US 20240095733A1

(19) United States

(12) Patent Application Publication

Gauvreau, JR.

(10) Pub. No.: US 2024/0095733 A1

(43) Pub. Date: Mar. 21, 2024

(54) **BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM**

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(21) Appl. No.: **18/339,721**

(22) Filed: **Jun. 22, 2023**

Related U.S. Application Data

(60) Provisional application No. 63/408,826, filed on Sep. 21, 2022.

Publication Classification

(51) **Int. Cl.**

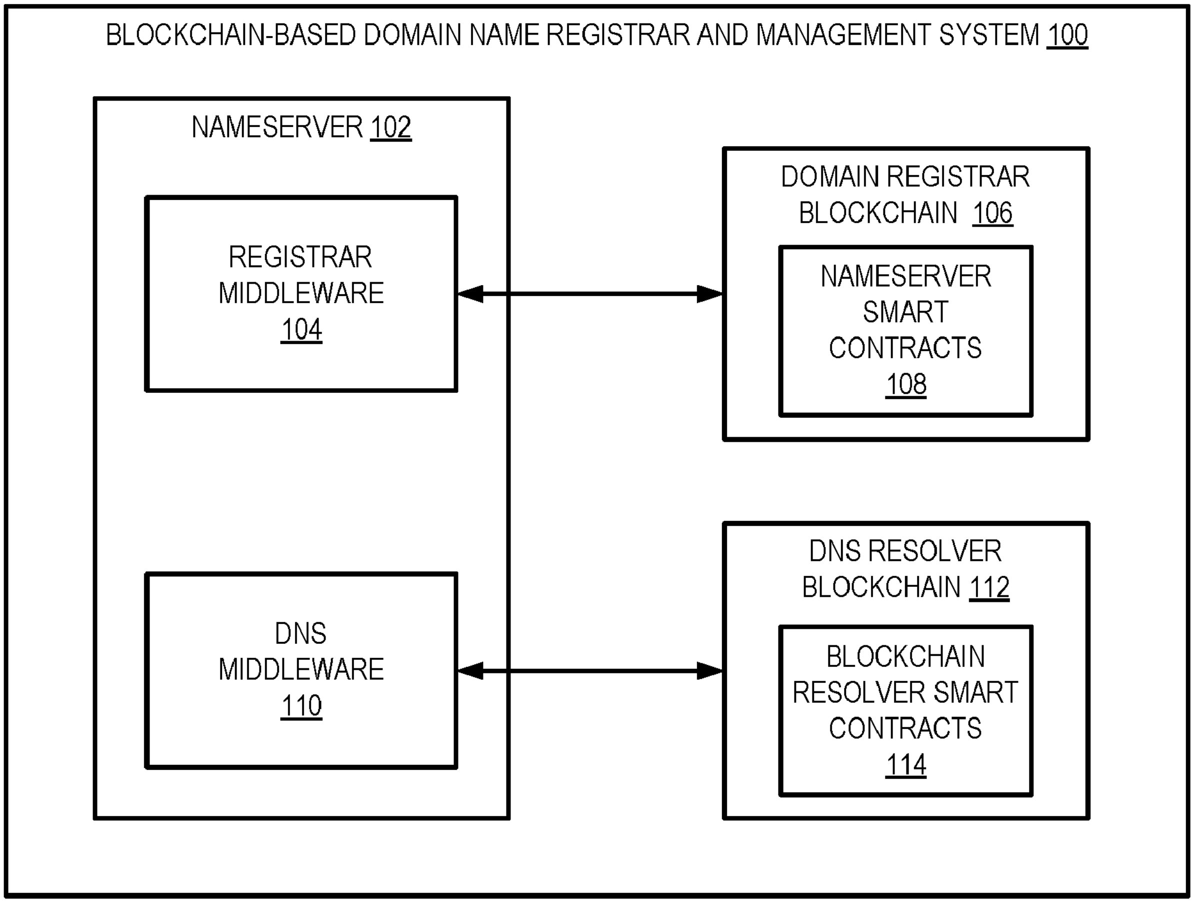
G06Q 20/38	(2006.01)
G06Q 20/36	(2006.01)

(52) **U.S. Cl.**

CPC ***G06Q 20/389*** (2013.01); ***G06Q 20/3672*** (2013.01)

(57) **ABSTRACT**

A nameserver receives a request to access a webpage from a client device. The nameserver generates a blockchain query based on the request for querying a domain registrar blockchain storing domain name registration data in smart contracts. The nameserver sends the first blockchain query to the domain registrar blockchain. In response to receiving a nameserver identifier from the domain registrar blockchain, the nameserver retrieves a DNS record for the webpage using the received nameserver identifier. The nameserver then provides information from the retrieved DNS record to the client device to allow the client device to access the webpage.


BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM 100
NAMESERVER 102
REGISTRAR MIDDLEWARE 104
DNS MIDDLEWARE 110
DOMAIN REGISTRAR BLOCKCHAIN 106
NAMESERVER SMART CONTRACTS 108
DNS RESOLVER BLOCKCHAIN 112
BLOCKCHAIN RESOLVER SMART CONTRACTS 114

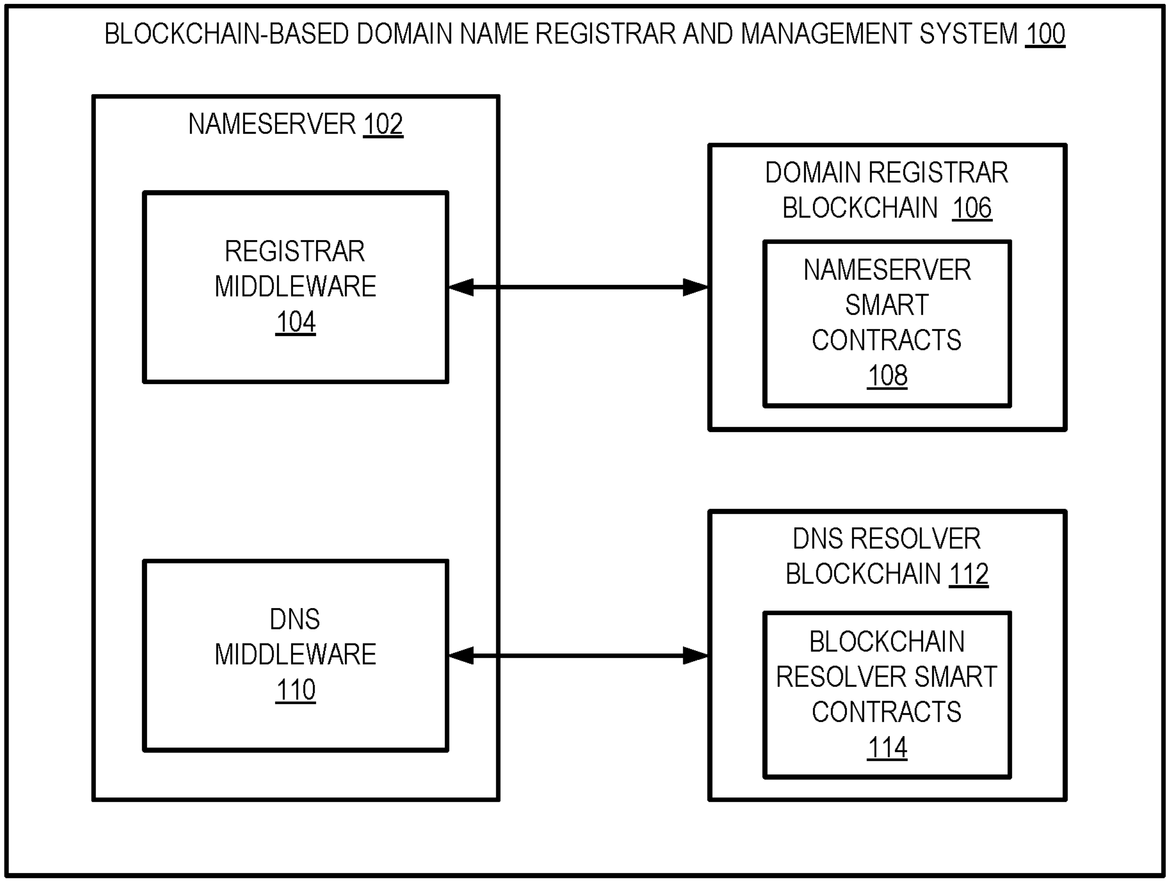

BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM 100
NAMESERVER 102
REGISTRAR MIDDLEWARE 104
DNS MIDDLEWARE 110
DOMAIN REGISTRAR BLOCKCHAIN 106
NAMESERVER SMART CONTRACTS 108
DNS RESOLVER BLOCKCHAIN 112
BLOCKCHAIN RESOLVER SMART CONTRACTS 114

FIG. 1

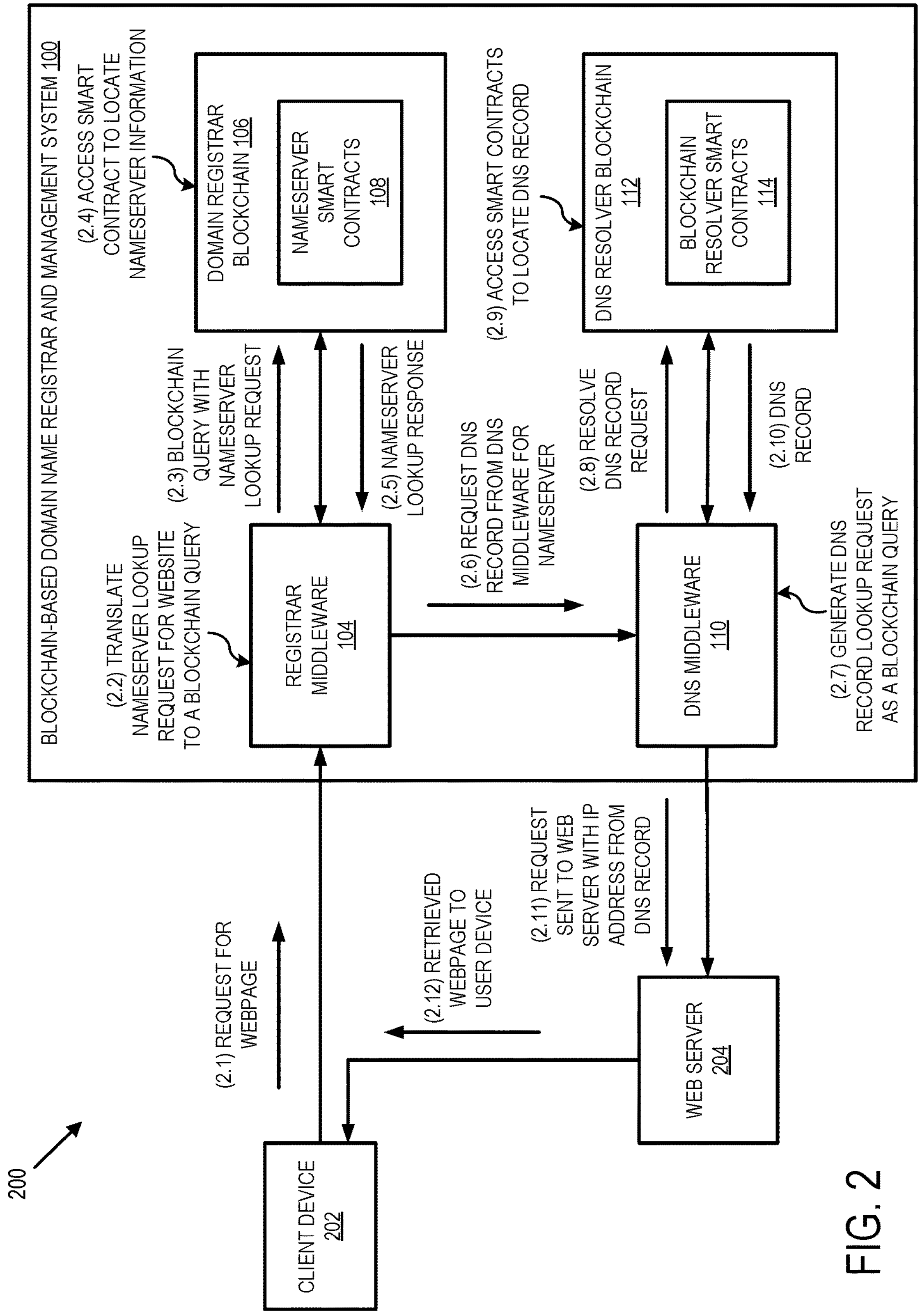

200
BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM 100
(2.4) ACCESS SMART CONTRACT TO LOCATE NAMESERVER INFORMATION
DOMAIN REGISTRAR BLOCKCHAIN 106
NAMESERVER SMART CONTRACTS 108
(2.9) ACCESS SMART CONTRACTS TO LOCATE DNS RECORD
DNS RESOLVER BLOCKCHAIN 112
BLOCKCHAIN RESOLVER SMART CONTRACTS 114
(2.2) TRANSLATE NAMESERVER LOOKUP REQUEST FOR WEBSITE TO A BLOCKCHAIN QUERY
(2.3) BLOCKCHAIN QUERY WITH NAMESERVER LOOKUP REQUEST
(2.5) NAMESERVER LOOKUP RESPONSE
REGISTRAR MIDDLEWARE 104
(2.6) REQUEST DNS RECORD FROM DNS MIDDLEWARE FOR NAMESERVER
(2.8) RESOLVE DNS RECORD REQUEST
(2.10) DNS RECORD
DNS MIDDLEWARE 110
(2.7) GENERATE DNS RECORD LOOKUP REQUEST AS A BLOCKCHAIN QUERY
(2.1) REQUEST FOR WEBPAGE
(2.12) RETRIEVED WEBPAGE TO USER DEVICE
(2.11) REQUEST SENT TO WEB SERVER WITH IP ADDRESS FROM DNS RECORD
CLIENT DEVICE 202
WEB SERVER 204

