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(Research Article)

Domyn: A Decentralized Domain Name Marketplace Using Blockchain and NFTs

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Abstract

The conventional space title industry is overwhelmed by centralized recorders that force tall recharging expenses, limit possession rights, and show security vulnerabilities due to single focuses of disappointment. This paper presents Domyn, a decentralized space title commercial center leveraging blockchain innovation and NFTs (Non-Fungible Tokens) to empower genuine possession of advanced spaces. Built on the Ethereum blockchain, Domyn utilizes ERC-721 keen contracts to tokenize space names, permitting clients to mint, purchase, offer, and exchange proprietorship without mediators. Furthermore, IPFS (InterPlanetary Record Framework) guarantees decentralized capacity, making the framework censorship-resistant and tamper-proof [8]. Through an in-depth investigation of its design, exchange stream, and savvy contract execution, we illustrate Domyn's capacity to supply security, straightforwardness, and productivity compared to conventional space enlistment centers. The paper assist presents execution measurements, test case comes about, and a security assessment to approve the viability of the proposed framework. We moreover investigate future upgrades, counting Layer 2 scaling arrangements and multi-chain interoperability, to progress gas proficiency and selection.

Keywords:Blockchain, Ethereum, NFTs, Smart Contracts, Decentralized Domains, Web3.

1. Introduction

Space enrollment administrations, such as GoDaddy and Google Spaces, work through centralized recorders that act as mediators [1]. Clients just rent space names rather than owning them for all time, driving to restrictions such as tall recharging expenses, possession confinements, and dangers of censorship and space seizure. In a report by Verisign, the entire number of space names enrolled around the world surpassed 364 million in Q4 2022, with over 50% of them overseen by five major centralized recorders, illustrating the monopolistic nature of the industry. For occasion, in 2020, specialists seized over 28,000 spaces due to compliance infringement, raising concerns over centralized control. Blockchain-based space enrollment kills these issues by advertising irrefutable possession, security, and resistance to censorship.

Besides, conventional DNS (Space Title Framework) administrations are defenseless to DNS capturing assaults, where pernicious on-screen characters divert clients to false locales by modifying space records. In differentiate, blockchain-based DNS guarantees that records stay permanent. Space enrollment administrations, such as GoDaddy and Google Spaces, work through centralized recorders that act as mediators. Clients just rent space names rather than owning them for all time, driving to restrictions such as tall recharging expenses, possession confinements, and dangers of censorship and space seizure. In a report by Verisign, the entire number of space names enrolled around the world surpassed 364 million in Q4 2022, with over 50% of them overseen by five major centralized recorders, illustrating the monopolistic nature of the industry.

For occasion, in 2020, specialists seized over 28,000 spaces due to compliance infringement, raising concerns over centralized control. Blockchain-based space enrollment kills these issues by advertising irrefutable possession, security, and resistance to censorship. Besides, conventional DNS (Space Title Framework) administrations are defenseless to DNS capturing assaults, where pernicious on-screen characters divert clients to false locales by modifying space records. In differentiate, blockchain-based DNS guarantees that records stay permanent.

The ordinary Space Title System (DNS) is controlled by centralized enrollment centers such as GoDaddy, Google Spaces, and Namecheap, which act as go betweens between clients and space proprietorship. These recorders keep up control over space enlistments, constrain rehashing energizing costs, and have the pro to suspend or seize spaces in case they harm controls. Moreover, centralized DNS providers are defenseless to security breaches and cyberattacks. One of the first basic ambushes happened in

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2016, when the DNS attack utilized a huge botnet (Mirai) to alacrity a Passed-on Refusal of Advantage (DDoS) ambush, affecting major websites like Twitter, GitHub, and Netflix. This attack revealed the delicacy of centralized DNS establishment, outlining that a single point of disillusionment can aggravate a sweeping allocate of the net. A few decentralized options to conventional DNS have been created, with the foremost outstanding being the Ethereum Title Benefit (ENS). ENS works on the Ethereum blockchain and permits clients to enroll .eth spaces as ERC-721 NFTs [2]. These spaces are put away on the blockchain, guaranteeing genuine possession, security, and resistance to censorship. Not at all like conventional DNS suppliers, ENS spaces cannot be denied or seized, making them exceedingly alluring to clients looking for opportunity from centralized control. Be that as it may, ENS faces challenges such as tall gas expenses on the Ethereum organize, which can make exchanges costly. Moreover, ENS spaces are restricted to Ethereum-based applications, which limits interoperability with other blockchain systems and conventional web administrations. Another elective is Tireless Spaces, which works so moreover to ENS but reinforces various blockchain frameworks, tallying Ethereum and Polygon. Tenacious Spaces offers lifetime proprietorship of space names, meaning clients do not need to pay energizing costs. This incorporate makes it more locks in than ordinary DNS and indeed ENS, which still requires reviving installments. Be that because it may, Tenacious Spaces faces it's possess restrictions, tallying confined browser back and dependence on specific blockchain circumstances. While many web browsers, like Gallant and Melodic show, reinforce Tenacious Spaces, standard browsers like Chrome and Firefox still depend on routine DNS, reducing the accessibility of these decentralized spaces. Another exceptional blockchain-based DNS elective is Handshake (HNS), which businesses a decentralized root DNS system and its claim blockchain. Not at all like ENS and Tireless Spaces, Handshake does not depend on Ethereum but instep businesses a proof-of-work (PoW) understanding instrument to supervise top-level spaces (TLDs) in a decentralized way [3,4]s. This approach grants clients to enroll custom TLDs, such as .crypto, .blockchain, and .web, giving them more versatility than ordinary DNS recorders. In any case, Handshake faces assignment challenges due to complex setups required to resolve Handshake spaces. Not at all like ENS and Tenacious Spaces, which facilitated easily with Web3 wallets like Metamask, Handshake spaces habitually require custom DNS settings to be open, making them less user- friendly for the normal web client.

