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(54) **CROSS-PLATFORM SINGLE SIGN-ON ACCESSIBILITY OF A PRODUCTIVITY APPLICATION WITHIN A SOFTWARE AS A SERVICE PLATFORM**

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(60) Provisional application No. 62/385,832, filed on Sep. 9, 2016.

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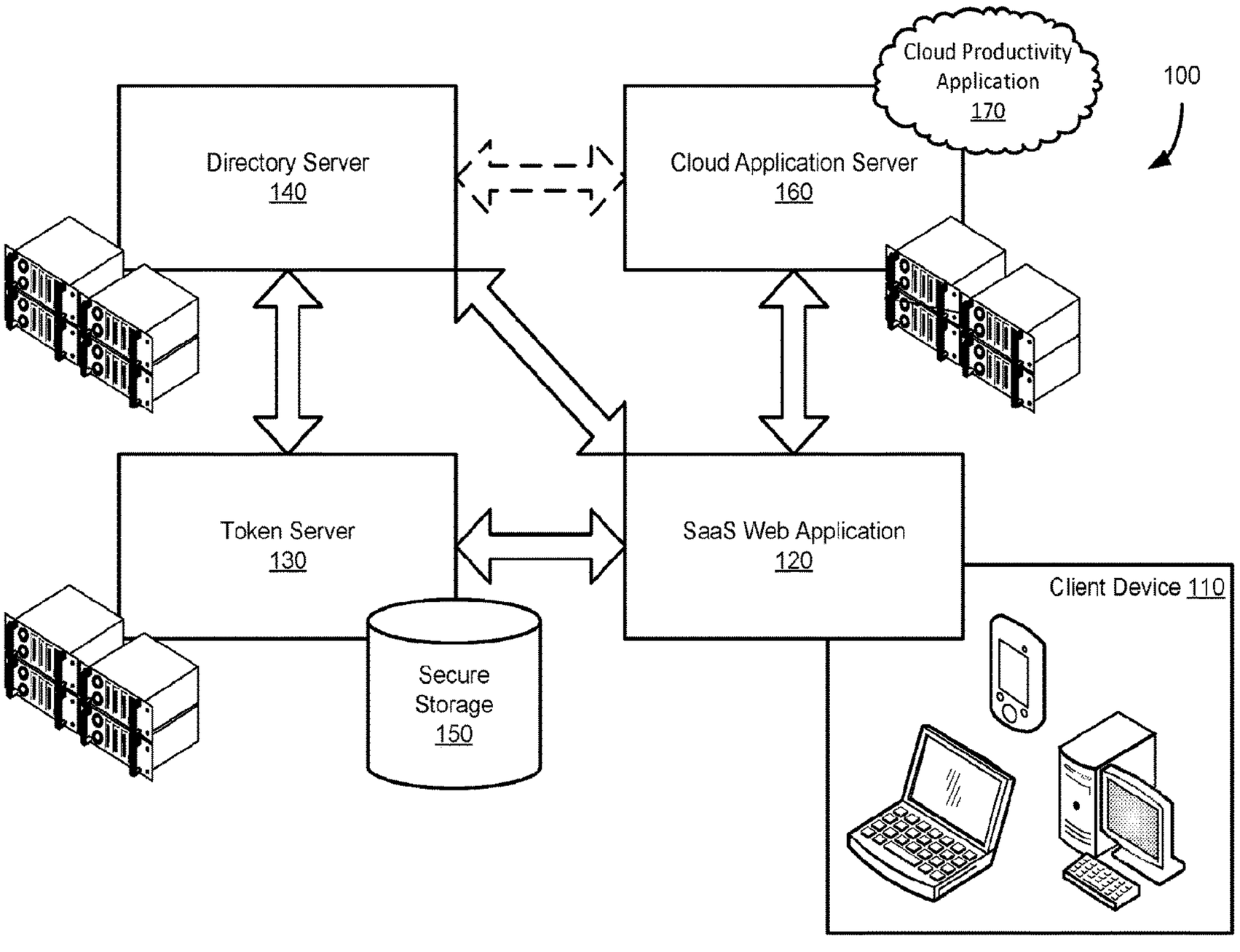
(52) **U.S. Cl.**

CPC ***H04L 63/0815*** (2013.01); ***H04L 63/0807*** (2013.01); ***G06Q 10/10*** (2013.01); ***H04L 63/0884*** (2013.01)

(57) **ABSTRACT**

A Cross-Platform Single Sign On (CP-SSO) experience is provided herein to enable users to access multiple services via a single login when working across different platforms. A user may work across different platform when using multiple devices, when using multiple browsers on a single device, or when an integrated application requires a separate login for access within a host web application or portal service. A proxy token service manages login requests and authentication tokens after a given service has been logged into once by a user, so that the user does not need to provide login credentials on subsequent requests for the given service. By enabling a CP-SSO experience, network efficiency is improved, and the user experience is also improved as users do not need to supply authentication credentials as frequently and may freely choose to use multiple platforms instead of limiting usage to a single platform.



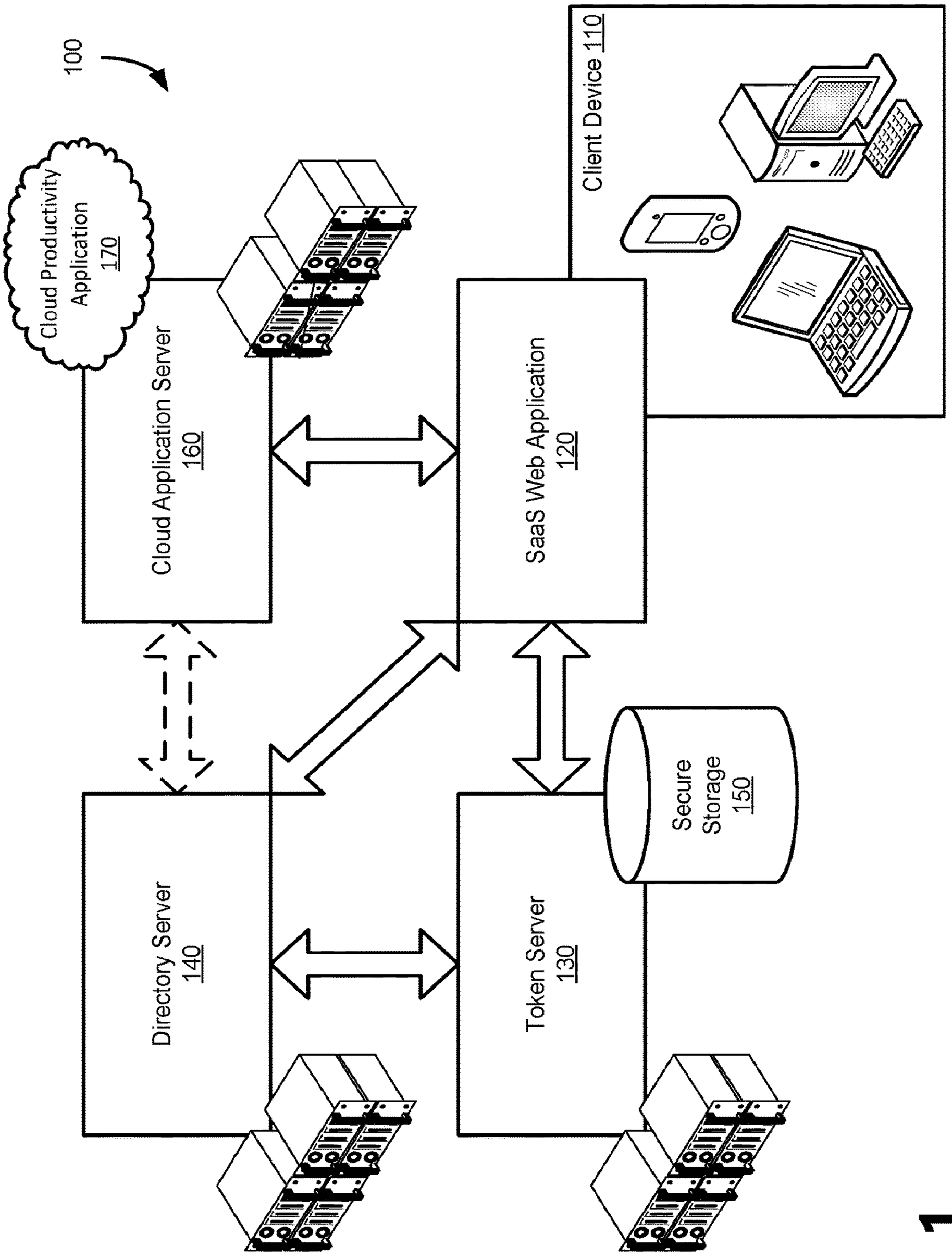

100
Client Device 110
Cloud Productivity Application 170
Cloud Application Server 160
SaaS Web Application 120
Secure Storage 150
Directory Server 140
Token Server 130

