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Singh et al.

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(54) **CONTROL OF CLIENT ACCESS TO SERVER-HOSTED RESOURCES**

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H04L 9/40 (2022.01)

(52) **U.S. Cl.**
CPC ***H04L 63/101*** (2013.01)

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CPC G06F 21/565; G06F 11/1448; G06F 21/53; G06F 21/554; G06F 2201/84; G06F 2221/033; G06F 11/3604; G06F 11/3612; G06F 2201/81; G06F 21/566
See application file for complete search history.

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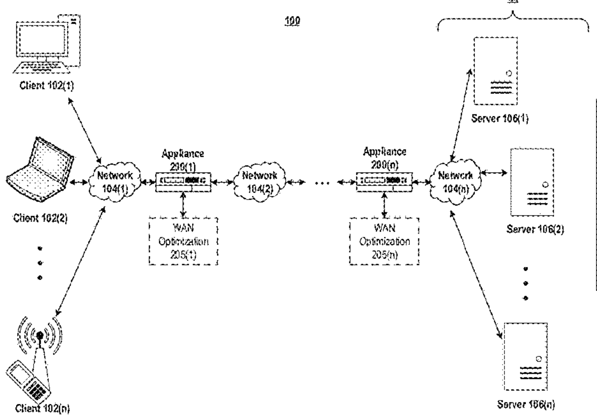
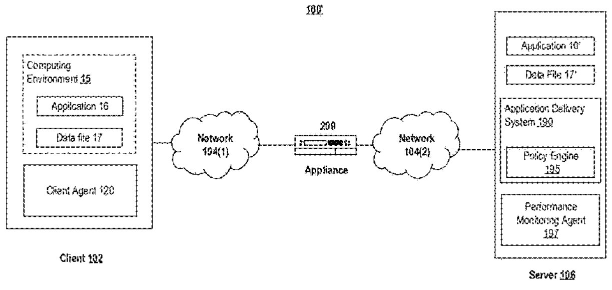
Primary Examiner — Kendall Dolly

(57) **ABSTRACT**

Described embodiments provide systems and methods for protecting access to a server. A device intermediary to a client and a server may identify a capability of the client to protect access to the server via an application. The device may determine that an element of a user interface provided by the application to the client is to be modified based at least on the capability. The device may modify, responsive to the determination, the element of the user interface to further protect access to the server in accordance with the capability. The device may provide the modified element to the client for the user interface of the application.

