

NOIDA INTERNATIONAL UNIVERSITY

NFT Marketplace Application using Blockchain

Project report submitted
in partial fulfillment of requirement for the degree
of

Bachelor of Computer Science

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DECLARATION

I hereby certify that the work which is being presented in this Project Report entitled (“**NFT-MARKETPLACE USING BLOCKCHAIN**”), in partial fulfillment of the requirement for the degree of **BCA**, submitted to the Department of Computer Science (School of Sciences) of Noida International University, Plot No-1, Sector-17A, Yamuna Expressway, Gautam Budh Nagar, Uttar Pradesh- 201310, is an authentic record of my own work carried out during a period from 2020 to 2023 under the supervision of **Dr. Deepika Sharma, (Assistant Professor Dept. of Computer Science and IT)**.

The matter presented in this project report has not been submitted by me for the award of any other degree elsewhere.

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ABSTRACT

Non-fungible tokens (NFTs) are transferrable rights to digital assets, such as images, videos, or music. The phenomenon and its markets have grown significantly since early 2021. The number of NFT marketplaces has been rising continuously since a couple of years. Majority of them employ centralized systems for storage of digital assets (files). This is contradictory to the notion of decentralized systems. In this project we propose a secure platform for trading digital assets in the form of non-Fungible tokens. It will enable the users to create new digital assets and trade them in exchange of Ethereum-based cryptocurrency. Along with this, we aim to explore technical feasibility of a decentralized file system (using IPFS protocol) for storing the digital assets in a more secured way. In this way, we attempt to address the issue of file storage. Also, this project is an attempt to advocate the use of block chain technology.

. This platform is an NFT marketplace where that we buy or sell artifacts virtually by paying some Cryptocurrency but here, there is no limitations at all. You may find anything unimaginable listed on the site. The transaction process works on a smart contract that is the heart of the NFT Marketplace. once a NFT is sold, the new owner's metawallet address is attached or given automatically to it until he himself list the same product by being seller. The application provides a listing feature for sellers where they can list the Name of the product and the price they want in exchange. Also for buyers there is a list of NFTs that they can buy and acquire its ownership. The main emphasis lies in providing a platform where users can buy or sell their art in the form of NFTs to hold their cryptocurrency with the ease and security of Blockchains.

Certificate

This is to certify that:

Mr. ASHISH PRAKASH Son of MR. ANAND PRAKASH PRF No. 20013751
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Blockchain**. This project is part of partial fulfillment of requirement for the
degree of Bachelors of computer Application.

To the best of my knowledge and belief, this is the original work and has not been
submitted for any other degree in any other university.

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Abbreviations:

Here are the abbreviations that have been used in the project:

IPFS: Inter Planetary File System

DAPP: Decentralized Application

USD: United States Dollars

MB: Megabytes

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1. Introduction

Blockchain is surely the next big thing. What makes blockchain special is its “decentralized” nature. Blockchain can be used for removing the third party in any field. Hence, it can have a major impact on Marketplace. There are huge firms involved in the digital marketplace, which simply act as a mediator between buyers and sellers. We are not only paying a significant amount for each buy but also, giving an enormous amount of information about us for free to them, without any knowledge. They very well know our likes and dislikes. With the amount of money and data they have, they are probably controlling everything. This is where Blockchain comes in handy by removing the “Middleman”. But, data storage in Blockchain is way more costly than we can think of. Here, IPFS comes to aid, which is a peer-to-peer file system. IPFS is like the sister of Blockchain and if both are combined, we can reach unimaginable heights. This project is about a small-scale NFT marketplace using IPFS, HARDHAT, PINATA, ALCHEMY and Blockchain. It is a two-way marketplace. A seller can list the artforms in the form of NFTs he/she wants to sell (with all the specifications) and a buyer can put his wants in it, thus making the marketplace user-friendly. All the details of "wants" and "haves" will be stored in the IPFS. Then, what's the use of blockchain here? IPFS converts the whole of the file into a hash, which is very difficult to understand for anyone. Hence, Blockchain will be the one storing the goods' names and their corresponding hash as normal transactions. Blockchain makes this data tamper-proof, hence keeping a good status of the whole of the marketplace. If someone wants to see any item, then he can use the hash, download the file and see the whole of the file. If a person likes the item, he can approach the seller straightaway through his metawallet address and buy the item by buying the NFT. Thus, there is a significant reduction in price in buying an item, without any breach of privacy.

1.1 Current scenario of internet

In this age, it's impossible to imagine a day without internet. May it be social media, transferring money, acquiring information or buying things internet always comes to the aid. What makes internet special is the way it works. Let's have a look at its working. We type in something in the search bar and on clicking the button, request for some information about the typed data. The data which we want is stored in HUGE computers which are known as "Servers". The big firms in the internet act as the servers. These firms have all the data that an internet-user needs. Hence, they are able to provide such good results. Once, we make the request, the requested data is searched in "Servers". The most relevant results are then returned to us in our Web Browser. This looks absolutely fine. All the big firms seem to provide us with the results, we want. It doesn't end here. These firms have made internet better than by giving us better recommendations each day. The current scenario of the Internet seems fine.

1.1.1 Fungible and Non-fungible

Familiarity with the concept of fungibility in economics might help one better understand fungible and NFTs (non-fungible tokens). The only difference is that crypto tokens express their fungibility property through a code script.

Fungible tokens or assets are divisible and non-unique. for instance, fiat currencies like the dollar are fungible: A \$1 bill in New York City has the same value as a \$1 bill in Miami. A fungible token can also be a crypto currency like Bitcoin: 1 BTC is worth 1 BTC, no matter where it is issued.

Non-fungible assets, on the other hand, are unique and non-divisible. They should be considered as a type of deed or title of ownership of a unique, non-replicable item. For example, a flight ticket is non-fungible because there cannot be another of the same kind due to its specific data. A house, a boat or a car are non-fungible physical assets because they are one-of-a-kind.

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The main difference between fungible assets and non-fungible assets resides in the content they store. While fungible tokens like Bitcoin store value, non-fungible tokens store data like an academic title or an artwork.



Figure 1 – Fungible & Non-Fungible example

1.1.2 Existing NFT Marketplaces Using Blockchain Technology

Before embarking in our idea, we wanted to see what work other people had done using Blockchain Technology to implement marketplaces. When most people think about Blockchains, they think about Bitcoin, and when people think about Bitcoin and marketplaces they think illicit transactions in the infamous Silk Road Market. However, while the Silk Road is gone not everything from it is completely gone. Opensea (<https://opensea.org>), a code fork of the Silk Road, continues to run until today. Furthermore, new companies are exploring Blockchain Technology in the marketplace and have released products like the Origami Network (<https://ori.network>). There are also several groups brainstorming ideas similar to what we did, but without much to show for it other than opening to an ICO as is the case with Multiven.io (<https://www.multiven.io>) who does not inspire much confidence doing an ICO in 2019 after all of the scam coins that have done ICO in the past few years.

1.1.3 Origami Network

The Origami Network is a protocol for building a Web site marketplace using the Ethereum Blockchain. However, it forces users to use Origami's own proprietary cryptocurrency, coin, known as Ori. The system uses a smart contract, like our project, to serve as an escrow system that will hold the funds transferred from the buyer to the seller until certain conditions are met. However, the platform is aimed more at serving as an alternative payment system to VISA or PayPal for small independent Web sites who want to sell their items and save money over VISA, with the advantages of being transparent on their sales with the use of the Blockchain. Unfortunately, there is still a centralized server.

1.1.4 Alchemy

Alchemy on the other side is a peer-to-peer network, using the Inter Planetary File System (IPFS) for hosting the Web marketplaces. It will directly connect A buyer to a seller's server

hosting their storefront. It uses multi signature escrow with Bitcoin to handle transactions. There are no smart contracts here, as Bitcoin cannot have them. Instead, funds are sent to an escrow account where three parties have a signature: the seller, the buyer, and a moderator. Using the multi signature, only two signatures are required to release the funds to a party. Normally, the buyer and seller can both sign and release funds to the seller, but in the case of a dispute, a moderator can sign and side with one party. This is all pending that the moderators are trustworthy and fair, a fair assumption. The decentralized nature of peer-to-peer and the multi signature allows for a decentralized NFT marketplace with an escrowed system for transferring cryptocurrency in exchange for goods. However, in order to search and view storefronts, it requires a centralized search engine. Opensea has a curated one that tries and maintains only legal goods; unfortunately, there is another search engine that contains more colorful items. This after all, is a fork of the Silk Road code infamous for selling drugs and weapons. Nevertheless, similar to The Onion Router (TOR), the necessity to maintain a centralized search engine limits the ability to truly be a decentralized marketplace. This in addition to the lack of smart contracts limits Open Bazaar to really be expanded to do more than a crude bazaar.

1.2 Applying Blockchain Technology to a World of Problems

Whenever someone hears the word Blockchain, they automatically assume cryptocurrencies, and while that has been a greatly successful and controversial use of Blockchain Technology, it is not all Blockchain Technology has to offer. While the crypto craze bubble grew and burst several times since its inception, with the most notable one being in January 2018, Blockchain Technology is still in its infancy in terms of applications. Exploration into the fields of healthcare recordkeeping, supply chain management and tracking, digital identity management, data sharing, copyright, voting, legal ownership, tax compliance, item tracking, equity trading, and many more is ongoing. Some of these applications have already been proven to be very successful as was the case of supply management tracking. Walmart and IBM teamed up to use Blockchain software developed by IBM to track food through the supply chain from the farmer all the way to the store. In an experiment tracing the source of sliced mangos it, “It took seven days for Walmart employees to locate the farm in Mexico that grew the fruit. With Blockchain software developed by IBM, the mangos could be tracked in a matter of seconds, according to Walmart”.