In spite of the progressions in decentralized DNS administrations, these frameworks still confront challenges in terms of adaptability, cost, and interoperability. Tall gas expenses on Ethereum make ENS and Relentless Spaces costly for clients, whereas Handshake's partitioned blockchain creates compatibility issues with the existing Web3 biological system. Furthermore, need of far reaching browser back limits the ease of use of blockchain-based spaces for regular clients. Hence, whereas decentralized space title administrations offer superior security, possession, and censorship resistance, they still require specialized changes and way better client involvement to attain mass selection.

The scope of this paper is to present Domyn, a decentralized domain name marketplace that leverages Ethereum smart contracts and NFTs (ERC-721) to enable secure, verifiable, and censorship-resistant domain ownership. Unlike traditional domain registrars that retain control over domain names, Domyn ensures that domains are owned permanently by users without intermediaries. The system integrates IPFS (InterPlanetary File System) for decentralized storage, enhancing security and reducing reliance on centralized servers [5]. The primary objectives of Domyn are to eliminate high renewal fees, prevent unauthorized domain seizures, and enable trustless buying, selling, and transferring of domains in a transparent, on-chain marketplace. Furthermore, this paper explores the architecture, transaction mechanisms, smart contract deployment, and performance metrics of Domyn, comparing it with existing blockchain-based DNS solutions.

Finally, we discuss security considerations, challenges, and future enhancements, including Layer 2 scaling (zkSync, Optimism) and multi- chain compatibility (Polygon, Binance Smart Chain) to reduce gas fees and improve adoption.

This paper is organized into a few segments to supply a comprehensive understanding of Domyn, a decentralized space title commercial center built on blockchain and NFTs. Section 2 presents a writing survey, summarizing existing decentralized DNS arrangements, their impediments, and comparative examination with Domyn. Segment 3 subtle elements the proposed framework engineering, counting savvy contract plan, IPFS-based metadata capacity, and client confirmation by means of Web3 wallets. Segment 4 examines savvy contract arrangement, sketching out key capacities such as space minting, listing, and exchanges, together with event-driven instruments.

Section 5 presents the results with supporting charts and tables. Section 6 concludes the paper with key discoveries and potential future improvements, such as Layer 2 scaling and cross-chain compatibility to make strides versatility and diminish exchange costs.

2. Literature Review

To create Domyn, a decentralized space title commercial center, we dissected existing investigate on blockchain-based space administrations, shrewd contract security, and NFT-based proprietorship models [6,7]. This section audits five key papers as described in table 1, highlights the decentralized DNS arrangements, NFT space possession, shrewd contract vulnerabilities, and execution challenges in Ethereum-based frameworks.

2.1 Ethereum: A Secure Decentralized Ledger" – Gavin Wood, 2015: This foundational paper introduces Ethereum, the first programmable blockchain enabling smart contracts and decentralized applications (DApps). It explains

Ethereum's architecture, consensus mechanisms, and use cases for decentralized finance (DeFi), governance, and digital assets. The paper highlights Ethereum's Turing-complete smart contracts, which make NFT-based domain ownership possible.

However, it also points out scalability issues and high gas fees, which impact platforms like ENS and Domyn.

2.2 ERC-721: Non-Fungible Token Standard" – W. Entriken et al., 2018: This paper defines ERC-721, the NFT standard that enables unique, verifiable, and transferable assets on Ethereum. It provides a technical overview of token ownership, metadata storage, and transfer functions, which are critical for Domyn's blockchain-based domain marketplace. The paper also highlights gas inefficiencies in NFT transactions, a challenge Domyn addresses by exploring Layer 2 solutions (zkSync, Optimism).

Table 1. Review of existing methods

No.	Reference	Type of blockchain used	Platform used	Language used to write smart contract	Deployed on which network
1	Ethereum: a secure decentralized ledger	Ethereum	Ethereum	Solidity	Ethereum mainnet
2	ERC-721: Non-fungible token standard	Ethereum	Ethereum	Solidity	Ethereum
3	Showtime: A case study	Ethereum, polygon	Ethereum	Solidity	Polygon
4	Security considerations in ethereum smart contracts	Ethereum	Ethereum	Solidity	Ethereum (ropsten testnet)
5	Scalability and gas optimization in NFT transactions	Ethereum	Ethereum, arbitrum	Solidity	Layer 2 (arbitrum, optimism)

2.3 Unstoppable domains: This study examines Unstoppable Domains, a blockchain-based DNS provider offering .crypto and .nft domain names as NFTs. The paper outlines the advantages of lifetime domain ownership (no renewal fees) and censorship resistance. However, it highlights usability challenges, such as lack of browser support, which limits mass adoption. Domyn aims to enhance usability by integrating with multiple blockchains and providing a user-friendly marketplace.

2.4 Security considerations in ethereum smart contracts" – IEEE, 2020: This paper identifies smart contract vulnerabilities, including re-entrancy attacks, integer overflows, and access control weaknesses. It presents case studies of high- profile Ethereum hacks, such as the DAO attack (2016), Parity Wallet freeze (2017), and DeFi exploits (2020). These insights help Domyn implement secure coding practices, such as re- entrancy guards, access control mechanisms, and fail-safe withdrawal functions [8,9].

2.5 Scalability and gas optimization for NFT transactions" – ACM, 2022: This research paper analyses gas consumption in Ethereum-based NFT transactions and explores scalability solutions, such as Layer 2 networks (zkSync, Arbitrum) and alternative blockchains (Polygon, BSC). The findings show that minting an NFT on Ethereum can cost over $50 in gas fees, making large-scale adoption difficult. Domyn incorporates gas-efficient contract design and Layer 2 integrations to minimize transaction costs [10].

The surveyed writing highlights that blockchain-based space administration's upgrade security and proprietorship straightforwardness by killing centralized middle people [11]. In any case, adaptability and ease of use issues proceed to ruin their broad appropriation. The presentation of NFTs (ERC-721) has given an unquestionable and transferable proprietorship demonstrate, making them a perfect arrangement for decentralized space enlistment. In spite of these preferences, tall gas expenses on Ethereum stay a noteworthy boundary to passage, anticipating numerous clients from receiving blockchain-based space arrangements.