20 Claims, 14 Drawing Sheets





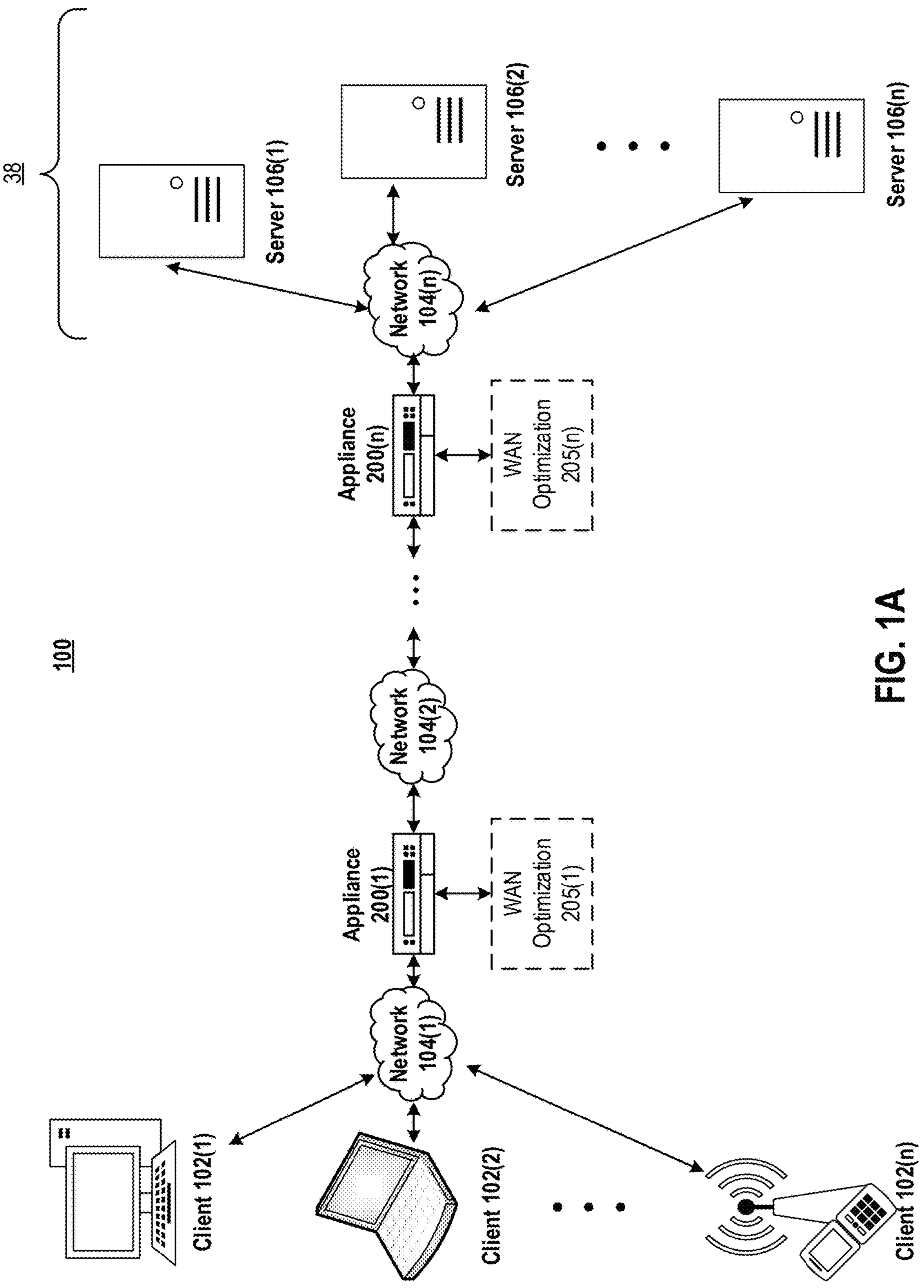

100
38
Server 106(1)
Server 106(2)
Server 106(n)
Network 104(n)
Appliance 200(n)
WAN Optimization 205(n)
Network 104(2)
Appliance 200(1)
WAN Optimization 205(1)
Network 104(1)
Client 102(1)
Client 102(2)
Client 102(n)