FIG. 2

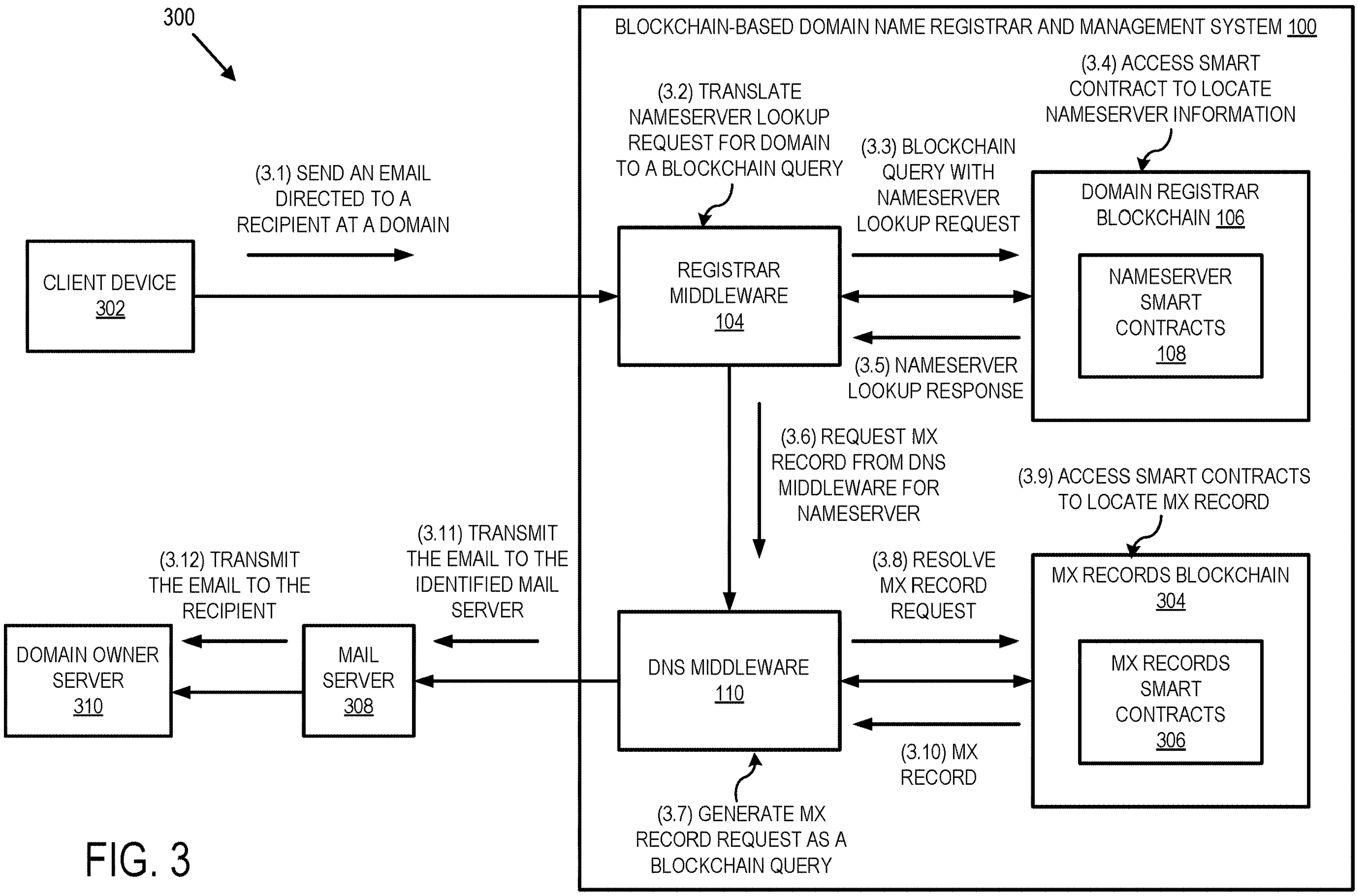

300
CLIENT DEVICE 302
(3.1) SEND AN EMAIL DIRECTED TO A RECIPIENT AT A DOMAIN
BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM 100
(3.2) TRANSLATE NAMESERVER LOOKUP REQUEST FOR DOMAIN TO A BLOCKCHAIN QUERY
REGISTRAR MIDDLEWARE 104
(3.3) BLOCKCHAIN QUERY WITH NAMESERVER LOOKUP REQUEST
(3.4) ACCESS SMART CONTRACT TO LOCATE NAMESERVER INFORMATION
DOMAIN REGISTRAR BLOCKCHAIN 106
NAMESERVER SMART CONTRACTS 108
(3.5) NAMESERVER LOOKUP RESPONSE
(3.6) REQUEST MX RECORD FROM DNS MIDDLEWARE FOR NAMESERVER
(3.7) GENERATE MX RECORD REQUEST AS A BLOCKCHAIN QUERY
DNS MIDDLEWARE 110
(3.8) RESOLVE MX RECORD REQUEST
(3.9) ACCESS SMART CONTRACTS TO LOCATE MX RECORD
MX RECORDS BLOCKCHAIN 304
MX RECORDS SMART CONTRACTS 306
(3.10) MX RECORD
(3.11) TRANSMIT THE EMAIL TO THE IDENTIFIED MAIL SERVER
MAIL SERVER 308
(3.12) TRANSMIT THE EMAIL TO THE RECIPIENT
DOMAIN OWNER SERVER 310

FIG. 3

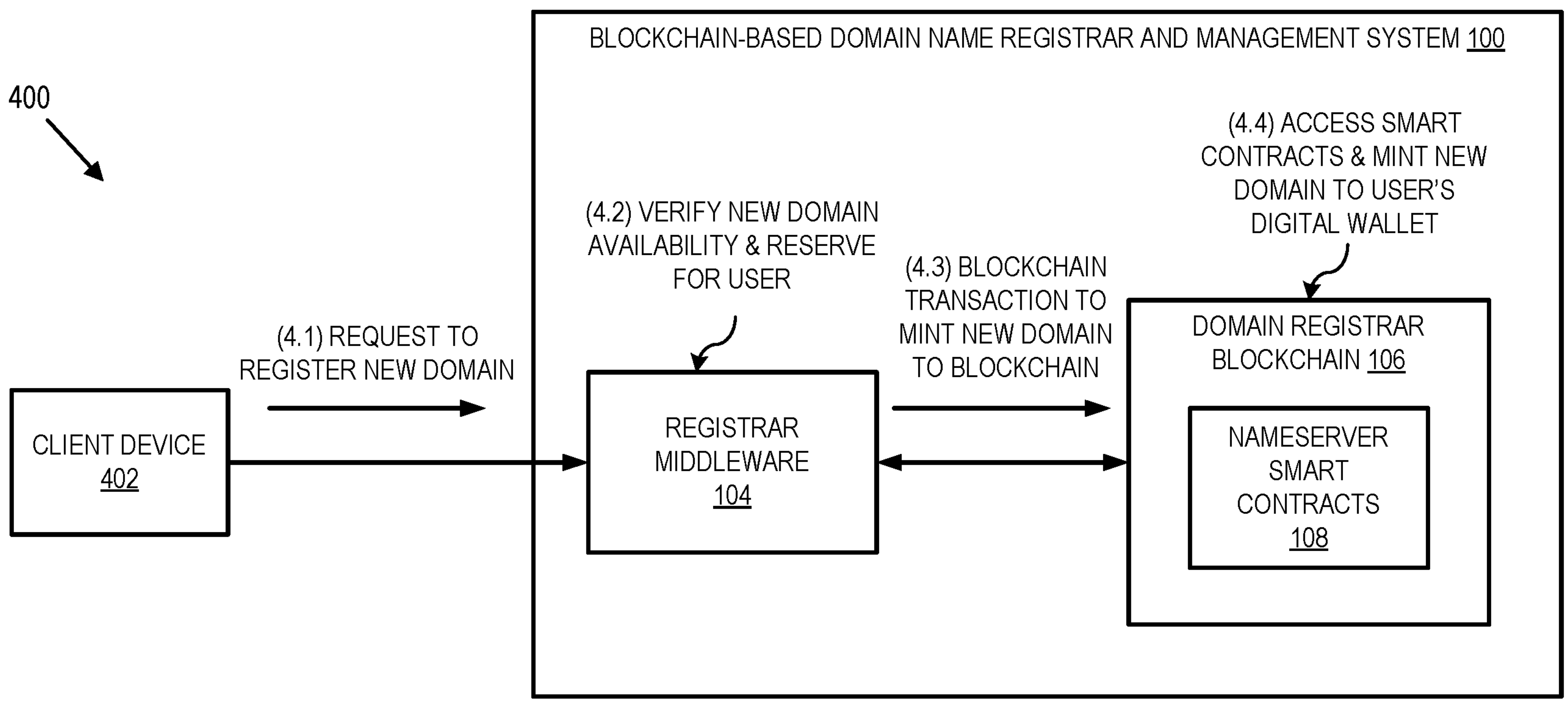

400
BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM 100
CLIENT DEVICE 402
(4.1) REQUEST TO REGISTER NEW DOMAIN
(4.2) VERIFY NEW DOMAIN AVAILABILITY & RESERVE FOR USER
REGISTRAR MIDDLEWARE 104
(4.3) BLOCKCHAIN TRANSACTION TO MINT NEW DOMAIN TO BLOCKCHAIN
(4.4) ACCESS SMART CONTRACTS & MINT NEW DOMAIN TO USER'S DIGITAL WALLET
DOMAIN REGISTRAR BLOCKCHAIN 106
NAMESERVER SMART CONTRACTS 108

FIG. 4

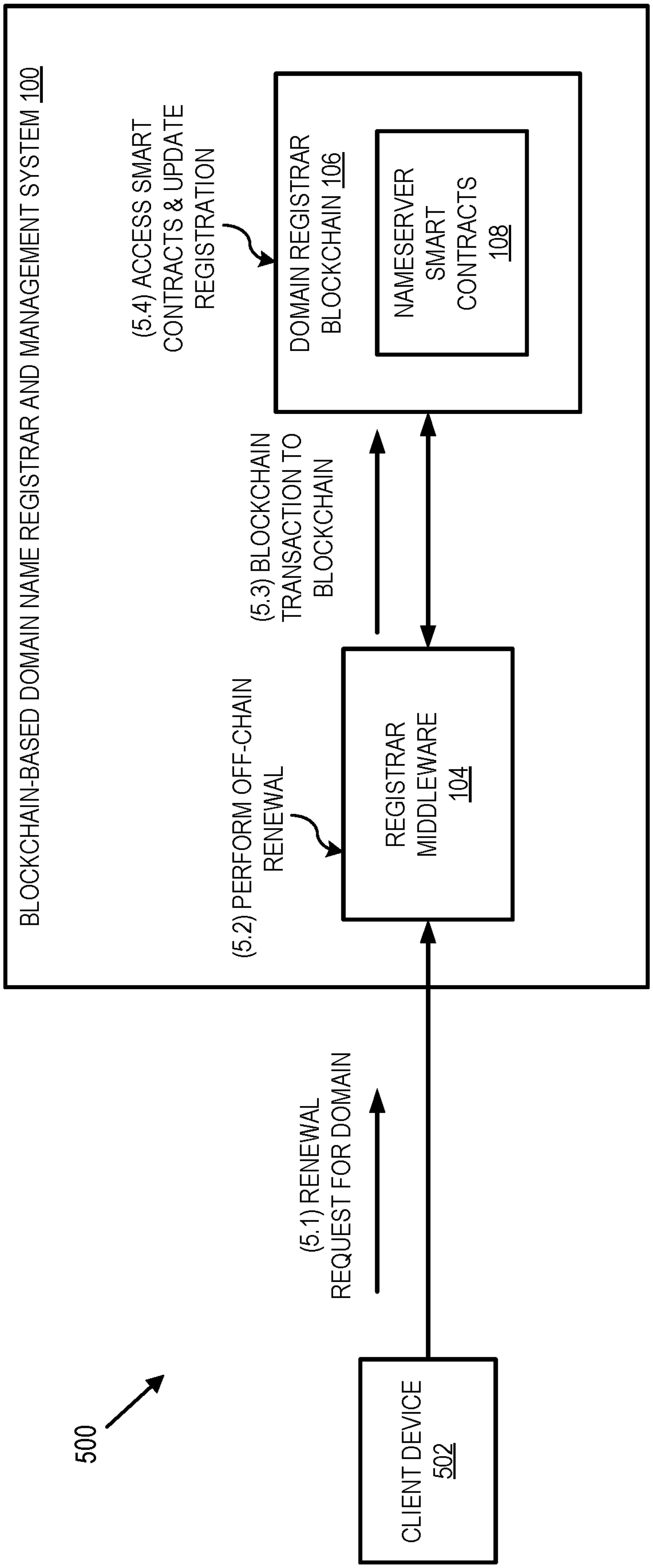

500
BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM 100
CLIENT DEVICE 502
(5.1) RENEWAL REQUEST FOR DOMAIN
REGISTRAR MIDDLEWARE 104
(5.2) PERFORM OFF-CHAIN RENEWAL
(5.3) BLOCKCHAIN TRANSACTION TO BLOCKCHAIN
DOMAIN REGISTRAR BLOCKCHAIN 106
NAMESERVER SMART CONTRACTS 108
(5.4) ACCESS SMART CONTRACTS & UPDATE REGISTRATION

