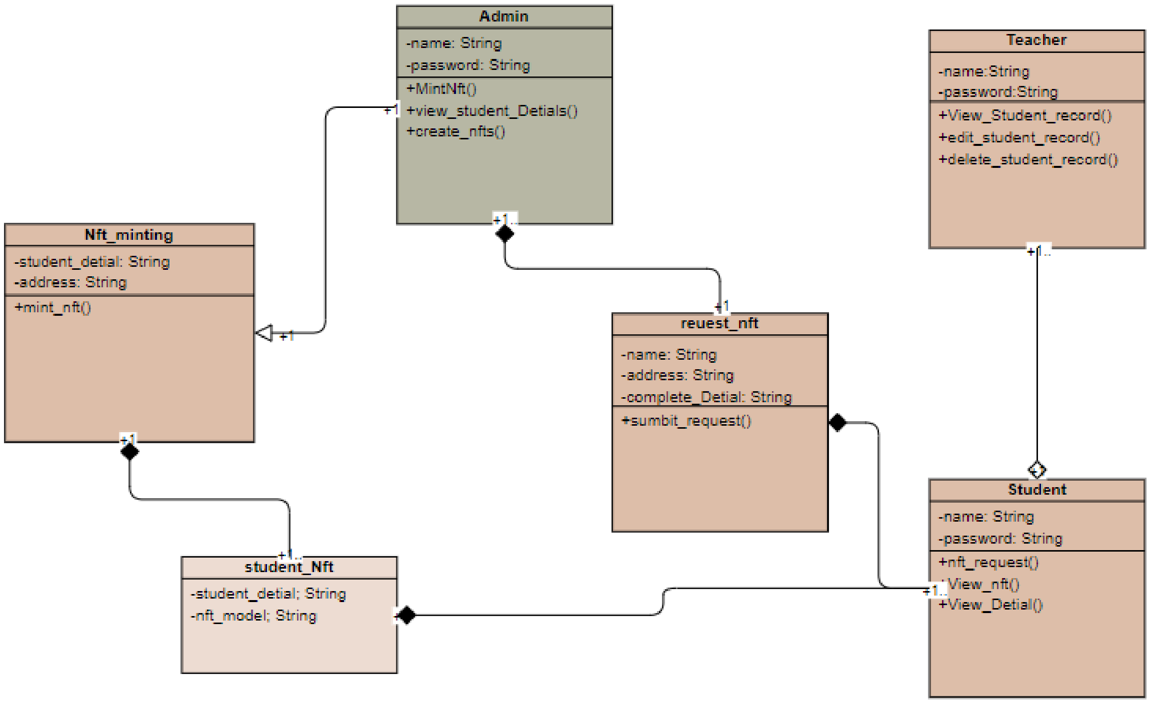
Attribute	Data Type	Data Format	Field Size	Description
Network ID	Integer	N/A	4 bytes	An identifier for the private blockchain network used by the institution.
Security Features	String	Text	Varies	Details about the security measures implemented in the blockchain network.
Data Storage Capacity	Integer	N/A	4 bytes	Information about the capacity of the blockchain network to store NFTs and related data.