1.3 Objective of the Project

Our goal with our project is one of cost saving and efficiency increase in the form of reducing or removing any form of middleman fees. We want to automate the process of escrow for monetary transactions between buyers and sellers. We also want to reduce the human factor in arbitrating transactions unless necessary. We also want to speed up the time from a user wanting to sell an item to it being available for sale in multiple NFT marketplaces that share a common inventory database. Finally, we want to decentralize the marketplace by not having monopolies control who can and cannot sell and more importantly, what they can and cannot sell (within the limits of the law). In this project, we will cover these goals and how we tackled them in our Blockchain marketplace by explaining the user interface and workflow. Then we will discuss the system architecture and the technology behind this architecture. These include Pinata (our decentralized storage), the Blockchain (for transparent, and shared, listings and transactions), and smart contracts (for our escrow service). We then discuss the working system, the ongoing challenges, and future work.

1.4 Need of the application-

- **Lower transaction costs and higher margin for sellers.** Blockchain gas fees are determined by the protocol used and don't depend on the item's price. For example, Solana blockchain built on the proof-of-stake protocol has an average transaction cost of \$0.0000000024 and the fee will be equal for items priced \$5 and \$5,000. The fees charged by traditional payment systems are commonly higher, for example 2.59% + \$0.49 per transaction is charged by Braintree for payment with credit cards and via digital wallets. Lower transaction costs result in higher margins and profit for sellers.
- **Better privacy and security for marketplace users.** Transactional information isn't stored centrally but gets instantly encrypted on the blockchain. This makes it immune to breach and theft.

- **Flexible marketplace moderation.** Smart contracts underlie all the business logic, permissions and regulations of a marketplace so it can exist without third-party moderation if you envision uncensored and unbiased space. In this case, you can introduce a system of downvoting to trace unfavorable behavior. Still, you can retain manual moderation over certain aspects (for example, monitor the artworks being sold if you want to restrict controversial topics like violence or religion).
- **Open platform.** To provide an open platform to create NFTs of the artworks and can freely sell them anywhere anytime at the desired price.

1.5 The Issue

Where is the issue then? First question. How are these big firms able to make our internet experience better than ever? The answer is DATA. Yes, the data about us. We are giving this data to them without any prior knowledge. Everything that we type in the search bar or every link we click, proves to be a source of data, which in turn proves to be a source money for them. Isn't it a breach of privacy? But, then people would say that it isn't causing any trouble because they are using it for making our experience better. But, if we think properly it does. In a way, we are being controlled. We see what they want us to see. This has become the very nature of the internet. It has become "CENTRALISED". They have an enormous data about us. Probably, the big firms know us better than we know ourselves.

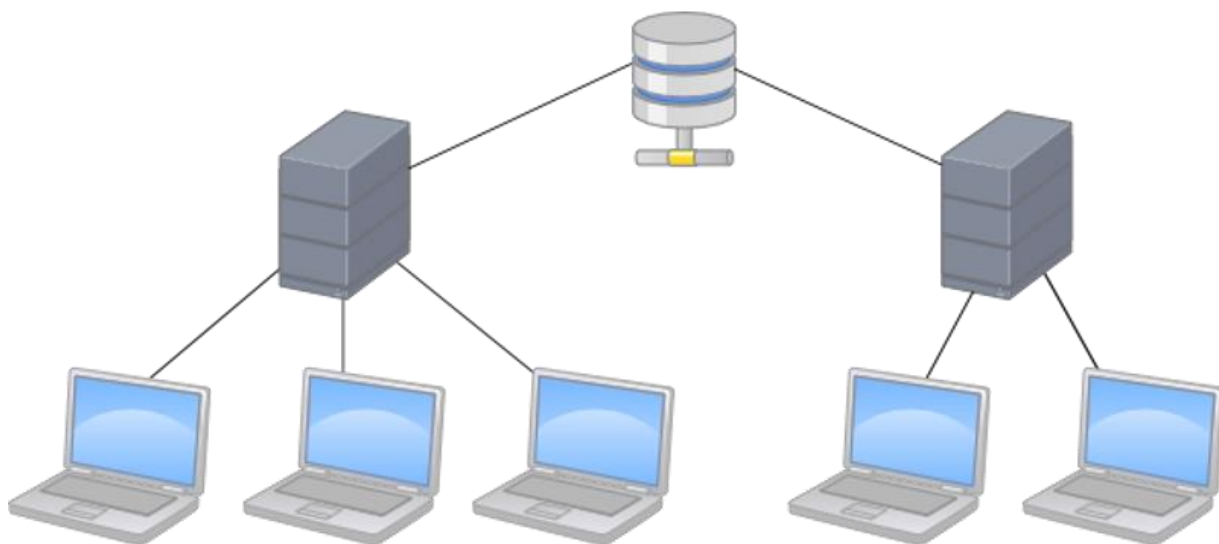


Fig 2: Pictorial representation of a Centralized database

The main drawbacks of the centralized nature of the internet are now very well evident. One of the most visited sites of internet are the e-commerce websites. They have become an integral part of our life. They act as a middleman between us and the seller. They charge both the seller and the buyer for every feature on the internet. This means anyone who is viewing something to buy, he/she is being charged, even if they are not buying. Moreover, they control the things that people see on their websites. Rather, people buy what they(the "Middlemen") want to sell. They have a huge amount of data about everyone. This is not known to everyone. We are giving information about us to them for free without any prior knowledge. Issues like website crash and Mobile App crash must have been also encountered by every internet user. Once the server goes down, we can't use the website for quite a bit of time. This project concentrates on this part of the internet, i.e., the marketplace and how to make a better overall buying and selling experience.

1.5.1 Solution of the Problem

The word "Centralized" has been used multiple times in the paragraphs above. This is where all the issue lies. So, the remedy is to make the whole thing "Decentralized". What does this mean? This implies that rather than having the Servers(like huge centers) hosting the information, the PCs that are in the network itself become a host for all the information. It sounds really very interesting because a node(a PC in the network) would act as a host and as a client at the same time.

What are the benefits? Acquiring data about someone else will become very difficult because the information that a person accesses will be scattered over the network. Next, the probability of failure of the network is bleak because there will be numerous nodes in the network and multiple nodes can host the same data. There's no way to censor data because it is distributed among the nodes. So, this type network architecture overcomes all the issues of the centralized for.

One of the system that acts as the same way is "Blockchain". A blockchain is a growing list of records, called blocks, which are connected by cryptographic hash(somewhat like a "Linked List"). The best part of it is that it is resistant to modification of data. There are many technical definitions of Blockchain. But, to put it in simple words "Blockchain" can be used wherever there is a third party involved. Hence, blockchain removes the middle man. It is a p2p network. Everyone has heard of blockchain in the field of cryptocurrency like Bitcoin, Ether, etc. That is only one of the use cases of blockchain. Like said, before it can be used anywhere there is a middleman. So, the issue of decentralization can be solved using blockchain.

So, this whole concept can be very well used in the marketplace, thus helping us to make a decentralized marketplace.

1.5.2 Advantages of NFT Marketplace

But, why should one invest in the development of a decentralized NFT marketplace? Well, we will let the advantages of a decentralized NFT marketplace answer.

- Elimination of middlemen from the marketplace for making it more efficient and cutting out their fees is among the main pros that come from using decentralized marketplaces.
- As there is no single source of data, there's a low chance of decentralized apps getting hacked. While hackers might try to penetrate the network, up until now they have rarely achieved success.
- Blockchain is not controlled by a central authority, giving censorship resistance from both government and centralized marketplaces that like to ban certain users.
- NFT marketplaces allow transparency between users, especially if the smart contract has a mutually agreed term to share data and information.
- Unlike centralized marketplaces that have to wade through banking regulations and laws for every jurisdiction to operate, a decentralized marketplace powered by blockchain gets global instantly.
- With the decentralized marketplace, value is redistributed to the ones who have contributed most to the network. This gives us a "better-than-free" economic model that rewards early users of a platform with rewards.
- It is an open and efficient way of selling artworks of the artists.

1.6 NFT Marketplace Use Cases

1.6.1 Digital Art

Despite increasing digitalization and a shift in public perception concerning digital goods, artists have found it difficult in the past to monetize their digital artworks. Like all other digital goods, artworks could easily be copied, and provenance was difficult- if not impossible-to track.

While NFTs do not prevent others from copying the digital files, they can be used to prove the artwork's authenticity, track its provenance, and indicate the rights an NFT represents permanently. Furthermore, unlike in the conventional art space, the data is publicly available on the blockchain and can therefore be accessed by anyone. Under certain circumstances, NFTs further allow artists to participate not only in the initial sale but in all future sales via royalties. As such, they may provide a permanent source of income.

1.6.2 Digital Goods

Similarly to the art use case, any assets can be represented by an NFT for some use cases; this can allow for interesting dynamics. For example, a centralized portal can create a system where the NFT gives special rights or benefits to the owner. This can create an independent and autonomous secondary market for example in the sector of video game based assets. This approach can provide to the developers a significant advantage in terms of reducing infrastructure investments to self-regulate and manage hosted items markets.