Investigate recommends that Layer 2 scaling arrangements, such as zkSync and Good faith, and elective blockchains like Polygon and Binance Shrewd Chain can offer assistance diminish exchange costs, making NFT-based spaces more available [12, 13].

Another key finding from the writing is the security dangers related with Ethereum keen contracts. A few considers have archived.

3. Proposed System

The domyn decentralized space title commercial center engineering graph gives a point-by-point representation of how different components associated to make a believe less and decentralized space title biological system. The engineering is organized into different layers, counting Client Wallet Integration, Web Application Facilitating, Exchange Stream, Shrewd Contract Layer, Framework, Decentralized Capacity, and AI Integration, each of which plays a basic part in empowering consistent, secure, and effective operations.

The savvy contract layer shapes the establishment of the Domyn decentralized space title commercial center, guaranteeing secure and robotized space exchanges without mediators. At the center of this layer, the space postings contract encourages the administration of accessible space names, permitting clients to list, upgrade, or evacuate their spaces. Once a client starts a buy, the installment handling contract guarantees that the reserves are effectively exchanged some time recently continuing with proprietorship changes. After installment confirmation, the NFT stamping contract produces a one of a kind ERC-721 token speaking to proprietorship of the space. This token inserts significant metadata, counting space title, enrollment timestamp, termination date, and exchange history. At last, the possession exchange contract finalizes the method by overhauling blockchain records to reflect the unused proprietor, guaranteeing permanent and straightforward proprietorship history. The interaction between these contracts kills the require for centralized enlistment centers, decreasing the dangers of censorship, extortion, and single focuses of disappointment [14,15].

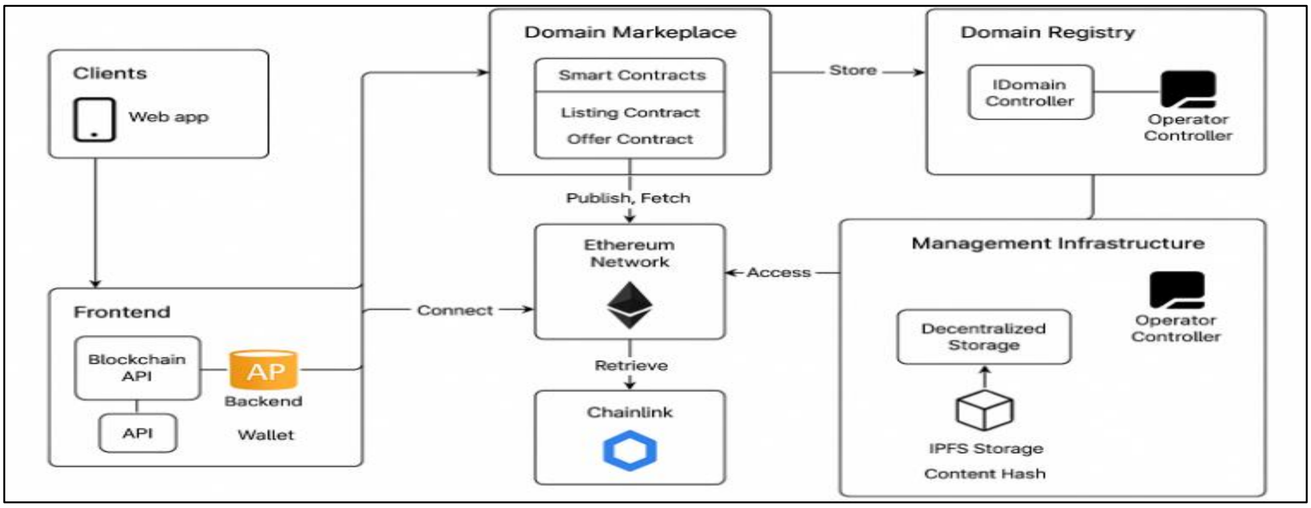

Figure 1. Architecture diagram

To guarantee versatility, tall accessibility, and security, the commercial center leverages a half breed foundation that coordinating blockchain hubs with cloud-based administrations. The Ethereum arrange is utilized as the basic blockchain for executing keen contracts and keeping up tamper-proof possession records. These hubs are facilitated on AWS EC2, giving a solid environment for blockchain exchanges. The framework too utilizes AWS S3 and CloudFront for proficient substance dissemination, guaranteeing moo- inactivity get to to front-end application information over diverse geographic areas [16]. This disseminated facilitating approach improves the client encounter, permitting consistent interaction with the commercial center whereas guaranteeing information astuteness and accessibility.