Entity: Administrator

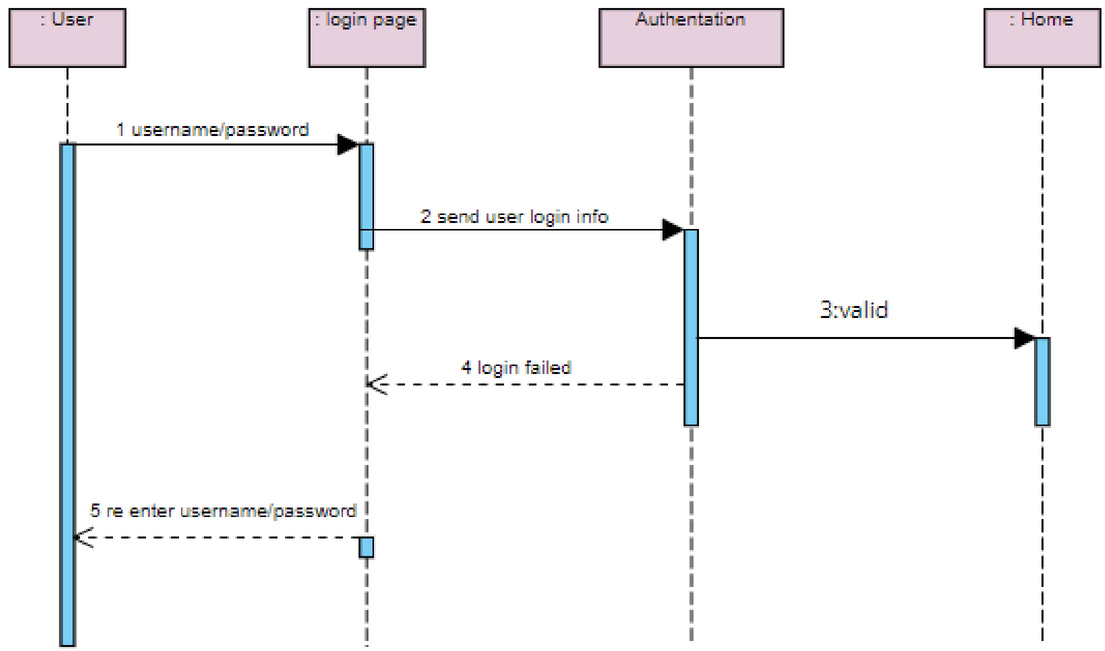
Attribute	Data Type	Data Format	Field Size	Description

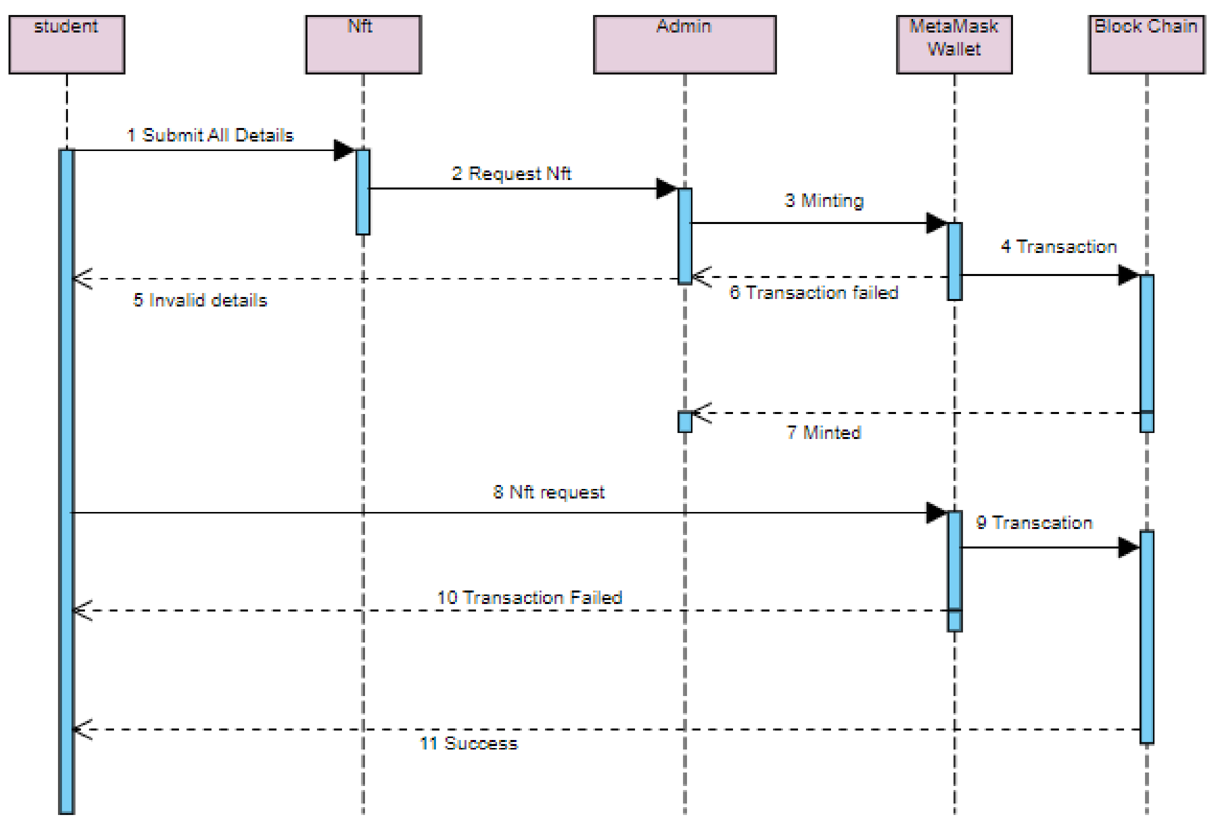
Administrator ID	Integer	N/A	4 bytes	A unique identifier for each administrator.
Name	String	Text	100 characters	The name of the administrator.
Role	String	Text	50 characters	Specifies the role or position of the administrator.
Administrative Permissions	String	Text	Varies	Information about the different levels of access and permissions for administrators.