1.6.3 Physical Goods

NFTs can also be a way to certify ownership of physical goods. In this case, the possible advantage is related to leveraging a permissionless ledger to store an information that can be (centrally) verified and possibly also use the keys owning the asset to create a pseudonymous identity system. The ability to use proven open source technologies can possibly be a significant advantage in this case but significant cultural and legal differences on the topic of ownership will likely be the biggest burden in terms of establishing long lasting international standards.

1.7 Scope of Project

The reach of e-commerce websites is huge. Amazon shipped more than 5 billion items in 2017 with Prime worldwide. The reach of online marketplace is very well evident from these numbers. In addition to this, Amazon is not the only e-commerce website running in India. We have Flipkart, Snapdeal, etc. too who are doing really well. So, this DAPP will surely do well if provided the right platform. The thing that makes this application perfect for India is its large population. In addition to this, most of the population is young, which wants technological advancements.

It has been predicted that there would be about 358 million e-commerce website users in India by 2020. So, obviously the reach of this application will be brilliant. It is the solution to the centralized system.

2- Feasibility Analysis

2.1 Introduction

A feasibility study is a detailed analysis that considers all of the critical aspects of a proposed project in order to determine the likelihood of it succeeding.

Success in business may be defined primarily by return on investment, meaning that the project will generate enough profit to justify the investment. However, many other important factors may be identified on the plus or minus side, such as community reaction and environmental impact. Although feasibility studies can help project managers determine the risk and return of pursuing a plan of action, several steps should be considered before moving forward.

A feasibility study analyzes the viability of a project to determine whether the project or venture is likely to succeed. The study is also designed to identify potential issues and problems that could arise while pursuing the project.

As part of the feasibility study, project managers must determine whether they have enough of the right people, financial resources, and technology. The study must also determine the return on investment, whether this is measured as a financial gain or a benefit to society, as in the case

of a nonprofit project. The feasibility study might include a cash flow analysis, measuring the level of cash generated from revenue versus the project's operating costs. A risk assessment must also be completed to determine whether the return is enough to offset the risk of undergoing the venture.

2.1.1 Types of Feasibility

The study considers the feasibility of four aspects of a project:

Technical: A list of the hardware and software needed, and the skilled labor required to make them work.

Financial: An estimate of the cost of the overall project and its expected return.

Market: An analysis of the market for the product or service, the industry, competition, consumer demand, sales forecasts, and growth projections

Organizational: An outline of the business structure and the management team that will be needed.

Social: it includes the social aspects of the society and ensures the product or service is not hurting any person's social aspects of life.

2.2 System Feasibility

The system feasibility can be divided into the following sections:

2.2.1 Economic Feasibility

The project is economically feasible as the only cost involved is having a computer with the minimum requirements mentioned earlier. For the users to access the application, the only cost involved will be in getting access to the Internet.

2.2.2 Technical Feasibility

To deploy the application, the only technical aspects needed are mentioned below

Operating Environment: Windows 7 or IOS operating system

Platform: Visual-studio code-Editor

Database: Pinata

For Users:

Internet Browser

Internet connection

2.2.3 Behavioral Feasibility

The application requires no special technical guidance and all the views available in the application are self-explanatory. The users are well guided with warning and failure messages for all the actions taken.

3-Software Requirement Specification (SRS)

3.1 Introduction

This document describes the requirements for a decentralized marketplace application. The application will allow users to buy and sell goods and services without the need for a central authority. Basically software requirements specification (SRS) is a document explaining how and what the software/system will do. It defines the features and functionality that the product requires to satisfy all stakeholders' (business, users) needs.

A standard SRS includes:

- A goal/purpose
- A summary of the whole process
- Specific Requirements

The best SRS documents describe how the program communicates with the embedded hardware or specific software with unique coding culture. The chosen real-life users also account for nice SRS documents.

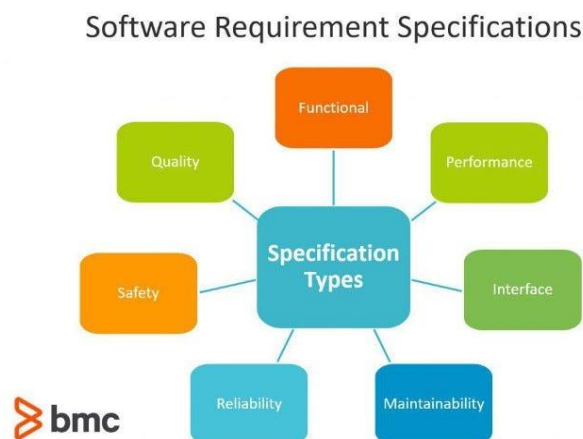


Fig:3 Specification types of a SRS document

3.1.1 What does an SRS document contain?

A typical SRS document describes all the software requirements and sometimes even contains a collection of use cases that describe the user interactions needed by the software. It defines the purpose of a software project, provides the overall definition and specifications of its features.

In general, SRS documents contain three kinds of program requirements:

- **Functional specifications** that include measures to be performed by the system.
- **Non-functional requirements** determining the software system's performance attributes.
- **Domain requirements** that are device limits on the service domain.

3.2 System Requirements

In order to get the desired Decentralized NFT application we need a bunch of cutting-edge technologies with a great understanding to use or implement them. Along with that we also need some basic hardware to built the application and test it alongside. This project needs a languages through which we can create logic for our transactions, frontend of the application, a wallet that is can be linked and a virtual blockchain environment for project purpose (EVM). The project can be divided into three parts-

1) Designing

2) Logic Implementation

3) Connecting frontend to the backend or Logic build Moreover, we need a technology to connect the meta wallets to the website and can do the transactions within seconds. We also need to connect a local Blockchain to Connect with the website for giving addresses to the NFT. Once the requirements are fulfilled, a developer is able to create this project.

The application must meet the following functional requirements:

- Users must be able to create an account and log in to the application by connecting their wallet.
- Users must be able to list NFTs for sale.
- Users must be able to see all the listed NFTs that are for sale.
- Users must be able to list NFTs from their accounts.
- Users must be able to buy NFTs from their accounts.
- Users must be able to complete transactions by paying Ethers.
- Users must be able to see their owned NFTs in their accounts.

The application must also meet the following non-functional requirements:

- The application must be secure.
- The application must be scalable.
- The application must be user-friendly.

3.2.1 Use Cases

The following use cases describe how users will interact with the application:

- User lists a NFT for sale: The user provides a description of the NFT, a price, and a Picture. The application lists the NFT for sale.
- User sees all the NFTs listed: The application returns a list of NFTs.
- User makes a purchase of his selected NFT: The user Successfully purchases the NFT.
- Seller receives the payment in the form of Ethers: the seller sells his NFT and NFT got its new owner by the application.
- Buyer completes a transaction: The buyer pays the seller. The buyer receives the good or service.

3.2.2 Acceptance Criteria

The application will be considered acceptable if it meets the following criteria:

- The application must be secure.
- The application must be scalable.
- The application must be user-friendly.

3.2.3 Deployment

The application will be deployed on a cloud-based platform called GITHUB. The application will be made available to users through a web browser.

3.2.4 Maintenance

The application will be maintained by a team of developers. The team will be responsible for fixing bugs, adding new features, and updating the application to keep it secure and up-to-date.

This is just an example of an SRS document for a decentralized marketplace application. The specific requirements for your application will vary depending on the features you want to include.

3.2.5 Hardware Specification

Processor: i3 or higher

RAM 250 MB

Minimum Space Required 100 MB

Display 16-bit color

3.2.6 Software Specification

Operating Environment: Windows 7 or IOS operating system

Languages Used: **Solidity, Reactjs, Javascript, HTML, CSS and Bootstrap 4**

Platform: Visual Studio Code-Editor

Database: Pinata and Nodejs server

3.3 Methodology Used to build the Application:

we have used the waterfall approach to build this application developing it step-by-step with one task contributing to the next.

The waterfall approach is a traditional methodology that's not very common in software development anymore. For many years, the waterfall model was the leading methodology, but its rigid approach couldn't meet the dynamic needs of software development. It's more common to see the waterfall method used for project management rather than product development. At the beginning of a project, project managers gather all of the necessary information and use it to make an informed plan of action up front. Usually, this plan is a linear, step-by-step process with one task feeding into the next, giving it the "waterfall" name. The approach is plan-driven and rigid, leaving little room for adjustments. It's more or less the opposite of agile, prioritizing sticking to the plan rather than adapting to new circumstances.

The development process of our NFT Marketplace Dapp involved several key stages, including designing the user interface, implementing smart contracts on the blockchain, integrating with third-party APIs, and conducting testing and evaluation. In this section, we provide a detailed overview of each stage, including the tools and technologies used, the challenges encountered, and the solutions developed. Additionally, we describe the methodologies used for connecting users' wallets securely, generating unique NFTs using deep learning models, minting NFTs on the blockchain, developing the marketplace for trading NFTs, and creating user profiles to manage NFT collections. By providing a comprehensive account of our development process, we aim to provide insights and best practices for building user-friendly and secure Dapps for managing and trading digital assets on the blockchain.

