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(54) **DATA SECURITY MEASURES FOR CYBERSECURITY THREATS**

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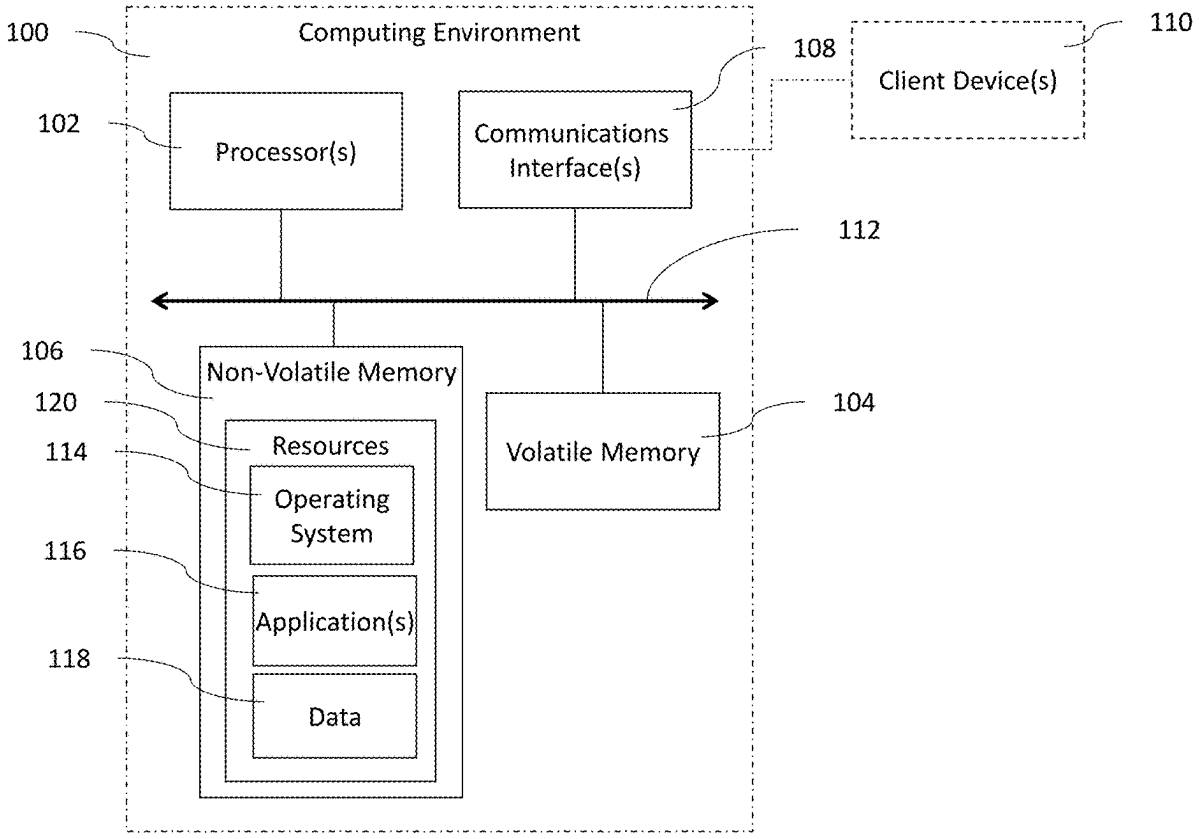
(57) **ABSTRACT**

Data security measures are provided. A method may include determining a status of an accessibility of a predefined host. The method may include determining that a data structure corresponds to controlled-access information. The method may include encrypting the data structure to secure the controlled-access information. The encryption may be responsive to the status indicating inaccessibility of the predefined host and the determination of the correspondence.



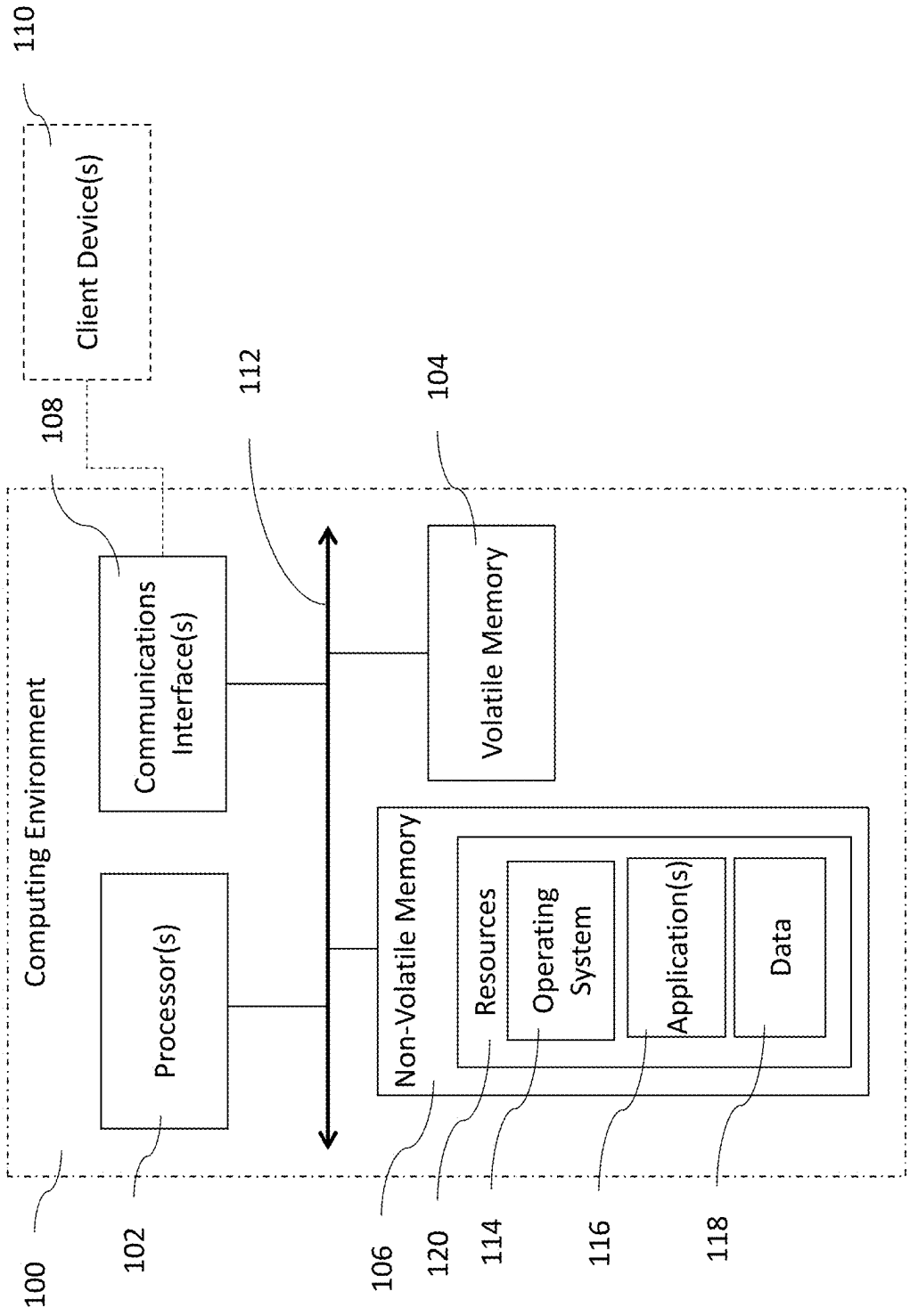

110
Client Device(s)
108
112
104
Computing Environment
Communications Interface(s)
Volatile Memory
Processor(s)
Non-Volatile Memory
Resources
Operating System
Application(s)
Data
100
102
106
120
114
116
118

FIG. 1

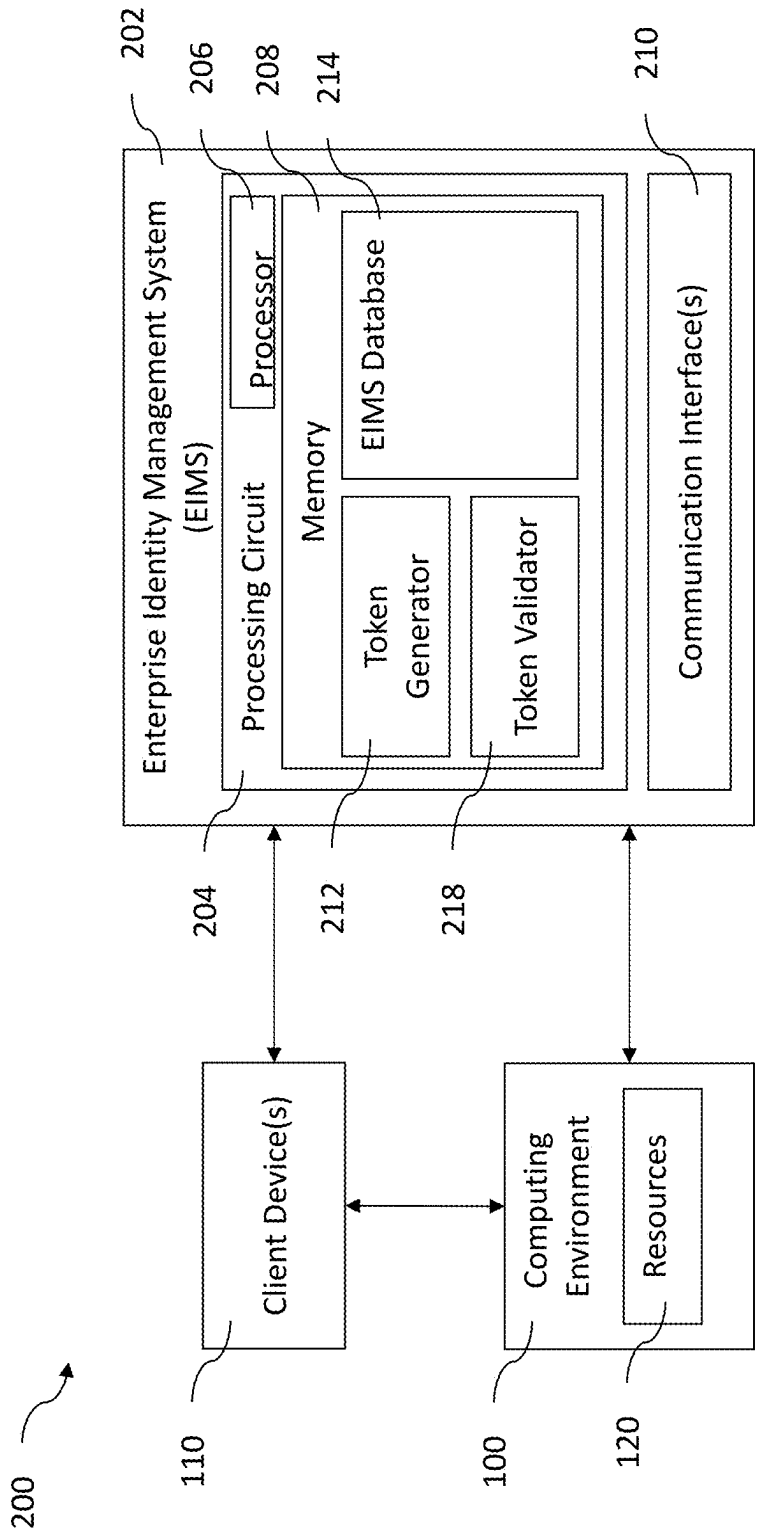

200
110
Client Device(s)
100
Computing Environment
120
Resources
204
212
218
202
206
208
214
210
Enterprise Identity Management System (EIMS)
Processing Circuit
Processor
Memory
EIMS Database
Token Generator
Token Validator
Communication Interface(s)