FIG. 1A

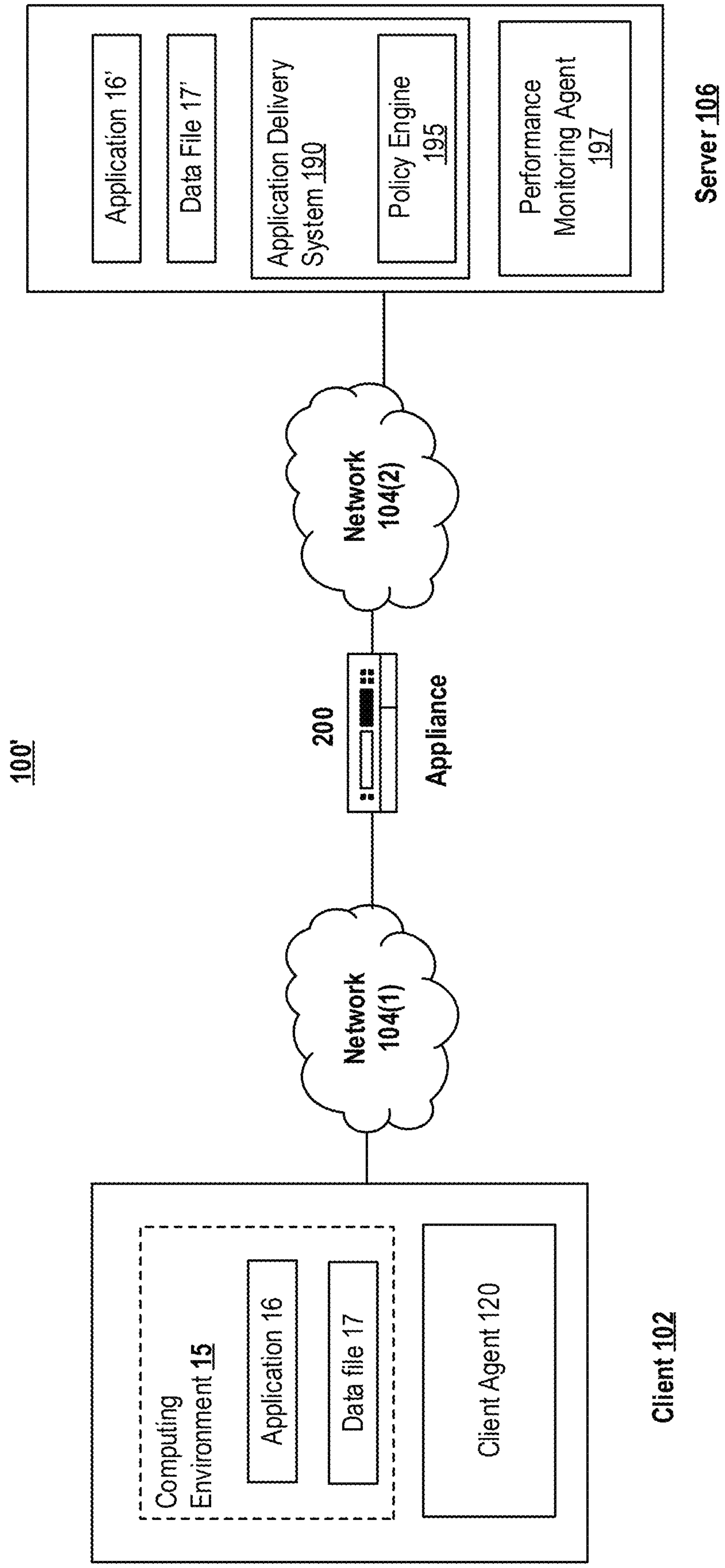

100'
Client 102
Computing Environment 15
Application 16
Data file 17
Client Agent 120
Network 104(1)
200
Appliance
Network 104(2)
Server 106
Application 16'
Data File 17'
Application Delivery System 190
Policy Engine 195
Performance Monitoring Agent 197