4.3. Class Diagram

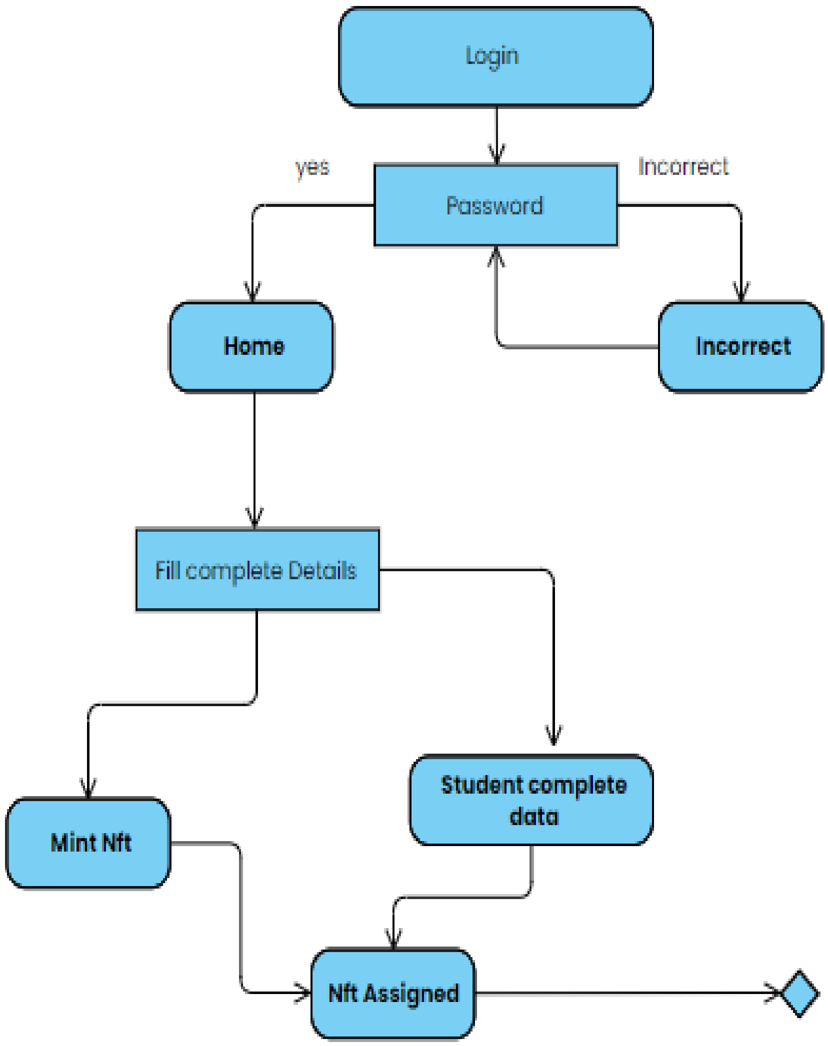


4.4. Sequence / Collaboration Diagram

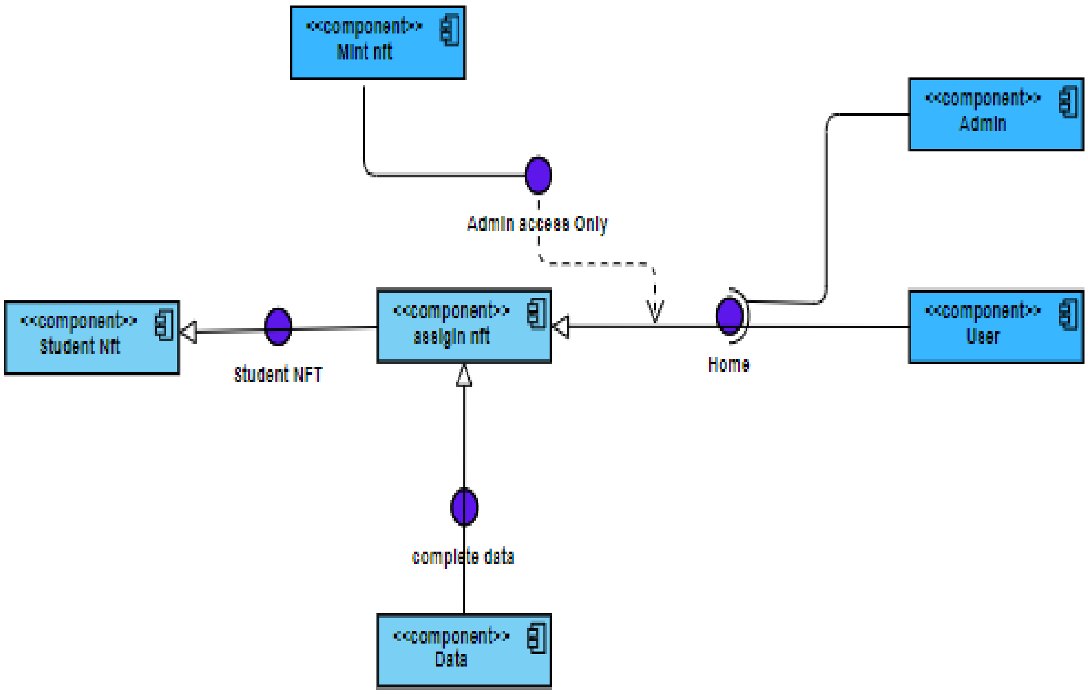




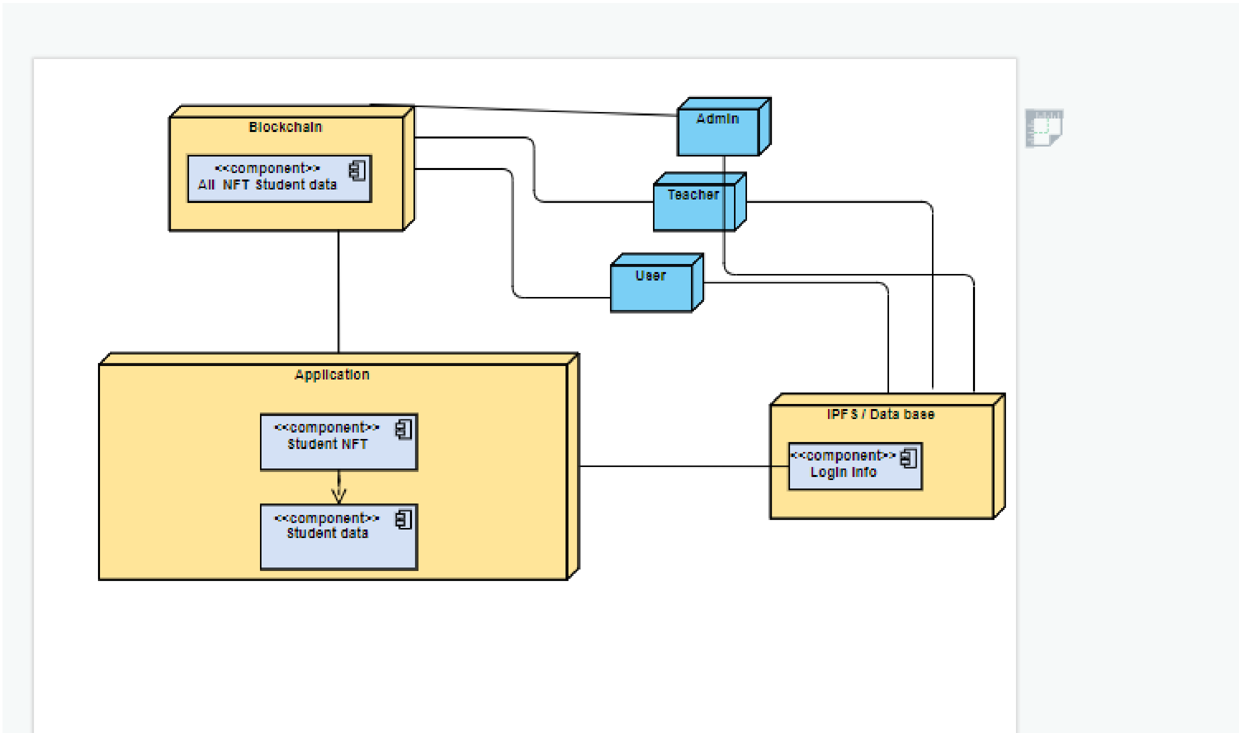
4.5. Activity Diagram



4.6. Component Diagram

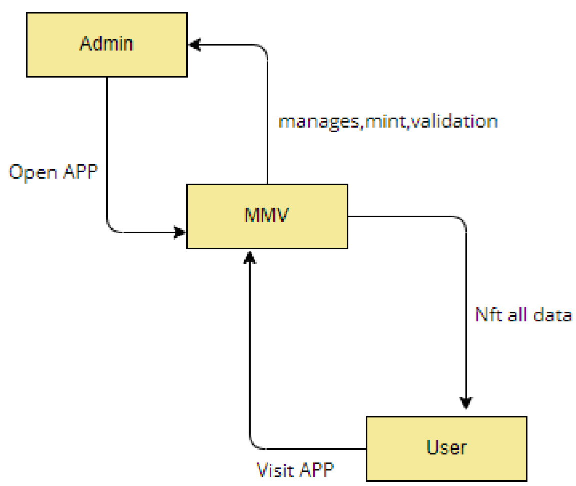


4.7. Deployment Diagram