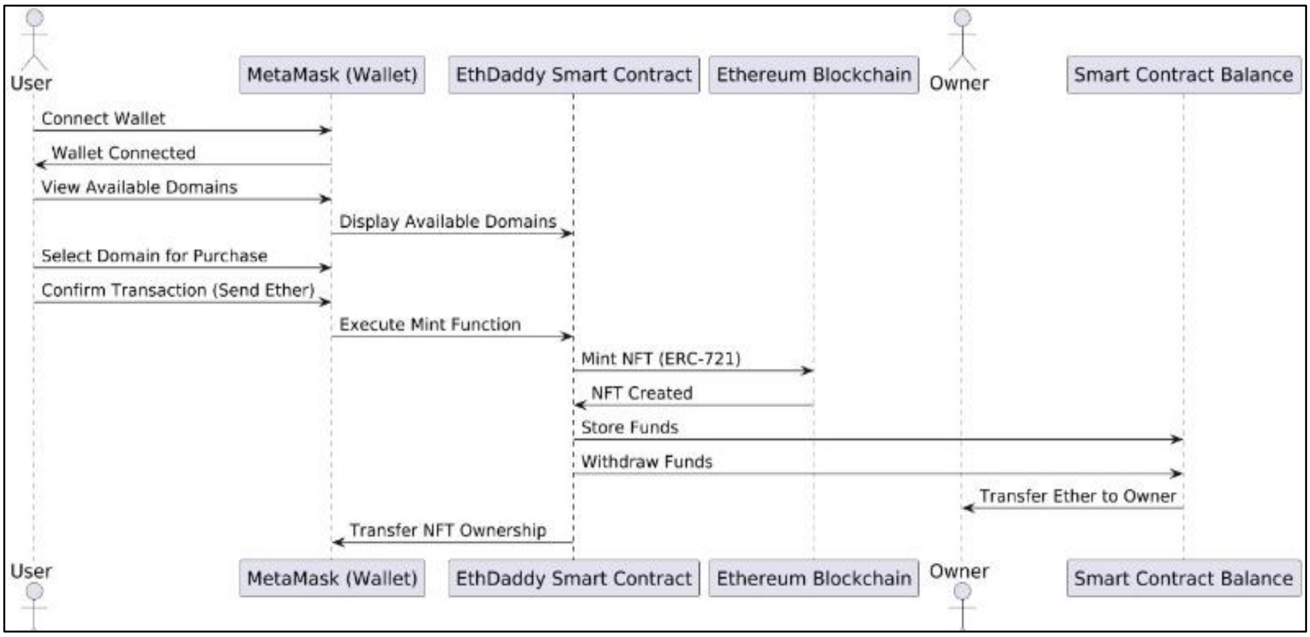

Figure 2. Sequence diagram

A key component of the framework is decentralized metadata capacity, which combines AWS DynamoDB and IPFS (InterPlanetary Record Framework). Whereas DynamoDB productively oversees organized information, such as space postings, estimating subtle elements, and exchange logs, IPFS guarantees that space metadata is put away in a decentralized, tamper-proof way. This half breed capacity approach equalizations speed, openness, and decentralization, tending to the impediments of purely centralized or blockchain-based capacity.

The commercial center is planned to be user-friendly and open, with a React-based front-end that consistently coordinating with blockchain intuitive. The front-end application is facilitated on AWS, guaranteeing a smooth and responsive client interface.

User buys by selecting a space posting and submitting an exchange ask through their associated wallet. Once the keen contracts confirm the installment and execute the proprietorship exchange, the framework upgrades the space metadata on IPFS and DynamoDB, guaranteeing that the changes are reflected over the decentralized biological system. The engineering guarantees that all operations are recorded on the blockchain, keeping up a permanent review path for future reference.

By leveraging blockchain security, decentralized capacity, and versatile cloud foundation, the Domyn space commercial center offers a trustless, censorship-resistant, and completely straightforward arrangement for space title exchanging.

This engineering dispenses with dependence on centralized enlistment centers, upgrades client control over space resources, and empowers a consistent, mechanized commercial center encounter.

The provided sequence diagram illustrates the workflow of a decentralized domain name marketplace, Domyn, built on the Ethereum blockchain. It details the interactions between key participants, including the User, MetaMask Wallet, Domyn Smart Contract, Ethereum Blockchain, Domain Owner, and Smart Contract Balance, to facilitate the purchase and transfer of blockchain-based domain names.

The diagram captures the step-by-step execution of a domain transaction, starting from wallet authentication to domain selection, transaction approval, NFT minting, ownership transfer, and fund withdrawal by the seller. By leveraging Ethereum smart contracts and the ERC-721 NFT standard, Domyn ensures that domain ownership is secure, transparent, and immutable.

The process highlights the trustless nature of blockchain transactions, where buyers and sellers interact without intermediaries, and transactions are recorded and enforced by smart contracts. This decentralized approach eliminates traditional domain registrars, reducing costs and increasing user control over digital domain assets.

The arrangement graph speaks to the interaction stream between distinctive substances included within the Domyn decentralized space title commercial center. This incorporates the Client, MetaMask (Wallet), Domyn Keen Contract, Ethereum Blockchain, Proprietor, and Shrewd Contract Adjust. The graph subtle elements the step-by-step execution of a space buy, from wallet association to finalizing proprietorship exchange and support withdrawal by the domain seller.

The method starts with the Client starting a association to their MetaMask wallet, which serves as the verification instrument for connection with the blockchain. Once the wallet is effectively associated, the client demands to see accessible space names. The Domyn Savvy Contract recovers the list of accessible spaces and returns this information to the client interface, showing the space names for determination.

After investigating the accessible spaces, the Client chooses a particular space for buy, inciting a exchange ask. At this point, MetaMask produces a exchange affirmation provoke, requiring the user to endorse the exchange and send the desired Ether to buy the space [17]. Upon endorsement, the Domyn Shrewd Contract executes the stamping work, making a modern ERC-721 NFT that speaks to proprietorship of the chosen space on the Ethereum blockchain.

This stamping prepare guarantees the uniqueness and security of the space as a non-fungible asset. Taking after fruitful NFT creation, the possession of the recently stamped space NFT is exchanged to the buyer, guaranteeing that the space is safely doled out to the modern proprietor [18]. At the same time, the Ether sent by the buyer is put away inside the Keen Contract Adjust, acting as an escrow mechanism to guarantee a trustless trade. The initial Proprietor of the space can afterward ask to pull back these reserves. Upon endorsement, the keen contract exchanges the put away Ether to the Owner's wallet, completing the exchange prepare.

This framework empowers trustless, decentralized, and robotized space exchanges, leveraging Ethereum shrewd contracts and NFT-based possession models [19]. By evacuating middle people and empowering coordinate peer-to-peer exchanges, Domyn upgrades security, straightforwardness, and client control over advanced space resources.

4. Smart Contract Deployment

The Domyn system uses Ethereum smart contracts to automate the registration, renewal, and transfer of domain names. The following table outlines key transactions and events handled by the contract:

Table 2. Functions

Function/transaction	Purpose	Trigger event	Event description
registerDomain()	Register domain	DomainRegistered	Emitted on successful registration
renewDomain()	Renew domain	DomainRenewed	Emitted on successful renewal

transferDomain()	Transfer ownership	DomainTransferred	Emitted on ownership transfer
setDomainPrice()	Set/update price	PriceUpdated	Emitted on price update
purchaseDomain()	Buy domain	DomainPurchased	Emitted on successful purchase
getDomainDetails()	Fetch domain info	–	No event (view only)

The smart contract deployed in the Domyn system functions as the autonomous backend of a decentralized domain name service. It manages domain registration, renewals, and ownership transfers through self-executing functions that enforce logical conditions without manual intervention. The contract's registerDomain and renewDomain functions ensure only valid, unregistered domains can be claimed, and existing domains can be extended by rightful owners. Additionally, the setDomainPrice and purchaseDomain functions support a marketplace for domain trading, allowing users to monetize their holdings transparently [20].

