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(54) **PINNING DEVICE IDENTIFIERS TO CRYPTOGRAPHIC KEY PAIRS**

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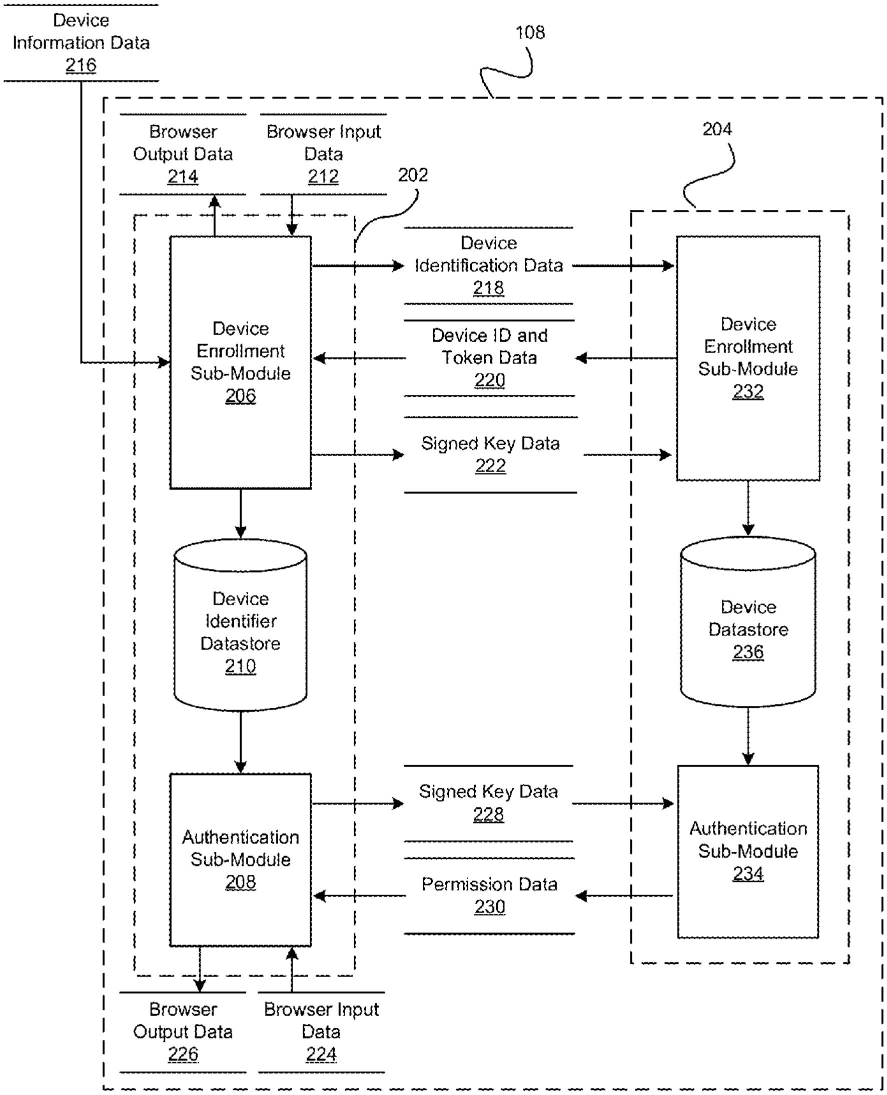
CPC ***H04L 63/0807*** (2013.01); ***G06F 21/56*** (2013.01); ***G06F 21/64*** (2013.01)

(57) **ABSTRACT**

In one embodiment, a method for authenticating a computer system is provided. The method includes: receiving, by a processor, device identifier information associated with the computer system; generating, by the processor, a device identifier and an enrollment token based on the device identifier information; communicating, by the processor, the device identifier and the enrollment token to the computer system; receiving, by the processor, key data in response to the communicating; and performing, by the processor, authentication of the computer system based on the key data.


Device Information Data 216
108
Browser Output Data 214
Browser Input Data 212
202
204
Device Identification Data 218
Device Enrollment Sub-Module 206
Device ID and Token Data 220
Device Enrollment Sub-Module 232
Signed Key Data 222
Device Identifier Datastore 210
Device Datastore 236
Signed Key Data 228
Authentication Sub-Module 208
Authentication Sub-Module 234
Permission Data 230
Browser Output Data 226
Browser Input Data 224