FIG. 1B

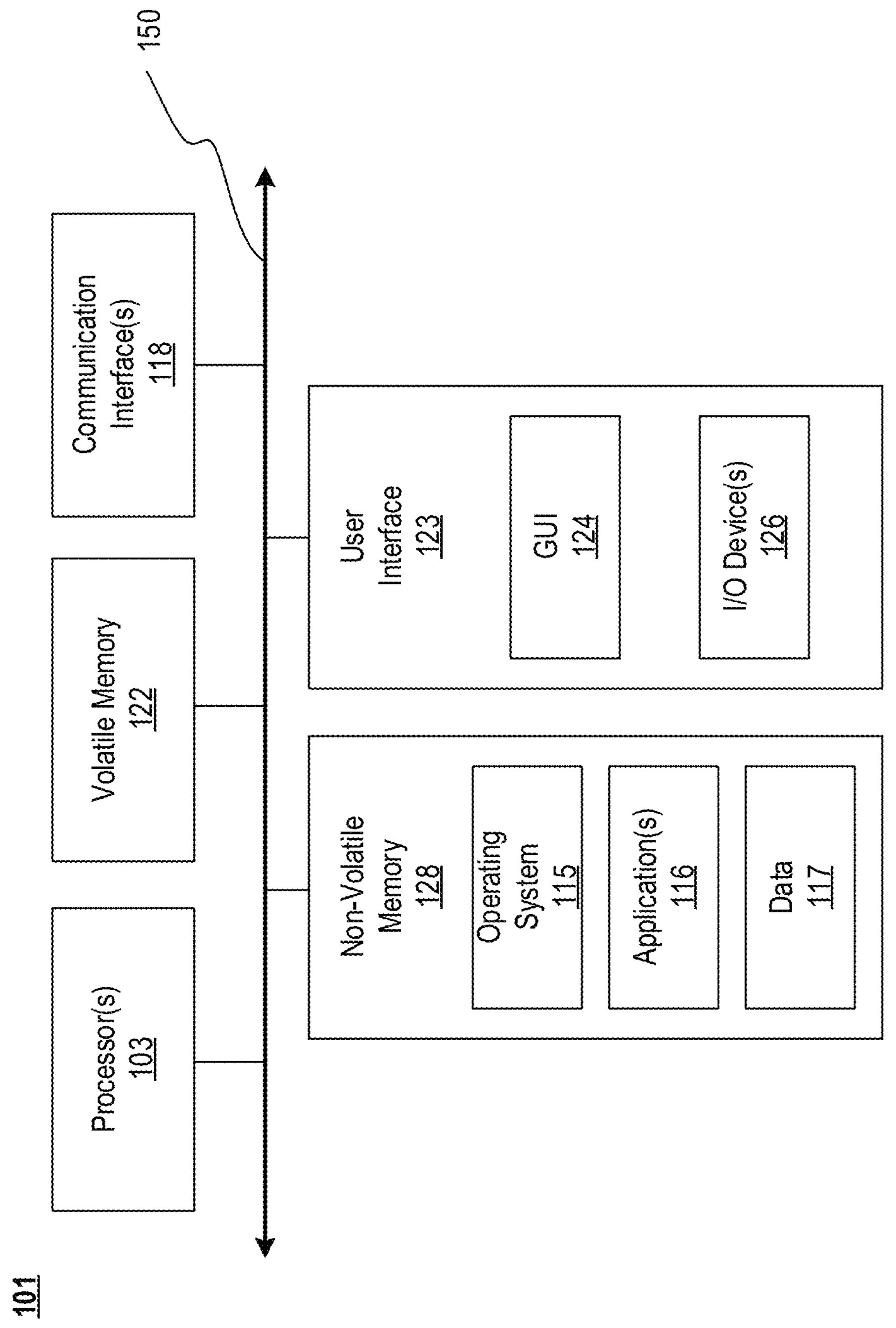

101
Processor(s) 103
Volatile Memory 122
Communication Interface(s) 118
150
Non-Volatile Memory 128
Operating System 115
Application(s) 116
Data 117
User Interface 123
GUI 124
I/O Device(s) 126