FIG. 2

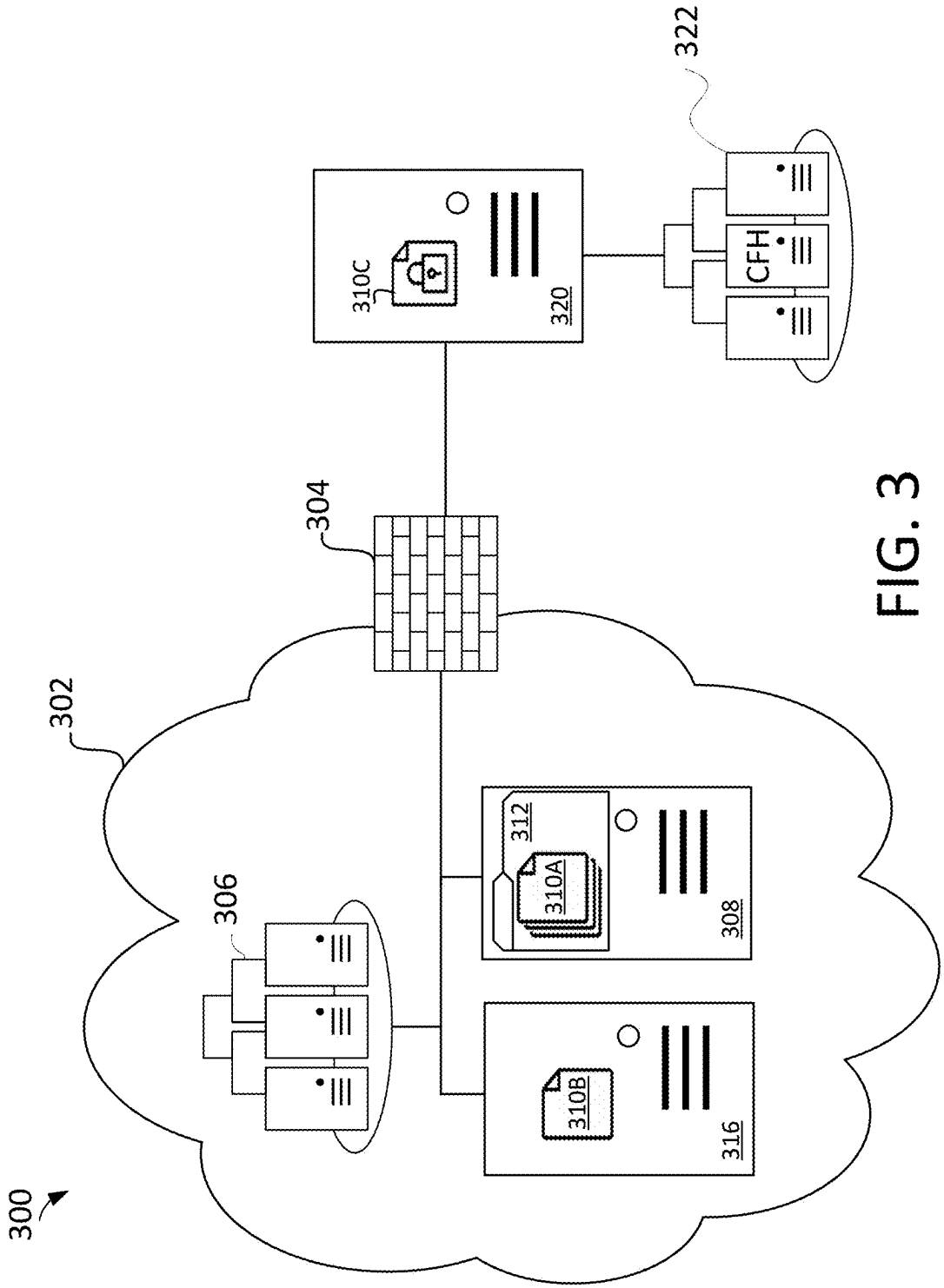


FIG. 3

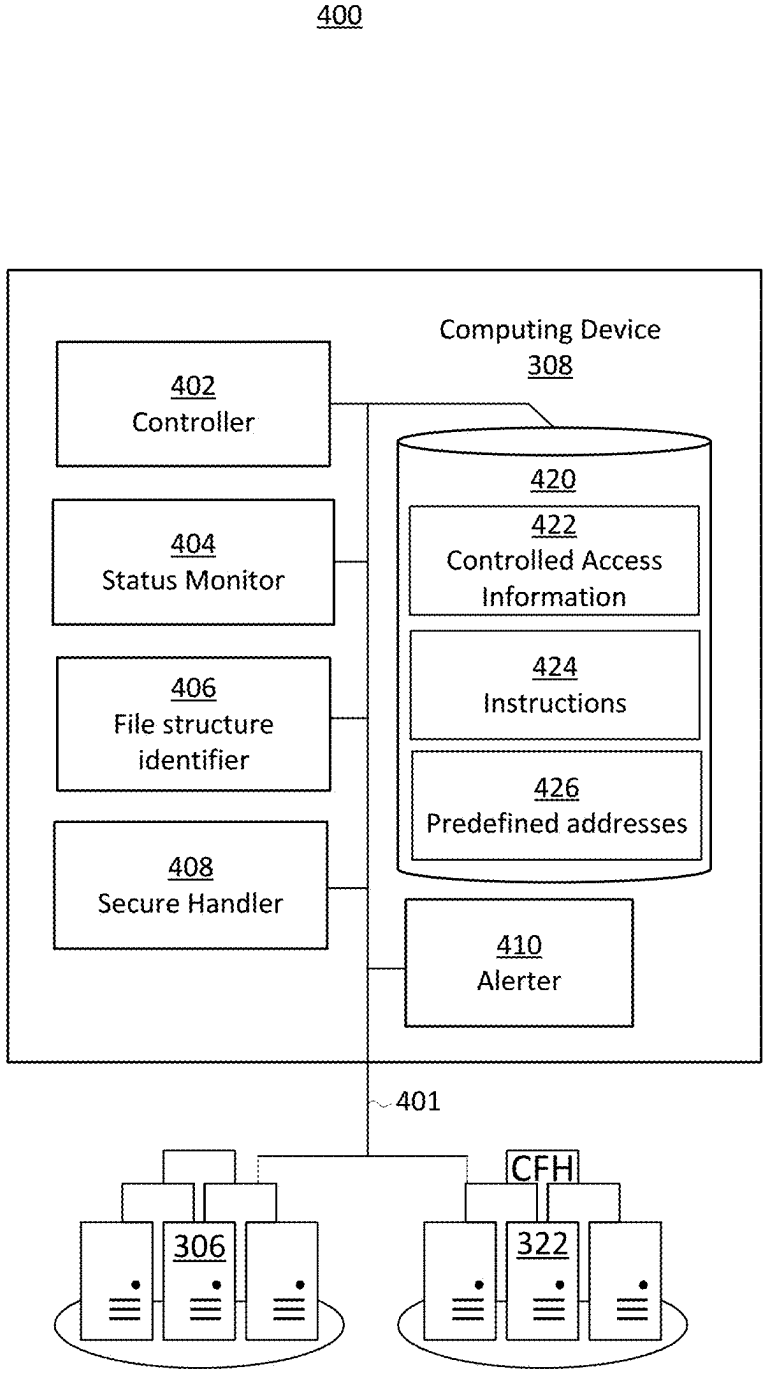

400
Computing Device
308
402
Controller
404
Status Monitor
406
File structure identifier
408
Secure Handler
420
422
Controlled Access Information
424
Instructions
426
Predefined addresses
410
Alerter
401
306
CFH
322