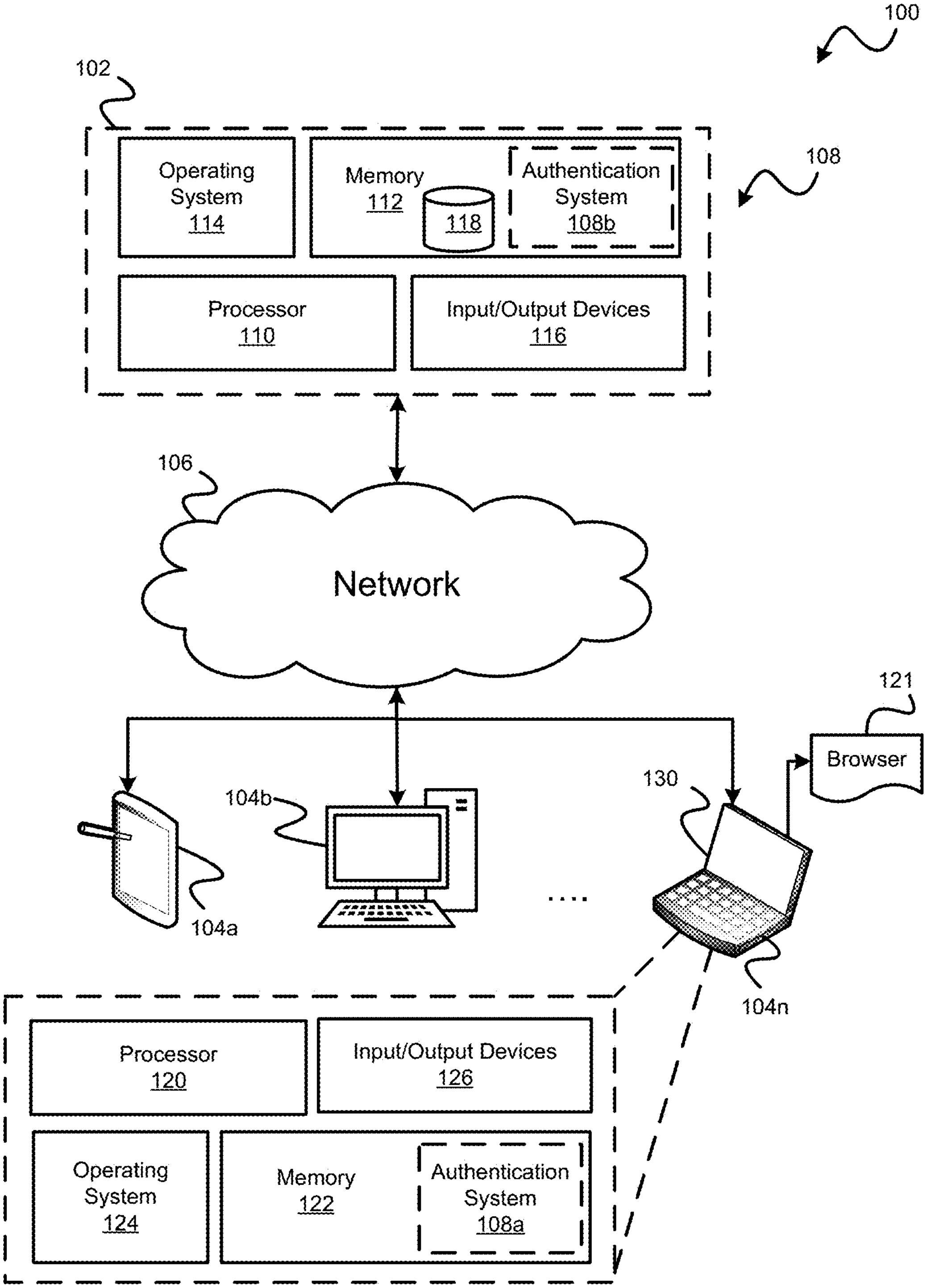

100
102
108
Operating System 114
Memory 112
118
Authentication System 108b
Processor 110
Input/Output Devices 116
106
Network
121
Browser
130
104b
104a
....
104n
Processor 120
Input/Output Devices 126
Operating System 124
Memory 122
Authentication System 108a