FIG. 1

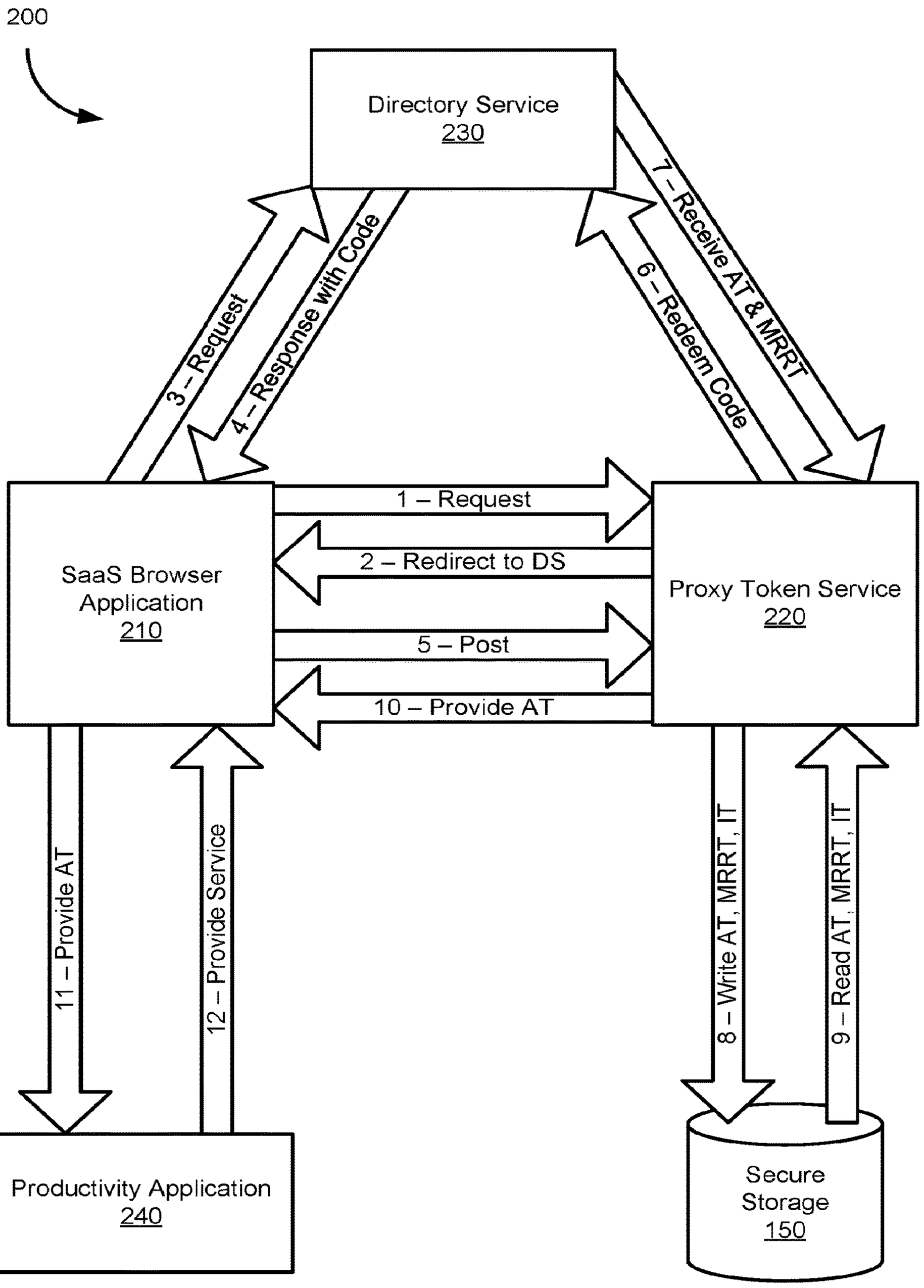

200
Directory Service
230
3 – Request
4 – Response with Code
7 – Receive AT & MRRT
6 – Redeem Code
SaaS Browser
Application
210
1 – Request
2 – Redirect to DS
5 – Post
10 – Provide AT
Proxy Token Service
220
11 – Provide AT
12 – Provide Service
8 – Write AT, MRRT, IT
9 – Read AT, MRRT, IT
Productivity Application
240
Secure
Storage
150

FIG. 2

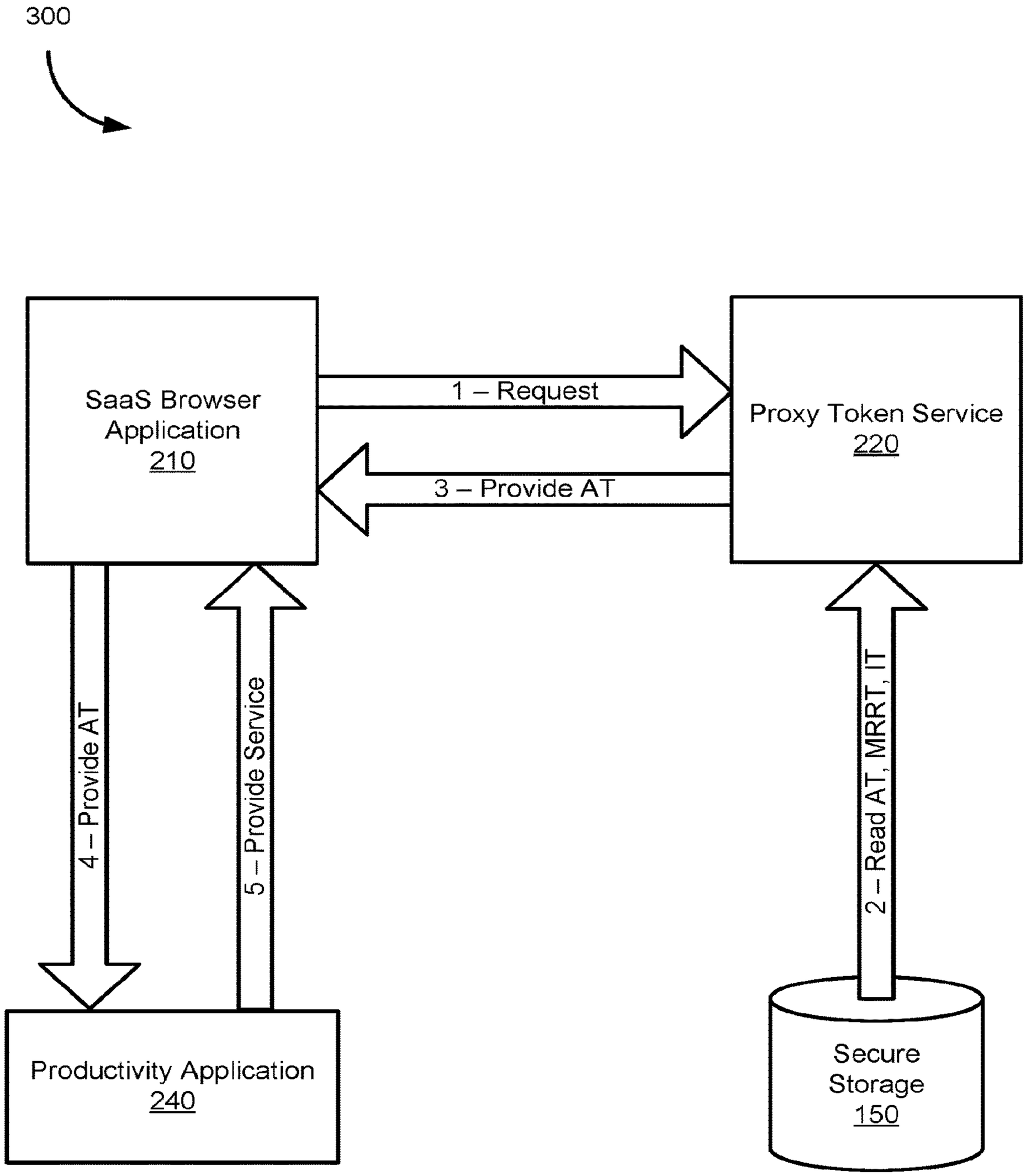

300
SaaS Browser Application 210
Proxy Token Service 220
1 – Request
3 – Provide AT
4 – Provide AT
5 – Provide Service
2 – Read AT, MRRT, IT
Productivity Application 240
Secure Storage 150