FIG. 4

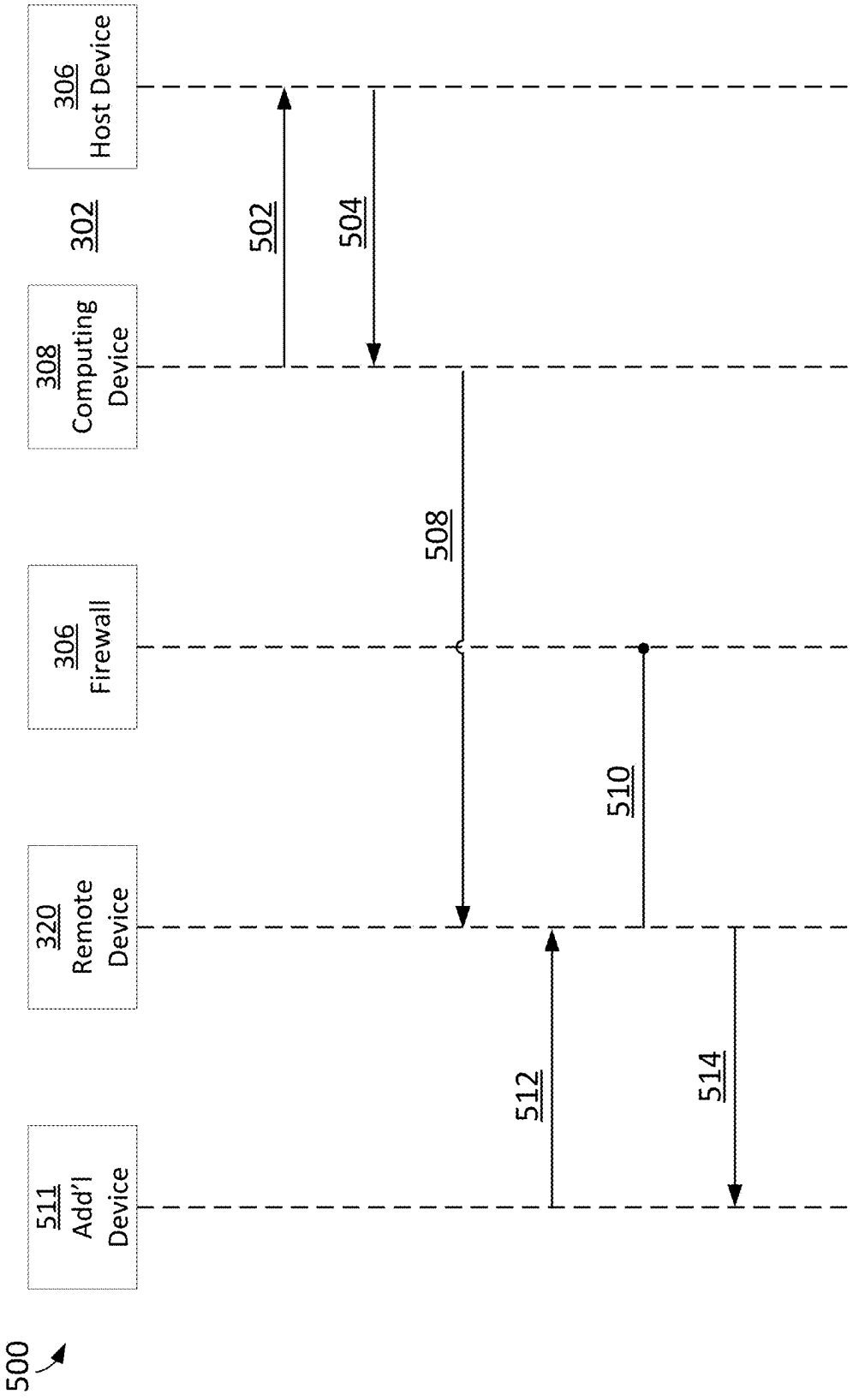

306 Host Device
302
308 Computing Device
306 Firewall
320 Remote Device
511 Add'l Device
502
504
508
510
512
514
500

FIG. 5

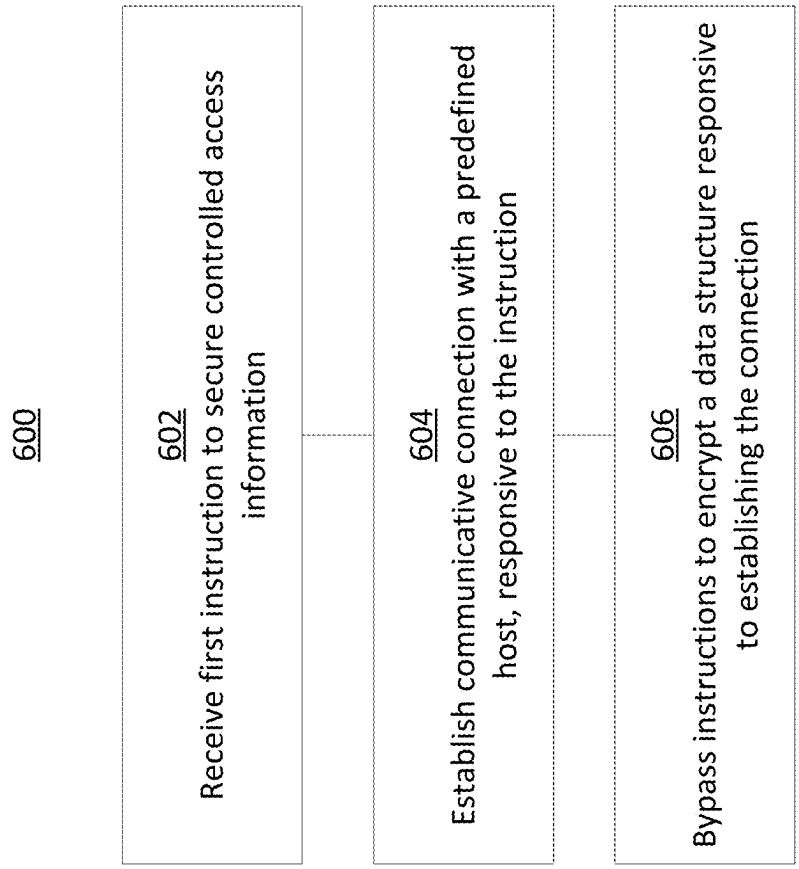

600
602
Receive first instruction to secure controlled access information
604
Establish communicative connection with a predefined host, responsive to the instruction
606
Bypass instructions to encrypt a data structure responsive to establishing the connection

FIG. 6

DATA SECURITY MEASURES FOR CYBERSECURITY THREATS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of and priority to U.S. Provisional Patent Application No. 63/556,126, filed Feb. 21, 2024, the entire disclosure of which is incorporated by reference herein.

BACKGROUND

[0002] One or more aspects of the present disclosure relate to data security. Particularly, some embodiments of the present disclosure relate to the securing controlled-access information based on a detection of a network location.

[0003] Ransomware and other data access attacks can encrypt, delete, transport, or otherwise render files or other data structures inaccessible. Organizations can maintain backup, failover, archive, or other versions of controlled-access information. However, copied instances of controlled-access information can be associated with public disclosure of non-public information, aid in reverse engineering or identification of other vulnerabilities, or otherwise contribute to enterprise risk.

SUMMARY

[0004] According to an aspect of an example embodiment, method of digital rights management is provided. The method includes determining a status of an accessibility of a predefined host. The method includes determining that a data structure corresponds to controlled-access information. The method includes encrypting the data structure to secure the controlled-access information responsive to the status indicating inaccessibility of the predefined host and the determination of the correspondence.

[0005] In an example embodiment, determining the data structure corresponds to the controlled-access information includes comparing a file extension of the data structure to a predefined set of file extensions.

[0006] In an example embodiment, determining the data structure corresponds to the controlled-access information is based on a location of the data structure within a file structure.

[0007] In an example embodiment, determining the data structure corresponds to the controlled-access information is based on a comparison of a unique identifier of the data structure to a predefined list of unique identifiers.

[0008] In an example embodiment, the method includes sending an indication of the status indicating the inaccessibility of the predefined host to a predefined address, comprising a source of the indication.

[0009] In an example embodiment, the indication of the status indicating the inaccessibility of the predefined host includes an email message, and the predefined address corresponds to a law enforcement agency.

[0010] According to an aspect of an example embodiment, the method includes determining a status of an accessibility of a second predefined host. The encryption of the data structure is responsive to the determination of the inaccessibility of the second predefined host. The determination is responsive to the status indicating the inaccessibility of the predefined host.

[0011] In an example embodiment, the instructions are executed automatically.

[0012] In an example embodiment, determining the status of the accessibility of the predefined host includes sending a request for an indication of a presence of the predefined host and determining that a predefined time has elapsed from the request without receiving a response.

[0013] According to an aspect of an example embodiment, a system includes a first computing device and a second computing device. The first computing device is configured to provide an indication of a communicative connection with a first set of network interfaces. The second computing device is configured to determine a status of the communicative connection based on the receipt of the indication at a first network interface of the first set of network interfaces. The second computing device is configured to bypass instructions to secure a data structure responsive to a determination that the communicative connection is present. The second computing device is configured to execute the instructions responsive to a determination that the communicative connection is absent. The instructions can include instructions to secure the data structure.

[0014] In an example embodiment, the system is configured to encrypt the data structure according to an asymmetric encryption protocol to secure the data structure.

[0015] In an example embodiment, the second computing device is configured to encrypt the data structure with a public key. The public key can correspond to a private key of the first computing device.

[0016] In an example embodiment, the second computing device is configured to delete the data structure from a local memory to secure the data structure.

[0017] In an example embodiment, the first computing device is separated from a second set of network interfaces by a network firewall, the network firewall configured to firewall a network. The network includes the first computing device and the first set of network interfaces. The network firewall is configured to block one or more of (1) the indication of the communicative connection from the first computing device to the second set of network interfaces, or (2) a request from one or more of the second set of network interfaces to the first computing device.

[0018] According to an aspect of an example embodiment, a method is performed by a controller including one or more processors coupled with memory. The method includes receiving a first instruction to secure controlled-access information. The method includes establishing a communicative connection with a predefined host, responsive to the receipt of the first instruction. The method includes bypassing, responsive to the establishment of the communicative connection, second instructions accessible to the controller to secure a data structure. The second instructions include instructions to locate the data structure corresponding to the controlled-access information. The second instructions include instructions to replace the data structure with an encrypted data structure.

[0019] In an example embodiment, the data structure is local to the controller and a decryption key to decrypt the encrypted data structure is not accessible to the controller.

[0020] In an example embodiment, the method includes establishing, subsequent to bypassing the instructions, an absence of the communicative connection. The method can further include executing, responsive to the absence of the communicative connection, the second instructions.

[0021] In an example embodiment, the instructions to locate the data structure corresponding to the controlled-access information include instructions for comparing a file extension of the data structure to a predefined set of file extensions.

[0022] In an example embodiment, the method includes receiving prior to the receipt of the first instruction, a first encryption key to encrypt the data structure from the predefined host.

[0023] In an example embodiment, the first instruction is received automatically.

[0024] In an example embodiment, the first instruction is received incident to an execution of an executable file stored on a same storage media as the second instructions, and the second instructions to locate the data structure are based on a relative path between a location of the executable file and the data structure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The above and other aspects and features of the present disclosure will become more apparent to those skilled in the art from the following detailed description of the example embodiments with reference to the accompanying drawings, in which:

[0026] FIG. **1** is a block diagram of an example computing environment within which aspects of the present disclosure may be implemented.

[0027] FIG. **2** is a block diagram of an example system for access management to resources in the computing environment of FIG. **1**.

[0028] FIG. **3** is a block diagram of an example networked environment;

[0029] FIG. **4**, a block diagram of an example system including a computing device;

[0030] FIG. **5** is a sequence diagram corresponding to data security measures, according to an embodiment of the present disclosure; and

[0031] FIG. **6** is a flow diagram of an example process or method for implementing data security measures, according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0032] Hereinafter, example embodiments will be described in more detail with reference to the accompanying drawings.

[0033] Referring now to FIG. **1**, a computing environment **100** is shown within which some of the aspects of the present disclosure may be implemented. The computing environment **100** may include one or more processors **102**, volatile memory **104** (e.g., random access memory (RAM)), non-volatile memory **106** (e.g., one or more hard disk drives (HDDs) or other magnetic or optical storage media, one or more solid state drives (SSDs) such as a flash drive or other solid state storage media, one or more hybrid magnetic and solid state drives, and/or one or more virtual storage volumes, such as a cloud storage, or a combination of such physical storage volumes and virtual storage volumes or arrays thereof, which may be referred to as a local memory) and one or more communications interfaces **108** which may also be referred to as a network interface, in the case of devices in network communication. Various client devices **110** (e.g., mobile devices, desktops, laptops, tablets, or other computing devices) may be configured to access the components included in the computing environment **100** via the communications interface **108** and through communication bus **112**.

[0034] Non-volatile memory **106** stores operating system **114**, one or more applications **116**, and data **118** (collectively referred to as resources **120**) such that, for example, computer instructions of operating system **114** and/or applications **116** are executed by processor(s) **102** out of volatile memory **104**. In some embodiments, volatile memory **104** may include one or more types of RAM and/or a cache memory that may offer a faster response time than a main memory. Various elements of computing environment **100** may communicate via one or more communication buses, shown as communication bus **112**.

[0035] The computing environment **100** (and client device **110**) are shown merely as an example. Such components may be implemented as various computing devices including client devices, servers, networking devices etc., and may be implemented by any computing or processing environment and with any type of machine or set of machines that may have suitable hardware and/or software capable of operating as described herein. Processor(s) **102** may be implemented by one or more programmable processors to execute one or more executable instructions, such as a computer program, to perform the functions of the system. As used herein, the term "processor" describes circuitry that performs a function, an operation, or a sequence of operations. The function, operation, or sequence of operations may be hard coded into the circuitry or soft coded by way of instructions held in a memory device and executed by the circuitry. A "processor" may perform the function, operation, or sequence of operations using digital values and/or using analog signals. In some embodiments, the "processor" may be embodied in one or more application specific integrated circuits (ASICs), microprocessors, digital signal processors (DSPs), graphics processing units (GPUs), microcontrollers, field programmable gate arrays (FPGAs), programmable logic arrays (PLAs), multi-core processors, general-purpose computers with associated memory, or other controllers. The "processor" may be analog, digital or mixed-signal. In some embodiments, the "processor" may be one or more physical processors or one or more "virtual" (e.g., remotely located or "cloud") processors. A processor including multiple processor cores and/or multiple processors multiple processors may provide functionality for parallel, simultaneous execution of instructions or for parallel, simultaneous execution of one instruction on more than one piece of data. In various embodiments, the components in the computing environment **100** may collectively be implemented within a server (or group of servers).