FIG. 1

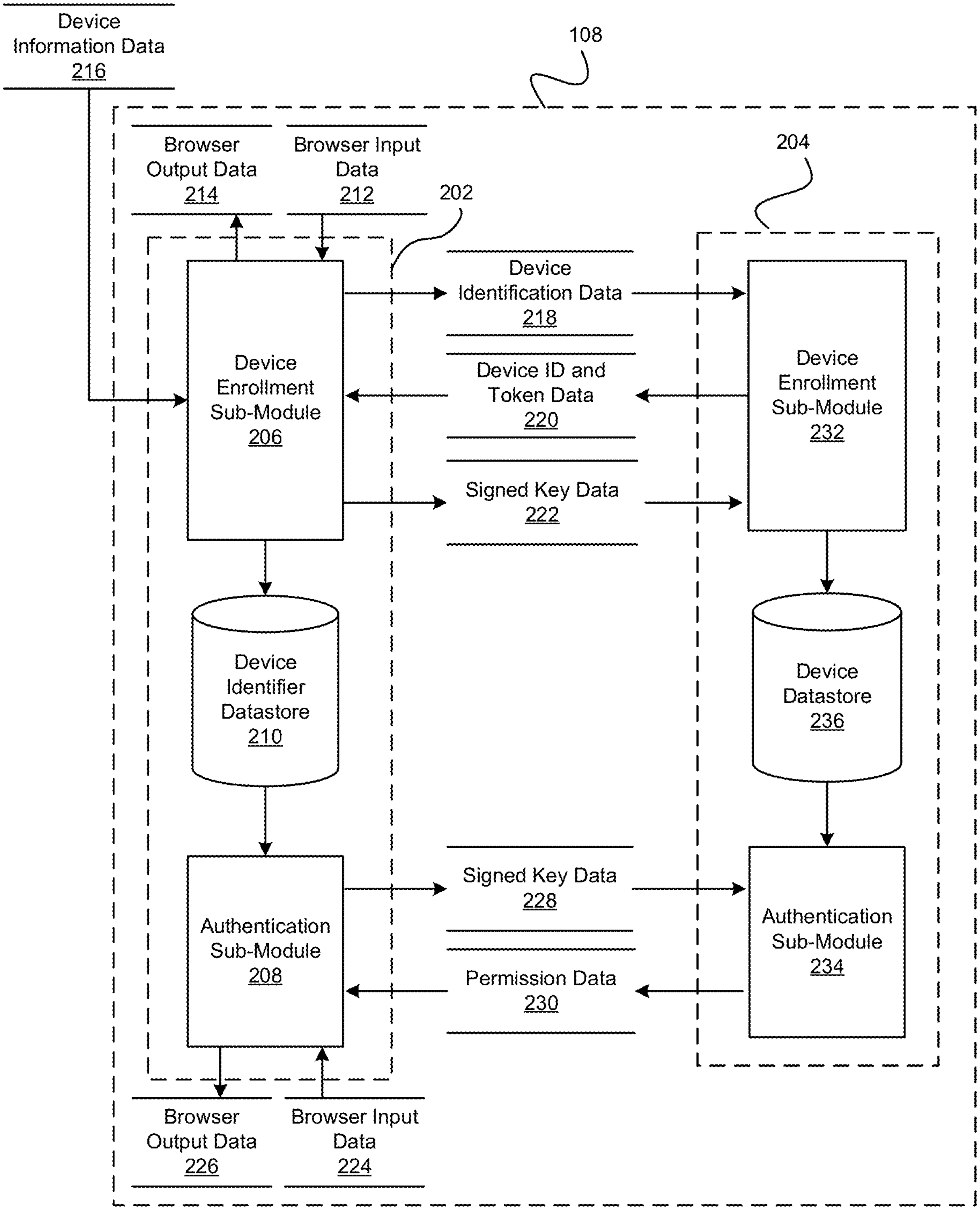

Device Information Data 216
108
Browser Output Data 214
Browser Input Data 212
202
204
Device Identification Data 218
Device Enrollment Sub-Module 206
Device ID and Token Data 220
Device Enrollment Sub-Module 232
Signed Key Data 222
Device Identifier Datastore 210
Device Datastore 236
Signed Key Data 228
Authentication Sub-Module 208
Permission Data 230
Authentication Sub-Module 234
Browser Output Data 226
Browser Input Data 224

FIG. 2

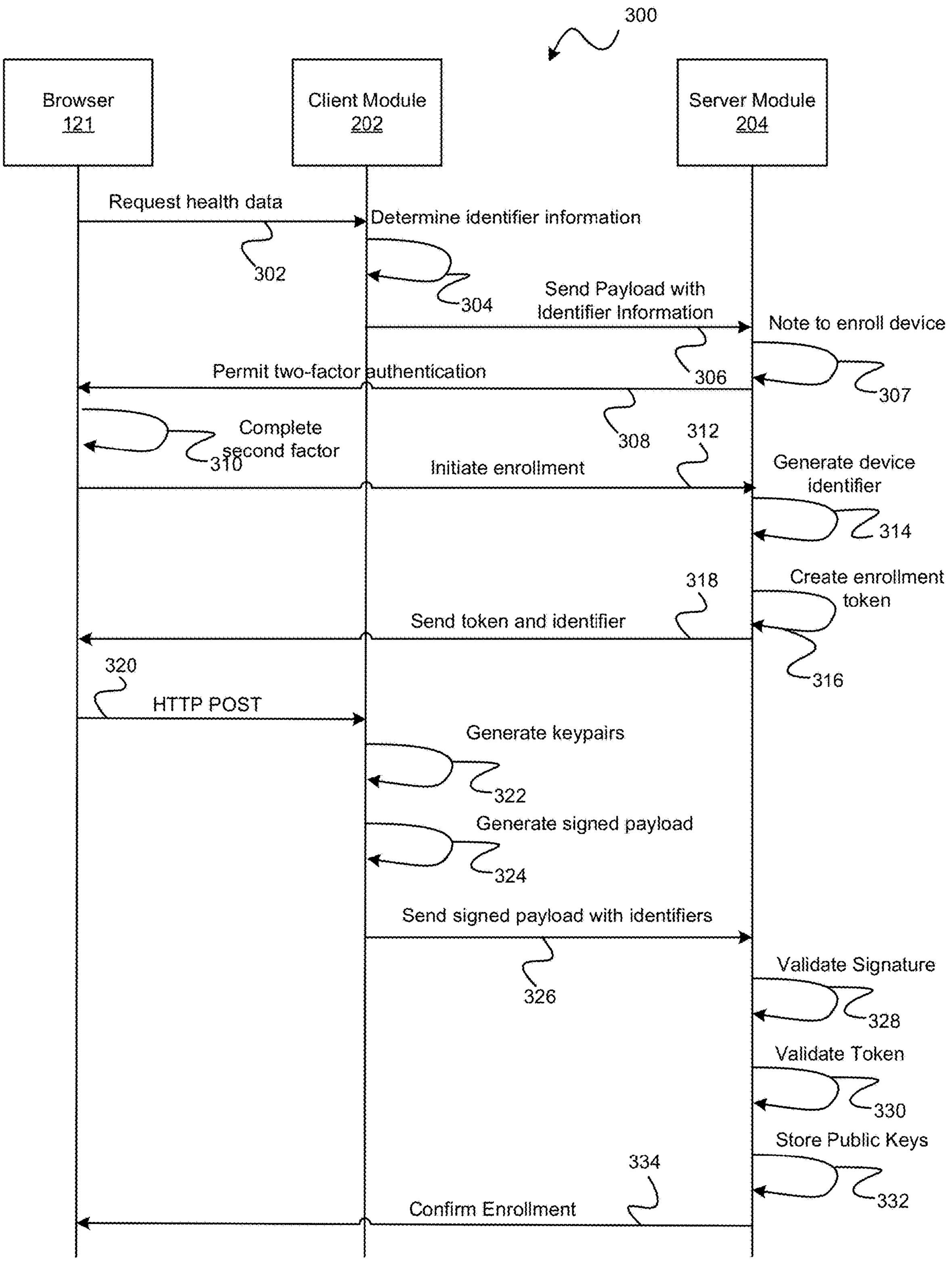

300
Browser
121
Client Module
202
Server Module
204
Request health data
302
Determine identifier information
304
Send Payload with
Identifier Information
306
Note to enroll device
307
Permit two-factor authentication
308
Complete
second factor
310
312
Initiate enrollment
Generate device
identifier
314
318
Create enrollment
token
316
Send token and identifier
320
HTTP POST
Generate keypairs
322
Generate signed payload
324
Send signed payload with identifiers
326
Validate Signature
328
Validate Token
330
Store Public Keys
332
334
Confirm Enrollment