FIG. 3

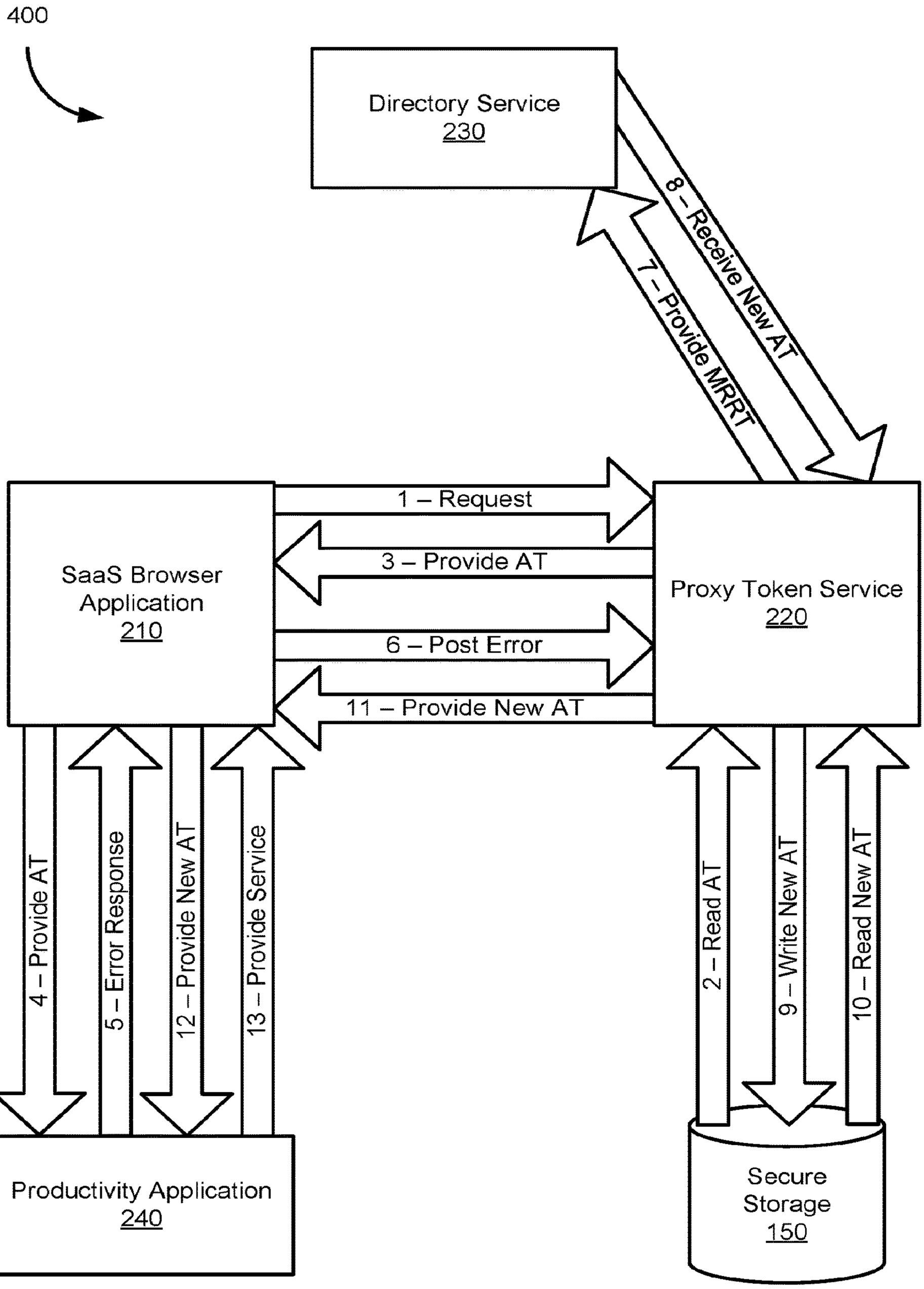

400
Directory Service
230
8 – Receive New AT
7 – Provide MRRT
SaaS Browser
Application
210
1 – Request
3 – Provide AT
6 – Post Error
11 – Provide New AT
Proxy Token Service
220
4 – Provide AT
5 – Error Response
12 – Provide New AT
13 – Provide Service
2 – Read AT
9 – Write New AT
10 – Read New AT
Productivity Application
240
Secure
Storage
150

FIG. 4

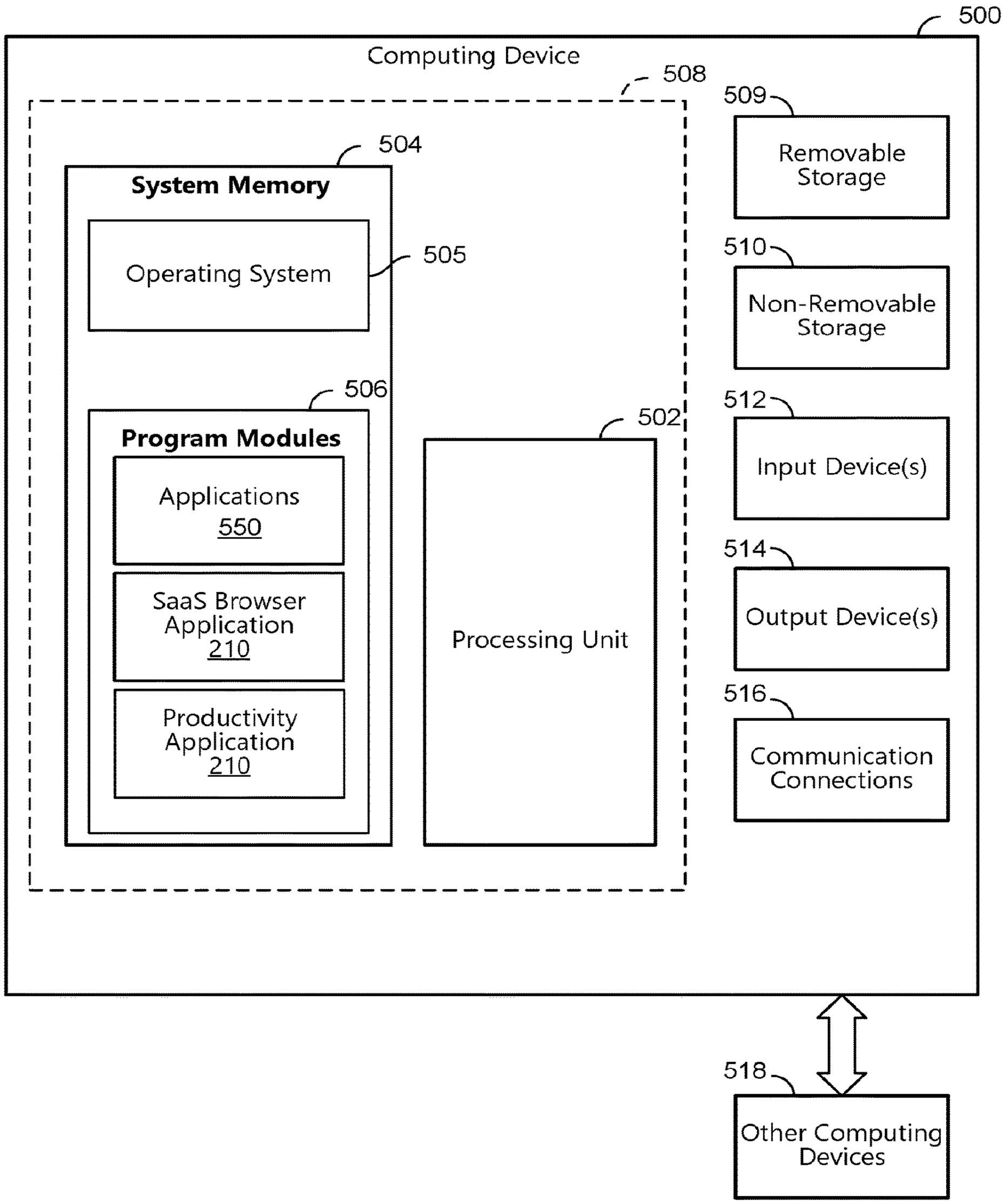
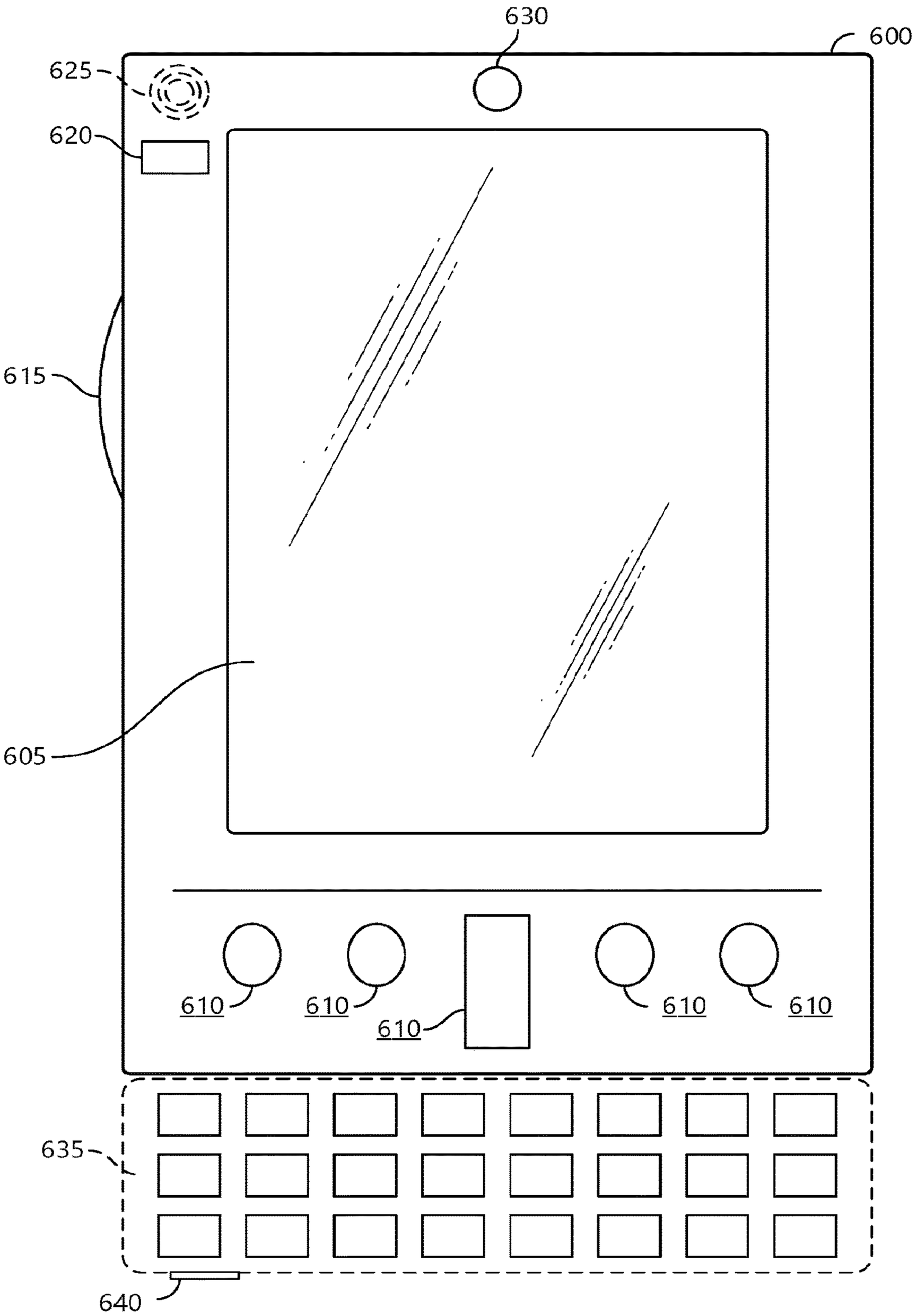