FIG. 5

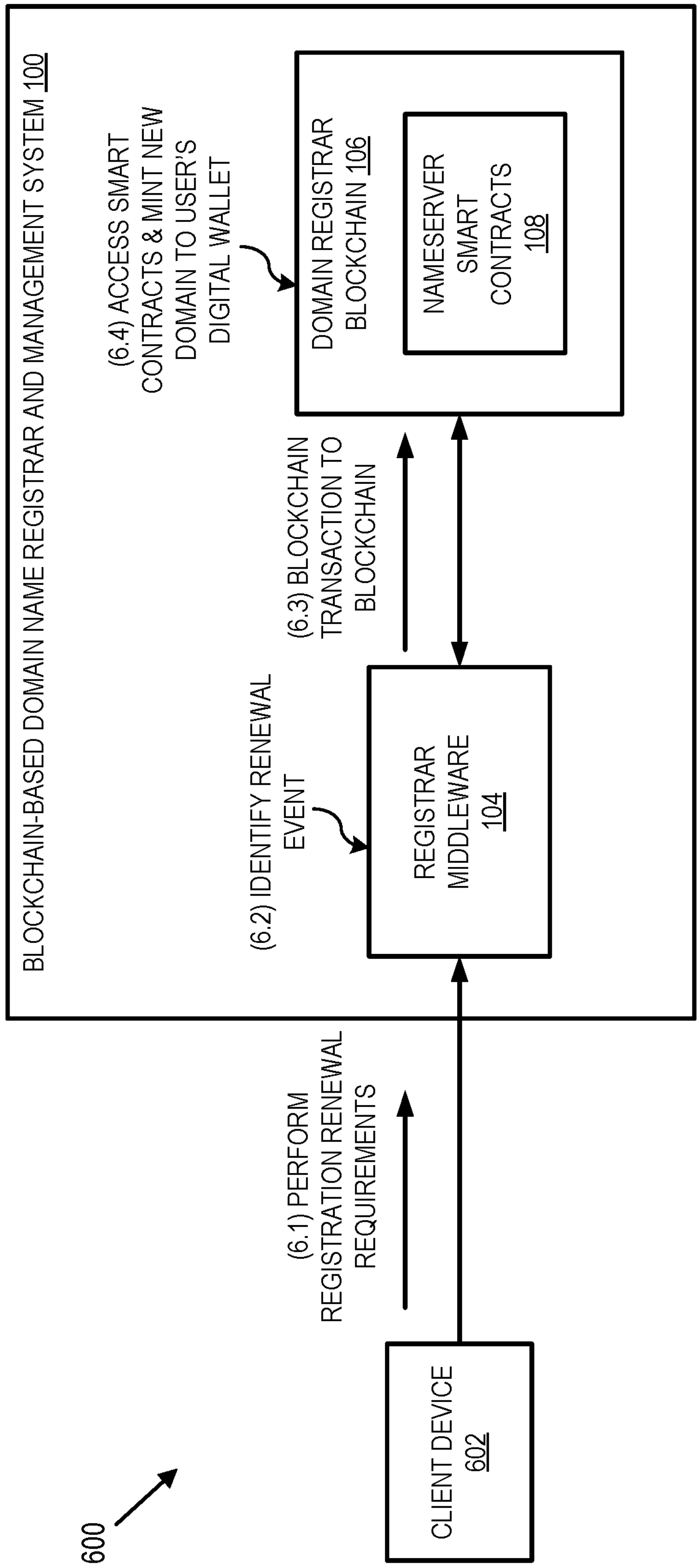

600
BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM 100
CLIENT DEVICE 602
(6.1) PERFORM REGISTRATION RENEWAL REQUIREMENTS
REGISTRAR MIDDLEWARE 104
(6.2) IDENTIFY RENEWAL EVENT
(6.3) BLOCKCHAIN TRANSACTION TO BLOCKCHAIN
DOMAIN REGISTRAR BLOCKCHAIN 106
NAMESERVER SMART CONTRACTS 108
(6.4) ACCESS SMART CONTRACTS & MINT NEW DOMAIN TO USER'S DIGITAL WALLET

FIG. 6

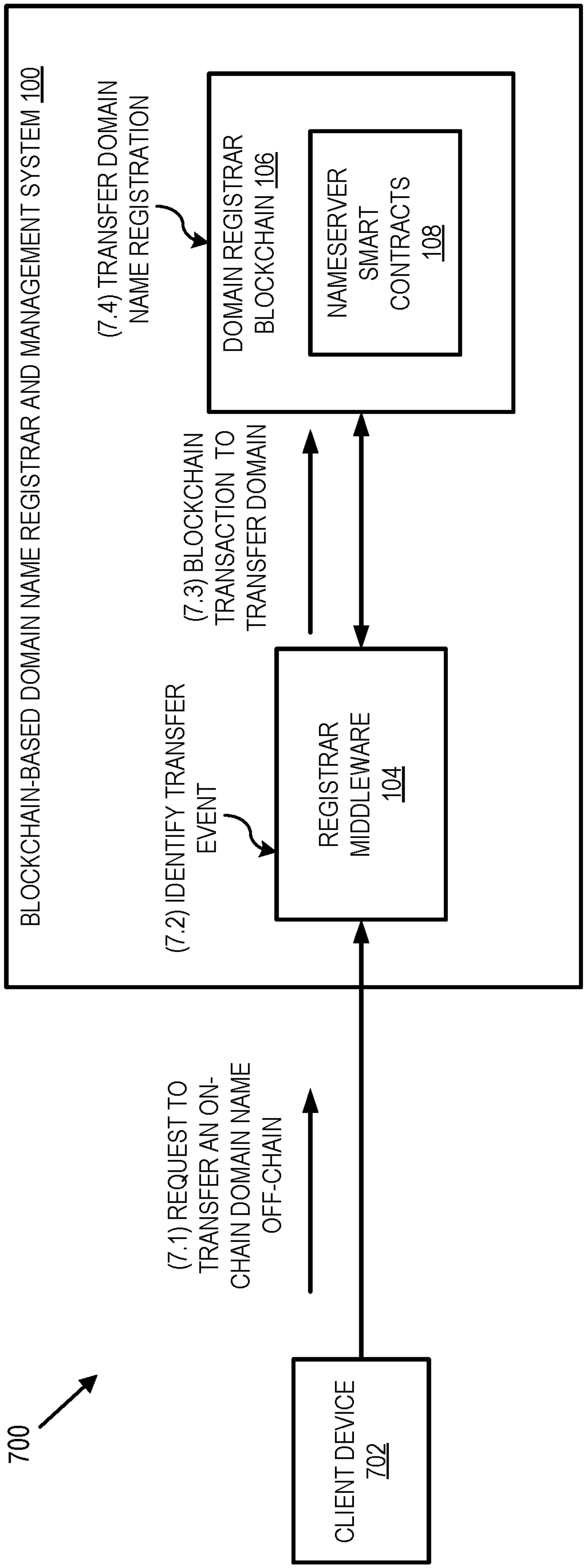

700
BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM 100
CLIENT DEVICE 702
(7.1) REQUEST TO TRANSFER AN ON-CHAIN DOMAIN NAME OFF-CHAIN
(7.2) IDENTIFY TRANSFER EVENT
REGISTRAR MIDDLEWARE 104
(7.3) BLOCKCHAIN TRANSACTION TO TRANSFER DOMAIN
(7.4) TRANSFER DOMAIN NAME REGISTRATION
DOMAIN REGISTRAR BLOCKCHAIN 106
NAMESERVER SMART CONTRACTS 108

FIG. 7

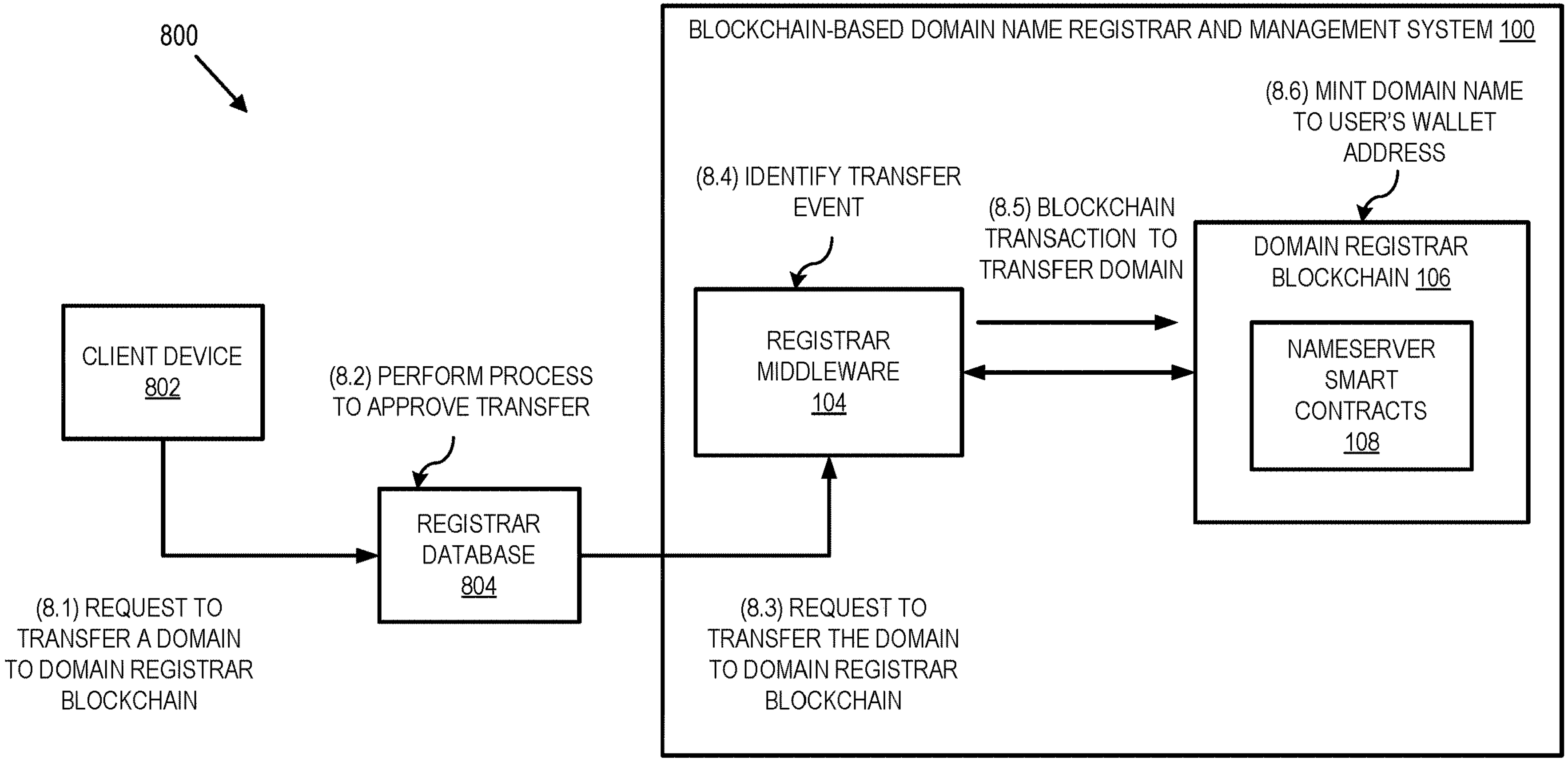

800
CLIENT DEVICE 802
(8.1) REQUEST TO TRANSFER A DOMAIN TO DOMAIN REGISTRAR BLOCKCHAIN
(8.2) PERFORM PROCESS TO APPROVE TRANSFER
REGISTRAR DATABASE 804
BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM 100
(8.3) REQUEST TO TRANSFER THE DOMAIN TO DOMAIN REGISTRAR BLOCKCHAIN
(8.4) IDENTIFY TRANSFER EVENT
REGISTRAR MIDDLEWARE 104
(8.5) BLOCKCHAIN TRANSACTION TO TRANSFER DOMAIN
(8.6) MINT DOMAIN NAME TO USER'S WALLET ADDRESS
DOMAIN REGISTRAR BLOCKCHAIN 106
NAMESERVER SMART CONTRACTS 108