FIG. 3

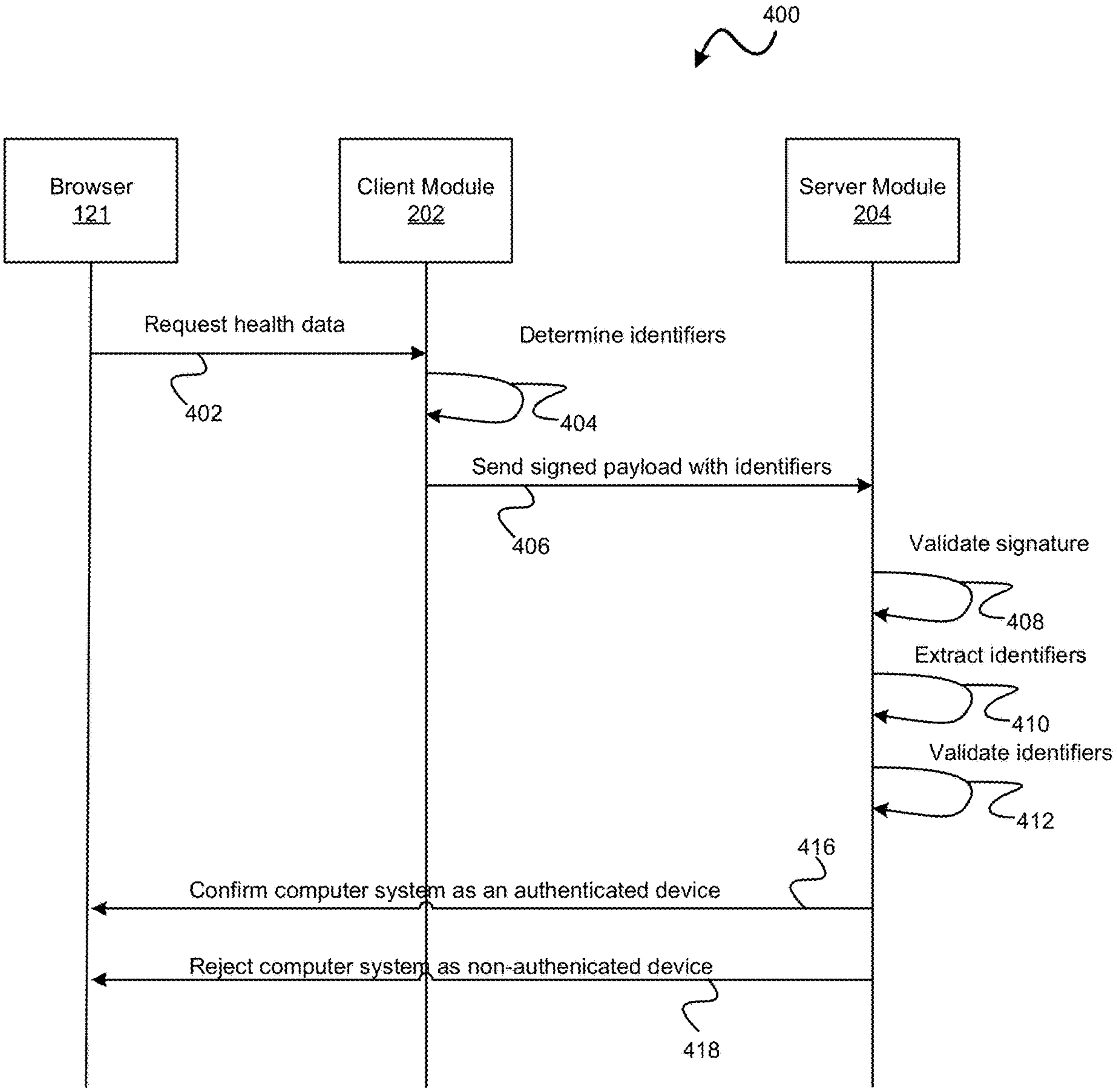

400
Browser
121
Client Module
202
Server Module
204
Request health data
402
Determine identifiers
404
Send signed payload with identifiers
406
Validate signature
408
Extract identifiers
410
Validate identifiers
412
416
Confirm computer system as an authenticated device
Reject computer system as non-authenicated device
418

FIG. 4

PINNING DEVICE IDENTIFIERS TO CRYPTOGRAPHIC KEY PAIRS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 63/553,552, filed Feb. 14, 2024, which is herein incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to security systems and more particularly to security systems for managing access to applications or services on devices.

BACKGROUND

[0003] Many service or application providers require a user to present authentication information in order to gain access to a specific service or application. For example, an employer may require an employee to enter a password or other authentication factor to access computer resources remotely. Many sensitive services and applications require multi-factor authentication. That is, a user provides multiple authenticators in order to gain access to a resource, service, and/or application. Authentication factors for individuals are generally categorized in three classes: something the user is (e.g., a biometric such as a fingerprint), something the user has (e.g., a security token), and something the user knows (e.g., a password). A typical security token may use a symmetric cryptography algorithm to provide authentication credentials. For example, the token and the verifying entity (e.g., a network server) may both maintain or generate the same value (e.g., using a particular algorithm and seed).