500
Computing Device
508
504
System Memory
Operating System
505
506
Program Modules
Applications
550
SaaS Browser
Application
210
Productivity
Application
210
502
Processing Unit
509
Removable
Storage
510
Non-Removable
Storage
512
Input Device(s)
514
Output Device(s)
516
Communication
Connections
518
Other Computing
Devices

FIG. 5



MOBILE COMPUTING DEVICE

FIG. 6A

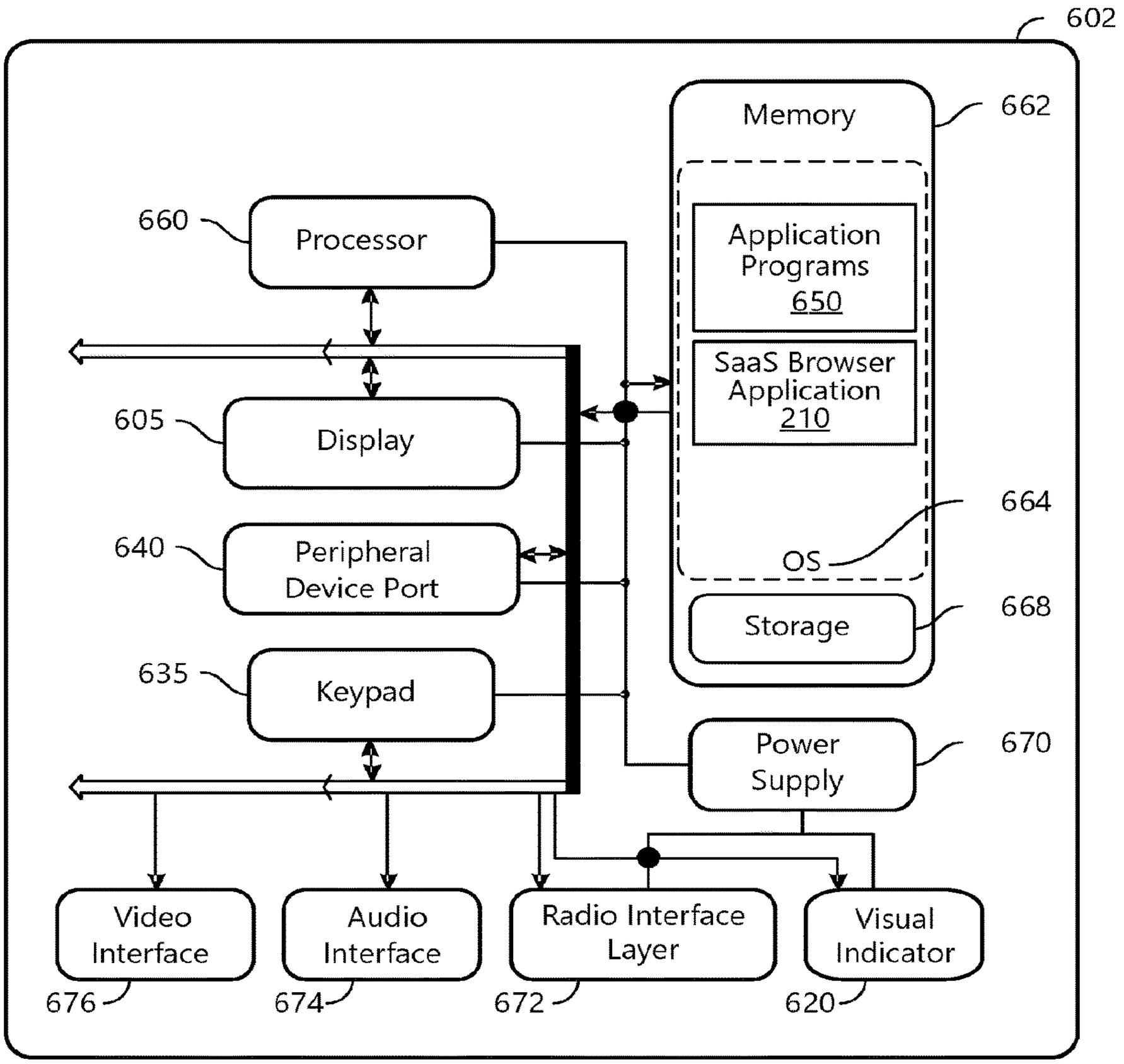

602
Memory
662
660
Processor
Application Programs 650
SaaS Browser Application 210
605
Display
664
OS
640
Peripheral Device Port
668
Storage
635
Keypad
Power Supply
670
Video Interface
Audio Interface
Radio Interface Layer
Visual Indicator
676
674
672
620

FIG. 6B

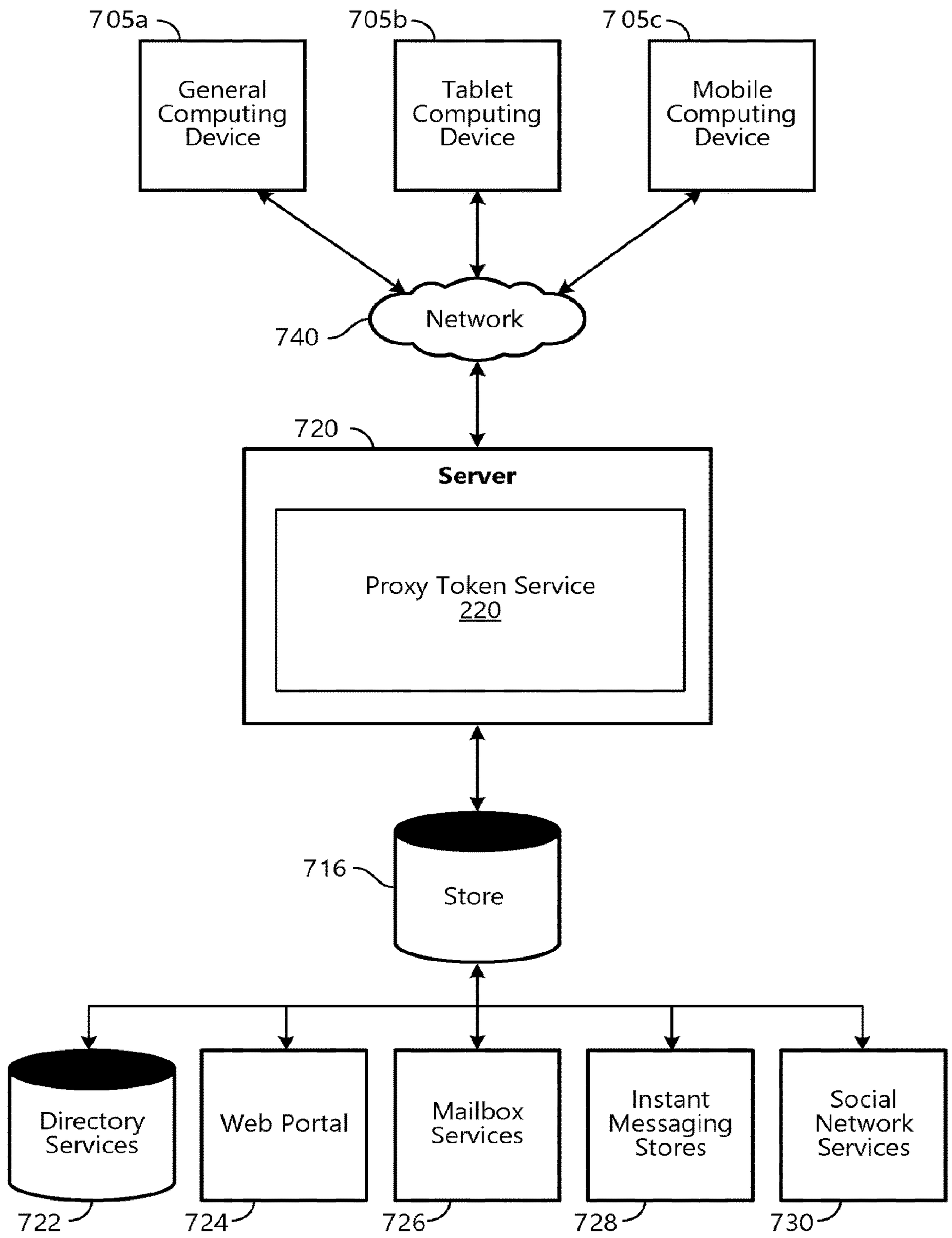

705a
General Computing Device
705b
Tablet Computing Device
705c
Mobile Computing Device
Network
740
720
Server
Proxy Token Service
220
716
Store
Directory Services
722
Web Portal
724
Mailbox Services
726
Instant Messaging Stores
728
Social Network Services
730

FIG. 7

CROSS-PLATFORM SINGLE SIGN-ON ACCESSIBILITY OF A PRODUCTIVITY APPLICATION WITHIN A SOFTWARE AS A SERVICE PLATFORM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 15/267,012 filed Sep. 15, 2016 which claims benefit of U.S. Provisional Patent Application No. 62/385,832 filed on Sep. 9, 2016, both titled "CROSS-PLATFORM SINGLE SIGN-ON ACCESSIBILITY OF A PRODUCTIVITY APPLICATION WITHIN A SOFTWARE AS A SERVICE PLATFORM," the entireties of which are hereby incorporated by reference.