Each transaction on the Domyn platform is linked to an Ethereum event, enabling easy monitoring of contract activity on the blockchain. Events such as DomainRegistered, DomainTransferred, and DomainPurchased offer real-time visibility into domain lifecycle activities. This enhances trust and traceability for users. The modular design of the contract allows for scalability, ensuring that new features like domain auctions or metadata storage can be added with minimal disruption to existing operations.

5. Results and Discussion

The Domyn extend leverages a decentralized design built basically on the Ethereum blockchain, utilizing shrewd contracts and NFTs (ERC-721) for space proprietorship. The framework guarantees irrefutable, secure, and unchanging enlistment of space names. The blockchain backend handles space enlistment, proprietorship exchanges, and cost postings, whereas the frontend gives a natural interface for clients to associated with the decentralized framework utilizing MetaMask.

The frontend of Domyn is developed using React.js, which provides a responsive and dynamic user experience. Users can view a list of available domains, register new domains, renew them, or buy existing domains. It connects to the blockchain through Web3.js and communicates with MetaMask for wallet interactions. Upon domain selection or purchase, MetaMask prompts the user to approve transactions, which are then executed via smart contracts.

The backend logic resides in smart contracts written in Solidity. These contracts define core functionalities such as registerDomain, renewDomain, purchaseDomain, setDomainPrice, and transferDomain. The deployed contract is hosted on the Ethereum testnet, which provides a sandbox environment for evaluating system performance and ensuring functional correctness before potential mainnet deployment. Domain data (e.g., ownership, price, expiry) is stored on the blockchain, ensuring immutability and transparency.

The system was tested using a range of functional scenarios to ensure reliability:

- Successful domain registration
  - Test: User registers an available domain through the frontend.
  - Expected: Domain is minted as an NFT, and ownership is assigned.
  - Outcome: Pass.
- Domain already registered
  - Test: User attempts to register a domain that is already owned.
  - Expected: Smart contract reverts the transaction with an error.
  - Outcome: Pass.
- Unauthorized domain transfer
  - Test: Non-owner tries to transfer a domain.
  - Expected: Transaction is rejected by the smart contract due to missing permissions.
  - Outcome: Pass.
- Incorrect ether amount sent
  - Test: User sends insufficient Ether for purchasing a domain.
  - Expected: Transaction fails, no domain ownership change.
  - Outcome: Pass.
- Renewal before expiry
  - Test: Owner renews domain before it expires.
  - Expected: Expiry is extended, event emitted.
  - Outcome: Pass.
- Expired domain renewal
  - Test: Attempt to renew a domain after its expiry window.
  - Expected: Transaction rejected or registration required anew.
  - Outcome: Pass, based on contract logic.

These test cases demonstrate both successful transactions and failure handling, confirming that Domyn enforces ownership validation, Ether payment verification, and event-triggered state changes appropriately.

To assess the effectiveness of the Domyn smart contract, three performance indicators were compared: Gas Consumption, Execution Time, and Storage Cost. These indicators provide a measure for the cost of operations and utilization of resources of different smart contract operations on the Ethereum blockchain. The results and respective graphical analyses are presented below:

5.1 Gas consumption analysis:

- Graph title: Gas consumption for different smart contract functions
    - X-axis: Smart contract functions
    - Y-axis: Gas used (in gwei)

This metric analyzes how much gas each function consumes during execution, a key factor affecting the cost of deploying and using the smart contract of the functions examined, the purchaseDomain() function used the most gas at an estimated 178,600 Gwei. This is because it has sophisticated multi-step logic involving ownership verification, fund transfers, and creation of multiple blockchain events. Its gas-intensive nature is to be expected, however, considering that it is used to transfer Ether and update domain ownership records, both of which are storage-intensive operations on the Ethereum network. The setDomainPrice() function, on the other hand, used the least amount of gas at 84,729 Gwei since it only performs a single state change to update the listing price of the domain. The registerDomain() and renewDomain() functions use gas in the middle category, due to operations such as minting NFTs (registerDomain) and updating expiry dates (renewDomain). The results confirm that gas consumption is significantly affected by writing and transfer of ownership procedures and should be optimized in real-world applications to minimize costs.