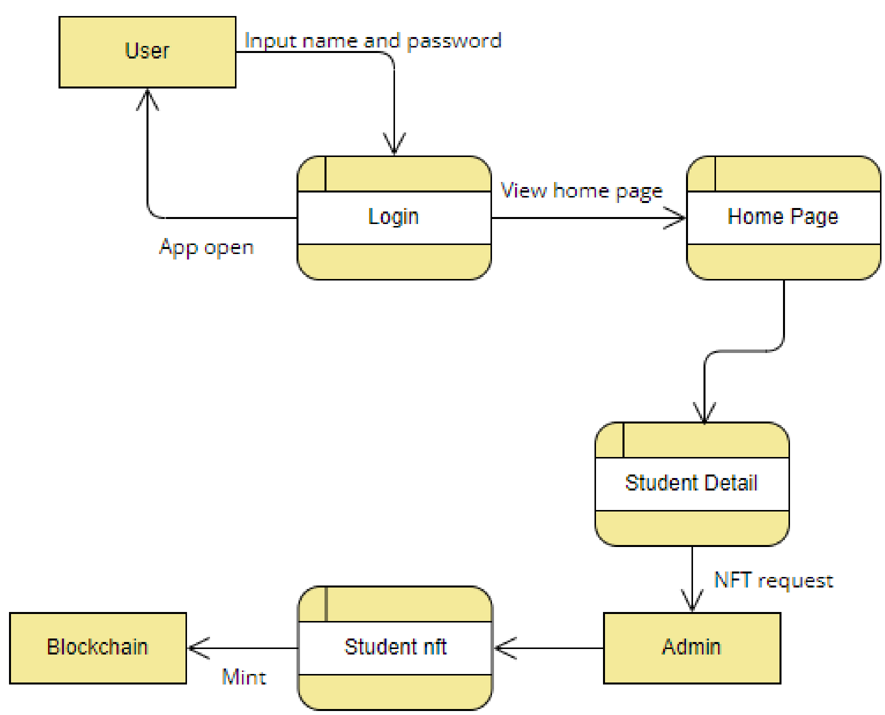


4.8. Data Flow diagram

Level 0



Level 1



Chapter 5

Implementation

Chapter 5: Implementation

In Implementation method, Student will enter essential information in form. After that, Admin will receive request by the student that he/she requested his/ her NFT. Admin will check all the essential information of student. After checking all the points, Admin will Mint NFT. Admin will be redirected to Meta Mask Wallet, he/she will pay Ethereum gas fee. This whole process will be done by NFT Minting Smart Contract and NFT Ownership Transfer Smart Contract.