BACKGROUND

[0002] When users access services on computer devices, they provide credentials to establish their identities with the service provider and thereby access the services. For example, a user may gain access to a social media account, an email server, an online productivity application, an online forum, an online bank account, an instant messenger service, etc., by providing a username and a shared secret, such as a password, biometric marker, a key, or a derived token. Some online services allow for a Single Sign On (SSO) experience, where a user provides a username and shared secret to for one service and may access a second service without resubmitting a username and shared secret. These SSO experiences are achieved either through an identity federation between services providers (agreeing to trust one another's authentications) or by maintaining a session-based authentication cookie for the user and an Identity Provider (Idp). In some aspects, a service provider is also an IdP, which may require its own authentication and authorization service to be used, which precludes the use of an SSO experience via an identity federation in some situations where the parties may not trust one another to provide secure logins. Similarly, authentication cookies are not platform agnostic, which precludes their use for providing an SSO experience in situations in which multiple platforms (or devices) are used.

SUMMARY

[0003] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description section. This summary is not intended to identify all key or essential features of the claimed subject matter, nor is it intended as an aid in determining the scope of the claimed subject matter.

[0004] Systems, methods, and computer readable media are provided herein to enable a Single Sign On (SSO) experience when working across different platforms. A user may work across different platform when using multiple devices, when using multiple browsers on a single device, or when an integrated application requires a separate Sign On to be accessed within a host web application or portal service.

[0005] When a user first makes use of the present disclosure for a given cloud productivity application, user credentials to access the given cloud productivity application are provided to a token service. The token service will handle the user's authorization with the cloud productivity application's service provider and will store the user's identity token and the access token as well as a multi-resource refresh token received from the service's identity provider in association with other login credentials and access for the user.

[0006] When a user subsequently makes use of the present disclosure and has been authorized to access a first service, the stored access tokens and multi-resource refresh tokens are used to automatically sign the user into other services as they are requested. For example, after a user has logged into a first social media website, productivity application, or other account, the user will be provided with the access tokens to access a second social media website, productivity application or other account without having to manually input user credentials again.

[0007] The present disclosure improves the efficiency of the computing devices employing it by reducing the amount of user input required to maintain connectivity to multiple cloud productivity application and provide an SSO therefor. The user experience is also improved, as users do not need to supply authentication credentials as frequently and may freely choose to use multiple platforms instead of limiting their use to a single platform.

[0008] Examples are implemented as a computer process, a computing system, or as an article of manufacture such as a device, computer program product, or computer readable medium. According to an aspect, the computer program product is a computer storage medium readable by a computer system and encoding a computer program comprising instructions for executing a computer process.

[0009] The details of one or more aspects are set forth in the accompanying drawings and description below. Other features and advantages will be apparent from a reading of the following detailed description and a review of the associated drawings. It is to be understood that the following detailed description is explanatory only and is not restrictive of the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate various aspects. In the drawings:

[0011] FIG. **1** is a block diagram of an example environment for providing cross-platform single sign-on;

[0012] FIG. **2** illustrates an example flow of data in an example cross-platform single sign-on in which the user has not yet been authenticated;

[0013] FIG. **3** illustrates an example flow of data in which the user has been previously authenticated;

[0014] FIG. **4** illustrates an example flow of data in which the user has been previously authenticated, but the access token has expired or been revoked;

[0015] FIG. **5** is a block diagram illustrating example physical components of a computing device;

[0016] FIGS. **6**A and **6**B are block diagrams of a mobile computing device; and

[0017] FIG. **7** is a block diagram of a distributed computing system.

DETAILED DESCRIPTION

[0018] The following detailed description refers to the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the following

description refers to the same or similar elements. While examples may be described, modifications, adaptations, and other implementations are possible. For example, substitutions, additions, or modifications may be made to the elements illustrated in the drawings, and the methods described herein may be modified by substituting, reordering, or adding stages to the disclosed methods. Accordingly, the following detailed description is not limiting, but instead, the proper scope is defined by the appended claims. Examples may take the form of a hardware implementation, or an entirely software implementation, or an implementation combining software and hardware aspects. The following detailed description is, therefore, not to be taken in a limiting sense.

[0019] Systems, methods, and computer readable media are provided herein to enable a Single Sign On (SSO) experience when working across different platforms. A user may work across different platform when using multiple devices, when using multiple browsers on a single device, or when an integrated application requires a separate Sign On to be accessed within a host web application or portal service.

[0020] When a user first makes use of the present disclosure for a given cloud productivity application, user credentials to access the given cloud productivity application are provided to an Identity Provider. The token service of the Identity Provider will handle the user's authorization with the cloud productivity application's service provider and will store the user's refresh token and the access token received from the service provider in association with other login credentials and access for the user.

[0021] When a user subsequently makes use of the present disclosure and has been authorized to access a first service, the stored access tokens and refresh tokens are used to automatically sign the user into other services as they are requested. For example, after a user has logged into a first social media website, productivity application, or other account, the user will be provided with the access tokens to access a second social media website, productivity application or other account without having to manually input user credentials again.

[0022] The present disclosure improves the efficiency of the computing devices employing it by reducing the amount of user input required to maintain connectivity to multiple cloud productivity application and provide an SSO therefor. The user experience is also improved, as users do not need to supply authentication credentials as frequently and may freely choose to use multiple platforms instead of limiting their use to a single platform.

[0023] FIG. **1** is a block diagram of an example environment **100** for providing cross-platform single sign-on (CP-SSO) when accessing productivity services that are integrated within a Software as a Service (SaaS) platform that acts as an Identity Provider (IdP). As illustrated, a SaaS web application **120** that integrates productivity application functionality is run on a client device **110** and is in selective communication with a token server **130** managing access to a secure storage **150**, a directory server **140**, and a cloud application server **160** operable to provide the productivity service. The directory server **140** is in turn in selective communication with the token server **130** and (optionally) the cloud application server **160**. As will be appreciated, although the example environment **100** shows one of each element, in various aspects multiple of each element may be provided.

[0024] Each of the client device **110**, token server **130**, directory server **140**, and cloud application server **160** are illustrative of a multitude of computing systems including, without limitation, desktop computer systems, wired and wireless computing systems, mobile computing systems (e.g., mobile telephones, netbooks, tablet or slate type computers, notebook computers, and laptop computers), handheld devices, multiprocessor systems, microprocessor-based or programmable consumer electronics, minicomputers, printers, and mainframe computers. The hardware of these computing systems is discussed in greater detail in regard to FIGS. **5**, **6**A, **6**B, and **7**. Client devices **110** are operated by users, who may be humans or automated systems (e.g., "bots"). In various aspects, the client device **110**, token server **130**, directory server **140**, and cloud application server **160** may be accessed by a user or each other locally and/or by a network, which may include the Internet, a Local Area Network (LAN), a private distributed network for an entity (e.g., a company, a university, a government agency), a wireless ad hoc network, a Virtual Private Network (VPN) or other direct data link (e.g., Bluetooth connection, a direct wired link).

[0025] The SaaS web application **120** runs on the client device **110** to provide a user with a service from one or more cloud application servers **160**. In various aspects, the SaaS web application **120** is an HTML or JavaScript-based application or portal running in an internet browser, but in other aspects may be an executable that is run locally which accesses the SaaS or another browser-based system that exposes hosted code to the client device **110** for executing as SaaS.

[0026] The directory server **140** provides authentication services for the user. According to certain aspects, the directory server **140** is an identity provider (IdP) which issues identity tokens, access tokens, and multi-resource refresh tokens, and may include, but is not limited to: Active Directory Federation Services (ADFS), Azure Active Directory, Open Directory, Apache DS, Facebook®, YahooID, GoogleID, OpenID, OpenLDAP, among other IdPs. Depending on the configuration of the directory server **140**, the SaaS web application **120** may direct its attempts for authentication for various productivity applications provided as SaaS to the directory server **140** instead of or in addition to the cloud application servers **160** providing those services.

[0027] The secure storage **150** in the present example stores for the directory server **140** various keys, tokens, and other shared secrets, as well as the associated identities (usernames, domains, account numbers, etc.) that are used for authentication with the directory server **140** and other services. In various aspects, the secure storage **150** is a database that maintains the access information and associated identities and the state of the access information related to the users' needs (e.g., whether a token has expired).

[0028] The token server **130** provides access tokens for identified users. As will be appreciated, an access token is an object that describes the security context of a process or thread, such as the SaaS web application **120**, and includes the identity and privileges of the user associated with that process or thread. When a user sends an authentication request, the token server **130** verifies the user's shared secret

by comparing it with information stored in a security database. If the shared secret is authenticated, the token server **130** produces an access token by communicating with the directory server **140**. The SaaS web application **120** may then share this access token to be authenticated by various other systems so that the SaaS web application **120** can supply the access token to identify the user when a thread or process interacts with another thread, process, or object that requires privileges (e.g., the cloud productivity application **170**) without having to resubmit the shared secret for that thread, process, or object.

[0029] The cloud application server **160** is a web service that the SaaS web application **120** will interact with to implement additional services for the user. In various aspects, the cloud application server **160** provides a second cloud productivity application **170** or communication application for integration into the SaaS web application **120**. For example, where the cloud productivity application **170** is an online word processor (e.g., the Google Docs™ or Word 365™ online word processing applications) the cloud application server **160** may provide an Instant messenger application or a spreadsheet application for integration with the word processor. In other aspects, the cloud application server **160** provides a second cloud productivity application **170** or communication application for integration into a web portal provided by the SaaS web application **120**. For example, where the SaaS web application **120** is a social media platform (e.g., Salesforce.com™, LinkedIn®, Facebook®), the cloud application server **160** may provide an email client, a music player linked to a music library or access rights account, or a productivity application (e.g., the Google Docs™ or Office 365™ suite of online productivity applications) that will be integrated into the SaaS web application **120** when accessed by the client device **110**.