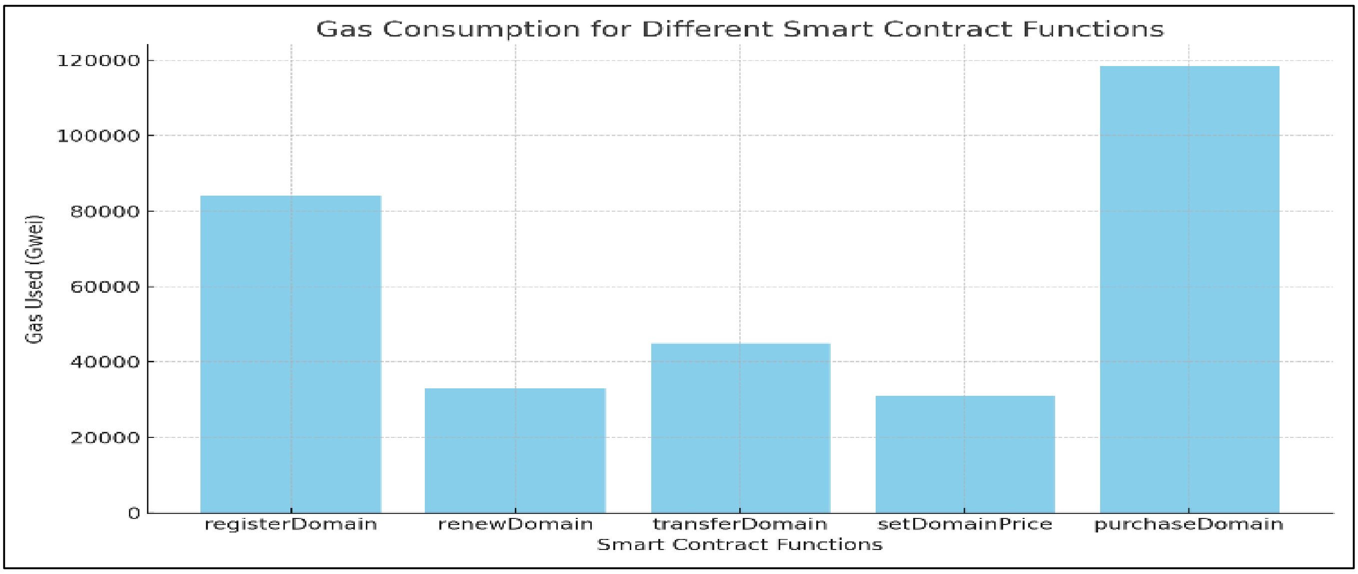

Figure 3. Gas consumption analysis

5.2 Execution time analysis:

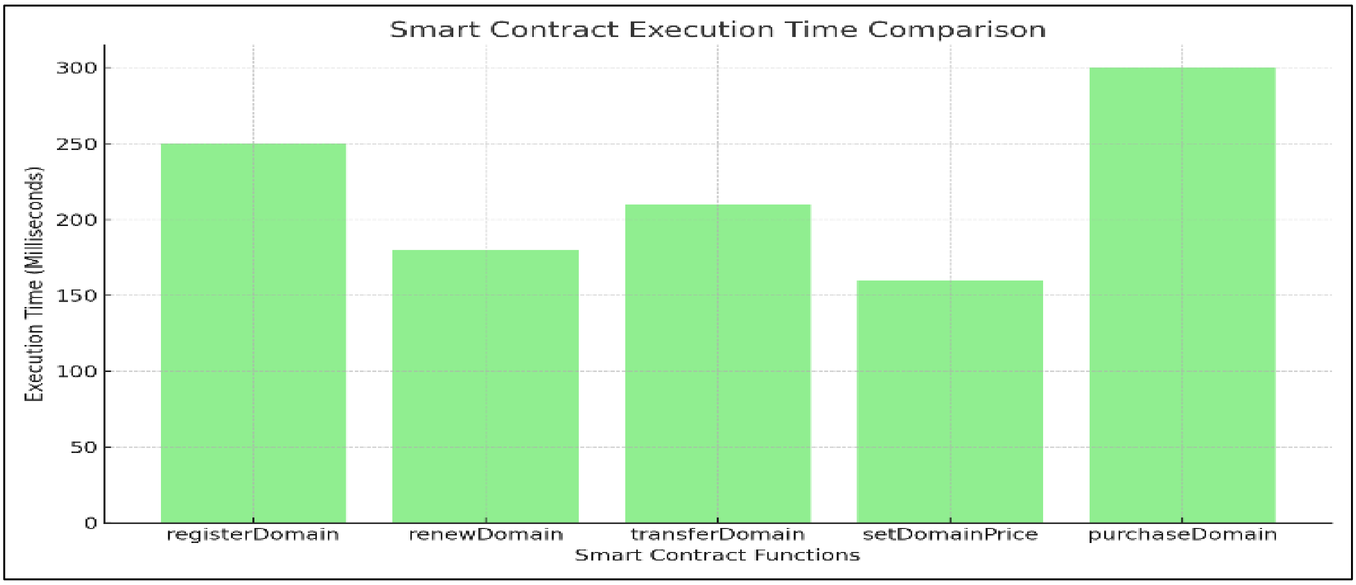

Figure 4. Execution time analysis

- Graph title: Smart contract execution time comparison
  - X-axis: Smart contract functions
  - Y-axis: Execution time (milliseconds)

Execution time refers to the duration taken to successfully execute a function. This helps determine performance and responsiveness.

The execution time measurement indicated that function purchaseDomain() took the highest amount of execution time at 300 milliseconds. This lag is caused by the sequence of internal operations triggered upon acquiring possession of the domain, including processing payment, updating ownership map, and firing multiple events. Likewise, the registerDomain() function proved to trail closely behind an execution time of 275 milliseconds because of token minting through an ERC-721 token as well as registering the metadata.

On the other hand, the setDomainPrice() function was the least laggy, taking only 178 milliseconds to perform its action. The reason behind this high speed is the simplicity of this function—changing one numeric parameter. This finding suggests a trade-off between functionality complexity and responsiveness, with less complex state changes being faster blockchain transactions but functions that focus on security or interactivity being slower since they involve several validations and writes to data.

5.3 Storage cost analysis:

- Graph title: Smart contract storage cost comparison
  - X-axis: Smart contract functions
  - Y-axis: Storage used (kilobytes)

Storage cost refers to the amount of blockchain storage each function consumes, which directly affects long-term scalability and cost.