[0036] In various embodiments, one or more client devices **110** may be configured to access, for instance, applications **116** in the non-volatile memory **106** of the computing environment **100**. Some of the applications **116** may be applications corresponding to the networked environment described herein. Other applications **116** may correspond to general enterprise systems. For instance, some applications **116** may correspond to human resources, and other applications **116** may correspond to the HVAC system. In various embodiments, at least one of the applications **116** may include or provide data (e.g., to a client device **110**) corresponding to various aspects of the system. The client device **110** may be associated with a respective entity (e.g., an enterprise, such as a business, residence, or other orga-

nization or portion thereof), and the entity may include (e.g., own or operate) various networks, subnets, or the like. The applications **116** may include or provide such data corresponding to one or more entities (including the entity associated with a particular client device **110**). The client devices **110**, however, may be limited to accessing resources **120** corresponding to their respective entity.

[0037] The client device **110** may be configured to access the applications **116** by providing token(s) as log-in credentials, or according to a network map or routing implemented by various network devices. The client device(s) **110** may access the resources **120** within the computing environment **100** via a respective communications interface through communications interfaces **108**. Communications interfaces **108** may include one or more interfaces to enable the client device(s) **110** to access a computer network, such as a Local Area Network (LAN), a Wide Area Network (WAN), a Personal Area Network (PAN), or the Internet through a variety of wired and/or wireless or cellular connections, upon which the resources **120** are available to the client device(s) **110**.

[0038] Referring to FIG. **2**, a block diagram of a system **200** is shown for providing access to enterprise-specific resources, according to an illustrative embodiment. The system **200** may provide access to the resources **120** in the computing environment **100** depicted in FIG. **1**. The system **200** is shown to include an enterprise identity management system (EIMS) **202**, a client device **110**, and a computing environment **100**. The client device **110** and computing environment **100** may include aspects similar to those described above with reference to FIG. **1**. As described in greater detail below, the EIMS **202** may be configured to generate token(s) for various client devices **110** to access resources **120** within the computing environment **100**. The EIMS **202** may be configured to subsequently validate token(s) received by the computing environment **100** from the client device(s) **110**. The EIMS **202** may be configured to provide the client device(s) **110** access to various resource (s) **120** responsive to validating the token, as described in greater detail below.

[0039] EIMS **202** may generally be designed or implemented to manage individual identities, their authentication, authorization, roles and privileges within or across system and enterprise boundaries and in various environments (including, for instance, the computing environment **100**). EIMS **202** may include various components or features which limit access to specific applications, systems, components, data, environments, or other resources to authorized, authenticated users. EIMS **202** may include various components for onboarding new users, access control of existing users, and offboarding of users who are no longer authorized access some or all resources. In some embodiments, EIMS **202** may be incorporated into or be a component or aspect of various computing environments.

[0040] In various embodiments, EIMS **202** may be deployed on a dedicated computing device (such as a dedicated server or network appliance). The dedicated computing device may be located on-premises (e.g., within a corresponding building for the enterprise), or EIMS **202** may be deployed in the cloud. EIMS **202** may apply various policies or protocols which define which client device **110** (and corresponding users) are permitted to access specific resources, and what permissions such users may have with respect to those resources. The embodiments described herein may be used for managing access to enterprise resources, while managing customer, partner, supplier, and device access to its systems and ensuring security is a priority for the enterprise.

[0041] Some embodiments and deployments of EIMS **202** may include features for management of individual identities, their authentication, authorization, roles and/or privileges within or across system and enterprise boundaries (also referred to herein as access control). However, such EIMS **202** may not provide for multi-organization token generation, in some embodiments. In some embodiments, multi-organization token generation and/or access control may be performed by separate entities. Furthermore, device registration and management and access control may be performed by separate entities (which may even occur on a resource-by-resource basis). Since these systems work independently of one another and there is no direct integration, such systems collectively may cause inefficiencies and increase downtime.

[0042] Furthermore, some deployments of EIMS **202** may not include or provide for impersonation features. Such features may be used for diagnostics or troubleshooting. Where EIMS **202** and impersonation features are separated, such embodiments may also decrease efficiency and increase downtime.

[0043] EIMS **202** is shown to include a processing circuit **204** including a processor **206** and/or memory **208**. The processor **206** may be the same as or similar in some aspects to processor(s) **102** described above with reference to FIG. **1**. Similarly, memory **208** may be the same as or similar in some aspects to memory described above with reference to FIG. **1**. Hence, memory **208** may be or include volatile and/or non-volatile memory.

[0044] EIMS **202** is shown to include a communications interface **210**. The communications interface **210** may provide for or enable communication between the computing environment and/or client device(s) **110**. Thus, the communications interface **108** may be communicably coupled to the computing environment **100** and/or client device(s) **110**. The communications interface **210** may be similar in at least some aspects to communications interface(s) **108** described above with reference to FIG. **1**.

[0045] The memory **208** is shown to include a token generator **212**. The token generator **212** may be or include any device, component, agent, application, and so forth designed or implemented to generate a token specific for client device(s) **110**, and/or resources **120**. The token may be a data packet or structure which is uniquely associated with the particular entity. In various embodiments, the tokens may be cryptographically secured (e.g., encrypted according to various cryptographic methods and contexts). The token may be shared with the client device(s) **110**, components within the computing environment **100** (e.g., via respective communications interface(s) **108**, **210**), and so forth.

[0046] In some embodiments, a client device **110** may be configured to request a token. In some embodiments, an application **116** (e.g., a processor **102** configured to execute the application **116**) may be configured to request a token. In some embodiments, the request may include various credentials. For instance, where a client device **110** requests a token, the request may include a username, password, organization name, PIN, and/or other identifiers which may be used for authenticating a particular node. Where the application **116** requests a token (for instance, when the appli-

cation is attempting to run and complete a scheduled job), the request may include a client identifier and client secret.

[0047] The token generator **212** may be configured to generate a token responsive to receiving the request. The token generator **212** may be configured to authenticate/authorize a user (e.g., using the client device **110**) responsive to receiving the request from the client device **110**. The token generator **212** may be configured to authenticate the user based on the username, password, organization name, PIN, etc.

[0048] The token generator **212** may be configured to compare data stored in the EIMS database **214** with the credentials received in the request (e.g., the username, password, organization name, etc.). The token generator **212** may be configured to cross-reference the credentials with each or a subset of entries in the EIMS database **214** to identify a matching entry. The token generator **212** may be configured to authenticate the user responsive to identifying a matching entry in the EIMS database **214**.

[0049] In various embodiments, the token generator **212** may be configured to generate a time-bound token. The time-bound token may be a token which is valid for a limited duration (e.g., a number of minutes, hours, days, etc.). The duration may be set by the enterprise, by the administrator, by the user, etc. The time-bound token may be active for a limited duration, and may have other security settings. For instance, the time-bound token may provide limited access to resources **120**. The time-bound token may provide read-only access to the resources **120**. According to such embodiments, the administrator may be configured to access resources **120** as a specific user and see resources **120** in the same manner as the specific user would see the same resources **120**, though the administrator may not be permitted to modify or change any resources **120**. In some embodiments, the time-bound token may provide the administrator full access to whatever resources the user is permitted to access for the limited duration. Hence, the administrator may be configured to access resource **120**, see resources **120**, and/or interact with resources **120** as the specific user for a limited duration.

[0050] The token generator **212** may be configured to automatically generate a token for each registered entity. The token generator **212** may be configured to identify entities as registered upon enrollment (e.g., by an enterprise administrator via a respective client device, for instance). The token generator **212** may be configured to provide the entity (e.g., via the communications interface **210**) the generated token. The token may indicate which resources the entity is permitted to access.

[0051] In some embodiments, the token generator **212** may be configured to store data corresponding to the generated tokens in the entries on the EIMS database **214**. For instance, where the token generator **212** generates a token for a particular client device **110**, the token generator **212** may be configured to store a copy of the token (e.g., in an entry of the EIMS database **214**) associated with the client device **110**. The stored copy or other data corresponding to the token may be used for subsequently validating the token, as described in greater detail below.

[0052] In some embodiments, the resource **120** may be configured to request a token from the token generator **212**. For instance, the processor **102** executing the application **116** may be configured to request a multi-organization token. The multi-organization token may be a resource-specific token which includes a plurality of tokens associated with various entities. The processor **102** may request the multi-organization token responsive to the resource having a scheduled job. The processor **102** may be configured to request the multi-organization token from the token generator **212** when the processor **102** is scheduled to perform the job. As described above, the request may include the client identifier and client secret. The client identifier and client secret may be uniquely associated with a particular resource **120**. The client identifier and client secret may be generated by the EIMS **202** when the resource is registered with EIMS **202** (e.g., by an administrator at enrollment).

[0053] The token generator **212** may be configured to identify the client identifier and client secret from the resource **120** (e.g., from the processor **102**). The token generator **212** may be configured to cross-reference the client identifier and client secret received in the request with data included in the EIMS database **214**. EIMS database **214** may be configured to store the client identifier and client secret for each resource **120** when the resource registers with EIMS **202**. The token generator **212** may determine the identity of the resource **120** based on the client identifier and client secret. Responsive to validating the client identifier and client secret, the token generator **212** may be configured to identify which entities are active for the corresponding resource **120**. The token generator **212** may be configured to compile a list of tokens for the active entities by extracting, copying, duplicating, or otherwise reproducing the tokens for the entities which are identified as active for the corresponding resource **120**. The token generator **212** may be configured to generate a multi-organization token which includes each of the tokens included in the list. Hence, the multi-organization token may include the tokens of tenants which are determined to be active with a particular resource.

[0054] The token generator **212** may be configured to provide generated token(s) to the source which requested the token. The token generator **212** may be configured to provide the token(s) through the communications interface (s) **210** to the processor **102** and/or client device(s) **110**. As described in greater detail below, the tokens may be received (e.g., through a resource **120**) by EIMS **202**. EIMS **202** may use the tokens to determine that the token is valid and the client device **110** is permitted to access the particular resource **120**.

[0055] The memory **208** is shown to include a token validator **218**. The token validator **218** may be or include any device, component, agent, application, and so forth designed or implemented to validate tokens received from resource(s) **120**. Generally speaking, the token validator **218** may be configured to validate the tokens received from the resource (s) **120**, and determine whether the client device **110** is permitted to access the particular resource **120**.

[0056] The client device **110** may be configured to provide a token to the communications interface **108** of the computing environment **100**. The client device **110** may be configured to provide the token when a particular user is requesting access to a particular resource **120**. In some embodiments, an administrator may provide the token on behalf of a particular user. In such embodiments, the administrator may be "impersonating" the user by providing a token which is associated with the user. In various embodiments, the client device **110** may provide the token to the communications interface **108** through an application program interface (API). The API may be or include a set of

instructions or protocols which define or specify the communications structure between the client device **110** and particular resources **120**. When the processor **102** determines that a token is received, the processor **102** may route the token to EIMS **202** for validation.