4- Design and Architecture of the Project

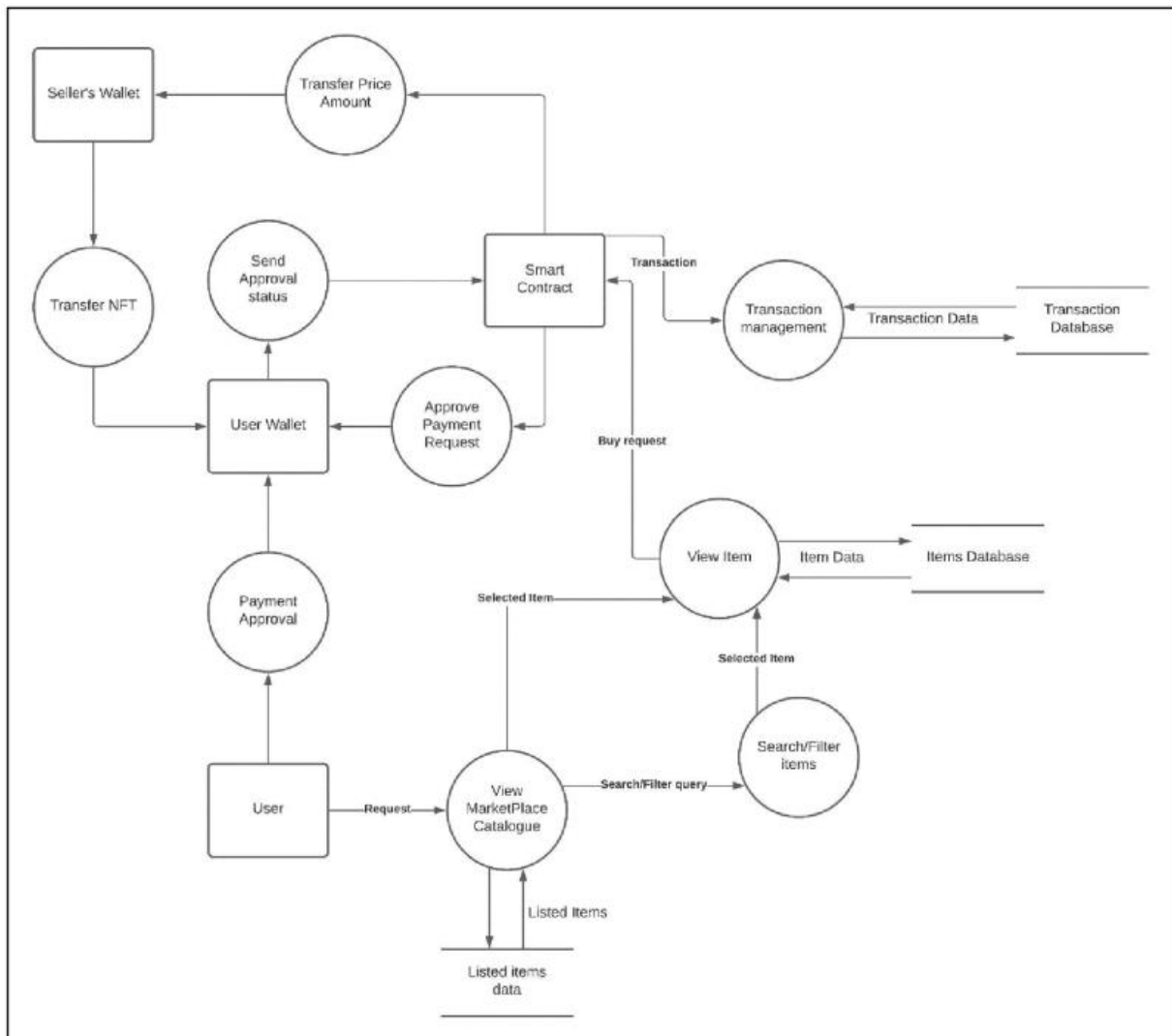


Fig 4: An overview of the architecture and information flow

The main goal that we wanted to achieve in our marketplace was to decentralize everything as much as possible:

- **Blockchain:** Decentralize the escrow service and information access. We use the Ethereum Blockchain for this.
- **Pinata:** We wanted to avoid a centralized database for Webhosting.

- Multiple frontend marketplaces: Allow sellers to have multiple storefronts by allowing multiple frontends to use the same shared backend Blockchain and Pinata data to resolve a seller having to maintain an inventory on each storefront that is not shared.
- Open source: We want transparency on development and the ability to collaborate with the community by democratizing development.

The way this was achieved can be seen in Fig. Each marketplace has its own Node.js server that serves the frontend that the users, buyers, and sellers interact with. Through this system, sellers can create and upload listing information while buyers can browse current listings and purchase NFTs. Information is stored in both the Blockchain and IPFS data structures. This information is served via the Node.js server. When a seller wishes to create a listing, larger-sized items like images will be stored in Pinata along with a hash that matches the product listing. At the same time, key information such as product ID and transaction details will be stored on the Blockchain along with the same hash in order to create information integrity between Swarm and the Blockchain. Information is stored in the Blockchain through state variables.

The Node.js server does not communicate directly to the Blockchain, it uses smart contracts as a way to bridge communication between the Blockchain and the Node.js server. Therefore, if a user creates a listing for a phone, images and product descriptions of the phone are stored on Pinata, which returns a hash value of the content stored.

This hash value along with other product information—such as product ID, price, and other key details that would normally be found in a sale’s receipt—are stored on the Blockchain through smart contracts. When a seller browses an item, he connects to the Node.js server, which then accesses the product information, including the Pinata hash, from the Blockchain via the smart contract, and then the Pinata hash is used to fetch the images and description from the Pinata node into the Node.js server, which is then served to the client.

In short, when adding a product, Node.js interacts first with Pinata and then the smart contract, when browsing, or fetching information, server calls the smart contract and then Pinata. If the buyer decides to make a purchase, the Node.js server tells the smart contract to create a new transaction, which is then written in the next block generated in the Blockchain. In this case, Pinata is not affected unless it needs to update images to display a sold-out symbol or anything

of the sort. Next, the buyer deposits funds to cover the purchase to the smart contract's address which then holds the funds until the seller ships the item and the buyer receives the item and releases the funds from the smart contract into the wallet of the seller. There can be Multiple Node.js servers communicating with the same shared Blockchain and Pinata to represent multiple marketplaces for a truly decentralized system.

4.1 ER Diagram

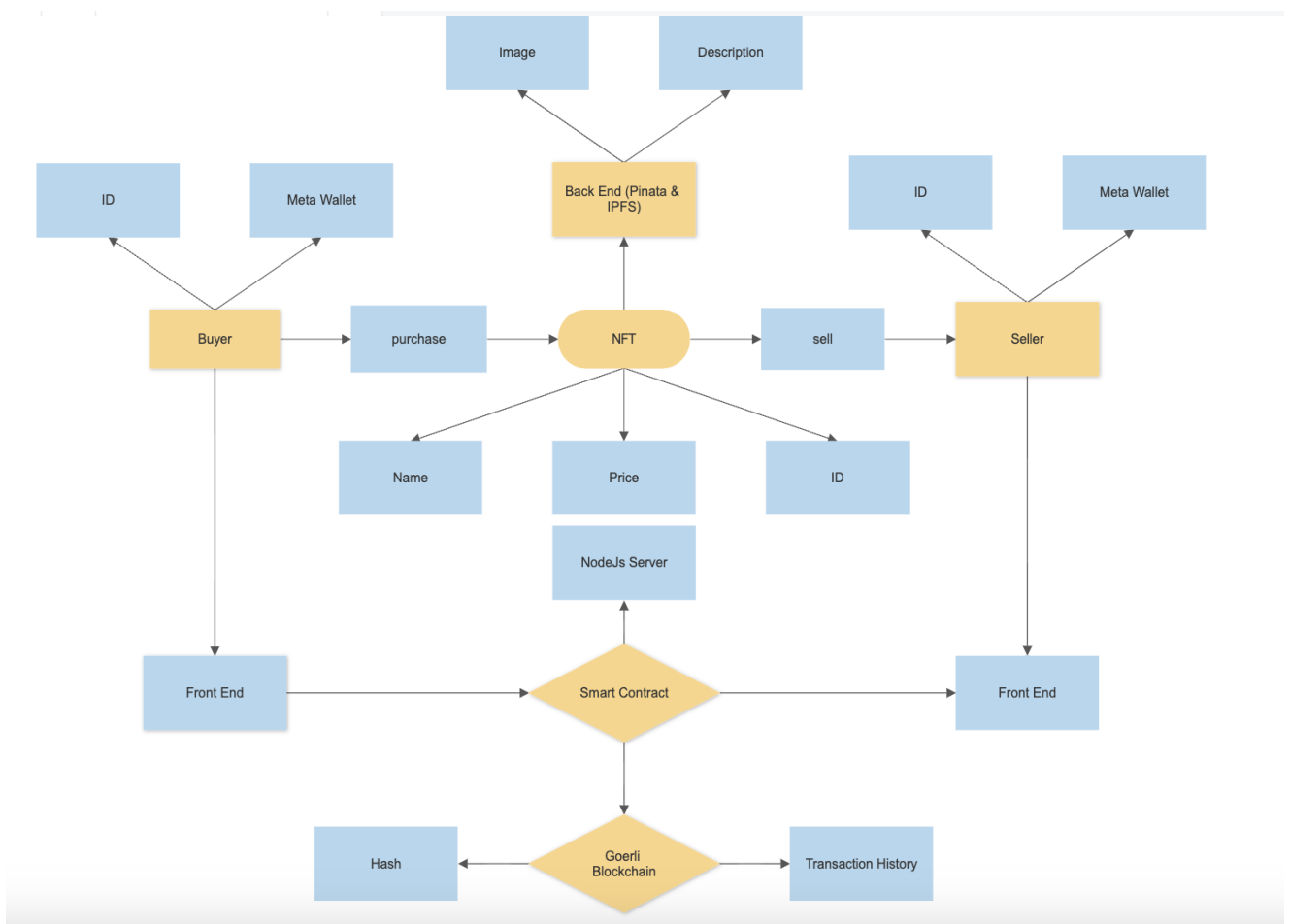


Fig:5 Entity Relation Ship Diagram

4.2 Use Case Diagram

This Use-Case diagram represents the functional requirements of the system. It covers following functional requirements:

- Browse Marketplace
- View Item
- Buy NFT Asset
- Sell NFT Asset
- Mint NFT

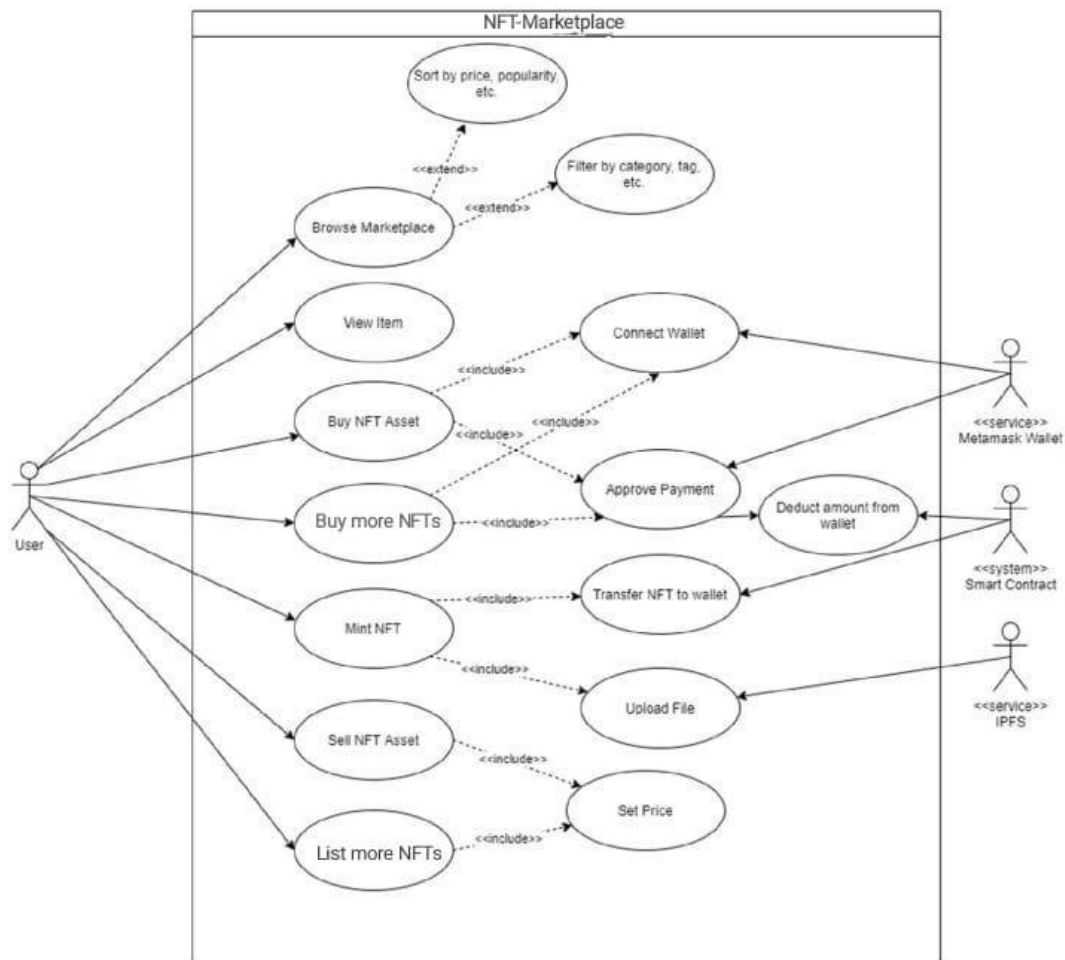


Fig:6 System UML Diagram

The figure shows the use cases defined with the NFT marketplace application. As it can be seen, the use cases have a straightforward mapping with the main activities a user can perform. A user can be able to buy, list and sell NFTs listed on the application.

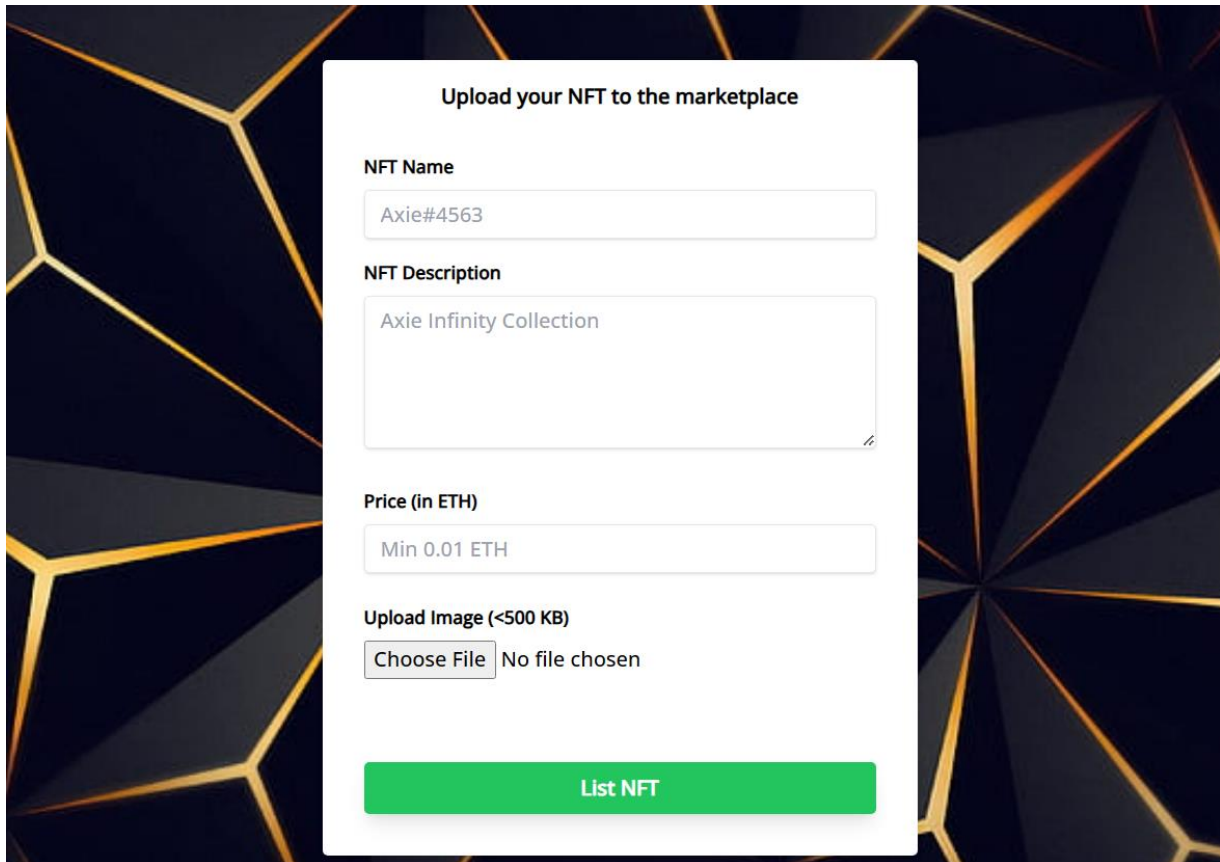
He can also see his NFTs that is listed and associated to his blockchain network with his address.

4.3 Procedural/Modular Approach

Following are all the modules designed for the Decentralized marketplace application.

4.3.1 Add or List Products Module

This module is about how a seller can list his NFT by clicking on the “List NFT button” on the application with the name and Price he wants for that. Once the seller adds the NFT it will get assigned by a unique address or key. Further the NFT will be listed on the application to be sold with its name and Price mentioned. The seller needs to have a metawallet to list a NFT so that it will have his address till the item is not being sold out . There can be many items with the same name but none can have the same address assigned.



Upload your NFT to the marketplace

NFT Name

Axie#4563

NFT Description

Axie Infinity Collection

Price (in ETH)

Min 0.01 ETH

Upload Image (<500 KB)

Choose File No file chosen

List NFT

Fig:7 Add NFT module of the project

4.3.2- Buy NFT Module

In this module, the Buyer can buy the items or NFTs that are listed on the application by clicking on the Buy button.

The Buyer can only buy a NFT once by paying the price in Ethers as listed.

The buyer needs to have enough ethers in his account so that he can make the transaction successful and can have his address assigned to the NFT bought. Once the NFT is sold,

The Buy button from the List will disappear and the new owner's address will be displayed.