[0004] In some instances, an administrator may wish to limit access to the application or service to a particular subset of devices. In such instances, digital certificates including a security token may be sent to these machines, as a stamp of approval of the device, in order to manage access by the particular devices. However, depending on how these digital certificates and security tokens are managed, the information still has a potential to be spoofed by a user attempting to gain access to the applications or services on other devices.

[0005] Accordingly, it is desirable to provide improved methods and systems for managing access of applications or services on devices. Furthermore, other desirable features and characteristics of the present disclosure will become apparent from the subsequent detailed description and the appended claims, taken in conjunction with the accompanying drawings and the foregoing technical field and background.

DRAWINGS

[0006] In order that the disclosure may be well understood, there will now be described various forms thereof, given by way of example, reference being made to the accompanying drawings, in which:

[0007] FIG. **1** is a functional block diagram illustrating a computing system having an authentication system in accordance with various embodiments;

[0008] FIG. **2** is a dataflow diagram illustrating an example an authentication system in accordance with various embodiments; and

[0009] FIGS. **3** and **4** are sequence diagrams illustrating example registration and authentication processes that may be performed by the authentication system in accordance with various embodiments.

DESCRIPTION OF EXAMPLE EMBODIMENTS

[0010] The following description is merely exemplary in nature and is not intended to limit the present disclosure, application, or uses. It should be understood that throughout the drawings, corresponding reference numerals indicate like or corresponding parts and features. As used herein, the term “module” refers to any hardware, software, firmware, electronic control component, processing logic, and/or processor device, individually or in any combination, including without limitation: application specific integrated circuit (ASIC), a field-programmable gate-array (FPGA), an electronic circuit, a processor (shared, dedicated, or group) and memory that executes one or more software or firmware programs, a combinational logic circuit, and/or other suitable components that provide the described functionality.

Overview

[0011] According to various embodiments, systems, methods, and computer program products are provided for authenticating a computer system. A method includes: receiving, by a processor, device identifier information associated with the computer system; generating, by the processor, a device identifier and an enrollment token based on the device identifier information; communicating, by the processor, the device identifier and the enrollment token to the computer system; receiving, by the processor, key data in response to the communicating; and performing, by the processor, authentication of the computer system based on the key data.

[0012] Another method includes determining, by a processor, device identifier information associated with the computer system; receiving, by the processor, a device identifier and an enrollment token based on the device identifier information; generating, by the processor, key data based on the device identifier and the enrollment token using cryptography; and performing, by the processor, authentication of the computer system based on the key data.

EXAMPLE EMBODIMENTS

[0013] With reference to FIG. **1**, an exemplary computer environment is shown generally at **100** having a server system **102** including one or more servers that are communicatively coupled to one or more computer systems **104***a*-**104***n* (generally referred to as the computer system **104**) through a network **106**. The computer environment **100** is shown having an authentication system shown generally at **108** in accordance with various embodiments. As can be appreciated, elements of the authentication system **108** disclosed herein may be located on one or more of the computer systems **104***a*-**104***n,* located on the server system **102**, located on a device or node of the network **106**, or distributed between any of the server system **102**, the one or more computer systems **104***a*-**104***n,* and one or more devices or nodes of the network **106**. For exemplary purposes, the disclosure will be discussed in the context of the authentication system **108** being implemented on the server system **102** and the computer system **104**, for example, as a client-server based authentication system **108** having an authentication system **108***a* and an authentication system **108***b*.

[0014] In various embodiments, the server system **102** stores and makes available services or applications to users of the computer environment **100**. These services or applications may provide secured data or other important information that requires security clearance before accessing. The server system **102** generally operates with any sort of conventional processing hardware, including, but not limited to, at least one processor **110**, memory **112**, an operating system **114**, an input/output device **116**, and a database **118** that stores the services, applications, and/or secured data.

[0015] The processor **110** may be implemented using any suitable processing system, such as one or more processors, controllers, microprocessors, microcontrollers, processing cores and/or other computing resources spread across any number of distributed or integrated systems, including any number of "cloud-based" or other virtual systems. The memory **112** represents any non-transitory short-or long-term storage or other computer-readable media capable of storing programming instructions for execution on the processor **110**, including any sort of random access memory (RAM), read only memory (ROM), flash memory, magnetic or optical mass storage, and/or the like. The computer-executable programming instructions, when read and executed by the processor **110**, cause the processor **110** to create, generate, or otherwise facilitate access to the secured data and perform one or more additional tasks, operations, functions, and/or processes described herein. In various embodiments, the memory **112** includes the database **118** that stores secured data associated with the applications or services.

[0016] As can be appreciated, the memory **112** represents one suitable implementation of such computer-readable media, and alternatively or additionally, the processor **110** could receive and cooperate with external computer-readable media that is realized as a portable or mobile component or application platform, e.g., a portable hard drive, a USB flash drive, an optical disc, or the like. The memory **112** may further store the authentication system **108** (e.g., authentication system **108***b*) in various embodiments.

[0017] The operating system **114** includes computer-executable programming instructions, when read and executed by the processor **110**, cause the processor **110** to operate the server system's basic functions such as scheduling tasks, executing applications, memory allocation, and controlling the input/output devices **116**. The input/output devices **116** generally represents the interface(s) to networks (e.g., to the network **106**, or any other local area, wide area, or other network), mass storage, display devices, data entry devices, and/or the like.

[0018] In various embodiments, the network **106** generally includes interconnected network nodes that are arranged according to one or more of a variety of network topologies and that are configured to communicate data according to one or more communication protocols. The network nodes can include, for example, network interface controllers, repeaters, hubs, bridges, switches, routers, firewalls, modems, etc. The network nodes may be interconnected based on physically wired, optical, and/or wireless radio-frequency topologies.