[0057] In some embodiments, when a resource **120** has a scheduled job, the processor **102** may communicate one of the plurality of tokens in the resource-specific token to EIMS **202**. As described in greater detail below, EIMS **202** may validate the token and provide an indication that that the entity which transmitted the token is permitted to access the resource **120**. The processor **102** may run the scheduled job, and communicate another token to EIMS **202**. The processor **102** may iteratively communicate tokens until the processor **102** has performed all scheduled jobs for the particular resource **120**.

[0058] The token validator **218** may be configured to validate the token received from the resource **120**. As stated above, the EIMS database **214** may be configured to store copies or data corresponding to tokens generated by the token generator **212**. The token validator **218** may be configured to cross-reference the token received from the resource **120** with entries in the EIMS database **214** to determine whether the token is valid (e.g., matches a token in the EIMS database **214**, corresponds to data in the EIMS database **214**, etc.). The token validator **218** may be configured to determine that the token is valid based on the cross-referencing.

[0059] The token validator **218** may be configured to determine which resources **120** correspond to the token received by the token validator **218**. The token validator **218** may be configured to determine which resources the client device **110** is permitted to access based on the token. The token validator **218** may be configured to identify the entry in the EIMS database **214** which included the data used for validating the token. The entry may include resources **120** which are accessible by the entity corresponding to the token. The token validator **218** may be configured to determine whether the resource **120** which provided the token to the token validator **218** is accessible by the entity corresponding to the token. The token validator **218** may be configured to provide an indication to the resource **120** which indicates 1) whether the token is valid and 2) whether the entity corresponding to the token is permitted to access the resource **120**. The processor **102** may provide (or deny) access to the resource based on the indication from the token validator **218**. As stated above, the illustrative embodiment is an example of a system **200** to provide access to various enterprise resources **120**, as is not intended to be limiting. The examples of data security measures disclosed hereinafter may be implemented within such an example system **200**, or in various other systems. Further, according to various embodiments, one or more computing devices may operate alternatively or simultaneously as, for example, a client device **110**, or another computing device configured to provide a resource **120** thereto. Further, some computing device can retrieve resources beyond an authorization according to various techniques, wherein the resources can include information that is not intended for public disclosure, and may be classified, tagged, or otherwise identifiable as controlled-access information. For example, resources may include any of the information stored in one or more data repositories of the various computing devices of a system.

[0060] Referring now to FIG. **3**, a block diagram of a network environment **300** is shown, according to some embodiments. The network environment **300** includes a network, such as the depicted enterprise network **302** (e.g., local area network or wide area network). The enterprise network **302** is presented as a logical network, and may include devices locally proximal to each other, or devices which are physically remote, as in the case of a virtual private network (VPN). The enterprise network **302** may be bounded from other networks (e.g., the Internet, other private networks, or other subnets of the enterprise network **302**) by one or more firewall **304** devices. The firewall **304** may be or include any device, component, element, processor, computer, or other various combinations of hardware configured to analyze messages at a network interface to selectively pass the messages through the interface. The firewall **304** may be configured with rules permitting or denying access.

[0061] Some firewalls **304** may implement restrictive or permissive rules. For example, a restrictive rule may correspond to the firewall **304** blocking traffic on a specified port. A permissive rule may correspond to the firewall **304** not blocking access within permit a certain address range. Firewalls **304** may have default restrictive or permissive access. For example, a firewall **304** may permit all messages that do not correspond to a rule, or restrict all messages that do not correspond to a rule. Various combinations of restrictive and permissive rules may be implemented according to a desired application. Although pictured along a boundary of the enterprise network **302**, firewalls **304** may be disposed at various network interfaces and between various devices. For example, each of the connections described herein may include a firewall **304** along the connection. In some instances, the firewall **304** may discriminate between a local and global address. For example, a local address (e.g., IP address) corresponding to another device of the enterprise network **302** may vary from an address for another internet connected device, such that the firewall **304** can route traffic according to a local subnet. That is, the firewall **304** may include or be implemented by a routing table or a router.

[0062] A host device **306** of the enterprise network **302** may connect to various other devices of the enterprise network **302**. For example, the host device **306** may be assigned or otherwise associated with a static internet protocol (IP) address, hostname, or other identifier which may be employed by another device to determine an accessibility of the host device **306**. The host device **306**, like other computing devices depicted herein (e.g., first computing device **308**, second computing device **316**, or remote device **320**) may include one or more servers, clusters, controllers, or so forth. For example, the host device **306**, like other devices of the network may include multiple instances or controllers to load-balance, provide redundancy, or provide horizontal scaling (of various services or microservices). The host device **306** may be accessible to at least a first computing device **308** of the enterprise network **302**. In some embodiments, the host device **306** may be accessible to all devices of the enterprise network **302**. The host device **306** may be inaccessible to one or more devices intermediated from the enterprise network **302** by the firewall **304**. Such devices remote from the enterprise network **302** may be referred to as remote devices **320**.

[0063] The first computing device **308** may include or interface with a file structure **312** containing various data

structures **310**A (e.g., files, linked lists, buffers, or memory registers). At least some of those data structures **310**A may include controlled-access information. For example, controlled-access information may refer to files or contents thereof which are not intended for access, modification, distribution, or other presence away from the enterprise network **302**.

[0064] Various instances of the data structures **310**A, **310**B, **310**C (referred to, generally, as data structures **310**) may be provided across an enterprise. For example, the file structure **312** of the first computing device **308** may include the first instance of the data structure **310**A. A second computing device **316** may include a second instance of the data structure **310**B. The second instance of the data structure **310**B may be identical to or vary from the first instance of the data structure **310**A. For example, the second instance of the data structure **310**B may be a base file for an incremental backup. In some instances, the second computing device **316** may include or omit various other data structures **310**A of a file structure **312** of the first computing device **308**. Either or both of the first computing device **308** and the second computing device **316** may be configured to secure access to data structures **310** based on a status of accessibility of the host device **306**. For example, the file structure **312** can further include instructions to secure the data structure, such as via encryption, deletion, or notification. Thus, upon an absence of the host device **306**, the first computing device **308** may be configured to secure the controlled-access information of the first instance of the data structure **310**A.

[0065] In the event that the first computing device **308**, or a file structure **312** or data structure **310**A thereof, is transported away from the enterprise network **302**, the other instructions in the file structure **312** may be executed to secure the controlled-access information. For example, the execution of the instructions may cause a controller to detect an accessibility of the host device **306**, and perform an action to secure at least one data structure **310**C. For example, the first computing device **308** may include instructions to secure the information via deletion, encryption, or other data transformations of the controlled-access information, or via generation of a message to a cyber-forensic hub **322** (e.g., a law enforcement agency). The message may include, for example, an email generated according to a simple mail transfer protocol, (SMTP). In some embodiments, as depicted, one or more components (e.g., an SMTP addressable portion) of the cyber-forensic hub **322** may be remote from the enterprise network **302**. In some embodiments, at least a portion of the cyber-forensic hub **322** may be disposed on the enterprise network **302**. In some embodiments, the instructions may determine a location and take a further action based on the determined location. For example, the instructions may include instances of instructions geofenced for particular geographic regions (e.g., corresponding to a lawful action in the geofenced region, or an address corresponding to a cyber-forensic hub **322** for the geographic region).

[0066] The instructions to secure the information may be stored in a same data structure **310**A or file structure **312** as the controlled-access information, such that upon an exfiltration of data from the first computing device **308** or other transportation of such a file structure **312** away from the network (e.g., a physical removal of the first computing device **308**), the instructions may be executed to secure such information. For example, wherein an instance of the file structure **312** is transported (e.g., copied) to the remote device **320**, such instructions may encrypt the files to generate a third instance of the data structure **310**C in which controlled-access information is not accessible (or not readily accessible) by the remote device **320**. In some embodiments, upon a restoration of an accessibility of the host device **306** (e.g., a cessation of a network connection issue), the host device **306** may provide a key to decrypt or otherwise restore at least a portion of the file structure **312**.

[0067] The first computing device **308** (to include, as indicated above, a remote device **320** storing at least a portion of a file structure **312** from the first computing device **308**) may determine a presence or absence of the enterprise network **302** by determining a status of a host device **306** (e.g., an accessibility or non-accessibility thereof). The determination of the status may include establishing a communicative connection with the host device **306** to determine a presence thereof, receipt of a broadcast or other message from the host device **306**, or another determination that the host device **306** is accessible to the first computing device **308** or other device in network communication therewith. The firewall **304** may filter messages between the host device **306** such that a remote device **320** determining a status of the host device **306** may determine that the host device **306** is inaccessible thereto, whereupon the execution of the instructions can secure controlled-access information. Determinations of inaccessibility can be determined according to an expiration of a watchdog or determination that a predefined time has elapsed from the request without receiving a response.

[0068] Referring now to FIG. **4**, a block diagram of an example system **400** including a computing device is provided, according to some embodiments. The computing device can be the first computing device **308** of FIG. **3**, as depicted, or another computing device, such as a remote device **320** including at least a portion of a file structure **312** exfiltrated from the first computing device **308**. That is, in some embodiments, the computing device can be a remote device **320** which is not communicatively coupled with a host device **306** of an enterprise network **302**. Thus, various references to the first computing device **308**, or the various elements thereof as provided herein, can be applied to any number of remote devices **320**.

[0069] The system **400** can include or interface with a network **401** to exchange information between various computing devices thereof, or in network communication therewith. The network **401** can include computer networks such as Ethernet networks, controller area networks (CAN) **401**, Peripheral Component Interconnect Express (PCIe), the Internet, local, wide, metro, or other area networks **401**, intranets, cellular networks **401**, satellite networks **401**, and other communication networks **401** such as Bluetooth, or data mobile telephone networks **401**. The network **401** can be public or private, or include public and private portions (e.g., the enterprise network **302** and the Internet). The various elements of the system **400** can communicate over the network **401**. Various instances of information exchanged between devices herein can refer to changes within a memory accessible to one or more components, or between devices, via a network interface corresponding to each device. That is, each device can include one or more network interfaces (e.g., a set of network interfaces) to communicate with further devices.

[0070] The first computing device **308** can communicatively couple with other devices, (e.g., one or more host devices **306**, remote devices **320**, or so forth) over the network **401**. In some instances, the communicative connection between the first computing device **308** and the host device **306** can be interrupted or absent, over at least one port, time, or other link portion so as to interrupt an operative connection therebetween. For example, a network outage between the first computing device **308** and the host device **306** or a routing instruction of a firewall **304** (not depicted) disposed between the first computing device **308** and the host device **306** can interrupt such an operative connection.

[0071] The first computing device **308** can include or interface with at least one controller **402** to execute instructions to implement various methods or operations described herein. The first computing device **308** can include or interface with at least one status monitor **404** to determine a status of a host device **306**. The first computing device **308** can include or interface with at least one file structure identifier **406** to determine a location of one or more data structures accessible to the controller **402**. The first computing device **308** can include or interface with at least one secure handler **408** to instantiate an operation to secure the one or more file structures, such as via encryption or deletion. The first computing device **308** can include or interface with at least one alerter **410** to generate a notification indicative of a storage location of the one or more data structures **310**.