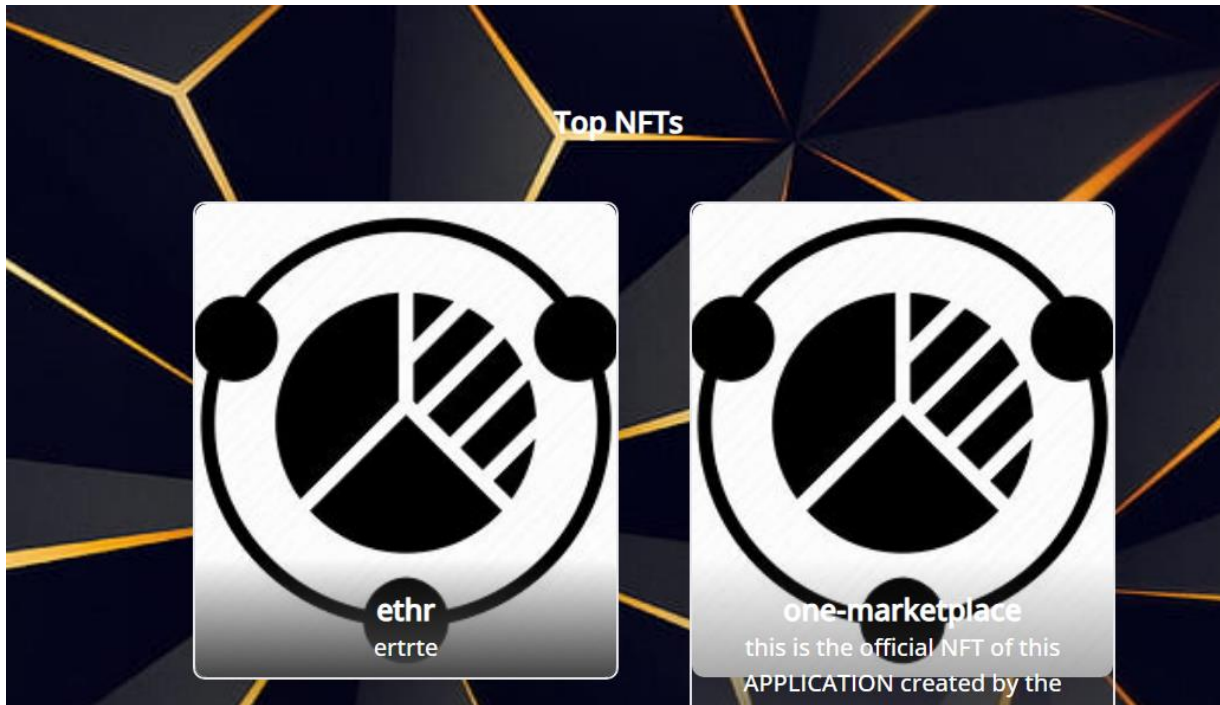


Fig:8 frontend view of the application

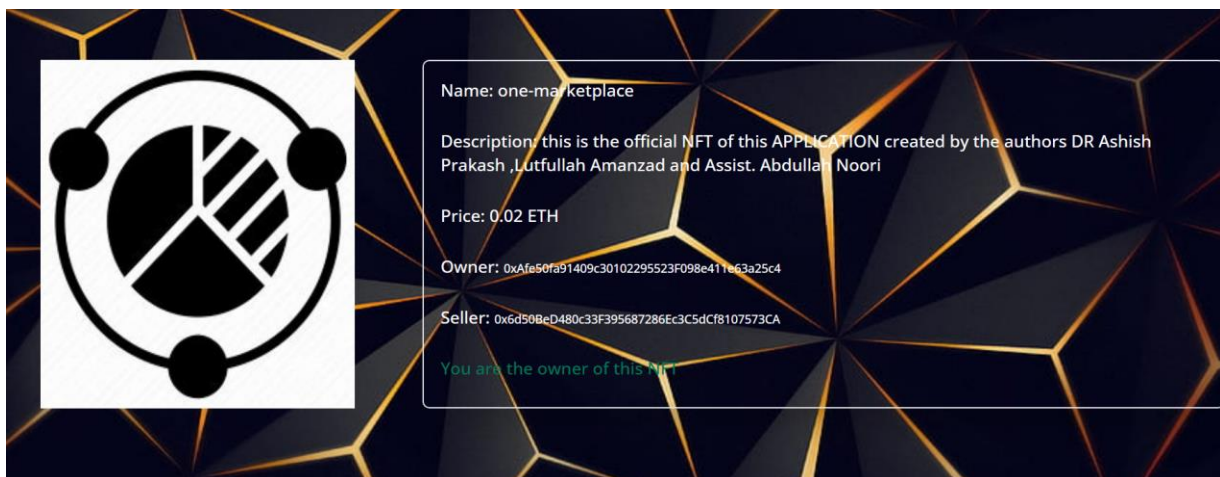


Fig:9 Buy NFT Module

4.3.3 User Profile Module

In this module, the user can see his owned NFTs by clicking on the button “My Profile” on the top right corner of the front-page. Here, he can see all the details of the NFTs he owns that includes No of NFTs, Total value, Pictures of all the NFTs and wallet address.



Fig:10 User profile Module of the application

5-Implementation

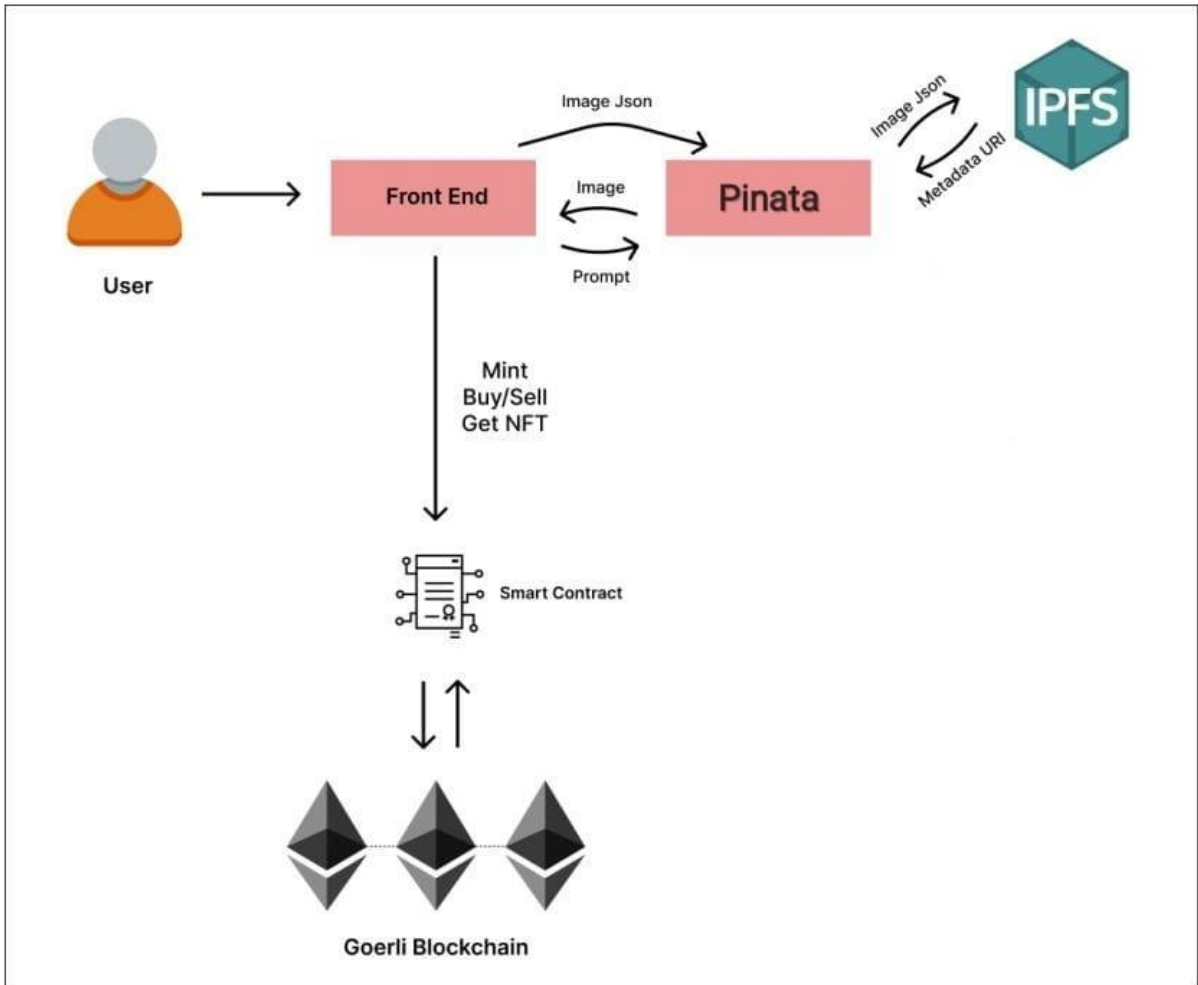


Fig:11 Implementation of the project

- The implementation of this project can be seen through the figure. at the starting stage, the user is having a metawallet(metamask) means he is connected to a blockchain and have funds in his wallet to buy any NFT.
- At the second stage, user is interacting with the frontend part of the project that is the browser's landing page where he can either add a NFT or buy a NFT. This is the page where all the frontend of the website lies.
- Then this frontend is Connected to a Goerli test network with the help of Web3.js for the transaction process.
- Then the user can see the metadata and images of the NFTs listed that are coming from the decentralized storages IPFS and Pinata respectively.