[0019] The computer system **104** generally includes any sort of personal computer, workstation, mobile telephone, tablet, or other network-enabled client device on the network **106**. The computer system **104** generally operates with any sort of conventional processing hardware, including but not limited to, at least one processor **120**, memory **122**, an operating system **124**, an input/output device **126**. The processor **120** may be implemented using any suitable processing system, such as one or more processors, controllers, microprocessors, microcontrollers, processing cores and/or other computing resources spread across any number of distributed or integrated systems, including any number of "cloud-based" or other virtual systems.

[0020] The memory **122** represents any non-transitory short-or long-term storage or other computer-readable media capable of storing programming instructions for execution on the processor **120**, including any sort of random access memory (RAM), read only memory (ROM), flash memory, magnetic or optical mass storage, and/or the like. The computer-executable programming instructions, when read and executed by the processor, cause the processor to create, generate, or otherwise facilitate the operations, functions, and/or processes described herein. It should be noted that the memory **122** represents one suitable implementation of such computer-readable media, and alternatively or additionally, the processor **120** could receive and cooperate with external computer-readable media that is realized as a portable or mobile component or application platform, e.g., a portable hard drive, a USB flash drive, an optical disc, or the like. The memory **122** may further store the authentication system **108** (e.g., authentication system **108***a*) in various embodiments.

[0021] The operating system **124** includes computer-executable programming instructions, when read and executed by the processor **120**, cause the processor **120** to operate the computer system's basic functions such as scheduling tasks, executing applications, memory allocation, and controlling input/output devices. The input/output device generally represents the interface(s) to networks (e.g., to the network **106**, or any other local area, wide area, or other network), mass storage, display devices, data entry devices and/or the like.

[0022] In an exemplary embodiment, the computer system **104** includes or communicates with a display device **130**, such as a monitor, screen, or another conventional electronic display capable of presenting application or service related content retrieved from the server system **102** or other internet device via the network **106**.

[0023] According to a typical use case, a user operates a conventional browser **121** or other client program such as an application executed by the computer system **104** to contact the server system **102** for access to an application or service via the network **106** using a networking protocol, such as the hypertext transport protocol (HTTP) or the like. The client-based authentication system **108***a* then communicates with the server-based authentication system **108***b* to coordinate secured access associated with the user and the specific computer system **104** (e.g., **104***n*). As will be discussed in more detail, the secured access process includes an improved pre-authentication trust check of the computer system **104** that is based on data established during a registration process.

[0024] With reference now to FIG. **2** and with continued reference to FIG. **1**, a dataflow diagram illustrates the authentication system **108** in accordance with various embodiments. As can be appreciated, various exemplary embodiments of the authentication system **108**, according to the present disclosure, may include any number of modules and/or sub-modules. In various exemplary embodiments, the modules and sub-modules shown in FIG. **2** may be combined and/or further partitioned to enable secure access to applications and services. In various embodiments, the authentication system **108** includes a client module **202** that, for example, may be implemented as part of the authentication system **108***a* and a server module **204** that, for example, may be implemented as part of the authentication system **108***b*.

[0025] In various embodiments, the client module **202** includes a device enrollment sub-module **206**, an authentication sub-module **208**, and a device identifier datastore **210**. The device enrollment sub-module **206** enrolls with the server module **204** any first-time computer systems **104** (e.g., computer system **104***n*) as a new device. For example, the device enrollment sub-module **206** interacts with a user of the computer system **104** by communicating data to and from the browser **121** through browser input data **212** and browser output data **214**. Upon receipt of the browser input data **212** from the browser indicating that health data has been requested, the device enrollment sub-module **206** obtains device identification data **216** associated with the particular computer system **104** and any other device health information and stores the data in the device identifier datastore **210**.

[0026] For example, the computer systems **104** generally have a notion of primary identifiers and secondary identifiers. The primary identifiers are fairly static, and the secondary identifiers are somewhat mutable and typically associate with a single primary identifier. The following table illustrates exemplary primary and secondary device identifiers that may be collected from the computer system **104** in various embodiments.

TABLE 1

Name	Description	Priority	Source
machine_guid	Unique identifier of the client machine. (Windows/Linux)	primary	Device Operating System (OS)
computer_sid	Security identifier of the computer.	secondary	Mobile Device Management (MDM)
domain_sid	Domain identifier of the computer.	n/a	MDM
hardware_uuid	Hardware identifier of the computer. (MacOS)	Primary	Device
intune_id	Intune identifier.	secondary	MDM
amp_guid	Advanced malware protection identifier.	secondary	Endpoint information

[0027] The device enrollment sub-module **206** communicates the device identification data **216** to the server module **204** as device identification data **218**. In response, if the computer system **104** is not yet enrolled as a device, the device enrollment sub-module **206** receives a one-time registration token and a device identifier (ID) from the server module **204**. For example, the one-time registration token and a device identifier (ID) are received as the device ID and token data **220**. The device enrollment sub-module **206** generates keypairs from the information. Each keypair can include a public key and a private key that is generated using, for example, cryptography. The keypair for the device identifier is stored in the device identifier datastore **210** and any subsequent enrollment on this computer system **104** will not generate a new device keypair. This ensures one consistent record is maintained to tie the identifiers of the computer system **104** to the computer system itself, regardless of how many users share it.

[0028] The device enrollment sub-module **206** communicates the public key signed with the private key to the server module **204** as signed key data **222**.