FIG. 8

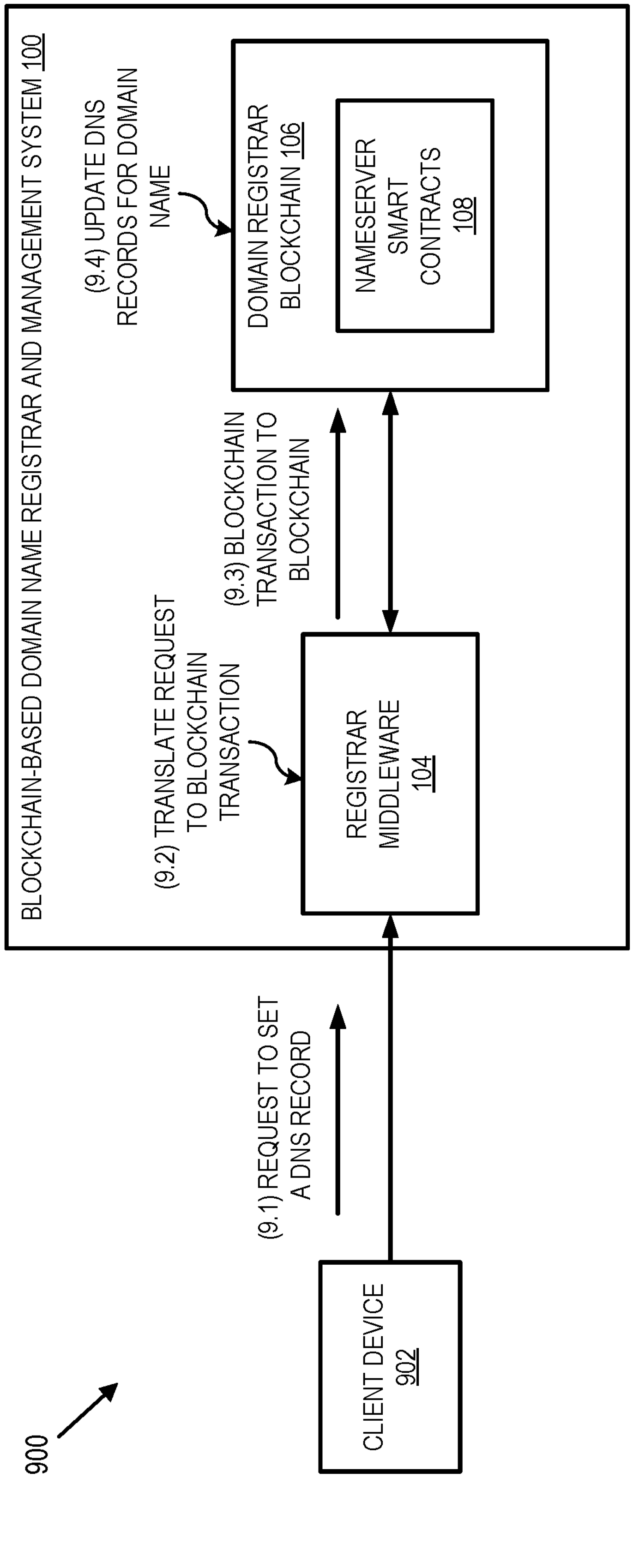

900
BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM 100
CLIENT DEVICE 902
(9.1) REQUEST TO SET A DNS RECORD
REGISTRAR MIDDLEWARE 104
(9.2) TRANSLATE REQUEST TO BLOCKCHAIN TRANSACTION
(9.3) BLOCKCHAIN TRANSACTION TO BLOCKCHAIN
DOMAIN REGISTRAR BLOCKCHAIN 106
NAMESERVER SMART CONTRACTS 108
(9.4) UPDATE DNS RECORDS FOR DOMAIN NAME

FIG. 9

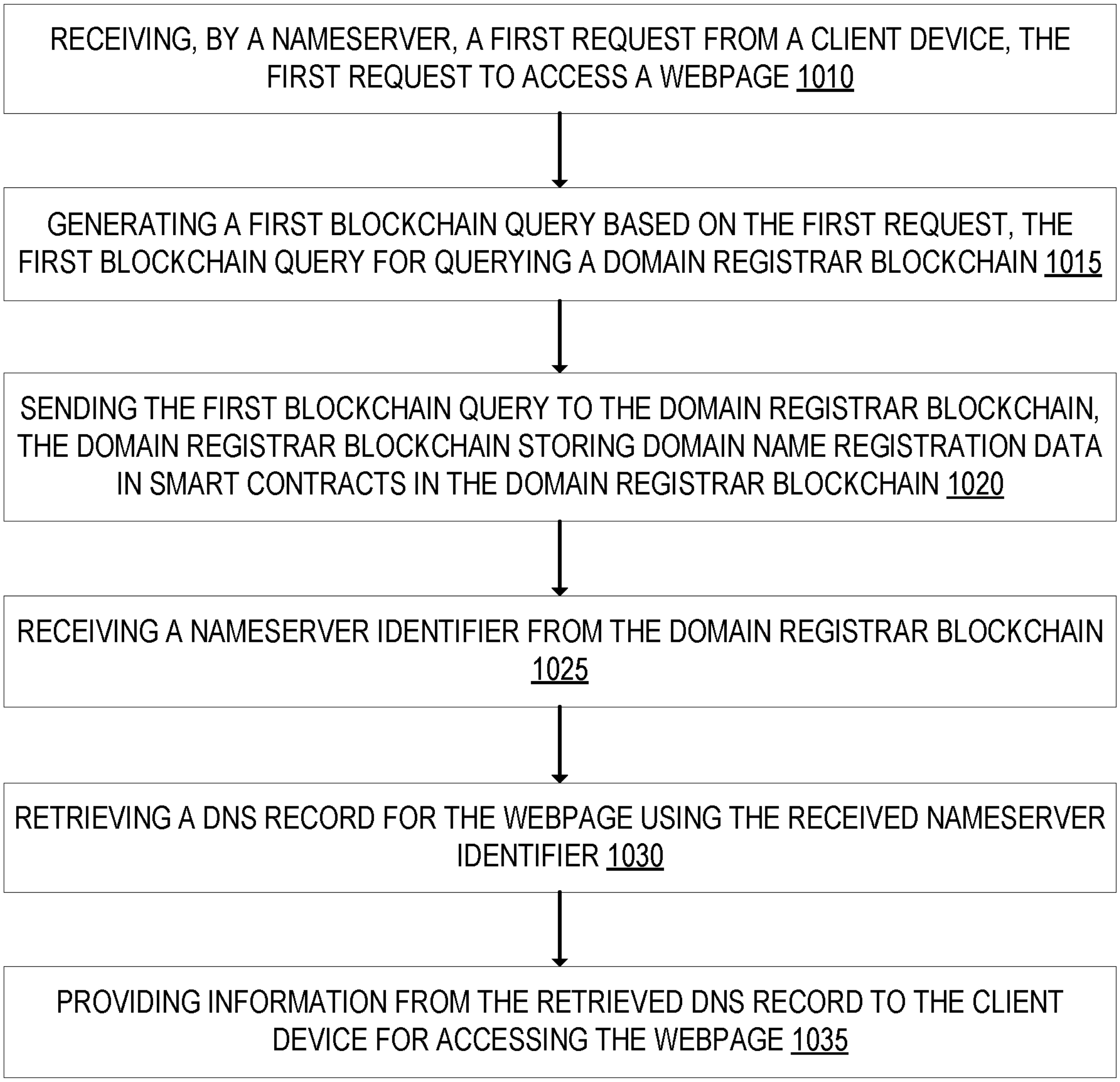

RECEIVING, BY A NAMESERVER, A FIRST REQUEST FROM A CLIENT DEVICE, THE FIRST REQUEST TO ACCESS A WEBPAGE 1010
GENERATING A FIRST BLOCKCHAIN QUERY BASED ON THE FIRST REQUEST, THE FIRST BLOCKCHAIN QUERY FOR QUERYING A DOMAIN REGISTRAR BLOCKCHAIN 1015
SENDING THE FIRST BLOCKCHAIN QUERY TO THE DOMAIN REGISTRAR BLOCKCHAIN, THE DOMAIN REGISTRAR BLOCKCHAIN STORING DOMAIN NAME REGISTRATION DATA IN SMART CONTRACTS IN THE DOMAIN REGISTRAR BLOCKCHAIN 1020
RECEIVING A NAMESERVER IDENTIFIER FROM THE DOMAIN REGISTRAR BLOCKCHAIN 1025
RETRIEVING A DNS RECORD FOR THE WEBPAGE USING THE RECEIVED NAMESERVER IDENTIFIER 1030
PROVIDING INFORMATION FROM THE RETRIEVED DNS RECORD TO THE CLIENT DEVICE FOR ACCESSING THE WEBPAGE 1035

FIG. 10

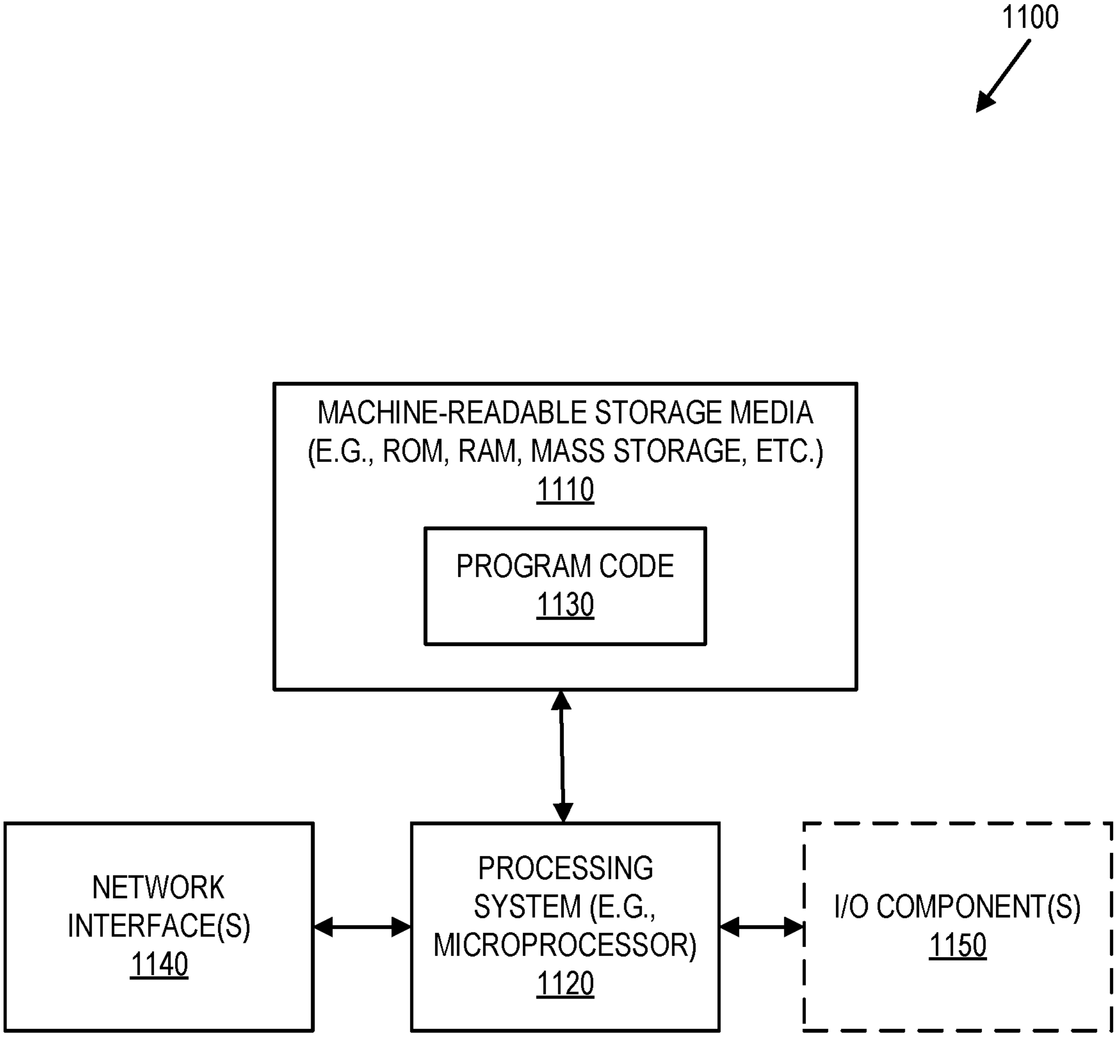

1100
MACHINE-READABLE STORAGE MEDIA (E.G., ROM, RAM, MASS STORAGE, ETC.) 1110
PROGRAM CODE 1130
NETWORK INTERFACE(S) 1140
PROCESSING SYSTEM (E.G., MICROPROCESSOR) 1120
I/O COMPONENT(S) 1150

FIG. 11

BLOCKCHAIN-BASED DOMAIN NAME REGISTRAR AND MANAGEMENT SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 63/408,826, filed Sep. 21, 2022, which is hereby incorporated by reference.