[0072] The system **400** can include at least one data repository **420**. The status monitor **404**, file structure identifier **406**, secure handler **408**, or alerter **410** can each include or interface with at least one processing unit or other logic device such as programmable logic array engine, or module configured to communicate with the data repository **420** or database (e.g., the controller **402**). Each device connected to a network **401** can include at least one instance of a controller **402**. The controller **402**, status monitor **404**, file structure identifier **406**, secure handler **408**, or alerter **410** can be separate components, a single component, or part of the first computing device **308**. The first computing device **308** can include hardware elements, such as one or more processors, logic devices, or circuits, some of which may be, be accessible to, or be non-addressable by, the controller **402**. For example, the system **400** can include one or more components or structures of functionality of computing devices depicted in FIG. **1**.

[0073] The data repository **420** can include one or more local or distributed databases, and can include a database management system. The data repository **420** can include computer data storage or memory and can store one or more data structures **310**, such as controlled-access information **422**, instructions **424** to secure the controlled-access information **422**, a predefined address **426**, or other data elements such as data structures **310** corresponding to non-controlled-access information.

[0074] Controlled-access information **422** may refer to or include any information which is restricted from public release. For example, the controlled-access information **422** can include information determined to have a security risk in excess of a threshold. Any data which is not controlled-access information can be referred to as non-controlled-access information. The data repository **420** can include various identifiers to distinguish the controlled-access information **422** from the non-controlled-access information, as is further discussed with regard to the file structure identifier **406**. For example, the controlled-access information **422** of the data repository **420** can be indicated by a list of predefined files, file types, or other indicia of access control (such as tags, flags, or other indicia which defines whether or not information is controlled-access information **422** or non-controlled-access information).

[0075] An executable file can include instructions **424** to secure the controlled-access information **422**. Upon execution of the file, the instructions **424** can determine an accessibility of a host device **306**, locate controlled-access information **422**, or secure the controlled-access information **422**. Securing the controlled-access information can include, for example, encryption or deletion of such information, generation of a notification indicative of a location of the information, or so forth). In some embodiments, the instructions **424** can include multiple instructions **424** corresponding to multiple device types. For example, a first set of instructions **424** can correspond to a windows device, a second set of instructions **424** can correspond to a Unix device, and so on. In some embodiments, the instructions **424** are configured for automatic execution on at least some devices (e.g., located in a startup folder for an operating system or application). In some embodiments, the instructions **424** are configured for execution via a manual action (e.g., opening of a file including macros). In some embodiments, the instructions **424** are stored in a predefined location and configured for execution upon a receipt of further instructions, such as further instructions received from a cyber-forensic hub **322** in network communication with the first computing device (e.g., over the Internet).

[0076] A predefined address **426** can refer to or include an address corresponding to a host device **306** or for notification messages generated by the alerter **410**. For example, the data repository **420** can include a predefined address **426** corresponding to a first host device **306** and a second host device **306** (e.g., a failover or secondary server). The predefined address **426** for the host device **306** can include an IP address, host name, uniform resource locator (URL) address, port number, or other predefined address **426**. The predefined address **426** may be resolvable locally, by the first computing device **308**, or by another device (e.g., router or domain name service). A firewall **304** associated with the enterprise network **302** can be configured to filter communications associated with the predefined address **426**, such that a message sent from outside the enterprise network **302** does not reach the host device **306**, or a reply from the host device **306** does not pass over a boundary between the enterprise network **302** and another network (e.g., the Internet). In some embodiments, the firewall **304** can selectively pass messages between the host device **306** and a device external to the network, such as based on a whitelist, blocklist, or admin user selection.

[0077] The data repository **420** can include a predefined address **426** corresponding to the alerter **410**. For example, the predefined address **426** corresponding to the alerter **410** can be for one or more devices on the enterprise network **302** (e.g., at the firewall **304**, inside of the firewall **304**, or in a network demilitarized zone (DMZ) along a network boundary). In some embodiments, the predefined address **426** can correspond to a public facing device, accessible via the internet (e.g., an email server). For example, the predefined address **426** can correspond to a network security team or a

law enforcement agency (e.g., the cyber-forensic hub **322**). In some embodiments, a firewall **304** associated with the enterprise network **302** can be configured to filter outgoing messages originating from the network and addressed to a cyber-forensic hub **322** (e.g., to reduce nuisance faults from internal network outages). A recipient corresponding to the predefined address **426** can store instructions **424** to respond to a receipt of a notification by tracing a source of the email, or taking further actions such as distributing computer-readable instructions **424** configured for execution by the controller **402** or another processor associated with a computing device. In some embodiments, such instructions **424** are configured for execution at the first computing device **308**, automatically (e.g., without a user interaction, or based on a user interaction associated with executing other instructions **424**, such as a selection of an element of a webpage, or an opening of a file including macros or other automatically executing instructions **424**).

[0078] The system **400** may include at least one controller **402**. The controller **402** may include or interface with one or more processors and memory. The processor may be implemented as a specific purpose processor, an application specific integrated circuit (ASIC), one or more field programmable gate arrays (FPGAs), a group of processing components, or other suitable electronic processing components, including those described at FIG. **1**. The processors and memory may be implemented using one or more devices, such as devices in a client-server implementation. The memory may include one or more devices (e.g., random access memory (RAM), read-only memory (ROM), flash memory, or hard disk storage) for storing data and computer code for completing and facilitating the various user or client processes, layers, and modules. The memory may be or include volatile memory or non-volatile memory and may include database components, object code components, script components, or any other type of information structure for supporting the various activities and information structures of the concepts disclosed herein. The memory may be communicably connected to the processor and include computer code or instruction circuits for executing one or more processes described herein. Such instructions may be stored on non-volatile memory. The memory may include various circuits, software engines, and/or modules that cause the processor to execute the systems and methods described herein, such as to cause the communication or processing of data.

[0079] The controller **402** may include or be coupled with communications electronics (e.g., a network interface). The communications electronics may conduct wired and/or wireless communications via the network **401** or other communication links. For example, the communications electronics may include one or more wired (e.g., Ethernet, PCIe, or AXI) or wireless transceivers (e.g., a Wi-Fi transceiver, a Bluetooth transceiver, an NFC transceiver, or a cellular transceiver). The controller **402** may be in network communication or otherwise communicatively coupled with the status monitor **404**, file structure identifier **406**, secure handler **408**, or alerter **410**. The controller **402** may cause one or more operations disclosed by employing another element of the first computing device **308**. For example, operations disclosed by other elements of the system may be initiated, scheduled, or otherwise controlled by the controller **402**.

[0080] The system **400** may include at least one status monitor **404**. The status monitor **404** can determine a status (e.g., accessibility or inaccessibility) of a host device **306** with respect to the first computing device **308**. The status monitor **404** can determine the status based on a message and reply. For example, the message and reply can include an internet control message protocol (ICMP) message, such as a ping echo request and corresponding ping echo reply. The status monitor **404** can determine the status responsive to a receipt of a periodic message (e.g., broadcast message from the host device **306**). For example, the status monitor **404** can service a timer upon receipt of a message from the host device **306**. Upon an expiration of the timer, the status monitor **404** can provide an indication of inaccessibility of the host device **306** to, for example, the secure handler **408**.

[0081] In some embodiments, the status monitor **404** can communicate with multiple host devices **306**. For example, the status monitor **404** can determine that a first host device **306** is inaccessible, and determine a status of a second host device **306**. The second host device **306** can be disposed on the enterprise network **302**, or accessible to public facing devices (e.g., on the internet). For example, placement of a host device **306** on the internet can delay securing (e.g., deletion or encryption) of data structures **310**, or prevent securing of data structures **310** (e.g., where a public use of such data structures is desired or encryption or deletion of data structures **310** is not desired).

[0082] In some embodiments, the status monitor **404** can establish a secure connection (e.g., tunnel) with one or more host devices **306**, or otherwise exchange one or more tokens between the host device **306** and the first computing device **308** (e.g., according to the operations discussed with regard to FIG. **2**). For example, the tokens can identify the first computing device **308**, where the host device **306** can determine an authorization of the identity of the first computing device **308** prior to providing a token, message, or other information to cause the status monitor **404** to determine an accessibility of the host device **306**. That is, the determination of accessibility can include a provision of an identity or authorization (e.g., key or token).

[0083] The system **400** can include at least one file structure identifier **406**. The file structure identifier **406** can determine an identity or location of one or more data structures **310** including controlled-access information **422** within a file structure **312**. The file structure identifier **406** can determine the identity or location of the data structures **310** within various media accessible to the controller **402**. For example, one or more files can be located at a predefined position within a file structure **312**. The predefined position can include, for example, a memory location or a name of a location within a file structure **312**. The predefined position can include a relative path or other location, such as a relative address location (e.g., range) or a relative position within a folder structure (e.g., within two hierarchical levels of an execution location of instructions **424** executed by the controller **402**).

[0084] In some embodiments, the file structure identifier **406** can identify one or more data structures **310** according to a type, size, identifier, or other attribute. The file structure identifier **406** can identity the data structures **310** in a local memory, or data structures **310** present in network attached storage. The local memory can include a hard drive, solid state drive, or other device housed within a same PC case, server rack, or other physical housing. An identifier for a

data structure **310** can include a unique or non-unique identifier. For example, the file structure identifier **406** can store a file name or other identifier (e.g., cyclic redundancy check (CRC) value, secure hash algorithm (SHA), message digest algorithm (MDX), etc.) The file structure identifier **406** can determine a data structure **310** includes or otherwise corresponds to controlled-access information **422** based on a file name, file path, or file extension. The file structure identifier **406** can detect one or more file types accessible to a controller **402** which are associated with controlled-access information **422**. For example, the file structure identifier **406** can compare a file extension to a predefined set of file extensions (e.g., DOC, .DOCX, .XLSX, or .CSV). According to various embodiments, the file structure identifier **406** can employ one or more of the identification operations disclosed herein. For example, in some embodiments, the file structure identifier **406** can identify all files of a predefined file type. In some embodiments, the file structure identifier **406** can identify files matching according to a SHA-512 or other cryptographically secure identifier, by comparing a predefined identifier to a set of predefined identifiers (sometimes referred to as predefined list of unique identifiers). That is, the file structure identifier **406** can be configured to be underinclusive (e.g., fail to detect files or other data structures which have been modified since a most recent indexing or which are not indexed as including controlled-access information **422**, via an index of the data repository **420**), or overinclusive (e.g., identify files or other data structures which do not include controlled-access information **422** based on a file extension alone).

[0085] The system **400** can include at least one secure handler **408**. The secure handler **408** can execute an operation to secure one or more data structures **310** of a file structure **312**. For example, the secure handler **408** can execute an operation of the status monitor **404** to determine the availability of the host device **306** or an operation of the file structure identifier **406** to identify one or more data structures **310**. In some embodiments, the secure handler **408** can operate automatically, without user interaction. For example, the secure handler **408** can include an executable file disposed in a location to be executed by the controller **402** (e.g., in a startup folder, registry, on same storage media, or the like). In some embodiments, the secure handler **408** can include a portion of the instructions **424** provided to the controller **402** via an email attachment, web browser, or file sharing network. In some embodiments, such an executable file can operate without a user action, or without a user action otherwise associated with executing the secure handler **408** (e.g., opening a file including automatically executable macros or other instructions **424**). In some embodiments, a user action associated with navigation of a webpage or a selection of an email can cause the secure handler **408** to initiate an operation. For example, the executable file can originate from (or execute responsive to) instructions **424** originating from a cyber-forensic hub **322** (e.g., law enforcement agency).