[0029] After enrollment of the computer system **104** as a new device, the authentication sub-module **208** authenticates subsequent uses of the computer system **104** by a user. For example, the authentication sub-module **208** interacts with a user of the computer system **104** via communicating data to and from the browser **121** through browser input data **224** and browser output data **226**. Upon receipt of browser input data **224** from the browser **121** indicating that health data has been requested, the authentication sub-module **208** obtains from the device identifier datastore **210** the device identifier data associated with the particular computer system **104**. The authentication sub-module **208** generates the key data for the user and communicates key data including the public key associated with the device identifier and the public key associated with the user to the server module **204**, as for example, signed key data **228** that is signed with a private key.

[0030] In response, the authentication sub-module **208** receives permission data **230**. The permission data **230** includes an indication of whether the server module **204** grants access to the application or service. The authentication sub-module **208** communicates the status of the permission data **230** to the browser **121** via the browser output data **226**.

[0031] The server module **204** includes a device enrollment sub-module **232**, an authentication sub-module **234**, and a device datastore **236**. The device enrollment sub-module **232** receives the device identification data **218** and begins enrollment by generating a server specific identifier for the device and a one-time enrollment token. The device enrollment sub-module **232** communicates the device identifier and the token as the device ID and token data **220**. In response, the device enrollment sub-module **232** receives the signed key data **222** and enrolls the computer system **104** as a new device by validating the signature from the signed key data **222**, validating the associated token from the signed key data **222**, and storing the public key in the device datastore **236**.

[0032] The authentication sub-module **234** receives this signed key data **228** and authenticates the user and the device by validating the signature from the signed key data **228**, validating the identifier of the device, and storing the public keys. When the validation is successful, the authentication sub-module **234** generates the permission data **230** granting access to the application or service. When the validation is not successful, the authentication sub-module **234** generates permission data **230** indicating that access to the application or service is denied.

[0033] In various other embodiments, the server module **204** may communicate the permission data **230** directly to the browser **121** instead of communicating to the browser **121** through the client module **202**.

[0034] With reference now to FIGS. **3** and **4** and with continued reference to FIGS. **1-2**, sequence diagrams illustrate example methods or processes **300**, **400** for authenticating a user and a computer system in accordance with various embodiments. As can be appreciated in light of the disclosure, the order of operations performed by the processes **300**, **400** is not limited to the sequential execution as illustrated in FIGS. **3**, **4** but may be performed in one or more varying orders as applicable and in accordance with the present disclosure. In various embodiments, the processes **300**, **400** can be scheduled to run based on one or more predetermined events or run automatically based on an occurrence of one or more events.

[0035] In one example, the process **300** may be performed to initially enroll the computer system **104** as a trusted device via the browser **121**, the client module **202**, and the server module **204**. In various embodiments, the enrollment is performed without administrator action and occurs automatically during the first time a user completes a two-factor authentication process. For example, during the two-factor authentication process a user authenticates with their first factor via the browser **121** and is sent to a device health check screen in the browser **121** and the process **300** begins.

[0036] The browser **121** initiates the device health check by requesting a collection of device health data, including any identifier information of the computer system **104** at **302**. The client module **202** determines the device identification information at **304**. The client module **202** communicates the device health data including the device identification information as a payload to the server module **204** at **306**. The server module **204** notes that the payload is in the same format as the current health data payload (i.e., not a signed payload by checking the absence or presence of a signature) and that enrollment should be triggered after the two-step authentication completes at **307**.

[0037] The server module **204** then sends confirmation to the browser **121** that that the second factor of authentication may proceed at **308**. The browser **121** then completes the second factor of authentication at **310**.

[0038] Once two-step authentication successfully completes, but before the user is sent to the protected application or service, the browser **121** notifies the server module **204** at **312** that enrollment for the computer system **104** can begin.

[0039] The server module **204** then begins enrollment by generating a server specific identifier for the computer system **104** based on the device information at **314**. The server module **204** then generates a one-time enrollment token at **316**. The server module **204** communicates the device identifier and the token to the browser **121** at **318**. The browser **121**, at **320**, forwards the identifier and the token via, for example, a HTTP(s) POST with the information needed to correlate a keypair to this user on this specific computer system.

[0040] The client module **202** receives the data, then generates the cryptographic keypairs for the user and the computer system **104** as a whole and stores the private keys in the device identifier datastore **210** at **322**. A payload is created including the public keys and identifiers to tie the user and the computer system to the private keys at **324**.

[0041] Once the private keys and other information is stored successfully in the datastore, the payload is signed and communicated to the server authentication module at **326**.

[0042] The signature of the signed payload is validated against the public keys provided in the payload at **328**. If the device identifier has not already been enrolled, the enrollment request passes the policy check of whether or not this device identifier has been used before and validation is completed at **328**. The token is validated at **330** and the public keys are stored at **332**.

[0043] Thereafter, the user has successfully completed device health automatic enrollment and, the server module **204** communicates a confirmation of the enrollment to the browser **121** at **334** so that all subsequent authentications will be able to use a signed data payload. Thereafter, the process **300** ends and the applications or services can be made available to the user.

[0044] As can be appreciated, in various other embodiments, enrollment may be initiated manually by, for example, an administrator through a browser or a user interface of an administrative application. For example, the request for health data for one or more computer systems **104** may be initiated by the administrator.

[0045] With reference now to FIG. **4**, the sequence diagram illustrates a process **400** for subsequent authentication of the user and the computer system **104** using the stored information from the enrollment process **300**.

[0046] For example, the browser **121** initiates the device health check by requesting a collection of device health data at **402**. The client module **202** determines the device identifier at **404**. The client module **202** communicates a signed payload including the device identifier to the server module **204** at **406**.

[0047] The signature of the payload is validated at **408**. The device identifier in the payload is extracted at **410** and validated at **412** by comparing the identifier with the stored identifier.