FIG. 1C

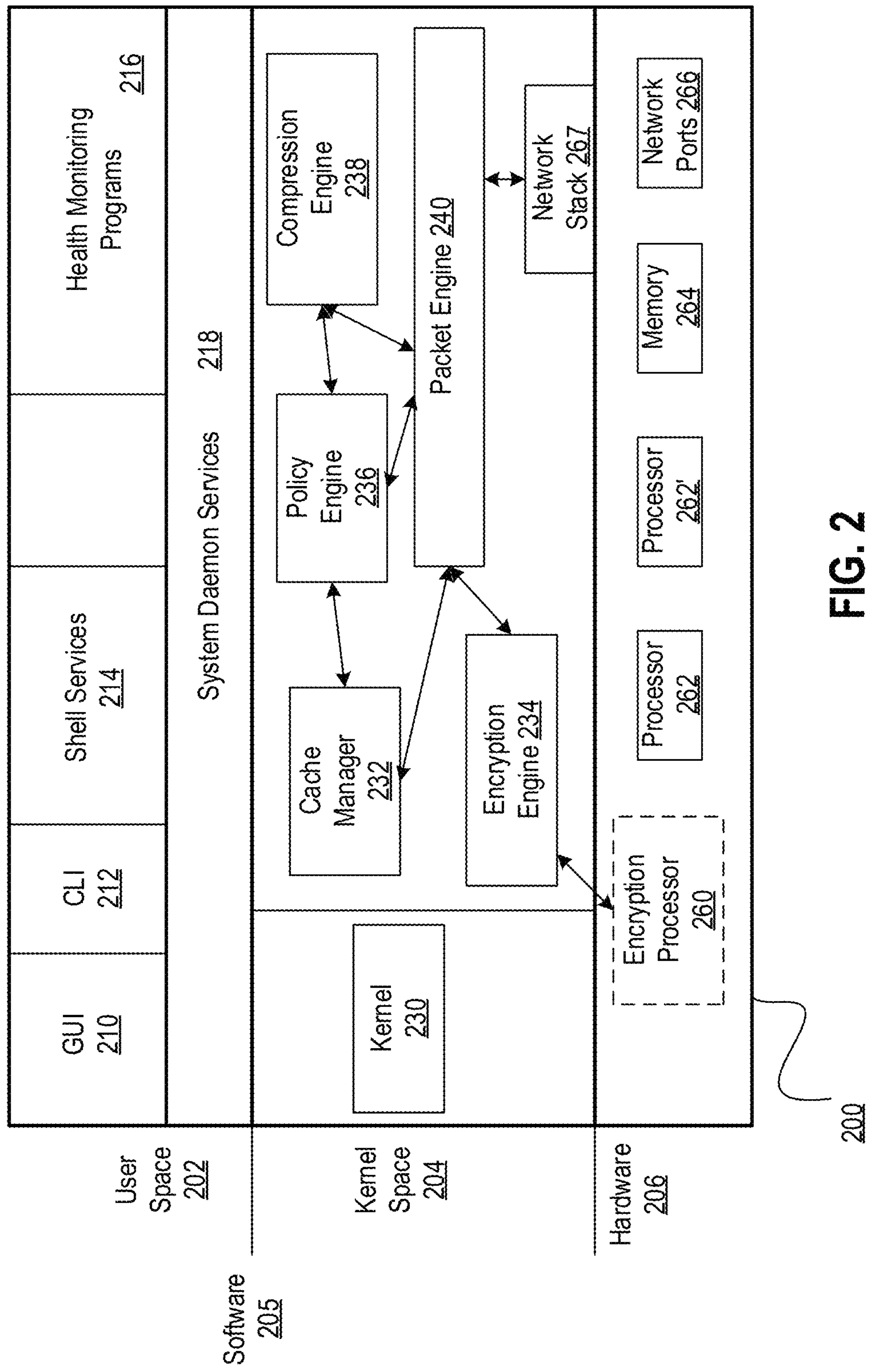

GUI 210
CLI 212
Shell Services 214
Health Monitoring Programs 216
System Daemon Services 218
Kernel 230
Cache Manager 232
Encryption Engine 234
Policy Engine 236
Compression Engine 238
Packet Engine 240
Network Stack 267
Encryption Processor 260
Processor 262
Processor 262'
Memory 264
Network Ports 266
User Space 202
Kernel Space 204
Hardware 206
Software 205
200