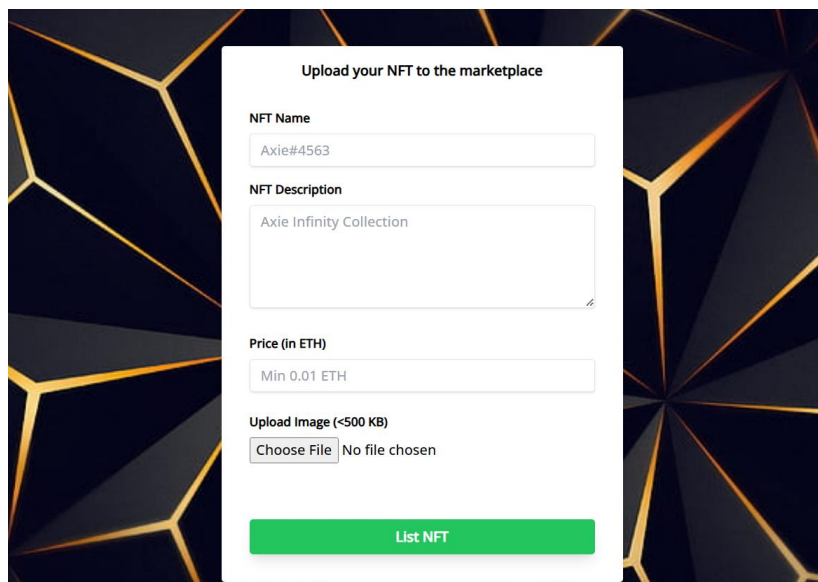
- The Goerli network has the smart Contract of the application that ensures the secured mode of transaction between the seller and the buyer.
- The transaction record further is stored on the blockchains and can be seen through metawallets.

5.1 Database Design

The design of the database was similar to the analysis phase. The database has been developed using Nodejs Server, Pinata and IPFS.

5.2 User Interface Design and Implementation

5.2.1 Add NFT Section: In this interface user can sell or list his NFT he wants to sell by assigning a name and a valid Price of the NFT. The Buyer can only buy a NFT once by paying the price in Ethers as listed. The buyer needs to have enough ethers in his account so that he can make the transaction successful and can have his address assigned to the NFT bought. Once the NFT is sold, The Buy button from the List will disappear and the new owner's address will be displayed.



The screenshot shows a web interface for listing an NFT. The background is a dark blue and black geometric pattern with yellow lines. A white modal box is centered on the screen with the title "Upload your NFT to the marketplace". Inside the modal, there are four input fields: "NFT Name" with the value "Axie#4563", "NFT Description" with the value "Axie Infinity Collection", "Price (in ETH)" with the value "Min 0.01 ETH", and "Upload Image (<500 KB)" with a "Choose File" button and the text "No file chosen". At the bottom of the modal is a green button labeled "List NFT".

Fig:12 List NFT page

5.2.2 Buy NFT Section: This is the buyer section where all the listed items are displayed with name, price and their unique address to which they belong to. Once the item is

purchased by the buyer account, the Buy button will disappear ensuring one NFT can only be sold to one person.

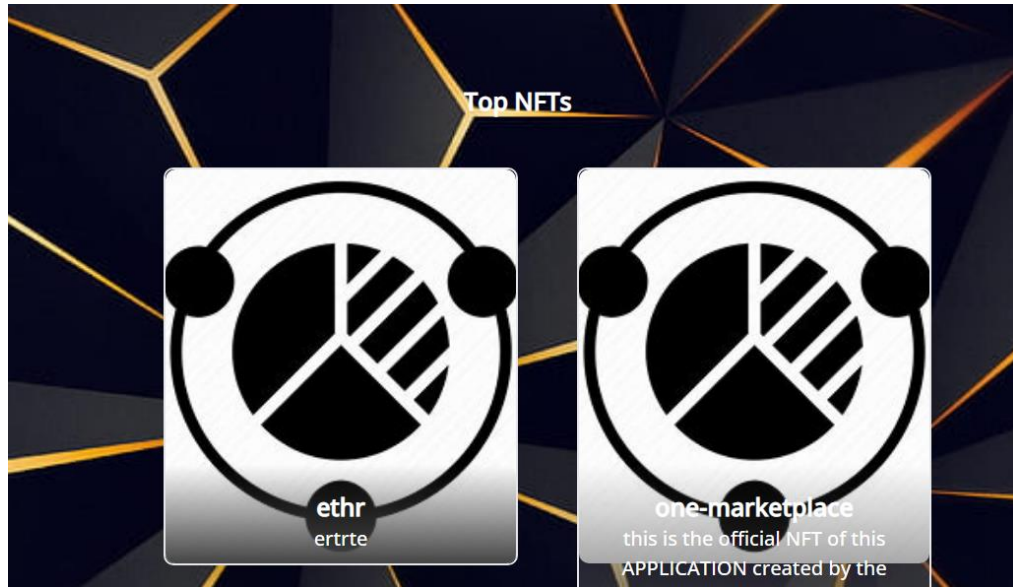


Fig:13 Figure showing all the listed items to be sold

5.2.3 Wallet Transaction Section 2:

This is the interface of the metawallet when a user sells or buys a NFT by clicking on confirm button it will be listed on the application and can be seen in case of selling and in case of buying it will require its price in Goethers as per the smart contract and once all the conditions are satisfied, the transaction will be completed.

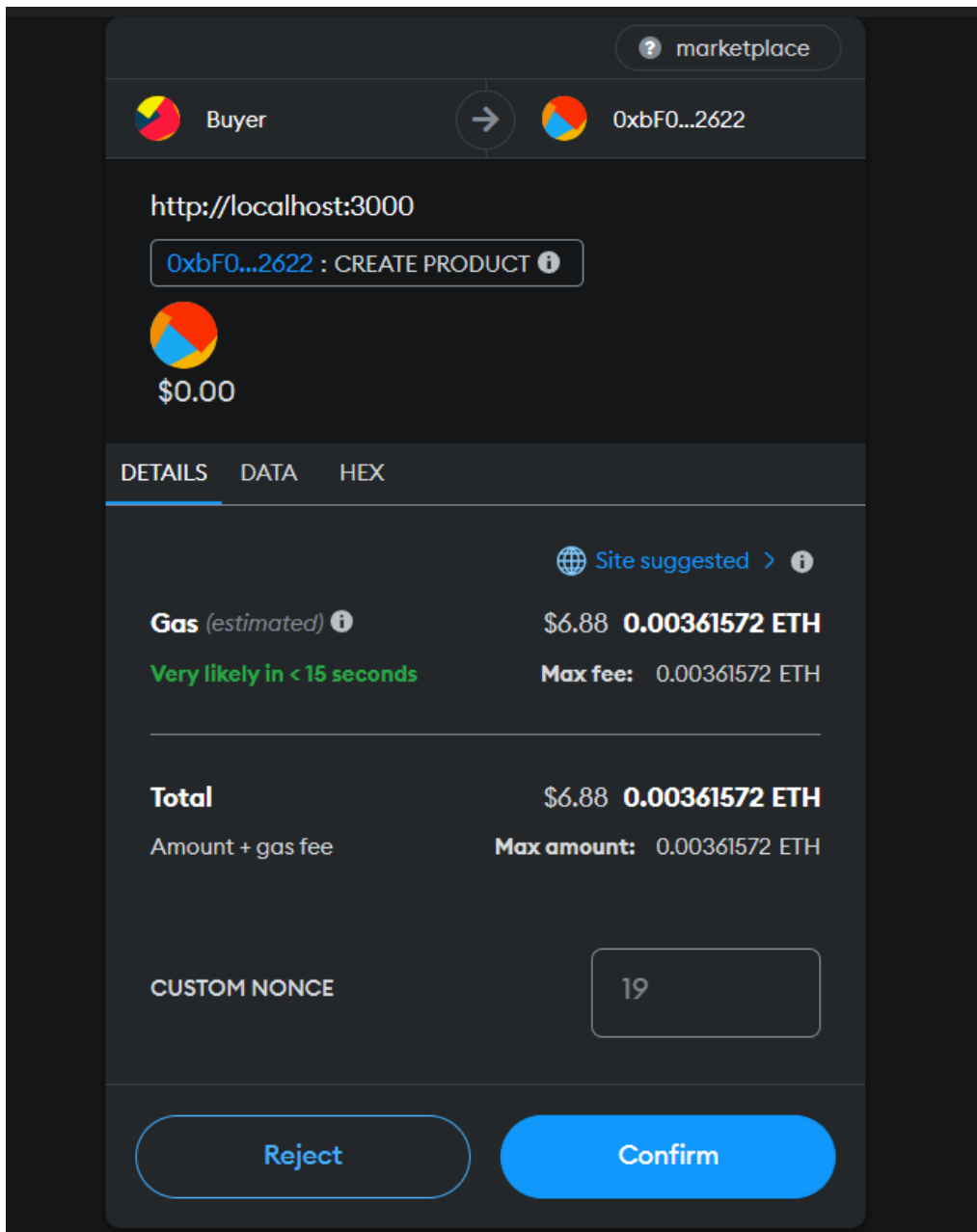


Fig:14 Metawallet Confirmation page while selling or buying a NFT

5.3 Technical Discussions

Consumers do not care whether their toaster runs on a MySQL database, a hamster wheel, or Blockchain Technology. They just want to eat nice, tasty toast. It is up to the engineers to figure out how to make the best toast. A true sign of when technology has succeeded is when it can be used on day-to-day life without the consumer even realizing it. The day we have a Blockchain toaster that works better than a non-Blockchain toaster is the day we know Blockchain has truly succeeded in the toaster business. Similarly, the goal of our Blockchain market is to be better than currently available marketplaces. Aside from removing censorship by decentralizing the marketplace and reducing fees, we also aim at unifying storefronts for the same seller on different frontend Node.js servers. So that if a seller wants to sell something on eBay and Amazon that they do not run into the problem mentioned earlier of creating a race condition on selling the same item twice and forcing one transaction to be delayed or canceled due to being out of stock. This can be achieved using a shared inventory, or ledger, between several frontend marketplaces, which is exactly what the Blockchain can do as each frontend accesses it. It also allows sellers to announce their NFTs freely among any frontend they wish to do so with. This also means that if Amazon or eBay were to adopt Blockchain for their inventory tracking they could phase in the decentralized marketplace while also maintaining their own Web sites for their own NFTs. This will aid in phasing out current technology, or coexisting until one proves to be better than the other.