FIELD

[0002] Embodiments of the invention relate to the field of data storage using blockchains; and more specifically, to a blockchain-based domain name registrar.

BACKGROUND

[0003] The domain name system is a naming system for computing devices and resource (e.g., webpages) on the internet. The domain name system utilizes Internet Protocol (IP) addresses that are assigned to computing devices and resources that allow them to be identifiable and reachable for communications, exchanging data, etc. One important aspect of the domain name system is the storing of domain names and their corresponding IP addresses. This allows users to access a desired webpage using a web address (e.g., URL), rather than requiring users to memorize the specific numerical values of the IP address corresponding to the desired webpage. When a domain name is registered with a domain name registrar, the registrar can provide domain name resolution services for the domain name. Thus, when a user requests a webpage (e.g., by providing a URL in a browser application), a domain name resolution process is performed to identify the corresponding IP address and return the address to the browser application. The domain name resolution process can include multiple recursive steps that query nameserver databases to locate the DNS record that includes the IP address.

SUMMARY

[0004] Introduced here are techniques/technologies that allow a blockchain-based domain name registrar and management system to convert domain names and their corresponding DNS records into on-chain assets that are stored and managed directly on a blockchain. The blockchain-based registrar system uses smart contracts, on the Ethereum network, to support the features and functions required by the Internet Corporation for Assigned Names and Numbers (ICANN) to be an accredited domain registrar. More specifically, the blockchain-based registrar system supports full feature parity with traditional web2 registrars, allowing for new domain names to be registered and existing domain names to be transferred and renewed.

[0005] A nameserver of blockchain-based domain name registrar and management system receives a first request from a client device to access a webpage. The nameserver generates a blockchain query based on the request for querying a domain registrar blockchain. The domain registrar blockchain stores domain name registration data in smart contracts. The nameserver sends the blockchain query to the domain registrar blockchain. The domain registrar blockchain checks the smart contracts to determine whether the requested domain name is stored on the domain registrar blockchain and retrieves a nameserver identifier. The nameserver identifier is used to retrieve a DNS record for the webpage and information from the retrieved DNS record (e.g., an IP address) is provided to the client device.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The invention may best be understood by referring to the following description and accompanying drawings that are used to illustrate embodiments of the invention. In the drawings:

[0007] FIG. **1** illustrates a blockchain-based domain name registrar and management system according to some embodiments described herein;

[0008] FIG. **2** illustrates an exemplary networked system for resolving a domain name using a blockchain-based domain registrar according to some embodiments described herein;

[0009] FIG. **3** illustrates an exemplary networked system for transmitting an email message using a blockchain-based domain registrar according to some embodiments described herein;

[0010] FIG. **4** illustrates an exemplary networked system for performing a registration process for a new domain name using a blockchain-based domain registrar according to some embodiments described herein;

[0011] FIG. **5** illustrates an exemplary networked system for performing an off-chain renewal process for a domain name using a blockchain-based domain registrar according to some embodiments described herein;

[0012] FIG. **6** illustrates an exemplary networked system for performing an on-chain renewal process for a domain name using a blockchain-based domain registrar according to some embodiments described herein;

[0013] FIG. **7** illustrates an exemplary networked system for performing a process of transferring a domain name from a blockchain-based domain registrar to a non-blockchain registrar according to some embodiments described herein;

[0014] FIG. **8** illustrates an exemplary networked system for performing a process of transferring a domain name from a non-blockchain registrar to a blockchain-based domain registrar according to some embodiments described herein;

[0015] FIG. **9** illustrates an exemplary networked system for setting a DNS record for a domain name with a blockchain-based domain registrar according to some embodiments described herein;

[0016] FIG. **10** is a flow diagram that illustrates exemplary operations for a blockchain-based domain name registrar according to an embodiment; and

[0017] FIG. **11** is a block diagram for an exemplary data processing system that can be used in some embodiments.

DESCRIPTION OF EMBODIMENTS

[0018] Embodiments of the present disclosure include a blockchain-based domain name registrar and management system. The blockchain serves as a key infrastructure layer for performing distributed computation across a trustless network. Using smart contracts, any set of parties can perform trustless interactions with one another off a predefined set of rules. Actions that occur on-chain are fully auditable, immutable, and cryptographically administered. Blockchains are decentralized systems that allow for heightened security and direct ownership/administration of assets. The blockchain-based domain name registrar and management system can perform operations and processes using blockchain queries and transactions, including registering, renewing, and transferring domain names, and resolving DNS record requests.

[0019] Traditional domain name registrars manage the registration of domain names by maintaining domain name registration information in centralized databases. Typical disadvantages of using centralized databases include introducing a single point of failure. In addition, centralized databases typically have over privileged administrators, inability to prove and verify the integrity of data, and a lack of auditable trails.

[0020] To address the deficiencies in conventional systems, the blockchain-based domain name registrar and management system of the present disclosure stores domain name registration information and DNS records in a blockchain. Since domain names and their corresponding DNS records are all stored on-chain, the blockchain-based domain name registrar uses "wrapper" middleware services to translate and convert traditional nameserver requests into blockchain queries.

[0021] Embodiments describe herein provide many technical advantages and improvements, in addition to addressing the deficiencies of previous solutions. By adhering to ICANN requirements, the blockchain-based domain name registrar and management system uses the security and finality guarantees of blockchain transactions to administer and facilitate the management of domain names, while maintaining their interoperability with traditional systems. For example, using serverless middleware services to translate and convert traditional nameserver requests into blockchain queries abstracts away the complexities of interfacing with smart contracts and provides an interface structured as a standard nameserver. This allows the blockchain-based domain name registrar to be queried using requests structured as if they will be process by traditional database-based domain name registrars.

[0022] Further, a blockchain-based domain name registrar and management system can provide the benefits of using a blockchain to store DNS records and resolve requests. For example, the decentralized approach to registering and resolving domain names and DNS records using the blockchain-based domain name registrar and management system provides a fully transparent, auditable, and cryptographically secure domain name registration system. A blockchain-based domain name registrar further allows current DNS records, historical versions, and administrative actions to be publicly accessible. Unlike traditional systems, resolving DNS records for on-chain domains does not require access to any centralized services provided by the administering registrar, but can instead be resolved directly by the user themselves. Transacting on top of domains does not require a third party but can be performed directly on-chain due to the composable nature of the assets. The blockchain-based registrar further increases the composability and interoperability of the domain name by issuing it on-chain.

[0023] Further, a blockchain-based domain name can have the benefits of real-time transfers and settlement guarantees. For example, because the registration of a domain name in the domain registrar blockchain is tied to an on-chain asset (e.g., a token or NFT) stored in a digital wallet of the owner of the domain, the domain name can be transferred to another person by transferring the on-chain asset from the digital wallet of the owner to a new owner's digital wallet. Once the on-chain asset is in the new owner's digital wallet, only the new owner has administrative capabilities for the domain.

[0024] FIG. **1** illustrates a blockchain-based domain name registrar and management system according to some embodiments described herein. The blockchain-based domain name registrar and management system **100** illustrated in FIG. **1** includes a nameserver **102**, a blockchain that operates a domain registrar blockchain **106**, and a blockchain that operates a DNS resolver blockchain **112**. The domain registrar blockchain **106** is a blockchain that operates a domain registrar and the DNS resolver blockchain **112** is a blockchain that operates a DNS resolver.

[0025] In some embodiments, the nameserver **102** is an authoritative name server configured and authorized to receive requests for domain names and transmit IP addresses in response. In the embodiment of FIG. **1**, the nameserver **102** includes registrar middleware **104** and DNS middleware **110** as separate modules/components. In other embodiments, the registrar middleware **104** and the DNS middleware **110** are a single module/component of nameserver **102**.

[0026] In one embodiment, registrar middleware **104** is an intermediary configured to receive requests from client devices. In embodiments, the registrar middleware **104** is further configured to translate received requests into blockchain queries for querying the domain registrar blockchain **106**. Example requests received by the registrar middleware **104** can include requests to access/retrieve a webpage, send an email, register a new domain name, renew a domain name, transfer a domain name off or onto the domain registrar blockchain **106**, etc. In one embodiment, the DNS middleware **110** is an intermediary configured to receive and translate DNS requests into blockchain queries for querying the DNS resolver blockchain **112** and returning IP addresses from DNS records. In embodiments, the purpose of the registrar middleware **104** and the DNS middleware **110** is to maintain the link between the information for a domain name stored off-chain and the information for the domain name in the domain registrar blockchain **106**

[0027] In embodiments, the registrar middleware **104** and DNS middleware **110** allow the blockchain-based domain name registrar and management system **100** to store domain names and DNS records to blockchains (e.g., domain registrar blockchain **106** and DNS resolver blockchain **112**) using on-chain assets (e.g., tokens or NFTs). For example, while the domain name registration process involves off-chain operations (e.g., process with ICANN, registering the nameserver with a top-level registry, etc.), when a domain name is registered to the domain registrar blockchain **106**, an on-chain asset can be minted and added to a digital wallet of the user who registered the domain name.

[0028] The on-chain asset functions as the controller/master of the domain name for the blockchain-based domain name registrar and management system **100**. In embodiments, as the on-set asset is stored in the holder's digital wallet, possession of the on-chain asset grants the holder of the on-chain asset exclusive administrative control/permission over the domain name corresponding to the on-chain asset. For example, any changes to a DNS record for a domain names stored in the DNS resolver blockchain **112** can only be performed by the owner of the on-chain asset associated with the domain name. To update a DNS record in the DNS resolver blockchain **112**, a request can include the owner's digital wallet address to indicate that the request is from the owner of the on-chain asset. In contrast, traditional database-based domain registrars have control over domain names stored in their centralized databases, such that while a user can contact a traditional domain registrar to reset credentials, modify DNS records, etc., the traditional domain registrar has ultimate control over whether the perform the request action(s). For example, a request to change a DNS records can be sent to the traditional domain registrar, the traditional domain registrar determines whether to fulfill the request.

[0029] In one embodiment, the on-chain asset can be transferred from one user to another user (e.g., via on-chain transactions between digital wallets). Once transferred, the new owner of the on-chain asset becomes the controller/master of the domain name and is the only identity that can make changes to the DNS record for the domain name associated with the on-chain asset.

[0030] In one embodiment, when a request for a domain name is received, the request is sent to a registry to identify the owner/nameserver that owns the domain name. Where the owner/nameserver stores the domain names in a domain registrar blockchain **106** and the DNS records in a DNS resolver blockchain **112**, the owner/nameserver is configured to read the appropriate blockchain and return whatever data is stored in the blockchain.

[0031] In one embodiment, the domain registrar blockchain **106**, or blockchain-based domain registrar, is a blockchain database, or distributed ledger, storing domain name registration data. The domain registrar blockchain **106** can use nameserver smart contracts **108** to build a registrar to store domain names. In embodiments, the nameserver smart contracts **108** can include one or more smart contracts. Smart contracts are state based logical units that operate on-chain. They are programmable agreements that can be used to build decentralized protocols on the domain registrar blockchain **106**. In some embodiments, the nameserver smart contracts **108** are used to mint and register new domain names on-chain in the domain registrar blockchain **106**. For the domain registrar blockchain **106**, the nameserver smart contracts **108** store which domain names are stored on-chain.

[0032] In one embodiment, the DNS resolver blockchain **112** is a blockchain database, or distributed ledger, storing DNS records. The DNS resolver blockchain **112** can use blockchain resolver smart contracts **114** to build a registrar to store and manage DNS records for corresponding domain names. In embodiments, the resolver smart contracts **114** can include one or more smart contracts. Smart contracts are programmable agreements that can be used to build decentralized protocols on the DNS resolver blockchain **112**. In some embodiments, the blockchain resolver smart contracts **114** are used to store and resolve DNS records associated with a specific domain name. For the DNS resolver blockchain **112**, the blockchain resolver smart contracts **114** store the different DNS records for each domain name.