FIG. 2

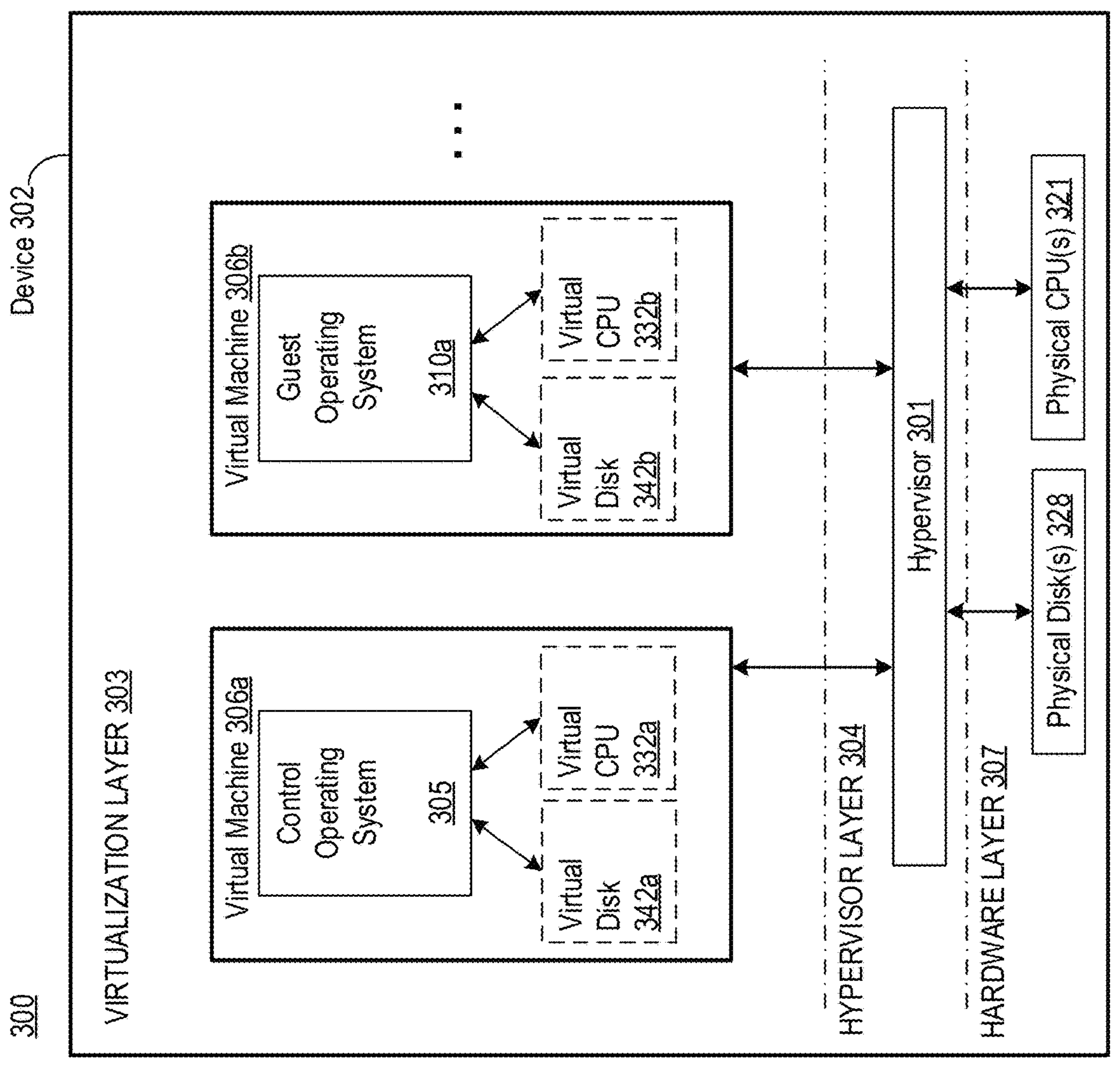

300
Device 302
VIRTUALIZATION LAYER 303
Virtual Machine 306a
Control Operating System 305
Virtual Disk 342a
Virtual CPU 332a
Virtual Machine 306b
Guest Operating System 310a
Virtual Disk 342b
Virtual CPU 332b
HYPERVISOR LAYER 304
Hypervisor 301
HARDWARE LAYER 307
Physical Disk(s) 328
Physical CPU(s) 321