[0086] The secure handler **408** can operate based on a status of the host device **306** and the data structures **310** identified by the file structure identifier **406**. For example, the secure handler **408** can bypass instructions **424** to secure a data structure **310** based on an indication that a communicative connection with the host device **306** is present, or based on an indication that no data structures **310** are identified by the file structure identifier **406**. Conversely, the secure handler **408** can execute instructions **424** to secure a data structure **310** based on an indication that a communicative connection with the host device **306** is absent, or based on an indication that one or more data structures **310** are identified by the file structure identifier **406** as including controlled-access information **422**.

[0087] The secure handler **408** can secure one or more data structures identified by the file structure identifier **406**. For example, the secure handler **408** can encrypt the data structures **310**, delete the data structures, tokenize one or more elements of the data structure, actuate a digital rights management (DRM) control, or take another action (e.g., cause the alerter **410** to generate a notification associated with the data structure **310**). Referring again to encryption of data structures **310** corresponding to (e.g., including) controlled-access information **422**, the secure handler **408** can encrypt the data structure **310** according to various encryption protocols to replace the data structure **310** with an encrypted data structure **310**C. In some embodiments, the secure handler **408** can encrypt the data structure **310** according to a symmetric key. Thereafter, the secure handler can delete or otherwise secure the key. In some embodiments, the secure handler **408** can encrypt the data structure **310** according to an asymmetric encryption protocol. For example, the secure handler **408** can retrieve (e.g., from the data repository **420**) a public key of a public-private key pair. The private key may be stored by, another device of the enterprise network **302** (e.g., the host device **306**), or otherwise in a location which is not accessible to the controller **402**.

[0088] In some embodiments, the secure handler **408** can receive an instruction **424** from a host device **306** to decrypt a data structure **310**. For example, the secure handler **408** can receive a message, from the host device **306** including the private key to decrypt the data structure **310** or otherwise restore the data structure **310** to a state prior to securing the data structure **310**. For example, responsive to an intermittent network outage, various instances of secure handlers **408** can encrypt files on various network devices. Upon a restoration of network connectivity, the host device **306** can provide one or more private keys, and cause the various network devices to change a public key (e.g., by providing an updated public key corresponding to a second private key or by causing the various network devices to increment an active public key to a second active public key pre-stored on the various devices). In some embodiments, the various network devices and the host device **306** can exchange data structures **310** such that the private key of the host device **306** remains private.

[0089] The system **400** can include at least one alerter **410**. The alerter **410** can generate a notification of an accessibility of the host device **306** with respect to another computing device. For example, various computing devices (e.g., the first computing device **308**, firewall **304** (sometimes referred to as a network firewall **304**, without limiting effect), remote devices **320**, etc.) can include an instance of the alerter **410**. Instructions **424** corresponding to the alerter **410** can be stored in a same file structure **312** as the one or more data structures **310** including the controlled-access information **422**. Thus, any instantiations of other aspects of the present disclosure can further cause an instantiation of an alerter instance **410**, (or be substituted for an instantiation of an alerter instance **410**).

[0090] The alerter **410** can generate a message for provision to a predefined address **426**. For example, the alerter **410** can generate a simple message system (SMS), email (e.g., SMTP), or other message. In some embodiments, the message can include a data payload of any information accessible to a controller **402** in network communication with the alerter **410**. In some embodiments, the message can omit payload data. For example, the alerter **410** can generate an empty email message via SMTP, wherein the empty email message lacks a body, but includes header information. The alerter **410** can transmit or otherwise cause the message to be converted to the predefined address **426**. Such a message may be employed, by a recipient thereof, to determine a source of the message. For example, a (logical or physical) network location associated with of potentially controlled-access information **422**, which is away from the enterprise network **302** can be determined. In some embodiments (e.g., corresponding to one or more geographic locations, the alerter **410** can cause the message to be sent without encryption, deletion, or other securing of data structures **310**).

[0091] Referring now to FIG. **5**, a sequence diagram **500** is provided corresponding to data security measures, according to some embodiments of the present disclosure. Like other aspects of the present disclosure, the sequence diagram **500** is an illustrative example, which can be modified according to the various disclosures provided herein. A first computing device **308** can provide a first message **502** to one or more host devices **306**. The first computing device **308** and the host device **306** can be on a same network (e.g., the enterprise network **302** of FIG. **3**). The host device **306** can provide a reply **504** to the first message **502**. The first computing device **308** can determine, based on the receipt of the reply **504**, that the host device **306** is accessible. Based on the determination of accessibility, the host device **306** can bypass instructions **424** to secure a data structure **310** stored thereon.

[0092] A data exfiltration event **508** can copy, relocate, or otherwise transport at least a portion of a file structure **312** away from the network including the first computing device **308** and the host device **306**, to the remote device **320**. The remote device **320** can be separated from the network by as firewall **304**. Although the first computing device **308** or another device can store a backup of the exfiltrated data, the exfiltrated data may include controlled-access information **422** which is not intended for public disclosure. Instructions **424** to secure the data can be stored along with the controlled-access information **422** (e.g., in a same file structure **312**, in a same logical or physical partition, or otherwise operatively coupled thereto). In some embodiments, the instructions **424** can be configured to automatically execute, to cause a controller **402** of the remote device **320** to determine an accessibility of the host device **306** (e.g., via a second message **510**), whereupon a controller **402** of the remote device **320** can determine that the host device **306** is inaccessible. For example, the second message **510** can be misaddressed due to a network location, or filtered by the firewall **304**.

[0093] In some instances, the instructions **424** may be stored on a storage medium which does not host an operating system, or is otherwise not configured for execution by a controller **402** or application of the remote device **320**. However, an additional computing device **511**, can deliver further instructions **512** to execute stored instructions **424** on the remote device **320** (e.g., the stored instructions **424** which were exfiltrated along with the controlled-access information **422**). The additional computing device **511** may be, in various embodiments, within a same enterprise network **302** as the host device **306** and the first computing device **308**, or away therefrom. In some embodiments, the additional computing device **511** can include a device of a cyber-forensic hub **322** which may be authorized by or otherwise corresponding to a law enforcement agency. The additional computing device **511** can deliver the further instructions **512** via email, web browser, or other connection over a public or private network (e.g., the Internet).

[0094] The remote device **320** can execute instructions **424** to secure one or more data structures **310**, responsive to a determination of a status of accessibility (e.g., inaccessibility) of the host device **306**. For example, the remote device **320** can delete or encrypt one or more data structures **310**, or generate a notification **514** (e.g., for delivery to the additional computing device **511** or another device associated with the cyber-forensic hub **322**). The deletion or encryption can be repeated one or more times with a predefined or random pattern to sanitize data previously stored on a memory device, such as in the case of a spinning magnetic media exhibiting memory effects.

[0095] Referring now to FIG. **6**, a method **600** of implementing data security measures is provided. The method **600** can be performed by one or more controllers **402** including various circuits, instructions, processors, or other logical elements, such as the logical elements described with respect to FIG. **1**, the controller **402** of FIG. **4** or otherwise herein. For example, the controller **402** can be a controller **402** of the various systems disclosed herein. In brief overview, at operation **602**, the method **600** includes receiving a first instruction **424** to secure controlled-access information. At operation **604**, the method includes establishing a communicative connection with a predefined host, responsive to the receipt of the first instruction **424**. At operation **606**, the method includes bypassing, responsive to the establishment of the communicative connection, second instructions **424** accessible to the controller **402** to secure the data structure **310**.

[0096] Referring again to operation **602**, the controller **402** can receive a first instruction **424** to secure controlled-access information **422**. The instruction **424** can be received from a network connected device, or from a local memory. For example, the instruction **424** can be received according to a periodic or other scheduled process, incident to an application opened by a user, or an interaction with a control element of a website. The execution of the instructions **424** can initiate one or more processes, such as processes corresponding to operation **604** and operation **606**. In some embodiments, the instructions **424** can include more than one instruction set, of which at least one instructions set corresponds to a local controller **402**, operating system, application, or other portion of a device configured to execute the instruction **424**.

[0097] Referring again to operation **604**, the controller **402** can establish a communicative connection with a predefined host (e.g., a host device **306** disposed on an enterprise network **302**). For establishment can include determining that the communicative connection is present. The establishment of the communicative connection can be according to a receipt of a message confirming a communicative coupling with the host (e.g., a reply to a request previously

sent by the controller **402**, or a periodic or other message initiated at the host device **306**). In some embodiments, the establishment of the communicative connection can include establishing a tunnel, such as a VPN session, SSH, or other connection with the host device **306**. In some embodiments, the establishment of the communicative connection can include a transfer of one or more tokens, keys (e.g., encryption keys), or other identifiers to identify (e.g., authenticate) one or more of the device of the controller **402** or the host device **306**.

[0098] Referring again to operation **606**, the controller **402** can bypass second instructions **424** responsive to establishing the communicative connection. Bypassing the connections can include executing a branch away from the connections, servicing a delay clement (e.g., timer, loop, or so forth), or otherwise not executing the second instructions **424**. The second instructions **424** can include instructions **424** to locate a data structure **310** corresponding to controlled-access information **422**, and replacing such a data structure **310** with an encrypted data structure **310**C. The data structure **310** can be local to a computing device including the controller **402** or in network communication therewith. The decryption (e.g., private) key may not be accessible to the controller **402**. That is, the encryption can be configured to secure information, by encrypting data for which the controller lacks a decryption key. In some embodiments, the controller **402** can receive, prior to receiving the first instruction **424**, a public key from the host device **306** (e.g., on the enterprise network **302**, at disk imaging time, etc.). The public key may correspond to a private key local or otherwise accessible by the host device **306**.

[0099] The construction and arrangement of the systems and methods as shown in the various exemplary embodiments are illustrative only. Although only a few embodiments have been described in detail in this disclosure, many modifications are possible (e.g., variations in sizes, dimensions, structures, shapes and proportions of the various elements, values of parameters, mounting arrangements, use of materials, colors, orientations, etc.). For example, the position of elements can be reversed or otherwise varied, and the nature or number of discrete elements or positions can be altered or varied. Accordingly, all such modifications are intended to be included within the scope of the present disclosure. The order or sequence of any process or method steps can be varied or re-sequenced according to alternative embodiments. Other substitutions, modifications, changes, and omissions can be made in the design, operating conditions and arrangement of the exemplary embodiments without departing from the scope of the present disclosure.

[0100] The present disclosure contemplates methods, systems and program products on any machine-readable media for accomplishing various operations. The embodiments of the present disclosure can be implemented using existing computer processors, or by a special purpose computer processor for an appropriate system, incorporated for this or another purpose, or by a hardwired system. Embodiments within the scope of the present disclosure include program products comprising machine-readable media for carrying or having machine-executable instructions or data structures stored thereon. Such machine-readable media can be any available media that can be accessed by a general purpose or special purpose computer or other machine with a processor. By way of example, such machine-readable media can comprise RAM, ROM, EPROM, EEPROM, CD-ROM or other optical disk storage, magnetic disk storage or other magnetic storage devices, or any other medium which can be used to carry or store desired program code in the form of machine-executable instructions or data structures and which can be accessed by a general purpose or special purpose computer or other machine with a processor. Combinations of the above are also included within the scope of machine-readable media. Machine-executable instructions include, for example, instructions and data which cause a general-purpose computer, special purpose computer, or special purpose processing machines to perform a certain function or group of functions.