6-Testing

Software testing is a process of running with intent of finding errors in software. Software testing assures the quality of software and represents final review of other phases of software like specification, design, code generation etc.

6.1.1 Unit Testing

Unit testing emphasizes the verification effort on the smallest unit of software design i.e.; a software component or module. Unit testing is a dynamic method for verification, where program is actually compiled and executed. Unit testing is performed in parallel with the coding phase. Unit testing tests units or modules not the whole software.

I have tested each view/module of the application individually. As the modules were built up testing was carried out simultaneously, tracking out each and every kind of input and checking the corresponding output until module is working correctly.

The functionality of the modules was also tested as separate units. Each of the three modules was tested as separate units. In each module all the functionalities were tested in isolation.

In the Add NFTs Module when a NFT has been added to it has been made sure that it has a name, a price and a unique address. It works accurately and does the transaction within seconds to list the NFT. There is no error while listing. NFT name and NFT Price space are also working properly.

In the Buy NFT Module it has been tested that all the NFTs are displayed properly and can be bought through a meta wallet. The owner's address after a NFT is purchased is verified to be the same on the NFT. It has been checked to see if the whole page refreshes or a partial page update happens when a user makes a transaction. It has been checked when a user purchase a particular NFT, the buy button is disappear after the transaction so that one NFT can be only bought by one user.

In the Meta wallet section it has been tested that when a user makes a transaction It clearly shows the record of that transaction. It has been tested that on the time of purchase, meta-wallet shows a proper confirmation before the transaction.

6.1.2 Integration Testing

In integration testing a system consisting of different modules is tested for problems arising from component interaction. Integration testing should be developed from the system specification. Firstly, a minimum configuration must be integrated and tested.

In my project I have done integration testing in a bottom up fashion i.e. in this project I have started construction and testing with atomic modules. After unit testing the modules are integrated one by one and then tested the system for problems arising from component interaction.

6.1.3 Validation Testing

It provides final assurances that software meets all functional, behavioral & performance requirement. Black box testing techniques are used.

There are three main components:

- Validation test criteria (no. in place of no. & char in place of char)
- Configuration review (to ensure the completeness of s/w configuration.)
- Alpha & Beta testing-Alpha testing is done at developer's site i.e. at home & Beta testing once it is deployed. Since I have not deployed my application, I could not do the Beta testing.

6.1.4 White Box Testing

In white box testing knowing the internal working of the NFT, tests can be conducted to ensure that internal operations are performed according to specification and all internal components have been adequately exercised. In white box testing logical path through the software are tested by providing test cases that exercise specific sets of conditions and loops.

Using white-box testing software developer can derive test case that

- Guarantee that all independent paths within a module have been exercised at least once.
- Exercise all logical decisions on their true and false side.
- Exercise all loops at their boundaries and within their operational bound.
- Exercise internal data structure to ensure their validity.

At every stage of project development, I have tested the logics of the program by supplying the invalid inputs and generating the respective error messages. All the loops and conditional statements are tested to the boundary conditions and validated properly.

6.1.5 Performance Testing

Jakarta JMeter, a tool for testing applications was used to simulate the virtual users (clients) and test the performance of the system. It can be used to test performance both on static and dynamic resources (files, Servlets, Perl scripts, Java Objects, Data Bases and Queries, FTP Servers and more). It can be used to simulate a heavy load on a server, network or object to test its strength or to analyze overall performance under different load types. It can be used to make a graphical analysis of performance and test the server/script/object behavior under heavy concurrent load.

I have done performance testing to achieve an estimate of the peak and sustained load the application. This has done with few pages like the Buy NFTs (extensive Database access, business logic Intensive and more Images) and the Marketplace (simple page). A few sample Screenshots of test results are shown below. The tests have been conducted by running the application (server) and JMeter on same machine. These test results do not include factors like network bandwidth etc as the server is running on the same machine along with JMeter.

Comparison of Constant Users vs. Constant Loop-Count

In the following test, the number of users has been kept constant and the Loop Count has been increased.

Users	Loop Count	Ramp Up period(sec)	Marketplace Page Average Response(ms)
100	150	10	1060
100	300	10	1071
100	600	10	1021
100	1000	10	1033

Table:1 high response average table which increases with the loop count.

Observations

Response Time increases rapidly with number of users but not very much when the users are kept constant and only loop-count is increased. This is because, if the number of users is kept constant and only the loop count is increased, the number of requests handled by the server per second remains constant for every execution of the loop count and for every increase in the loop count. Hence the response time will not increase drastically in this case. Whereas, if the users are increased and loop count is kept constant, the requests handled by the server per second increases with increasing users and hence the longer response time.

Comparison of Response Times of the 2 Webpages Local Testing:

Users	Loop Count	Ramp Up period(sec)	List NFT Page(ms)	Buy NFTs page(ms)
100	150	10	1060	28177
500	150	10	8075	105388
1000	150	10	11993	135273

Table:2 Response time of List NFT and buy NFT page

Observations:

Response Time of a complex webpage with database and business logic functions is far more than a simple webpage.

Factors affecting Response Time:

- 1-Limited System Hardware Resources (CPU, RAM, Disks) and Configuration
- 2-JMeter Tests and Application running on the same machine.

Remote Testing:

Users	Loop Count	Ramp Up period(sec)	Sell NFT Page(ms)	Buy NFTs page(ms)
100	150	10	792	8312
500	150	10	6392	99069
1000	150	10	20457	227056

Table:3 Remote testing readings

Observations:

Response Time of a complex webpage with database and business logic functions is far more than a simple webpage. The Response times of remote testing are better than those of local testing when the number of users is comparatively lesser.

Factors affecting Response Time:

- Better Hardware Resources (CPU, RAM, Disks) and Configuration for the Application as it was hosted on a web server.
- JMeter had better access to hardware resources as the application is not on the same machine.

Using this above tabular data, I can say that the system is adequate to handle the normal load and the users won't lose their focus.

6.2 Results & Challenges

The application can be used for any Ecommerce application. It is easy to use. unlike other web applications, it uses the Blockchains which makes it a secure source of network. User friendly screens are provided. The application is easy to use and interactive making it more interesting with the ease to buy with cryptocurrencies. It has been thoroughly tested and implemented.

6.2.1 Challenges

- Compatibility with browsers like Internet explorer, opera mini, etc.
- Using a layered approach in developing the application which would make the application maintainable.

- Learning new technologies like using web3.js, Solidity, Hardhat, Alchemy, Pinata and IPFS requires a little guidance.
- Keeping the track record of the transactions is crucial.
- Making people understand this new technology is the most difficult task.

7 Conclusion

The ‘Decentralized Marketplace using Blockchains’ is designed to provide a web3 based application that would make buying and selling a virtual NFT easier with the use of Blockchain technology. The application overall works properly and well tested on a test network. The interfaces allow the users to Add and Buy any NFT listed. The Metamask wallets are the key feature that enables the transaction to become successful after the confirmation. It also keeps the previous track record of the transactions happened. The application is a proof of work of a secured network and a platform to trade things. The last but not the least, the application ensures no two buyers buys the same NFT. We have presented a truly decentralized NFT marketplace using Blockchain, cryptocurrency, and Pinata Technology built on the Ethereum Blockchain. We discussed the technology and provide a walkthrough of the system architecture and workflow. The main advantages of using a decentralizing a marketplace are the ability to avoid NFT censorship—compared to current e-commerce platforms like Amazon—removing the middleman fees in transactions by using an escrow service created with Ethereum smart contracts that offer an alternative to current payment gate-ways like PayPal and because we believe in not just a decentralized open market, but a decentralized project development, we are open sourcing the entire project and making it freely available for the community to use.

8 Scope for Future Work

The following things can be done in future.

- The current system can be extended to allow the users to interact with each other on the application.
- More interactive and responsive interface can be added to the application.
- The NFT marketplace can be extended to trade in every cryptocurrency.
- The users will be able to search for the NFT.
- The system can have more user interfaces so that it becomes more versatile and more interesting.
- The NFT marketplace application can also be extended to buy or sell audio NFTs as well.

The overall idea of doing this project is to get a real time experience. Learn new technologies.

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