5.1. Important Flow Control/Pseudo codes

- Login/Sign Up
- Student's complete data
- Student fill required information and submitted to the admin
- Admin verify the student data and assign student NFT
- Student can see complete record
- Teachers update student records like marks and attendance etc.

5.2. Components, Libraries, Web Services and stubs

Components:

- **Blockchain Platform**: Choose Ethereum, Binance Smart Chain, or Hyperledger for NFT-based student identification.
- **Database**: Select MySQL, or IPFS to store student information and link it to NFT tokens.
- **Mobile/Web Application**: Develop a user-friendly app or web portal for students to access NFT-based identification.

Libraries:

- **Blockchain SDK/Library**: Use a platform-specific SDK or library to interact with the blockchain, create NFTs, and manage token operations.
- **Identity Management Libraries**: Employ libraries or frameworks for authentication, access control, and security management in the system.

Web Services:

- **External APIs**: Integrate with external APIs to retrieve additional student information like enrollment status and course details. Additionally, leverage APIs to enable specific functionalities such as sending notifications and integrating with other institutional systems.

Stubs:

- **Blockchain Stub**: Simulate blockchain behavior for testing without live transactions.

External Service Stubs: Mimic external services to facilitate development and testing.

5.3. Deployment Environment

Front End:

We have designed front end using Figma and developed this design using visual studio code for web application. Web Application is based on React Js. Both Figma design and developed app are responsive on all devices. With increasing end user expectations in relation to the quality, expressiveness and performance of decentralized applications, we have given more attention tosatisfy the customer.

Back End:

For Blockchain, we are using solidity language for developing of smart contacts: NFT MINTING and NFT TRANSFER. Where all the data stored is on Ethereum Blockchain. Also, we are using IPFS server for meta data uploading.

For Web Application we are using Google Cloud Computing's Module i.e., mySQL for storage of student's details. And Using Google Map API for drawing polygon.

5.4. Tools and Techniques

Tools:

- Vs Code (Front End Development)
- Vs Code (Back End Development)
- Figma (UI Design)
- Ethereum Blockchain
- mySQL (User Auth and Data Storage)
- React Js (Web App Development)
- IPFS for Meta Data Uploading

5.5. Best Practices / Coding Standards

- Consistent Naming, Modular Code.
- Comments and Documentation.
- Error Handling.
- Code Formatting.
- Code Review.
- Security Considerations.
- Testing.
- Version Control.
- Performance Optimization.

5.6. Version Control

Version control manages code changes over time. It includes features like repositories, commits, branching, merging, conflict resolution, history tracking, and collaboration. Git, Subversion, and Mercurial are popular version control systems. It helps developers work efficiently, track progress, and collaborate effectively.

Chapter 6

Testing and Evaluation

Chapter 6: Testing and Evaluation

In the "BlockArt Selfdom" project, testing and evaluation play a crucial role, particularly for its blockchain and NFT-based system. This phase ensures the system's reliability, verifying that it functions as expected under various scenarios. Security is a focal point, given the system's handling of sensitive digital identities, requiring rigorous testing of smart contracts, encryption methods, and access controls. Performance testing is equally vital to maintain high efficiency, especially in processing transactions and accessing student records. Overall, this comprehensive testing approach aims to establish the system as a reliable, secure, and efficient solution for managing student identities in educational institutions.

6.1. Use Case Testing

Use case testing involves testing the system's functionalities by simulating real-life scenarios. In the context of "BlockArt Selfdom," this might include testing the process of minting NFTs for student identities, registering and updating student records, and ensuring secure access to these records. The objective is to validate that the system meets its intended purposes from the user's perspective.