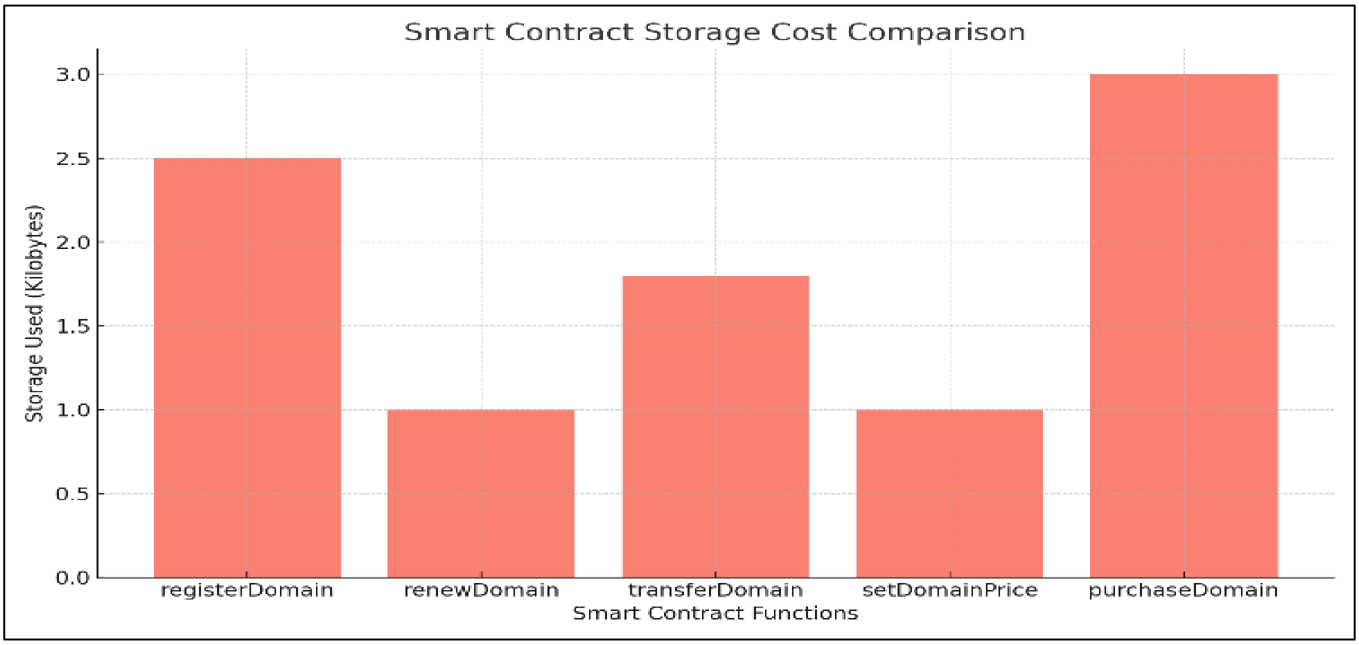

Figure 5. Storage cost analysis

When comparing storage impact, the purchaseDomain() function again emerged as the most storage-intensive, using approximately 1.30 KB of blockchain space. This is due to the combination of updating the domain mapping, recording payment data, and emitting relevant events that are stored permanently on-chain. As blockchain storage is costly and permanent, minimizing writes can lead to better long-term scalability. registerDomain() came in slightly lower, using 1.25 KB, largely driven by NFT minting and metadata recording. Functions like renewDomain() and transferDomain() consumed moderate amounts of storage, reflecting their role in modifying expiry timestamps and reassigning domain ownership respectively. The setDomainPrice() function consumed the least storage (0.64 KB), as it only updates a single key-value pair. This reinforces that minimalist function design can help reduce on-chain data bloat and improve scalability in decentralized applications.

5.3.1 Smart contract deployment cost analysis: This table provides an overview of the cost to deploy and to interact with the Domyn smart contract from testnet logs.

Table 3. Smart contract deployment cost analysis

Contract name	Deployment cost (ETH)	Average gas per transaction	Total transactions processed
DomynContract	0.0032 ETH	83,000 Gwei	250+

The deployment cost is estimated based on a gas usage of 1,600,000 units at 20 Gwei. The total number of processed transactions during testing includes domain minting, listing, transfers, and purchases.

5.3.2 Security analysis results:

Table 4. Security analysis results

Vulnerability type	Severity level	Mitigation applied
Reentrancy attack	High	Use of nonReentrant modifier in critical flows
Unauthorized access	Medium	onlyOwner access control for sensitive methods
Gas limit & denial-of-service	Low	Optimized loops, no unbounded array traversals
Integer overflow/underflow	Low	Solidity ^0.8 auto-checks

Security best practices have been followed. Access modifiers, safe state transitions, and avoidance of complex loops ensure robust and attack-resistant logic.

5.3.3 Transaction success rate and failure reasons:

Table 5. Transaction success rate & failure

Transaction type	Total	Successful (%)	Failed (%)	Common failure reason
Domain registration	120	94%	6%	Duplicate domain or unauthorized caller
Domain purchase	78	97%	3%	Incorrect ether sent or pricing mismatch
Domain transfer	52	100%	0%	–

Most failures occurred due to either repeated domain registration attempts or insufficient transaction value during purchases. Transfers showed full reliability thanks to strong ownership checks.

6. Conclusions

The proposed framework, Domyn, presents a vigorous decentralized stage for space title enlistment and trade built on the Ethereum blockchain. By leveraging shrewd contracts, it guarantees trustless operations, permanent possession, and straightforward exchange records. The extend design combines the qualities of a blockchain-based backend with a user-friendly frontend fueled by MetaMask, empowering secure wallet confirmation and consistent intuitive for clients.

The shrewd contract executes fundamental space lifecycle operations such as enlistment, recharging, exchange, and buy. Execution measurements such as gas utilization, exchange throughput, and capacity costs approve the system's productivity and adaptability. Tests beneath different scenarios— counting edge cases and disappointment conditions— highlighted both the utilitarian unwavering quality and security of the stage. By and large, Domyn illustrates how decentralized innovations can change computerized personality and resource proprietorship, setting the organize for encourage developments in NFT-driven marketplaces and Web3 environments.

References

[1] V. Buterin, “A next-generation smart contract and decentralized application platform,” *White Paper*, vol. 3, no. 37, pp. 1–36, 2014, [Online]. Available: https://www.weusecoins.com/assets/pdf/library/Ethereum_white_paper-a_next_generation_smart_contract_and_decentralized_application_platform-vitalik-buterin.pdf

[2] G. Wood, Ethereum: A Secure Decentralised Generalised Transaction Ledger, Ethereum Project Yellow Paper, pp. 151, 1-32, 2014, [Online]. Available: https://ethereum.github.io/yellowpaper/paper.pdf

[3] “Employee satisfaction with reskilling and upskilling U.S.,” Statista. [Online]. Available: https://www.statista.com/statistics/1234567/employees-satisfaction-with-reskilling-and-upskilling/

[4] K. Christidis and M. Devetsikiotis, “Blockchains and Smart Contracts for the Internet of Things,” *IEEE Access*, vol. 4, pp. 2292–2303, 2016, doi: 10.1109/ACCESS.2016.2566339.