[0030] With reference now to FIG. **2**, a data flow diagram **200** is provided that illustrates an example flow of data in an example cross-platform single sign-on (CP-SSO) for accessing productivity services that are integrated within a Software as a Service (SaaS) web application **120** for improving the efficiency of the network. More specifically, the data flow diagram illustrates an example flow of data in which the user has not been previously authenticated by the data flow or the one or more productivity services that are integrated within a SaaS web application.

[0031] In the illustrated example, the flow of data starts when the user uses a computing device to access a SaaS browser application **210**. More specifically, the user enters a URL that is associated with the SaaS browser application **210** into a web browser. It should be noted that a magnitude of web browsers are suitable for employing in the flow of data including, without limitation, Internet Explorer® by Microsoft Corp., Firefox™ by Mozilla, Chrome™ by Google, and Safari® by Apple, etc. Further, upon navigating the web browser to the URL associated with the SaaS web application, the user is typically required to enter a user credential or a user password to sign-in to the SaaS web application **120**. Once the user logs into to the SaaS web application, the SaaS web application includes a variety of selectable functionalities.

[0032] As illustrated in Step **1** of FIG. **2**, the SaaS browser application **210** includes one or more selectable controls for interacting with the various functionalities provided by the SaaS web application **120**. According to one aspect, the user may select a displayed banner relating to the productivity application **240**. According to another aspect, the user selects an entry point associated with a productivity application **240**. According to other aspects, the user chooses to "sign-in" to the productivity application **240**. In one example, the SaaS browser application **210** sends a HTTP Request to a proxy token service end point for processing where the proxy token service **220** analyzes the request to determine how to respond. For example, the proxy token service **220** may analyze the request by determining whether an access token and/or a ID token is responsive to the request.

[0033] Further, in Step **2** of FIG. **2**, the proxy token service **220** returns a response to the HTTP request. It should be recognized that because the user has not been previously authenticated by the data flow, the proxy token service **220** is unable to identify an access token or an ID token that is associated with the user. Accordingly, the proxy token service's **220** response redirects the user to an endpoint to provide authorization. In one example, the proxy token service **220** response is a HTTP Response status code "302 found," which redirects the user. Specifically, an example response includes a URL for redirecting the user to a directory service **230** for authorization and a nonce for security purposes.

[0034] As illustrated in Step **3** of FIG. **2**, the user's SaaS browser application **210** is redirected to request user authentication from a directory service **230**. The directory service **230** prompts the user for account credentials associated with the productivity application **240**. For example, the sign-in request includes the client ID for the productivity application **240** and a redirect URL associated with the proxy token service **220**. According to one aspect, the user's SaaS browser application **210** is re-directed to a directory service end point, which includes a setting state with the value of nonce identified in Step **2** of FIG. **2** and another nonce value for its own for security. According to another aspect, the user's SaaS browser application **210** is re-directed to a directory service end point including an additional security feature that identifies the proxy token service **220**, such as identifying the URL associated with the proxy token service **220**. It should also be appreciated that in some aspects the proxy token service **220** is used as an additional security feature when the proxy token service **220** is a registered confidential 0Auth2.0 client associated with the directory service **230**.

[0035] Further, in Step **4** of FIG. **2**, the productivity service requests an identity token and an authorization code from the directory service **230**. According to one aspect, in response to the SaaS browser application **210** being redirected to the directory service end point, the directory service **230** attempts to establish whether to require entering a user password associated with the productivity application **240** or if the productivity application **240** has SSO configured. If the password is necessary, the directory service **230** receives the password from the user and compares the password with a hash stored in the directory service's identity store.

[0036] When the directory service **210** determines that the user account is stored in the directory service's identity store, it returns a JSON object or other notification to the SaaS browser application **230**. For example, the directory service may return a **200** OK status code. When the directory service **230** determines that the user and password are authorized, the directory service **230** returns an identity

token and an authorization code. According to another aspect, the directory service **230** posts the credentials to the directory service authorization end point. For example, the directory service **230** posts the credentials to "/common" in order to enable use of a multi-resource refresh token (MRRT).

[0037] Step **5** of FIG. **2** illustrates that the SaaS browser application **210** communicates the authorization to the proxy token service **220**. According to one aspect, the SaaS browser application **210** passes the identity token and the authorization code to the proxy token service **220**. According to another aspect, a middleware component (e.g., an OWIN component) intercepts to POST the message.

[0038] In Step **6** of FIG. **2**, the proxy token service **220** requests the access token and MRRT from the directory service **230**. According to one aspect, the proxy token service **220** redeems the authorization code provided to the SaaS browser application **210**. According to another aspect, the middleware components redeem the authorization code to retrieve the access token and MRRT. In another example, the middleware component communicates the authorization code to the proxy token service **220** for redeeming the access token and MRRT. It should be appreciated that the later may allow the proxy token service **220** or the directory service **230** to perform load balancing and for backend secure storage. Further, in Step **7** of FIG. **2**, the directory service **230** communicates the access token and the MRRT to the proxy token service **220**.

[0039] As illustrated in Steps **8-10** of FIG. **2**, the access token, MRRT, and identity token are stored. According to one aspect, the proxy token service **220** writes the access token, the MRRT, and the identity token in secure storage **150**. Further, after the access token, the MRRT, and the identity token are stored in secure storage **150**, the proxy token service **220** retrieves the access token based on the mapping of the SaaS browser application **210** to the productivity application **240**. Further, the proxy token service **220** communicates the access token to the SaaS browser application **210**.

[0040] Further, in Step **11** of FIG. **2**, the SaaS browser application **210** communicates the access token to the productivity application **240**. Specifically, the SaaS browser application **210** uses the access token to instantiate the productivity application **240** via a web SDK (software developer kit). In one example, the SaaS browser application **210** calls a productivity application API with the access token to discover the productivity application's home pool and POSTs the access token to the productivity application **240**. The productivity application **240** validates the user's access token and returns requested resources in Step **12** of FIG. **2**. Thereafter, the productivity application **240** is provided in the SaaS browser application **210**.

[0041] With reference now to FIG. **3**, a data flow diagram **300** is provided that illustrates an example flow of data in an example cross-platform single sign-on (CP-SSO) for accessing productivity services that are integrated within a Software as a Service (SaaS) web application **120** for improving the efficiency of the network. More specifically, the data flow diagram illustrates an example flow of data in which the user has been previously authenticated, within a selected period of time, by the data flow or the one or more productivity services that are integrated within a SaaS web application.

[0042] In Step **1** of FIG. **3**, the SaaS browser application **210** sends a request to the proxy token service **220** for processing.

[0043] As illustrated in Steps **2-3** of FIG. **3**, the proxy token service **220** analyzes the request to determine how to respond. In one example, the proxy token service **220** determines whether the access token and/or the identity token are responsive to the request. It should be recognized that because the user has been previously authenticated by the data flow illustrated in FIG. **2**, the proxy token service **220** is able to identify an access token, MMRT, and/or identity token that is associated with the user. Thereafter, in Step **3**, the proxy token service **220** responds to the request from STEP **1** with the access token.

[0044] Steps **4-5** of FIG. **3** illustrate that the SaaS browser application **210** communicates the access token to the productivity application **240** for resource access. In one example, the SaaS browser application **210** uses the access token to instantiate the productivity application **240** via a web SDK. In Step **5**, the productivity application **240** returns requested resources or requests a new access token based on the validation result of the access token passed in Step **4**. Upon requesting the new access token, the SaaS browser application **210** communications with the proxy token service **220** to acquire the requested access token and then passes it back to the productivity application **240**. Thereafter, the productivity application **240** is provided in the SaaS browser application **210**.

[0045] With reference now to FIG. **4**, a data flow diagram **400** is provided that illustrates an example flow of data in an example cross-platform single sign-on (CP-SSO) for accessing productivity services that are integrated within a Software as a Service (SaaS) web application **120** for improving the efficiency of the network. More specifically, the data flow diagram illustrates an example flow of data in which the user has been previously authenticated, but the access token has expired or been revoked.

[0046] The data flow starts at Step **1** of FIG. **4**, where the SaaS browser application **210** sends a request to the proxy token service **220** for processing.

[0047] As illustrated in Steps **2-3** of FIG. **4**, the proxy token service **220** analyzes the request to determine how to respond. In one example, the proxy token service **220** determines whether an access token and/or the identity token a responsive to the request. It should be recognized that because the user has been previously authenticated by the data flow illustrated in FIG. **2**, the proxy token service **220** is able to identify an access token, MMRT, and/or identity token that is associated with the user. Thereafter, in Step **3**, the proxy token service **220** responds to the request in STEP **1** with the access token.

[0048] Steps **4** of FIG. **4** illustrates that the SaaS browser application **210** communicates the access token to the productivity application **240** for authentication. In one example, the SaaS browser application **210** uses the access token to instantiate the productivity application via a web SDK.

[0049] In Step **5** of FIG. **4**, the productivity application **240** fails to authenticate the account. As mentioned above, in this data flow **400**, the access token has expired or has been revoked. More specifically, in one example, the productivity application communicates a **401/403** Response. In response, as illustrated in Step **6** of FIG. **4**, the SaaS browser application **210** posts the error response to the proxy token service **220**.

[0050] As illustrated in Step **7** of FIG. **4**, the proxy token service **220** requests a new access token from the directory service **230**. According to one aspect, the proxy token service **220** redeems the MRRT. Further, in Step **8** of FIG. **4**, the directory service **230** communicates the new access token to the proxy token service **220**.