6.2. Equivalence partitioning

Equivalence partitioning is a method where input data is divided into equivalent partitions to reduce the total number of test cases. For example, input data for student information could be categorized into valid, invalid, and boundary cases. This method ensures efficient testing by covering all possible input scenarios with a minimal set of test cases.

6.3. Boundary value analysis

Boundary value analysis focuses on testing the edges of input ranges. In "BlockArt Selfdom," this might involve testing the limits of student data fields (like maximum characters in names, boundary dates in academic records), ensuring the system correctly handles data at these boundary points.

6.4. Data flow testing

Data flow testing in "BlockArt Selfdom" would focus on the paths that data takes through the system. This includes tracing how student data is input, processed, stored in the blockchain, and retrieved. The goal is to ensure data integrity and correct data processing throughout these paths.

6.5. Unit testing

Unit testing involves testing individual components or units of the software independently. For a blockchain-based system, this could mean testing individual smart contracts, functions within the smart contracts, and modules of the user interface to ensure they function correctly in isolation.

6.6. Integration testing

Integration testing checks how different modules or services of the system work together. In the case of "BlockArt Selfdom," it would involve testing the integration of smart contracts with the front-end interface, the synchronization of blockchain transactions with the database, and the interaction between user authentication and data access modules.

6.7. Performance testing

Performance testing assesses how the system performs under various conditions. This includes testing the speed and efficiency of blockchain transactions, the responsiveness of the user interface, and the system’s capacity to handle a large number of concurrent users or transactions.

6.8. Stress Testing

Stress testing pushes the system beyond its normal operational capacity to see how it behaves under extreme conditions. For "BlockArt Selfdom," this might involve simulating a high volume of simultaneous blockchain transactions or a surge in user access requests, to identify the system's breaking point and how it recovers from such scenarios.

Chapter 7

Summary, Conclusion and Future Enhancements

Chapter 7: Summary, Conclusion & Future Enhancements

7.1. Project Summary

The "BlockArt Selfdom" project embarked on an innovative journey to integrate blockchain technology and Non-Fungible Tokens (NFTs) into the realm of educational identity management. The primary goal was to create a decentralized, secure, and efficient system for managing student identities and academic records using blockchain. The project involved developing a user-friendly interface for students and administrators, creating smart contracts for the secure and transparent handling of data, and implementing NFTs to represent unique student identities. This integration of cutting-edge technology aimed to revolutionize how educational institutions handle and secure student data, ensuring authenticity, privacy, and ease of access.

7.2. Achievements and Improvements

The project achieved several milestones, including the successful creation of a blockchain-based system for storing student data, the implementation of NFTs representing student identities, and the development of a robust user interface. The system demonstrated significant improvements in data security, transparency, and integrity over traditional methods. The use of blockchain technology ensured that student records were immutable and traceable, while NFTs introduced a novel way of representing and managing student identities. The user interface was designed for simplicity and ease of use, allowing seamless interaction for users with varying levels of technical expertise.

7.3. Critical Review

The "BlockArt Selfdom" project, while innovative and successful in many aspects, also presented challenges and learning opportunities. The integration of blockchain and NFTs in an educational setting was a complex task, requiring careful consideration of data security, system performance, and user experience. The project highlighted the need for balancing technological innovation with practical usability. While the system excelled in security and data integrity, the challenges related to blockchain scalability and user interface design were notable. The project served as a valuable case study in the application of emerging technologies in education.

7.4. Lessons Learnt

One of the key lessons from this project was the importance of thorough research and planning in implementing new technologies. The complexities of blockchain and NFTs required a deep understanding of their workings and implications. The project also underscored the significance of user-centric design; ensuring the system was accessible and intuitive was as crucial as its technological robustness. Additionally, the project highlighted the necessity of comprehensive testing and iterative development to refine the system continually.

7.5. Future Enhancements/Recommendations

Looking forward, the "BlockArt Selfdom" project opens several avenues for enhancement and further research. Future iterations could explore the integration of advanced blockchain functionalities, such as smart contract optimization for greater efficiency and scalability. The system could be expanded to include more interactive features, like digital badges or certificates as NFTs. Interoperability with other educational platforms and blockchain networks is another potential area of development. Additionally, incorporating advanced analytics for educational insights and further refining the user experience would significantly enhance the system's utility and adoption.

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