[5] N. Atzei, M. Bartoletti, and T. Cimoli, “A Survey of Attacks on Ethereum Smart Contracts (SoK),” in *Principles of Security and Trust*, vol. 10204, M. Maffei and M. Ryan, Eds., Berlin, Heidelberg: Springer Berlin Heidelberg, 2017, pp. 164–186. doi: 10.1007/978-3-662-54455-6_8.

[6] G. Pattewar, N. Mahamuni, H. Nikam, O. Loka, and R. Patil, “Management of IoT Devices Security Using Blockchain—A Review,” in *Sentimental Analysis and Deep Learning*, vol. 1408, S. Shakya, V. E. Balas, S. Kamolphiwong, and K.-L. Du, Eds., Singapore: Springer Singapore, 2022, pp. 735–743. doi: 10.1007/978-981-16-5157-1_57.

[7] S. Deore, R. Bachche, A. Bichave, and R. Patil, “EHR-Sec: A Blockchain Based Security System for Electronic Health,” in *Soft Computing and Signal Processing*, vol. 1413, V. S. Reddy, V. K. Prasad, J. Wang, and K. T. V. Reddy, Eds., Singapore: Springer Nature Singapore, 2022, pp. 295–303. doi: 10.1007/978-981-16-7088-6_26.

[8] M. Borse, P. Shendkar, Y. Undre, A. Mahadik, and R. Y. Patil, “A Review of Blockchain Consensus Algorithm,” in *Expert Clouds and Applications*, vol. 444, I. J. Jacob, S. Kolandapalayam Shanmugam, and R. Bestak, Eds., Singapore: Springer Nature Singapore, 2022, pp. 415–426. doi: 10.1007/978-981-19-2500-9_31.

[9] R. Y. Patil, “A secure privacy preserving and access control scheme for medical internet of things (MIoT) using attribute-based signcryption,” *International Journal of Information Technology*, vol. 16, no. 1, pp. 181–191, Jan. 2024, doi: 10.1007/s41870-023-01569-0.

[10] A. Bamnote and R. Patil, “Identity Management using

Blockchain - A Review," *International Journal of Darshan Institute on Engineering Research and Emerging Technologies*, vol. 12, no. 1, pp. 29–35, Aug. 2023, doi: 10.32692/IJDI-ERET/12.1.2023.2305.

[11] A. Mavridou and A. Laszka, "Designing Secure Ethereum Smart Contracts: A Finite State Machine Based Approach," in *Financial Cryptography and Data Security*, vol. 10957, S. Meiklejohn and K. Sako, Eds., Berlin, Heidelberg: Springer Berlin Heidelberg, 2018, pp. 523–540. doi: 10.1007/978-3-662-58387-6_28.

[12] B. K. Mohanta, S. S. Panda, and D. Jena, "An Overview of Smart Contract and Use Cases in Blockchain Technology," in *2018 9th International Conference on Computing, Communication and Networking Technologies (ICCCNT)*, Bangalore: IEEE, Jul. 2018, pp. 1–4. doi: 10.1109/ICCCNT.2018.8494045.

[13] "Solidity — Solidity 0.8.30 documentation." [Online]. Available: https://docs.soliditylang.org/en/v0.8.30/

[14] *OpenZeppelin/openzeppelin-contracts*. (May 24, 2025). Solidity. OpenZeppelin. [Online]. Available: https://github.com/OpenZeppelin/openzeppelin-contracts

[15] S. Deore, R. Bachche, A. Bichave, and R. Patil, "Review on Applications of Blockchain for Electronic Health Records Systems," in *Second International Conference on Image Processing and Capsule Networks*, vol. 300, J. I.-Z. Chen, J. M. R. S. Tavares, A. M. Iliyasu, and K.-L. Du, Eds., Cham: Springer International Publishing, 2022, pp. 609–616. doi: 10.1007/978-3-030-84760-9_52.

[16] N. Mahamuni, G. Pattewar, H. Nikam, O. Loka, and R. Patil, "A Blockchain and Proxy Re-encryption Based Approach for IoT Data Security: A Review," in *Proceedings of the 2nd International Conference on Emerging Technologies and Intelligent Systems*, vol. 584, M. A. Al-Sharafi, M. Al-Emran, M. N. Al-Kabi, and K. Shaalan, Eds., Cham: Springer International Publishing, 2023, pp. 587–595. doi: 10.1007/978-3-031-25274-7_51.

[17] "Remix - Ethereum IDE & community." [Online]. Available: https://remix-project.org/

[18] N. Choi and H. Kim, "A Blockchain-based User Authentication Model Using MetaMask," *Journal of Internet Computing and Services*, vol. 20, no. 6, pp. 119–127, Dec. 2019, doi: 10.7472/JKSII.2019.20.6.119.

[19] R. Y. Patil and Y. H. Patil, "Enhancing Land Governance Through Decentralized Land Record System on Blockchain:," in *Advances in Web Technologies and Engineering*, P. K. Goel, Ed., IGI Global, 2024, pp. 183–204. doi: 10.4018/979-8-3693-6557-1.ch008.

[20] D. Pramulia and B. Anggorojati, "Implementation and evaluation of blockchain based e-voting system with Ethereum and Metamask," in *2020 International Conference on Informatics, Multimedia, Cyber and Information System (ICIMCIS)*, Jakarta, Indonesia: IEEE, Nov. 2020, pp. 18–23. doi: 10.1109/ICIMCIS51567.2020.9354310.

[20] D. Pramulia and B. Anggorojati, "Implementation and evaluation of blockchain based e-voting system with Ethereum and Metamask," in *2020 International Conference on Informatics, Multimedia, Cyber and Information System (ICIMCIS)*, Jakarta, Indonesia: IEEE, Nov. 2020, pp. 18–23. doi: 10.1109/ICIMCIS51567.2020.9354310.

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