[0048] The server module **204** communicates a confirmation or rejection of the authentication of the computer system **104** to the browser **121** at **416** or **418**, respectively. Thereafter, the process **400** ends and the applications or services can be made available to the user.

[0049] As used herein, the phrase at least one of A, B, and C should be construed to mean a logical (A OR B OR C), using a non-exclusive logical OR, and should not be construed to mean "at least one of A, at least one of B, and at least one of C."

[0050] In this application, the term "controller" and/or "module" may refer to, be part of, or include: an Application Specific Integrated Circuit (ASIC); a digital, analog, or mixed analog/digital discrete circuit; a digital, analog, or mixed analog/digital integrated circuit; a combinational logic circuit; a field programmable gate array (FPGA); a processor circuit (shared, dedicated, or group) that executes code; a memory circuit (shared, dedicated, or group) that stores code executed by the processor circuit; other suitable hardware components (e.g., op amp circuit integrator as part of the heat flux data module) that provide the described functionality; or a combination of some or all of the above, such as in a system-on-chip.

[0051] The term memory is a subset of the term computer-readable medium. The term computer-readable medium, as used herein, does not encompass transitory electrical or electromagnetic signals propagating through a medium (such as on a carrier wave); the term computer-readable medium may therefore be considered tangible and non-transitory. Non-limiting examples of a non-transitory, tangible computer-readable medium are nonvolatile memory circuits (such as a flash memory circuit, an erasable programmable read-only memory circuit, or a mask read-only circuit), volatile memory circuits (such as a static random access memory circuit or a dynamic random access memory circuit), magnetic storage media (such as an analog or digital magnetic tape or a hard disk drive), and optical storage media (such as a CD, a DVD, or a Blu-ray Disc).

[0052] The apparatuses and methods described in this application may be partially or fully implemented by a special purpose computer created by configuring a general-purpose computer to execute one or more particular functions embodied in computer programs. The functional blocks, flowchart components, and other elements described above serve as software specifications, which can be translated into the computer programs by the routine work of a skilled technician or programmer.

[0053] The description of the disclosure is merely exemplary in nature and, thus, variations that do not depart from the substance of the disclosure are intended to be within the scope of the disclosure. Such variations are not to be regarded as a departure from the spirit and scope of the disclosure.

What is claimed is:

1. A method for authenticating a computer system, comprising:

receiving, by a processor, device identifier information associated with the computer system;

generating, by the processor, a device identifier and an enrollment token based on the device identifier information;

communicating, by the processor, the device identifier and the enrollment token to the computer system;

receiving, by the processor, key data in response to the communicating; and

performing, by the processor, authentication of the computer system based on the key data.

2. The method of claim **1**, wherein the device identifier information includes at least one of a unique machine identifier, a security identifier of the computer system, a domain identifier, a hardware identifier, an intune identifier, and an advanced malware protection identifier.

3. The method of claim **1**, wherein the device identifier information is received in response to a completion of a first factor authentication of a two-factor authentication.

4. The method of claim **3**, wherein the generating the device identifier and the enrollment token is performed in response to a completion of a second factor authentication of the two-factor authentication.

5. The method of claim **1**, further comprising determining that enrollment of the computer system is needed based on an absence or a presence of a signature associated with the device identifier information.

6. The method of claim **5**, further comprising enrolling the computer system as a secure device based on the key data.

7. The method of claim **6**, wherein the enrolling is based on a validation of the enrollment token extracted from the key data.

8. The method of claim **1**, wherein the key data is generated using cryptography.

9. The method of claim **1**, wherein the key data includes a key associated with the device identifier and a keypair associated with a user.

10. The method of claim **9**, further comprising performing authentication of the user based on the key data.

11. A method for authenticating a computer system, comprising:

determining, by a processor, device identifier information associated with the computer system;

receiving, by the processor, a device identifier and an enrollment token based on the device identifier information;

generating, by the processor, key data based on the device identifier and the enrollment token using cryptography; and

performing, by the processor, authentication of the computer system based on the key data.

12. The method of claim **11**, wherein the device identifier information includes at least one of a unique machine identifier, a security identifier of the computer system, a domain identifier, a hardware identifier, an intune identifier, and an advanced malware protection identifier.

13. The method of claim **11**, further comprising completing a first factor authentication of a two-factor authentication, and wherein the determining the device identifier information is in response to the completing.

14. The method of claim **13**, further comprising completing a second factor authentication of the two-factor authentication, and wherein the receiving the device identifier and the enrollment token is in response to the completing of the second factor authentication of the two-factor authentication.

15. The method of claim **14**, further comprising enrolling the computer system as a secure device based on the key data.

16. The method of claim **15**, wherein the key data includes a public key generated from the enrollment token and the device identifier information.

17. The method of claim **11**, wherein the key data is generated using cryptography.

18. The method of claim **11**, wherein the key data includes key data associated with the device identifier and a key data associated with a user.

19. The method of claim **18**, further comprising performing authentication of the user based on the key data.

20. A system for authenticating a computer system, comprising:

one or more processors; and

at least one of a first computer-readable storage medium and a second computer-readable storage medium,

the first computer-readable storage medium storing instructions which, when executed by the one or more processors, cause the one or more processors to:

receive device identifier information associated with the computer system;

generate a device identifier and an enrollment token based on the device identifier information;

communicate the device identifier and the enrollment token to the computer system;

receive key data in response to the communicating; and

perform authentication of the computer system based on the key data; and

the second computer-readable storage medium storing instructions which, when executed by the one or more processors, cause the one or more processors to:

determine the device identifier information associated with the computer system;

receive the device identifier and the enrollment token based on the device identifier information;

generate the key data based on the device identifier and the enrollment token using cryptography; and

perform the authentication of the computer system based on the key data.

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