[0033] FIG. **2** illustrates an exemplary networked system for resolving a domain name using a blockchain-based domain registrar according to some embodiments described herein. The exemplary networked system **200** illustrated in FIG. **2** includes blockchain-based domain name registrar and management system **100**, a client device **202**, and a web server **204**. The blockchain-based domain name registrar and management system **100** includes registrar middleware **104**, a domain registrar blockchain **106**, DNS middleware **110**, and a DNS resolver blockchain **112**.

[0034] Examples of client device **202** include computing devices (e.g., laptops, workstations, smartphones, palm tops, mobile phones, tablets, gaming systems, set top boxes, wearable devices, electronic devices, etc.) that are capable of transmitting and/or receiving network traffic. In some embodiments, client device **202** executes a client network application that is capable of transmitting and/or receiving network traffic. For example, client network applications may be a web browser or other application that can access network resources (e.g., web pages).

[0035] In one embodiment, the web server **204** is a device that receives request (e.g., HTTP/S requests) for resources, such as a webpage. For example, the web server **204** can receive a request for a resource (e.g., a webpage) that includes an address (e.g., IP address) for the resource and either return the requested resource or an error message.

[0036] In one embodiment, a request for a webpage is received at the registrar middleware **104** from a client device **202**, at operation 2.1. The request for the webpage can be generated in response to a user selecting a link or URL for the webpage (e.g., in a browser application or client network application). For example, the request can be for the webpage "http://page.example.com." In embodiments, to determine the nameserver that owns or manages the requested webpage, a forward lookup process is performed by first sending the request to a local DNS server. If the address of the nameserver for the webpage is not stored in a cache of the local DNS server, the local DNS server performs a recursive query, or recursive lookup, to other DNS servers determine the identity (e.g., IP address) of the nameserver for the webpage. For example, where the request is for "page.example.com," the local DNS server may first forward the request to a DNS root server, which returns the address for the ".com" top level DNS server. The local DNS server than forwards the request to the ".com" top level DNS server, which returns the address for the "example.com" nameserver, where the "example.com" nameserver stores DNS records on-chain. The local DNS server than forwards the request to the "example.com" nameserver, on which the registrar middleware **104** is executing.

[0037] In one embodiment, the registrar middleware **104** translates the request for the webpage to a blockchain query, at operation 2.2. For example, the registrar middleware **104** translates the request for the webpage to a blockchain query by decoding the DNS request and performing a recursive query on the associated DNS records. The blockchain query is then sent to the domain registrar blockchain **106** to perform the nameserver lookup request is, at operation 2.3. Common DNS requests can include a QName (or target zone) and a QType (or requested record type). Each recursive query performs a series of record lookups by asking the smart contract for the records for X QName and X QType. The blockchain query is then sent to the domain registrar blockchain **106** to perform the nameserver lookup request, at operation 2.3.

[0038] In one embodiment, the nameserver smart contracts **108** are accessed to locate nameserver information, at operation 2.4. In one embodiments, when the blockchain query generated by the registrar middleware **104** hits the domain registrar blockchain **106**, the domain registrar blockchain **106** checks the nameserver smart contracts **108** to determine whether the requested domain name is stored on the domain registrar blockchain **106**. In one embodiment, the blockchain query is sent to a public remote procedure code (RPC) node, in which the node carries out the RPC request and returns the corresponding data. In other embodiments, an RPC node is run locally and in sync with the blockchain network. The blockchain query is then sent to the local RPC node, which carries out the RPC request and returns the data. In both cases, the blockchain queries are queries (e.g., non-transactional, interactions with the node and network), where they only read data from the blockchain. As they are used to lookup DNS records, they do not modify the state.

[0039] In one embodiment, the registrar middleware **104** performs a series of recursive queries to determine the zone associated with the DNS request. Because all zones are treated as their own registration, the registrar middleware **104** performs a recursive query from left to right to determine the parent zone that the request corresponds to. For example, a request for "a.b.example.com" could have three possible zones (e.g., "a.b.example.com," "b.example.com," and "example.com"). However, each zone may be owned by a different user/entity. For example, a first user/entity owns "example.com" and mints a subdomain, "b.example.com" as an on-chain asset (e.g., tokens or NFTs) to a second user/entity's digital wallet. The registration link between the domain and the zone is stored in the domain registrar blockchain **106**. In such situations, the DNS record for "b.example.com" can be set in the context of the first user's zone in the resolver blockchain, but the second user's zone records take precedence. The first user's DNS records overlapping with the second user's zone may only be referenced if the second user's zone is burned. Thus, if a blockchain query is received for "a.b.example.com," the second user's zone (e.g., "x.example.com") is referenced instead of the first user's zone (e.g., "example.com").

[0040] Once the registrar middleware **104** identifies the parent zone from the domain registrar blockchain **106**, that zone (or node) is then used to query the corresponding DNS records.

[0041] When the requested domain name is determined to be stored on the domain registrar blockchain **106**, a nameserver lookup response is returned to the registrar middleware **104**, at operation 2.5. The nameserver lookup response can include the nameserver (e.g., an address for the nameserver) for the requested domain name. For example, the nameserver for "example.com" is provided. The nameserver for the requested domain name is then sent to the DNS middleware **110**, at operation 2.6.

[0042] In one embodiment, the DNS middleware **110** then generates a DNS record lookup request as a blockchain query using the nameserver for the requested domain name, at operation 2.7. The DNS middleware **110** then resolves the DNS record request by sending the blockchain query to the DNS resolver blockchain, at operation 2.8. In embodiments, the blockchain query is specific to the configuration of the blockchain resolver smart contracts **114** and the schema of the data stored in the blockchain resolver smart contracts **114**. In one embodiment, the blockchain resolver smart contracts **114** include a function, "DNSRecord," that takes in a root zone, a qname (or query name), and a resource (e.g., indicating the requested DNS record type). Using the "http://page.example.com" example, the root zone is "example.com," the qname is "page.example.com," and the resource is an "A record").

[0043] In one embodiment, the blockchain resolver smart contracts **114** are accessed to locate the DNS record for the requested webpage, at operation 2.9. If the requested domain name is stored on the DNS resolver blockchain **112**, a DNS record lookup is performed to determine if the requested domain name delegates control elsewhere. For example, a delegate DNS record type (e.g., a DS record) can be used to point authoritative control to a different IP address or canonical name (CNAME). If the requested domain name does delegate control, the request is forwarded. If the requested domain name does not delegate control, DNS resolver blockchain **112** checks to see if the corresponding record exists. If the record exists, the data is returned, including the nameserver(s) upon which to locate the DNS records. If the record does not exist, a "no data" response is returned. If the requested domain name is not stored on the DNS resolver blockchain **112**, the DNS request is denied. For example, continuing the example, the root server for "http://page.example.com" can be queried, and the server that controls ".com" is returned. The ".com" server is then queried for "example.com", and the server that controls "example.com" is returned. The "example.com" server is then queried for "page.example.com," and the "page.example.com" record can be returned. In some embodiments, if the "example.com" server has delegated control of the subdomain to another server, the querying process continues until the server that has the record is identified.

[0044] In some embodiments, the data in the blockchain resolver smart contracts **114** is tracked and then stored in an off-chain database. In such embodiments, a bot can be used to monitor new transactions and mirror any modifications made to DNS records on-chain, in the off-chain database. To perform a lookup where the data is stored in an off-chain database, the off-chain database can be simply queried.

[0045] In one embodiment, after locating the DNS record, the DNS record or an IP address determined from the DNS record, is returned, at operation 2.10. In one embodiment, after receiving the DNS record, the DNS middleware **110** directs the request for the webpage to a web server using the IP address indicated by the DNS record, at operation 2.11. In other embodiments, the DNS middleware **110** returns the IP address indicated by the DNS record to the client device **202** directly, and the client device **202** sends the request for the webpage using the IP address to the web server **204**.

[0046] In one embodiment, the retrieved webpage is transmitted to the client device **202**, at operation 2.12.

[0047] FIG. **3** illustrates an exemplary networked system for transmitting an email message using a blockchain-based domain registrar according to some embodiments described herein. The exemplary networked system **300** illustrated in FIG. **3** includes blockchain-based domain name registrar and management system **100**, a client device **302**, a mail server **308** and a domain owner server **310**. The blockchain-based domain name registrar and management system **100** includes registrar middleware **104**, a domain registrar blockchain **106**, DNS middleware **110**, and an MX records blockchain **304**.

[0048] In one embodiment, the MX records blockchain **304** is a blockchain database, or distributed ledger, storing mail exchanger (MX) records. An MX record is a record indicating how an email message should be routed to arrive at a mail server. The MX records blockchain **304** can use MX records smart contracts **306** to build a registrar to store and managed MX records for corresponding domain names.

Smart contracts are programmable agreements that can be used to build decentralized protocols on the MX records blockchain **304**. In some embodiments, the MX records smart contracts **306** are used to store and resolve MX records associated with a specific domain name. For the MX records blockchain **304**, the MX records smart contracts **306** store the different MX records for each domain name.

[0049] In one embodiment, the mail server **308** is a device configured to receive and send email messages between computing devices. For example, the mail server **308** can receive an email from a sending computing device (e.g., client device **302**) to a recipient computing device (e.g., via a domain owner server **310**).

[0050] In one embodiment, a client device **302** sends an email message directed to a recipient at a domain that is received at the registrar middleware **104**, at operation 3.1. For example, the email message can be directed to the email address: "mail@ example.com," where "example.com" is the domain of the recipient. In embodiments, the email message can be sent using a client application (e.g., an email application). In embodiments, to determine the nameserver that owns or manages the requested email domain, a forward lookup process is performed, as described with respect to FIG. **2**.

[0051] In one embodiment, the registrar middleware **104** translates a nameserver lookup request for the domain to a blockchain query, at operation 3.2. In some embodiments, the registrar middleware **104** translates the request for the webpage to a blockchain query, as described with respect to FIG. **2**. The blockchain query to perform the nameserver lookup request is then sent to the domain registrar blockchain **106**, at operation 3.3.

[0052] In one embodiment, the nameserver smart contracts **108** are accessed to locate nameserver information, at operation 3.4. In one embodiments, when the blockchain query generated by the registrar middleware **104** hits the domain registrar blockchain **106**, the domain registrar blockchain **106** checks the nameserver smart contracts **108** to determine whether the requested domain name (e.g., "example.com") is stored on the domain registrar blockchain **106**.

[0053] When the requested domain name is determined to be stored on the domain registrar blockchain **106**, a nameserver lookup response is returned to the registrar middleware **104**, at operation 3.5. The nameserver lookup response can include the nameserver (e.g., an address for the nameserver) for the requested domain name. For example, the nameserver for "example.com" is provided. The nameserver for the requested domain name is then sent to the DNS middleware **110**, at operation 3.6.

[0054] In one embodiment, the DNS middleware **110** then generates an MX record lookup request as a blockchain query using the nameserver for the requested domain name, at operation 3.7. The DNS middleware **110** then resolves the MX record request by sending the blockchain query to the MX records blockchain **304**, at operation 3.8.

[0055] In one embodiment, the MX records smart contracts **306** are accessed to locate the MX record for the requested domain, at operation 3.9. If the requested domain name is stored on the MX records blockchain **304**, a MX record lookup is performed to determine if the requested domain name delegates control elsewhere. If the requested domain name does delegate control, the request is forwarded. If the requested domain name does not delegate control, MX records blockchain **304** checks to see if the corresponding record exists. If the record exists, the data is returned, including the nameserver(s) upon which to locate the MX records. If the record does not exist, a "no data" response is returned. If the requested domain name is not stored on the MX records blockchain **304**, the MX request is denied.

[0056] In one embodiment, after locating the MX record, the MX record or an IP address determined from the MX record, is returned, at operation 3.10. In one embodiment, after receiving the MX record, the DNS middleware **110** directs the email message to a mail server **308** using the IP address indicated by the MX record, at operation 3.11. In one embodiment, the mail server **308** then transmits the email message to the domain owner server **310** for delivery to a recipient client device, at operation 3.12.

[0057] FIG. **4** illustrates an exemplary networked system for performing a registration process for a new domain name using a blockchain-based domain registrar according to some embodiments described herein. The exemplary networked system **400** illustrated in FIG. **4** includes blockchain-based domain name registrar and management system **100** and a client device **402**. The blockchain-based domain name registrar and management system **100** includes registrar middleware **104** and a domain registrar blockchain **106**.