FIG. 3

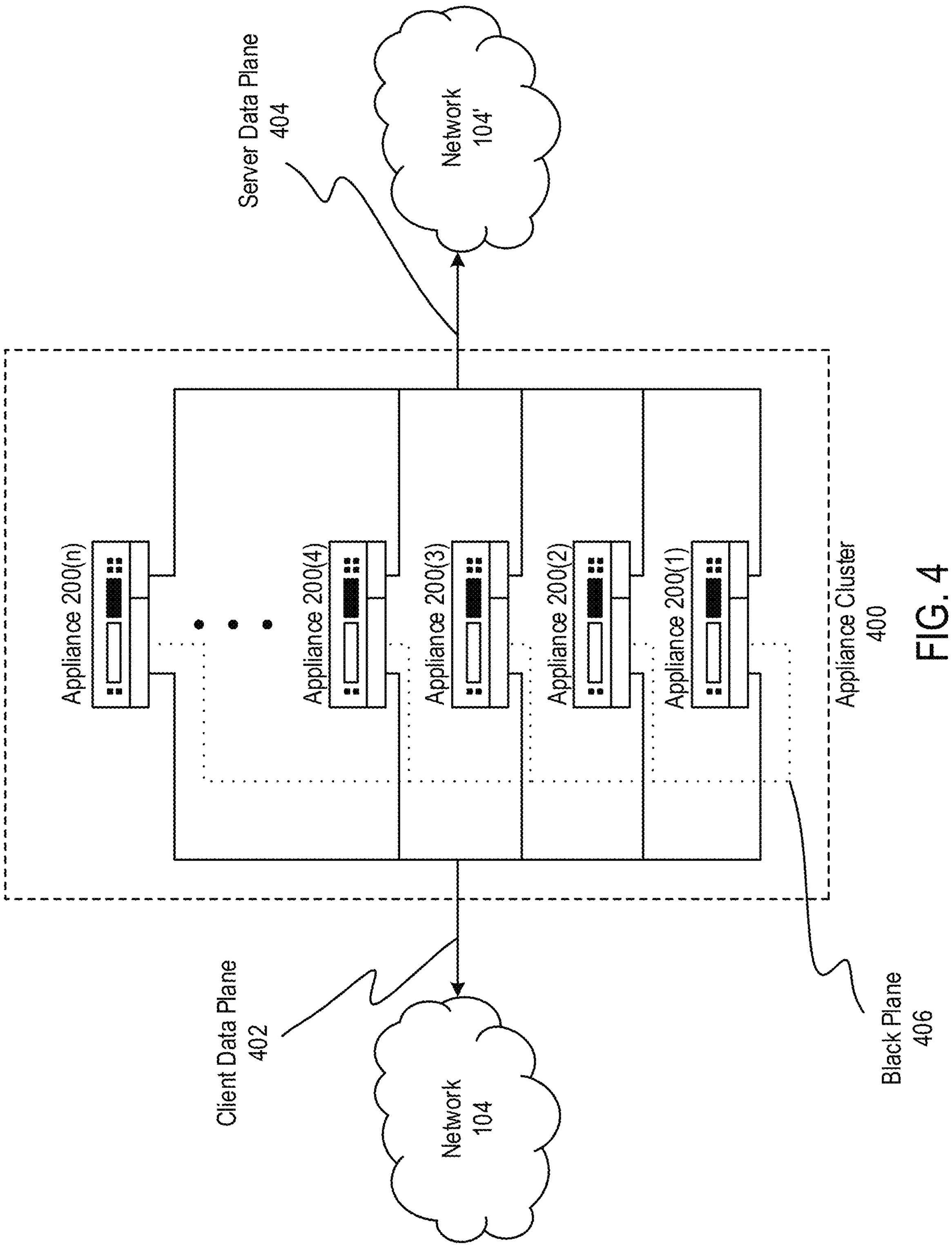

Server Data Plane
404
Network
104'
Appliance 200(n)
Appliance 200(4)
Appliance 200(3)
Appliance 200(2)
Appliance 200(1)
Appliance Cluster
400
Client Data Plane
402
Network
104
Black Plane
406