[0051] Steps **9-11** of FIG. **4** illustrate that the new access token is stored, retrieved and transmitted to the SaaS browser application **210**. According to one aspect, the proxy token service **220** stores the new access token in secure storage **150**. Further, the proxy token service **220** retrieves the new access token based on the mapping of the SaaS browser application **210** to the productivity application **240**. Further, the proxy token service **220** communicates the new access token to the SaaS browser application **210**.

[0052] In Steps **12-13** of FIG. **4**, the SaaS browser application **210** communicates the new access token to the productivity application **240**. When the productivity application **240** authenticates the user's productivity application account, the SaaS browser application **210** is provided with an authentication cookie. Thereafter, the productivity application **240** is provided in the SaaS browser application **210**.

[0053] While implementations have been described in the general context of program modules that execute in conjunction with an application program that runs on an operating system on a computer, those skilled in the art will recognize that aspects may also be implemented in combination with other program modules. Generally, program modules include routines, programs, components, data structures, and other types of structures that perform particular tasks or implement particular abstract data types.

[0054] The aspects and functionalities described herein may operate via a multitude of computing systems including, without limitation, desktop computer systems, wired and wireless computing systems, mobile computing systems (e.g., mobile telephones, netbooks, tablet or slate type computers, notebook computers, and laptop computers), handheld devices, multiprocessor systems, microprocessor-based or programmable consumer electronics, minicomputers, and mainframe computers.

[0055] In addition, according to an aspect, the aspects and functionalities described herein operate over distributed systems (e.g., cloud-based computing systems), where application functionality, memory, data storage and retrieval and various processing functions are operated remotely from each other over a distributed computing network, such as the Internet or an intranet. According to an aspect, user interfaces and information of various types are displayed via on-board computing device displays or via remote display units associated with one or more computing devices. For example, user interfaces and information of various types are displayed and interacted with on a wall surface onto which user interfaces and information of various types are projected. Interaction with the multitude of computing systems with which implementations are practiced include, keystroke entry, touch screen entry, voice or other audio entry, gesture entry where an associated computing device is equipped with detection (e.g., camera) functionality for capturing and interpreting user gestures for controlling the functionality of the computing device, and the like.

[0056] FIGS. **5-7** and the associated descriptions provide a discussion of a variety of operating environments in which examples are practiced. However, the devices and systems illustrated and discussed with respect to FIGS. **5-7** are for purposes of example and illustration and are not limiting of a vast number of computing device configurations that are utilized for practicing aspects, described herein.

[0057] FIG. **5** is a block diagram illustrating physical components (i.e., hardware) of a computing device **500** with which examples of the present disclosure may be practiced. In a basic configuration, the computing device **500** includes at least one processing unit **502** and a system memory **504**. According to an aspect, depending on the configuration and type of computing device, the system memory **504** comprises, but is not limited to, volatile storage (e.g., random access memory), non-volatile storage (e.g., read-only memory), flash memory, or any combination of such memories. According to an aspect, the system memory **504** includes an operating system **505** and one or more program modules **506** suitable for running software applications **550**. According to an aspect, the system memory **504** includes the SaaS browser application **210** and/or one or more productivity application **240**. The operating system **505**, for example, is suitable for controlling the operation of the computing device **500**. Furthermore, aspects are practiced in conjunction with a graphics library, other operating systems, or any other application program, and are not limited to any particular application or system. This basic configuration is illustrated in FIG. **5** by those components within a dashed line **508**. According to an aspect, the computing device **500** has additional features or functionality. For example, according to an aspect, the computing device **500** includes additional data storage devices (removable and/or non-removable) such as, for example, magnetic disks, optical disks, or tape. Such additional storage is illustrated in FIG. **5** by a removable storage device **509** and a non-removable storage device **510**.

[0058] As stated above, according to an aspect, a number of program modules and data files are stored in the system memory **504**. While executing on the processing unit **502**, the program modules **506** (e.g., SaaS browser applications **210**) perform processes including, but not limited to, one or more of the stages of the data flows **200**, **300**, and **400** illustrated in FIGS. **2**, **3**, and **4**. According to an aspect, other program modules are used in accordance with examples and include applications such as electronic mail and contacts applications, word processing applications, spreadsheet applications, database applications, slide presentation applications, drawing or computer-aided application programs, etc.

[0059] According to an aspect, the computing device **500** has one or more input device(s) **512** such as a keyboard, a mouse, a pen, a sound input device, a touch input device, etc. The output device(s) **514** such as a display, speakers, a printer, etc. are also included according to an aspect. The aforementioned devices are examples and others may be used. According to an aspect, the computing device **500** includes one or more communication connections **516** allowing communications with other computing devices **518**. Examples of suitable communication connections **516** include, but are not limited to, radio frequency (RF) transmitter, receiver, and/or transceiver circuitry; universal serial bus (USB), parallel, and/or serial ports.

[0060] The term computer readable media, as used herein, includes computer storage media. Computer storage media include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instruc-

tions, data structures, or program modules. The system memory **504**, the removable storage device **509**, and the non-removable storage device **510** are all computer storage media examples (i.e., memory storage.) According to an aspect, computer storage media include RAM, ROM, electrically erasable programmable read-only memory (EEPROM), flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other article of manufacture which can be used to store information and which can be accessed by the computing device **500**. According to an aspect, any such computer storage media is part of the computing device **500**. Computer storage media do not include a carrier wave or other propagated data signal.

[0061] According to an aspect, communication media are embodied by computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as a carrier wave or other transport mechanism, and include any information delivery media. According to an aspect, the term "modulated data signal" describes a signal that has one or more characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media include wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, radio frequency (RF), infrared, and other wireless media.

[0062] FIGS. **6**A and **6**B illustrate a mobile computing device **600**, for example, a mobile telephone, a smart phone, a tablet personal computer, a laptop computer, and the like, with which aspects may be practiced. With reference to FIG. **6**A, an example of a mobile computing device **600** for implementing the aspects is illustrated. In a basic configuration, the mobile computing device **600** is a handheld computer having both input elements and output elements. The mobile computing device **600** typically includes a display **605** and one or more input buttons **610** that allow the user to enter information into the mobile computing device **600**. According to an aspect, the display **605** of the mobile computing device **600** functions as an input device (e.g., a touch screen display). If included, an optional side input element **615** allows further user input. According to an aspect, the side input element **615** is a rotary switch, a button, or any other type of manual input element. In alternative examples, mobile computing device **600** incorporates more or fewer input elements. For example, the display **605** may not be a touch screen in some examples. In alternative examples, the mobile computing device **600** is a portable phone system, such as a cellular phone. According to an aspect, the mobile computing device **600** includes an optional keypad **635**. According to an aspect, the optional keypad **635** is a physical keypad. According to another aspect, the optional keypad **635** is a "soft" keypad generated on the touch screen display. In various aspects, the output elements include the display **605** for showing a graphical user interface (GUI), a visual indicator **620** (e.g., a light emitting diode), and/or an audio transducer **625** (e.g., a speaker). In some examples, the mobile computing device **600** incorporates a vibration transducer for providing the user with tactile feedback. In yet another example, the mobile computing device **600** incorporates input and/or output ports, such as an audio input (e.g., a microphone jack), an audio output (e.g., a headphone jack), and a video output (e.g., a HDMI port) for sending signals to or receiving signals from an external device. In yet another example, the mobile computing device **600** incorporates peripheral device port **640**, such as an audio input (e.g., a microphone jack), an audio output (e.g., a headphone jack), and a video output (e.g., a HDMI port) for sending signals to or receiving signals from an external device.

[0063] FIG. **6**B is a block diagram illustrating the architecture of one example of a mobile computing device. That is, the mobile computing device **600** incorporates a system (i.e., an architecture) **602** to implement some examples. In one example, the system **602** is implemented as a "smart phone" capable of running one or more applications (e.g., browser, e-mail, calendaring, contact managers, messaging clients, games, and media clients/players). In some examples, the system **602** is integrated as a computing device, such as an integrated personal digital assistant (PDA) and wireless phone.

[0064] According to an aspect, one or more application programs **650** are loaded into the memory **662** and run on or in association with the operating system **664**. Examples of the application programs include phone dialer programs, e-mail programs, personal information management (PIM) programs, word processing programs, spreadsheet programs, Internet browser programs, messaging programs, and so forth. According to an aspect, SaaS browser application **210** is loaded into memory **662**. The system **602** also includes a non-volatile storage area **668** within the memory **662**. The non-volatile storage area **668** is used to store persistent information that should not be lost if the system **602** is powered down. The application programs **650** may use and store information in the non-volatile storage area **668**, such as e-mail or other messages used by an e-mail application, and the like. A synchronization application (not shown) also resides on the system **602** and is programmed to interact with a corresponding synchronization application resident on a host computer to keep the information stored in the non-volatile storage area **668** synchronized with corresponding information stored at the host computer. As should be appreciated, other applications may be loaded into the memory **662** and run on the mobile computing device **600**.

[0065] According to an aspect, the system **602** has a power supply **670**, which is implemented as one or more batteries. According to an aspect, the power supply **670** further includes an external power source, such as an AC adapter or a powered docking cradle that supplements or recharges the batteries.

[0066] According to an aspect, the system **602** includes a radio **672** that performs the function of transmitting and receiving radio frequency communications. The radio **672** facilitates wireless connectivity between the system **602** and the "outside world," via a communications carrier or service provider. Transmissions to and from the radio **672** are conducted under control of the operating system **664**. In other words, communications received by the radio **672** may be disseminated to the application programs **650** via the operating system **664**, and vice versa.