[0101] Although the figures show a specific order of method steps, the order of the steps may differ from what is depicted. Also, two or more steps can be performed concurrently or with partial concurrence. Such variation will depend on the software and hardware systems chosen and on designer choice. All such variations are within the scope of the disclosure. Likewise, software implementations could be accomplished with standard programming techniques with rule-based logic and other logic to accomplish the various connection steps, processing steps, comparison steps and decision steps.

[0102] The term "client or "server" include all kinds of apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, a system on a chip, or multiple ones, or combinations, of the foregoing. The apparatus may include special purpose logic circuitry, e.g., a field programmable gate array (FPGA) or an application specific integrated circuit (ASIC). The apparatus may also include, in addition to hardware, code that creates an execution environment for the computer program in question (e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, a cross-platform runtime environment, a virtual machine, or a combination of one or more of them). The apparatus and execution environment may realize various different computing model infrastructures, such as web services, distributed computing and grid computing infrastructures.

[0103] The systems and methods of the present disclosure may be completed by any computer program. A computer program (also known as a program, software, software application, script, or code) may be written in any form of programming language, including compiled or interpreted languages, declarative or procedural languages, and it may be deployed in any form, including as a stand-alone program or as a module, component, subroutine, object, or other unit suitable for use in a computing environment. A computer program may, but need not, correspond to a file in a file system. A program may be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub programs, or portions of code). A computer program may be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

[0104] The processes and logic flows described in this specification may be performed by one or more programmable processors executing one or more computer programs to perform actions by operating on input data and generating

output. The processes and logic flows may also be performed by, and apparatus may also be implemented as, special purpose logic circuitry (e.g., an FPGA or an ASIC).

[0105] Processors suitable for the execution of a computer program include, by way of example, both general and special purpose microprocessors, and any one or more processors of any kind of digital computer. Generally, a processor will receive instructions and data from a read only memory or a random-access memory or both. The essential elements of a computer are a processor for performing actions in accordance with instructions and one or more memory devices for storing instructions and data. Generally, a computer will also include, or be operatively coupled to receive data from or transfer data to, or both, one or more mass storage devices for storing data (e.g., magnetic, magneto-optical disks, or optical disks). However, a computer need not have such devices. Moreover, a computer may be embedded in another device (e.g., a mobile telephone, a personal digital assistant (PDA), a mobile audio or video player, a game console, a Global Positioning System (GPS) receiver, or a portable storage device (e.g., a universal serial bus (USB) flash drive), etc.). Devices suitable for storing computer program instructions and data include all forms of non-volatile memory, media and memory devices, including by way of example semiconductor memory devices (e.g., EPROM, EEPROM, and flash memory devices; magnetic disks, e.g., internal hard disks or removable disks; magneto-optical disks; and CD ROM and DVD-ROM disks). The processor and the memory may be supplemented by, or incorporated in, special purpose logic circuitry.

[0106] In various implementations, the steps and operations described herein may be performed on one processor or in a combination of two or more processors. For example, in some implementations, the various operations could be performed in a central server or set of central servers configured to receive data from one or more devices (e.g., edge computing devices/controllers) and perform the operations. In some implementations, the operations may be performed by one or more local controllers or computing devices (e.g., edge devices), such as controllers dedicated to and/or located within a particular building or portion of a building. In some implementations, the operations may be performed by a combination of one or more central or offsite computing devices/servers and one or more local controllers/computing devices. All such implementations are contemplated within the scope of the present disclosure. Further, unless otherwise indicated, when the present disclosure refers to one or more computer-readable storage media and/or one or more controllers, such computer-readable storage media and/or one or more controllers may be implemented as one or more central servers, one or more local controllers or computing devices (e.g., edge devices), any combination thereof, or any other combination of storage media and/or controllers regardless of the location of such devices.

[0107] To provide for interaction with a user, implementations of the subject matter described in this specification may be implemented on a computer having a display device (e.g., a CRT (cathode ray tube), LCD (liquid crystal display), OLED (organic light emitting diode), TFT (thin-film transistor), or other flexible configuration, or any other monitor for displaying information to the user and a keyboard, a pointing device, e.g., a mouse, trackball, etc., or a touch screen, touch pad, etc.) by which the user may provide input to the computer. Other kinds of devices may be used to provide for interaction with a user as well; for example, feedback provided to the user may be any form of sensory feedback (e.g., visual feedback, auditory feedback, or tactile feedback), and input from the user may be received in any form, including acoustic, speech, or tactile input. In addition, a computer may interact with a user by sending documents to and receiving documents from a device that is used by the user; for example, by sending web pages to a web browser on a user's client device in response to requests received from the web browser.

[0108] Implementations of the subject matter described in this disclosure may be implemented in a computing system that includes a back-end component (e.g., as a data server), or that includes a middleware component (e.g., an application server), or that includes a front end component (e.g., a client computer) having a graphical user interface or a web browser through which a user may interact with an implementation of the subject matter described in this disclosure, or any combination of one or more such back end, middleware, or front end components. The components of the system may be interconnected by any form or medium of digital data communication (e.g., a communication network). Examples of communication networks include a LAN and a WAN, an inter-network (e.g., the Internet), and peer-to-peer networks (e.g., ad hoc peer-to-peer networks).

[0109] The present disclosure may be embodied in various different forms, and should not be construed as being limited to only the illustrated embodiments herein. Rather, these embodiments are provided as examples so that this disclosure will be thorough and complete, and will fully convey the aspects and features of the present disclosure to those skilled in the art. Accordingly, processes, elements, and techniques that are not necessary to those having ordinary skill in the art for a complete understanding of the aspects and features of the present disclosure may not be described. Unless otherwise noted, like reference numerals denote like elements throughout the attached drawings and the written description, and thus, descriptions thereof may not be repeated. Further, features or aspects within each example embodiment should typically be considered as available for other similar features or aspects in other example embodiments.

[0110] It will be understood that, although the terms "first," "second," "third," etc., may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are used to distinguish one element, component, region, layer or section from another element, component, region, layer or section. Thus, a first element, component, region, layer or section described below could be termed a second element, component, region, layer or section, without departing from the spirit and scope of the present disclosure.

[0111] The terminology used herein is for the purpose of describing particular embodiments and is not intended to be limiting of the present disclosure. As used herein, the singular forms "a" and "an" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises," "comprising," "includes," and "including," "has," "have," and "having," when used in this specification, specify the presence of the stated features, integers, steps,

operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof. As used herein, the term "and/or" includes any and all combinations of one or more of the associated listed items. Expressions such as "at least one of," when preceding a list of elements, modify the entire list of elements and do not modify the individual elements of the list.

[0112] As used herein, the term "substantially," "about," and similar terms are used as terms of approximation and not as terms of degree, and are intended to account for the inherent variations in measured or calculated values that would be recognized by those of ordinary skill in the art. Further, the use of "may" when describing embodiments of the present disclosure refers to "one or more embodiments of the present disclosure." As used herein, the terms "use," "using," and "used" may be considered synonymous with the terms "utilize," "utilizing," and "utilized," respectively. Also, the term "exemplary" is intended to refer to an example or illustration.

[0113] A portion of the disclosure of this patent document contains material which is subject to copyright protection. The copyright owner has no objection to the facsimile reproduction by anyone of the patent document or the patent disclosure, as it appears in the Patent and Trademark Office patent file or records, but otherwise reserves all copyright rights whatsoever.

What is claimed is:

1. A method of digital rights management, the method comprising:
- determining a status of an accessibility of a predefined host;
- determining that a data structure corresponds to controlled-access information; and
- responsive to the status indicating inaccessibility of the predefined host and the determination of the correspondence, encrypting the data structure to secure the controlled-access information.

2. The method of claim **1**, wherein determining the data structure corresponds to the controlled-access information comprises:
- comparing a file extension of the data structure to a predefined set of file extensions.

3. The method of claim **1**, wherein determining the data structure corresponds to the controlled-access information is based on a location of the data structure within a file structure.

4. The method of claim **1**, wherein determining the data structure corresponds to the controlled-access information is based on a comparison of a unique identifier of the data structure to a predefined list of unique identifiers.

5. The method of claim **1**, further comprising:
- sending an indication of the status indicating inaccessibility of the predefined host to a predefined address, comprising a source of the indication.

6. The method of claim **5**, wherein:
- the indication of the status indicating the inaccessibility of the predefined host comprises an email message; and
- the predefined address corresponds to a law enforcement agency.

7. The method of claim **1**, further comprising:
- determining, responsive to the status indicating the inaccessibility of the predefined host, a status of an accessibility of a second predefined host, wherein the encryption of the data structure is responsive to a determination of the inaccessibility of the second predefined host.

8. The method of claim **1**, wherein determining the status of the accessibility of the predefined host comprises:
- sending a request for an indication of a presence of the predefined host; and
- determining that a predefined time has elapsed from the request without receiving a response.

9. A system, comprising:
- a first computing device configured to provide an indication of a communicative connection with a first set of network interfaces; and
- a second computing device configured to:
  - determine a status of the communicative connection based on a receipt of the indication at a first network interface of the first set of network interfaces;
  - responsive to a determination that the communicative connection is present, bypass instructions to secure a data structure; and
  - responsive to a determination that the communicative connection is absent, execute the instructions, the instructions comprising instructions to secure the data structure.

10. The system of claim **9**, wherein, to secure the data structure, the system is configured to:
- encrypt the data structure according to an asymmetric encryption protocol.

11. The system of claim **10**, wherein the second computing device is configured to encrypt the data structure with a public key, the public key corresponding to a private key of the first computing device.

12. The system of claim **9**, wherein, to secure the data structure, the second computing device is configured to delete the data structure from a local memory.

13. The system of claim **9**, wherein the first computing device is separated from a second set of network interfaces by a network firewall, the network firewall configured to firewall a network comprising:
- the first computing device; and
- the first set of network interfaces,

the network firewall being configured to block:
- the indication of the communicative connection from the first computing device to the second set of network interfaces; or
- a request from one or more of the second set of network interfaces to the first computing device.

14. A method, comprising:
- receiving, by a controller, a first instruction to secure controlled-access information;
- establishing, by the controller, a communicative connection with a predefined host, responsive to the receipt of the first instruction; and
- bypassing, responsive to the establishment of the communicative connection, second instructions accessible to the controller to secure a data structure, the second instructions comprising instructions to:
  - locate the data structure corresponding to the controlled-access information; and
  - replace the data structure with an encrypted data structure.

15. The method of claim **14**, wherein:
the data structure is local to the controller; and
a decryption key to decrypt the encrypted data structure is not accessible to the controller.

16. The method of claim **14**, further comprising:
establishing, by the controller and subsequent to bypassing the instructions, an absence of the communicative connection; and
executing, by the controller, responsive to the absence of the communicative connection, the second instructions.

17. The method of claim **16**, wherein the instructions to locate the data structure corresponding to the controlled-access information comprise:
comparing a file extension of the data structure to a predefined set of file extensions.

18. The method of claim **14**, further comprising:
receiving, by the controller, a first encryption key to encrypt the data structure from the predefined host prior to the receipt of the first instruction.

19. The method of claim **14**, wherein the first instruction is received, by the controller, automatically.

20. The method of claim **14**, wherein:
the first instruction is received incident to an execution of an executable file stored on a same storage media as the second instructions; and
the second instructions to locate the data structure are based on a relative path between a location of the executable file and the data structure.

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