[0058] In one embodiment, the client device **402** sends a registration request to register a new domain for a user, at operation 4.1. For example, the client device **402** can send a registration request to register "newexample.com." The registration request is received by the registrar middleware **104**. In embodiments, to determine the nameserver that owns or manages the new domain, a forward lookup process is performed, as described with respect to FIG. **2**.

[0059] In one embodiment, the registrar middleware **104** verifies the availability of the new domain and reserves the new domain for the user. In some embodiments, the registrar middleware **104** first verifies that the new domain name is unique and perform an off-chain registration prior to issuing the domain name on-chain. For example, the registrar middleware **104** performs a verification process with the Internet Corporation for Assigned Names and Numbers (ICANN) for the new domain name. This can include providing identifying contact information for the registrant, among others.

[0060] In some embodiments, instead of performing an off-chain registration, all domains can be stored on the domain registrar blockchain **106**, as a top-level domain. In such embodiments, the registrar middleware **104** does not interface with any other off-chain systems to verify if a new domain name is available, as the registrar middleware **104** can just check the domain registrar blockchain **106**.

[0061] In one embodiment, after the registrar middleware **104** reserves the new domain, the registrar middleware **104** sends a blockchain transaction to mint the new domain name to the domain registrar blockchain **106**, at operation 4.3. The blockchain transaction may include an authorization signature which is used by the registrar smart contract to authorize the mint. Funds may be collected on-chain or off-chain. The nameserver smart contracts **108** are accessed and the new domain name is minted as a new on-chain asset to the user's digital wallet, at operation 4.4. For example, the on-chain asset is assigned to the address of the user's digital wallet. In some embodiments, this includes storing a mapping in a specific smart contract that maps the new domain name to the user's wallet address. The mapping stores all domain names that are registered on the domain registrar blockchain **106** and their owners. This allows for lookups for registered domains, and if registered, to whom they are registered.

[0062] In some embodiments, a notification message can be transmitted back to the client device **402** confirming the registration of the new domain name. In some embodiments, the newly registered domain can be returned to the client device **402** as an NFT.

[0063] FIG. **5** illustrates an exemplary networked system for performing an off-chain renewal process for a domain name using a blockchain-based domain registrar according to some embodiments described herein. The exemplary networked system **500** illustrated in FIG. **5** includes blockchain-based domain name registrar and management system **100** and a client device **502**. The blockchain-based domain name registrar and management system **100** includes registrar middleware **104** and a domain registrar blockchain **106**.

[0064] In one embodiment, the client device **502** sends a renewal request for a domain, at operation 5.1. For example, the client device **502** can send a renewal request to be performed off-chain for the renewal of the domain "example.com." The renewal request is received by the registrar middleware **104**. In embodiments, to determine the nameserver that owns or manages the domain, a forward lookup process is performed, as described with respect to FIG. **2**.

[0065] In one embodiment, the registrar middleware **104** updates the ICANN registration for the domain name off-chain. In one embodiment, after the registrar middleware **104** updates the ICANN registration for the domain name to reflect the renewal, the registrar middleware **104** sends a blockchain transaction to update the domain expiration date to the domain registrar blockchain **106**, at operation 5.3. The nameserver smart contracts **108** are accessed and the registration expiration date for the domain name is updated to the user's wallet address, at operation 5.4. For example, an expiration metadata variable associated with the existing on-chain asset in the domain registrar blockchain **106** is updated.

[0066] In some embodiments, a notification message can be transmitted back to the client device **502** confirming the renewal of the domain name, including the updated expiration date of the user's registration of the domain name.

[0067] FIG. **6** illustrates an exemplary networked system for performing an on-chain renewal process for a domain name using a blockchain-based domain registrar according to some embodiments described herein. The exemplary networked system **600** illustrated in FIG. **6** includes blockchain-based domain name registrar and management system **100** and a client device **602**. The blockchain-based domain name registrar and management system **100** includes registrar middleware **104** and a domain registrar blockchain **106**.

[0068] In one embodiment, the client device **602** performs the registration renewal requirements (e.g., pays registrar to extend the domain), at operation 6.1. For example, the client device **602** performs the renewal to extend the registration of the domain "example.com." In embodiments, to determine the nameserver that owns or manages the domain, a forward lookup process is performed, as described with respect to FIG. **2**.

[0069] In one embodiment, the registrar middleware **104** identifies a renewal event, at operation 6.2. In one embodiment, the registrar middleware **104** emits the renewal event. The emitting of the renewal event indicates that a renewal transaction has been successfully executed on the domain registrar blockchain **106**. This allows the renewal event to be a transparent and auditable event. Further, the emitting of the renewal event indicates that the renewal should be replicated in off-chain. In one embodiment, after the registrar middleware **104** identifies the renewal event, the registrar middleware **104** sends a blockchain transaction to update the domain expiration date to the domain registrar blockchain **106**, at operation 6.3. The nameserver smart contracts **108** are accessed and the registration expiration date for the domain name is updated to the user's digital wallet, at operation 6.4. For example, the expiration date for the on-chain asset is updated.

[0070] In some embodiments, a notification message can be transmitted back to the client device **602** confirming the renewal of the domain name, including the updated expiration date of the user's registration of the domain name.

[0071] FIG. **7** illustrates an exemplary networked system for performing a process of transferring a domain name from a blockchain-based domain registrar to a non-blockchain registrar according to some embodiments described herein. The exemplary networked system **700** illustrated in FIG. **7** includes blockchain-based domain name registrar and management system **100** and a client device **702**. The blockchain-based domain name registrar and management system **100** includes registrar middleware **104** and a domain registrar blockchain **106**.

[0072] In one embodiment, the client device **702** requests to transfer a domain name on the domain registrar blockchain **106** to a new non-blockchain-based registrar (e.g., a traditional registrar database), at operation 7.1. For example, the client device **702** can send a request to burn the on-chain token in the user's wallet for the on-chain domain name at the domain registrar blockchain **106**. The request can further include information regarding the new non-blockchain-based registrar. The registration request is received by the registrar middleware **104**. In embodiments, to determine the nameserver that owns or manages the domain, a forward lookup process is performed, as described with respect to FIG. **2**.

[0073] In one embodiment, the registrar middleware **104** identifies the transfer event, at operation 7.2. In one embodiment, the registrar middleware **104** emits the transfer event. The emitting of the transfer event indicates that a transfer transaction has been successfully executed to transfer the domain name from the domain registrar blockchain to a non-blockchain registrar. This allows the transfer event to be a transparent and auditable event. Further, the emitting of the transfer event indicates that the transfer should be replicated in off-chain. In one embodiment, the registrar middleware **104** sends a blockchain transaction to transfer the domain from the domain registrar blockchain **106** to the new non-blockchain-based registrar, at operation 7.3. The domain registrar blockchain **106** updates the ICANN registration for the domain name to reflect the transfer of the domain name from the domain registrar blockchain **106** to the new non-blockchain-based registrar, at operation 7.4.

[0074] In some embodiments, a notification message can be transmitted back to the client device **702** confirming the transfer of the domain from the domain registrar blockchain **106** to the new non-blockchain-based registrar.

[0075] FIG. **8** illustrates an exemplary networked system for performing a process of transferring a domain name from a non-blockchain registrar to a blockchain-based domain registrar according to some embodiments described herein. The exemplary networked system **800** illustrated in FIG. **8** includes blockchain-based domain name registrar and management system **100**, a client device **802**, and a registrar database **804**. The registrar database **804** can be a database storing domain names for a domain name registrar. The blockchain-based domain name registrar and management system **100** includes registrar middleware **104** and a domain registrar blockchain **106**.

[0076] In one embodiment, the client device **802** requests to transfer a domain name on a non-blockchain-based registrar (e.g., registrar database **804**) to a domain registrar blockchain (e.g., domain registrar blockchain **106**), at operation 8.1. In such embodiments, the client device **802** can further provide a wallet address to the registrar database **804** for transferring the domain name to the domain registrar blockchain **106**

[0077] In one embodiment, the registrar database **804** sends a request to transfer the domain to the domain registrar blockchain **106**, at operation 8.3. In embodiments, to determine the nameserver that owns or manages the domain, a forward lookup process is performed, as described with respect to FIG. **2**. The registration request is received by the registrar middleware **104** and the transfer event is identified, at operation 8.4. The emitting of the transfer event indicates that a transfer transaction has been successfully executed to transfer the domain name from the domain registrar blockchain to a non-blockchain registrar. This allows the transfer event to be a transparent and auditable event. Further, the emitting of the transfer event indicates that the transfer should be replicated in off-chain. In one embodiment, the registrar middleware **104** sends a blockchain transaction to transfer the domain to the domain registrar blockchain **106**, at operation 8.3. The domain registrar blockchain **106** mints the domain name to the wallet address received from the client device **802**, at operation 8.6.

[0078] In some embodiments, a notification message can be transmitted back to the client device **802** confirming the transfer of the domain from to the domain registrar blockchain **106**.

[0079] FIG. **9** illustrates an exemplary networked system for setting a DNS record for a domain name with a blockchain-based domain registrar according to some embodiments described herein. The exemplary networked system **900** illustrated in FIG. **9** includes blockchain-based domain name registrar and management system **100** and a client device **902**. The blockchain-based domain name registrar and management system **100** includes registrar middleware **104** and a domain registrar blockchain **106**.

[0080] In one embodiment, the client device **902** sends a request to set a DNS record associated with a domain name stored on the domain registrar blockchain **106**, at operation 9.1. The request can include, at least, information identifying the domain name and an address for the DNS record (e.g., a new or updated IP address). In some embodiments, the request can be to change or update a DNS record. In embodiments, to determine the nameserver that owns or manages the domain, a forward lookup process is performed, as described with respect to FIG. **2**. The request is received by the registrar middleware **104** and the request is translated to a blockchain transaction, at operation 9.2. In one embodiment, the registrar middleware **104** sends the blockchain transaction to set the DNS record for the domain to the domain registrar blockchain **106**, at operation 9.3. The domain registrar blockchain **106** updates the DNS records for the domain name, at operation 9.4.

[0081] FIG. **10** is a flow diagram that illustrates exemplary operations for a blockchain-based domain name registrar according to an embodiment. The operations of FIG. **10** will be described with reference to the exemplary embodiment of the other figures. However, it should be understood that the operations of FIG. **10** can be performed by embodiments of the invention other than those discussed with reference to the other figures, and the embodiments discussed with reference to the other figures can perform operations different than those discussed with reference to FIG. **10**. The operations of FIG. **10** are described as being performed by the nameserver **102** of a blockchain-based domain name registrar and management system **100**.

[0082] At operation **1010**, a nameserver receives a first request from a client device, the first request to access a webpage. In some embodiments, the request for the webpage can be generated in response to a user selecting a link or URL for the webpage (e.g., in a browser application or client network application)." In embodiments, to determine the nameserver that owns or manages the requested webpage, a recursive forward lookup process is performed to identify the nameserver that is the authoritative name server for the requested webpage.

[0083] At operation **1015**, the nameserver generates a first blockchain query based on the first request, the first blockchain query for querying a domain registrar blockchain. In one embodiment, the nameserver includes middleware services (e.g., register middleware) that is configured to translate request messages from a first request type to a second request type. For example, the register middleware can translate a nameserver lookup request structured for identifying nameserver (NS) records from a centralized database into the first blockchain query structured for querying data in a blockchain.

[0084] At operation **1020**, the nameserver sends the first blockchain query to the domain registrar blockchain, the domain registrar blockchain storing domain name registration data in smart contracts in the domain registrar blockchain.

[0085] At operation **1025**, the nameserver receives a nameserver identifier from the domain registrar blockchain. In some embodiments, when the blockchain query generated by the registrar middleware hits the domain registrar blockchain, the domain registrar blockchain checks the nameserver smart contracts to determine whether the requested domain name is stored on the domain registrar blockchain. When the requested domain name is determined to be stored on the domain registrar blockchain, a nameserver lookup response is returned to the registrar middleware. The nameserver lookup response can include a nameserver identifier (e.g., an address for the nameserver) for the requested domain name. For example, the nameserver for "example.com" is provided. The nameserver for the requested domain name is then sent to the DNS middleware **110**, at operation 2.6.

[0086] At operation **1030**, the nameserver retrieves a DNS record for the webpage using the received nameserver identifier. After receiving the nameserver identifier from the domain registrar blockchain, the nameserver identifier for the requested domain name can then be sent to middleware (e.g., DNS middleware). In some embodiments, the registrar middleware and the DNS middleware can be a single component of the nameserver. In one embodiment, the DNS middleware generates a DNS record lookup request as a second blockchain query using the nameserver identifier for the requested domain name. In some embodiments, a DNS resolver blockchain storing DNS records in smart contracts is designated by the domain registrar blockchain. For example, the blockchain-based domain name registrar can set the DNS resolver blockchain as a default smart contract controlled by the blockchain-based domain name registrar. In embodiments, when the blockchain-based domain name registrar updates the smart contract for subsequent registrations, users with existing registrations can either migrate to the new smart contract or keep the existing registration. In one embodiment, migration to the new smart contract includes changing the address of the resolver smart contract corresponding to a zone in the registrar smart contract. In some embodiments, migration can further include setting the same DNS records in the new resolver smart contract. The DNS middleware then resolves the DNS record request by sending the second blockchain query to the DNS resolver blockchain. In one embodiment, blockchain resolver smart contracts are accessed to locate the DNS record for the requested webpage. If the record exists, the DNS record is returned back to the nameserver.