[0067] According to an aspect, the visual indicator **620** is used to provide visual notifications and/or an audio interface **674** is used for producing audible notifications via the audio transducer **625**. In the illustrated example, the visual indicator **620** is a light emitting diode (LED) and the audio transducer **625** is a speaker. These devices may be directly

coupled to the power supply **670** so that when activated, they remain on for a duration dictated by the notification mechanism even though the processor **660** and other components might shut down for conserving battery power. The LED may be programmed to remain on indefinitely until the user takes action to indicate the powered-on status of the device. The audio interface **674** is used to provide audible signals to and receive audible signals from the user. For example, in addition to being coupled to the audio transducer **625**, the audio interface **674** may also be coupled to a microphone to receive audible input, such as to facilitate a telephone conversation. According to an aspect, the system **602** further includes a video interface **676** that enables an operation of an on-board camera **630** to record still images, video stream, and the like.

[0068] According to an aspect, a mobile computing device **600** implementing the system **602** has additional features or functionality. For example, the mobile computing device **600** includes additional data storage devices (removable and/or non-removable) such as, magnetic disks, optical disks, or tape. Such additional storage is illustrated in FIG. **6**B by the non-volatile storage area **668**.

[0069] According to an aspect, data/information generated or captured by the mobile computing device **600** and stored via the system **602** are stored locally on the mobile computing device **600**, as described above. According to another aspect, the data are stored on any number of storage media that are accessible by the device via the radio **672** or via a wired connection between the mobile computing device **600** and a separate computing device associated with the mobile computing device **600**, for example, a server computer in a distributed computing network, such as the Internet. As should be appreciated such data/information are accessible via the mobile computing device **600** via the radio **672** or via a distributed computing network. Similarly, according to an aspect, such data/information are readily transferred between computing devices for storage and use according to well-known data/information transfer and storage means, including electronic mail and collaborative data/information sharing systems.

[0070] FIG. **7** illustrates one example of the architecture of a system for providing a cross-platform single sign-on (CP-SSO) experience as described herein. Content developed, interacted with, or edited in association with the proxy token service **220** is enabled to be stored in different communication channels or other storage types. For example, various documents may be stored using a directory service **722**, a web portal **724**, a mailbox service **726**, an instant messaging store **728**, or a social networking site **730**. The proxy token service **220** is operative to use any of these types of systems or the like for providing a cross-platform single sign-on (CP-SSO) experience, as described herein. According to an aspect, a server **720** provides the proxy token service **220** to clients **705***a,b,c*. As one example, the server **720** is a web server providing the proxy token service **220** over the web. The server **720** provides the proxy token service **220** over the web to clients **705** through a network **740**. By way of example, the client computing device is implemented and embodied in a personal computer **705***a*, a tablet computing device **705***b* or a mobile computing device **705***c* (e.g., a smart phone), or other computing device. Any of these examples of the client computing device are operable to obtain content from the store **716**.

[0071] Implementations, for example, are described above with reference to block diagrams and/or operational illustrations of methods, systems, and computer program products according to aspects. The functions/acts noted in the blocks may occur out of the order as shown in any flowchart. For example, two blocks shown in succession may in fact be executed substantially concurrently or the blocks may sometimes be executed in the reverse order, depending upon the functionality/acts involved.

[0072] The description and illustration of one or more examples provided in this application are not intended to limit or restrict the scope as claimed in any way. The aspects, examples, and details provided in this application are considered sufficient to convey possession and enable others to make and use the best mode. Implementations should not be construed as being limited to any aspect, example, or detail provided in this application. Regardless of whether shown and described in combination or separately, the various features (both structural and methodological) are intended to be selectively included or omitted to produce an example with a particular set of features. Having been provided with the description and illustration of the present application, one skilled in the art may envision variations, modifications, and alternate examples falling within the spirit of the broader aspects of the general inventive concept embodied in this application that do not depart from the broader scope.

1. (canceled)

2. A method for providing single sign-on access to a productivity application integrated within a cloud-based service, the method comprising:

receiving, by a proxy token service, a request from a computing system providing the cloud-based service, the request having been transmitted in response to the computing system authenticating a client device to access the cloud-based service, the request identifying an account of the productivity application;

in response to determining that the account is not associated with a valid access token for the productivity application, redirecting the computing system to a directory service of the productivity application to provide authentication credentials associated with the account; and

in response to determining that the authentication credentials associated with the account were provided to the directory service, providing the computing system with an access token to access the productivity application, the computing system using the access token to provide the client device with the productivity application integrated within the cloud-based service.

3. The method of claim **2**, wherein determining that the account is not associated with the valid access token for the productivity application comprises:

searching a secure storage based on the account of the productivity application that is identified in the request.

4. The method of claim **2**, wherein determining that the authentication credentials associated with the account were provided to the directory service comprises:

receiving an authorization code from the computing system, the authorization code having been provided to the computing system by the directory service in response to the authentication credentials associated with the account being provided to the directory service.

5. The method of claim 4, wherein providing the computing system with the access token to access the productivity application comprises:

transmitting the authorization code to the directory service to redeem the access token; and

receiving the access token from the directory service.

6. The method of claim 5, further comprising:

storing the access token in a secure storage and associated the access token with the account of the productivity application.

7. The method of claim 6, further comprising:

receiving a subsequent request from the computing system providing the cloud-based service, the subsequent request identifying the account of the productivity application;

accessing the access token by searching the secure storage based on the account of the productivity application that is identified in the subsequent request; and

providing the computing system with the access token to access the productivity application.

8. The method of claim 7, wherein the subsequent request was transmitted in response to the computing system authenticating a second client device to access the cloud-based service the computing system and the computing system uses the access token to provide the second client device with the productivity application integrated within the cloud-based service.

9. A proxy token service for providing single sign-on access to a productivity application integrated within a cloud-based service, the proxy token service comprising:

one or more computer processors; and

one or more machine readable mediums storing instructions that, when executed by the one or more computer processors, cause the proxy token service to perform operations comprising:

receiving a request from a computing system providing the cloud-based service, the request having been transmitted in response to the computing system authenticating a client device to access the cloud-based service, the request identifying an account of the productivity application;

in response to determining that the account is not associated with a valid access token for the productivity application, redirecting the computing system to a directory service of the productivity application to provide authentication credentials associated with the account; and

in response to determining that the authentication credentials associated with the account were provided to the directory service, providing the computing system with an access token to access the productivity application, the computing system using the access token to provide the client device with the productivity application integrated within the cloud-based service.

10. The proxy token service of claim 9, wherein determining that the account is not associated with the valid access token for the productivity application comprises:

searching a secure storage based on the account of the productivity application that is identified in the request.

11. The proxy token service of claim 9, wherein determining that the authentication credentials associated with the account were provided to the directory service comprises:

receiving an authorization code from the computing system, the authorization code having been provided to the computing system by the directory service in response to the authentication credentials associated with the account being provided to the directory service.

12. The proxy token service of claim 11, wherein providing the computing system with the access token to access the productivity application comprises:

transmitting the authorization code to the directory service to redeem the access token; and

receiving the access token from the directory service.

13. The proxy token service of claim 12, the operations further comprising:

storing the access token in a secure storage and associated the access token with the account of the productivity application.

14. The proxy token service of claim 13, the operations further comprising:

receiving a subsequent request from the computing system providing the cloud-based service, the subsequent request identifying the account of the productivity application;

accessing the access token by searching the secure storage based on the account of the productivity application that is identified in the subsequent request; and

providing the computing system with the access token to access the productivity application.

15. The proxy token service of claim 14, wherein the subsequent request was transmitted in response to the computing system authenticating a second client device to access the cloud-based service the computing system and the computing system uses the access token to provide the second client device with the productivity application integrated within the cloud-based service.

16. A machine readable medium storing instructions for providing single sign-on access to a productivity application integrated within a cloud-based service, the instructions, when executed by one or more computer processors of a proxy token service, causing the proxy token service to perform operations comprising:

receiving a request from a computing system providing the cloud-based service, the request having been transmitted in response to the computing system authenticating a client device to access the cloud-based service, the request identifying an account of the productivity application;

in response to determining that the account is not associated with a valid access token for the productivity application, redirecting the computing system to a directory service of the productivity application to provide authentication credentials associated with the account; and

in response to determining that the authentication credentials associated with the account were provided to the directory service, providing the computing system with an access token to access the productivity application, the computing system using the access token to provide the client device with the productivity application integrated within the cloud-based service.

17. The machine readable medium of claim 16, wherein determining that the account is not associated with the valid access token for the productivity application comprises:

searching a secure storage based on the account of the productivity application that is identified in the request.

18. The machine readable medium of claim **16**, wherein determining that the authentication credentials associated with the account were provided to the directory service comprises:

receiving an authorization code from the computing system, the authorization code having been provided to the computing system by the directory service in response to the authentication credentials associated with the account being provided to the directory service.

19. The machine readable medium of claim **18**, wherein providing the computing system with the access token to access the productivity application comprises:

transmitting the authorization code to the directory service to redeem the access token; and

receiving the access token from the directory service.

20. The machine readable medium of claim **19**, the operations further comprising:

storing the access token in a secure storage and associated the access token with the account of the productivity application;

receiving a subsequent request from the computing system providing the cloud-based service, the subsequent request identifying the account of the productivity application;

accessing the access token by searching the secure storage based on the account of the productivity application that is identified in the subsequent request; and

providing the computing system with the access token to access the productivity application.

21. The machine readable medium of claim **20**, wherein the subsequent request was transmitted in response to the computing system authenticating a second client device to access the cloud-based service the computing system and the computing system uses the access token to provide the second client device with the productivity application integrated within the cloud-based service.

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