[0087] At operation **1035**, the nameserver provides information from the retrieved DNS record to the client device for accessing the webpage. For example, the nameserver can extract or retrieve an IP address for the requested webpage from the retrieved DNS records. In some embodiments, the nameserver can contact the web server hosting the webpage using the IP address and retrieve the requested webpage on behalf of the client device.

[0088] FIG. **11** illustrates a block diagram for an exemplary data processing system **1100** that may be used in some embodiments. One or more such data processing systems **1100** may be utilized to implement the embodiments and operations described with respect to the nameserver **102**, the domain registrar blockchain **106**, and the DNS resolver blockchain **112**, or other computing devices. The data processing system **1100** is a computing device that stores and transmits (internally and/or with other computing devices over a network) code (which is composed of software instructions and which is sometimes referred to as computer program code or a computer program) and/or data using machine-readable media (also called computer-readable media), such as machine-readable storage media **1110** (e.g., magnetic disks, optical disks, read only memory (ROM), flash memory devices, phase change memory) and machine-readable transmission media (also called a carrier) (e.g., electrical, optical, radio, acoustical or other form of propagated signals—such as carrier waves, infrared signals), which is coupled to the processing system **1120** (e.g., one or more processors and connected system components such as multiple connected chips). For example, the depicted machine-readable storage media **1110** may store program code **1130** that, when executed by the processing system **1120**, causes the data processing system **1100** to perform any of the operations described herein.

[0089] The data processing system **1100** also includes one or more network interfaces **1140** (e.g., a wired and/or wireless interfaces) that allows the data processing system **1100** to transmit data and receive data from other computing devices, typically across one or more networks (e.g., Local Area Networks (LANs), the Internet, etc.).

[0090] The data processing system **1100** also includes one or more input or output ("I/O") components **1150**, which are provided to allow a user to provide input to, receive output from, and otherwise transfer data to and from the system. These I/O components **1150** may include a mouse, keypad, keyboard, a touch panel or a multi-touch input panel, camera, frame grabber, optical scanner, an audio input/output subsystem (which may include a microphone and/or a speaker), other known I/O devices or a combination of such I/O devices. The one or more I/O components **1150** may include wireless transceivers, such as an IEEE 802.11 transceiver, an infrared transceiver, a Bluetooth transceiver, a wireless cellular telephony transceiver (e.g., 2G, 3G, 4G, 5G), an NFC transceiver, or another wireless protocol to connect the data processing system **1100** with another device, external component, or a network and receive stored instructions, data, tokens, etc.

[0091] Additional components, not shown, may also be part of the data processing system **1100**, and, in certain embodiments, fewer components than that shown in FIG. **11** may also be used in a data processing system **1100**. One or more buses may be used to interconnect the various components shown in FIG. **11**.

[0092] The techniques shown in the figures can be implemented using code and data stored and executed on one or more computing devices (e.g., client devices, servers, etc.). Such computing devices store and communicate (internally and/or with other computing devices over a network) code and data using machine-readable media, such as machine-readable storage media (e.g., magnetic disks; optical disks; random access memory; read only memory; flash memory devices; phase-change memory) and machine-readable communication media (e.g., electrical, optical, acoustical or other form of propagated signals—such as carrier waves, infrared signals, digital signals, etc.). In addition, such computing devices typically include a set of one or more processors coupled to one or more other components, such as one or more storage devices, user input/output devices (e.g., a keyboard, a touchscreen, and/or a display), and network connections. The coupling of the set of processors and other components is typically through one or more busses and bridges (also termed as bus controllers). The storage device and signals carrying the network traffic respectively represent one or more machine-readable storage media and machine-readable communication media. Thus, the storage device of a given computing device typically stores code and/or data for execution on the set of one or more processors of that computing device. Of course, one or more parts of an embodiment of the invention may be implemented using different combinations of software, firmware, and/or hardware.

[0093] In the preceding description, numerous specific details are set forth. However, it is understood that embodiments of the invention may be practiced without these specific details. In other instances, well-known circuits, structures, and techniques have not been shown in detail in order not to obscure the understanding of this description. Those of ordinary skill in the art, with the included descriptions, will be able to implement appropriate functionality without undue experimentation.

[0094] References in the specification to "one embodiment," "an embodiment," "an example embodiment," etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to effect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0095] In the preceding description and the claims, the terms "coupled" and "connected," along with their derivatives, may be used. It should be understood that these terms are not intended as synonyms for each other. "Coupled" is used to indicate that two or more elements, which may or may not be in direct physical or electrical contact with each other, co-operate or interact with each other. "Connected" is used to indicate the establishment of communication between two or more elements that are coupled with each other.

[0096] While the flow diagrams in the figures show a particular order of operations performed by certain embodiments of the invention, it should be understood that such order is exemplary (e.g., alternative embodiments may perform the operations in a different order, combine certain operations, overlap certain operations, etc.).

[0097] While the invention has been described in terms of several embodiments, those skilled in the art will recognize that the invention is not limited to the embodiments described, can be practiced with modification and alteration within the spirit and scope of the appended claims. The description is thus to be regarded as illustrative instead of limiting.

1. A method, comprising:

performing an off-chain registration process for a domain name with an off-chain domain registrar, the off-chain registration process including verifying and reserving the domain name with the off-chain domain registrar accredited by the Internet Corporation for Assigned Names and Numbers (ICANN);

responsive to the off-chain registration process, performing an on-chain registration process for the domain name with a domain registrar blockchain, wherein an on-chain asset for the domain name is stored at the domain registrar blockchain, and wherein the on-chain asset enables a controller relationship over the domain name;

receiving a first request from a client device, the first request to access a webpage using the domain name;

determining that a domain name associated with the webpage is stored in the domain registrar blockchain;

generating a first blockchain query based on the first request, the first blockchain query for querying the domain registrar blockchain;

sending the first blockchain query to the domain registrar blockchain, the domain registrar blockchain storing domain name registration data in smart contracts in the domain registrar blockchain;

receiving a nameserver identifier from the domain registrar blockchain;

retrieving a DNS record for the domain name associated with the webpage using the received nameserver identifier; and

providing information from the retrieved DNS record to the client device for accessing the webpage.

2. The method of claim **1**, wherein retrieving the DNS record for the webpage using the received nameserver identifier comprises:

generating, by the nameserver, a second blockchain query including the received nameserver identifier;

sending the second blockchain query to a DNS resolver blockchain, the DNS resolver blockchain storing DNS records in smart contracts in the DNS resolver blockchain; and

receiving the DNS record for the webpage from the DNS resolver blockchain.

3. The method of claim **2**, wherein the DNS resolver blockchain for retrieving the DNS record for the webpage is designated by the domain registrar blockchain.

4. The method of claim **1**, wherein generating the first blockchain query based on the first request comprises:

translating a nameserver lookup request of a first request type to the first blockchain query of a second request type.

5. The method of claim **1**, wherein the nameserver receives the first request responsive to a forward lookup process identifying the nameserver as an authoritative nameserver for the domain name.

6. The method of claim **1**, wherein performing the on-chain registration process for the domain name with the domain registrar blockchain further comprises:

sending a blockchain transaction to the domain registrar blockchain, wherein the blockchain transaction causes the domain registrar blockchain to mint the on-chain asset for the domain name, store the on-chain asset to a digital wallet associated with a user, and store a mapping between the domain name and the digital wallet in a smart contract.

7. A non-transitory machine-readable storage medium that provides instructions that, when executed by a processor, cause said processor to perform operations comprising:

performing an off-chain registration process for a domain name with an off-chain domain registrar, the off-chain registration process including verifying and reserving the domain name with the off-chain domain registrar accredited by the Internet Corporation for Assigned Names and Numbers (ICANN);

responsive to the off-chain registration process, performing an on-chain registration process for the domain name with a domain registrar blockchain, wherein an on-chain asset for the domain name is stored at the domain registrar blockchain, and wherein the on-chain asset enables a controller relationship over the domain name;

receiving a first request from a client device, the first request to access a webpage using the domain name;

determining that a domain name associated with the webpage is stored in the domain registrar blockchain;

generating a first blockchain query based on the first request, the first blockchain query for querying the domain registrar blockchain;

sending the first blockchain query to the domain registrar blockchain, the domain registrar blockchain storing domain name registration data in smart contracts in the domain registrar blockchain;

receiving a nameserver identifier from the domain registrar blockchain;

retrieving a DNS record for the domain name associated with the webpage using the received nameserver identifier; and

providing information from the retrieved DNS record to the client device for accessing the webpage.

8. The non-transitory machine-readable storage medium of claim **7**, wherein retrieving the DNS record for the webpage using the received nameserver identifier comprises:

generating, by the nameserver, a second blockchain query including the received nameserver identifier;

sending the second blockchain query to a DNS resolver blockchain, the DNS resolver blockchain storing DNS records in smart contracts in the DNS resolver blockchain; and

receiving the DNS record for the webpage from the DNS resolver blockchain.

9. The non-transitory machine-readable storage medium of claim **8**, wherein the DNS resolver blockchain for retrieving the DNS record for the webpage is designated by the domain registrar blockchain.

10. The non-transitory machine-readable storage medium of claim **7**, wherein generating the first blockchain query based on the first request comprises:

translating a nameserver lookup request of a first request type to the first blockchain query of a second request type.

11. The non-transitory machine-readable storage medium of claim **7**, wherein the nameserver receives the first request responsive to a forward lookup process identifying the nameserver as an authoritative nameserver for the domain name.

12. The non-transitory machine-readable storage medium of claim **7**, wherein performing the on-chain registration process for the domain name with the domain registrar blockchain further comprises:

sending a blockchain transaction to the domain registrar blockchain, wherein the blockchain transaction causes the domain registrar blockchain to mint the on-chain asset for the domain name, store the on-chain asset to a digital wallet associated with a user, and store a mapping between the domain name and the digital wallet in a smart contract.

13. An apparatus, comprising:

a processor; and

a non-transitory machine-readable storage medium coupled with the processor, the non-transitory machine-readable storage medium storing instructions that, when executed by the processor, cause said processor to perform the following operations:

perform an off-chain registration process for a domain name with an off-chain domain registrar, the off-chain registration process including verifying and reserving the domain name with the off-chain domain registrar accredited by the Internet Corporation for Assigned Names and Numbers (ICANN);

responsive to the off-chain registration process, perform an on-chain registration process for the domain name with a domain registrar blockchain, wherein an on-chain asset for the domain name is stored at the domain registrar blockchain, and wherein the on-chain asset enables a controller relationship over the domain name;

receive a first request from a client device, the first request to access a webpage using the domain name;

determine that a domain name associated with the webpage is stored in the domain registrar blockchain;

generate a first blockchain query based on the first request, the first blockchain query for querying the domain registrar blockchain;

send the first blockchain query to the domain registrar blockchain, the domain registrar blockchain storing domain name registration data in smart contracts in the domain registrar blockchain;

receive a nameserver identifier from the domain registrar blockchain;

retrieve a DNS record for the domain name associated with the webpage using the received nameserver identifier; and

provide information from the retrieved DNS record to the client device for accessing the webpage.

14. The apparatus of claim **13**, wherein retrieving the DNS record for the webpage using the received nameserver identifier further causes said processor to:

generate, by the nameserver, a second blockchain query including the received nameserver identifier;

send the second blockchain query to a DNS resolver blockchain, the DNS resolver blockchain storing DNS records in smart contracts in the DNS resolver blockchain; and

receive the DNS record for the webpage from the DNS resolver blockchain.

15. The apparatus of claim **14**, wherein the DNS resolver blockchain for retrieving the DNS record for the webpage is designated by the domain registrar blockchain.

16. The apparatus of claim **13**, wherein generating the first blockchain query based on the first request further causes said processor to:

translate a nameserver lookup request of a first request type to the first blockchain query of a second request type.

17. The apparatus of claim **13**, wherein the nameserver receives the first request responsive to a forward lookup process identifying the nameserver as an authoritative nameserver for the domain name.

18. The apparatus of claim **13**, wherein performing the on-chain registration process for the domain name with the domain registrar blockchain further causes said processor to perform the following:

send a blockchain transaction to the domain registrar blockchain, wherein the blockchain transaction causes the domain registrar blockchain to mint the on-chain asset for the domain name, store the on-chain asset to a digital wallet associated with the user, and store a mapping between the domain name and the digital wallet in a smart contract.

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