FIG. 4

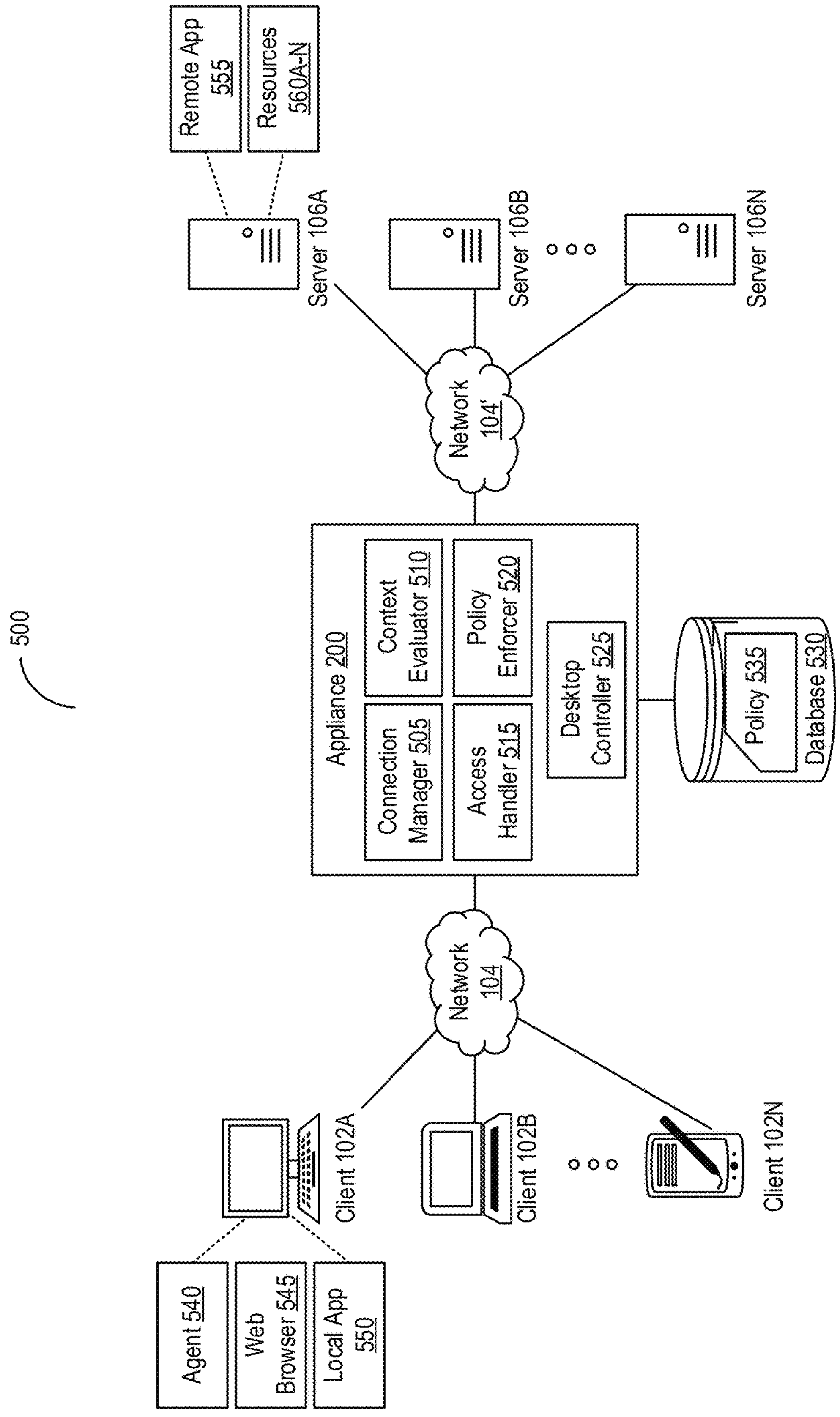

500
Agent 540
Web Browser 545
Local App 550
Client 102A
Client 102B
Client 102N
Network 104
Appliance 200
Connection Manager 505
Context Evaluator 510
Access Handler 515
Policy Enforcer 520
Desktop Controller 525
Policy 535
Database 530
Network 104'
Server 106A
Server 106B
Server 106N
Remote App 555
Resources 560A-N

FIG. 5

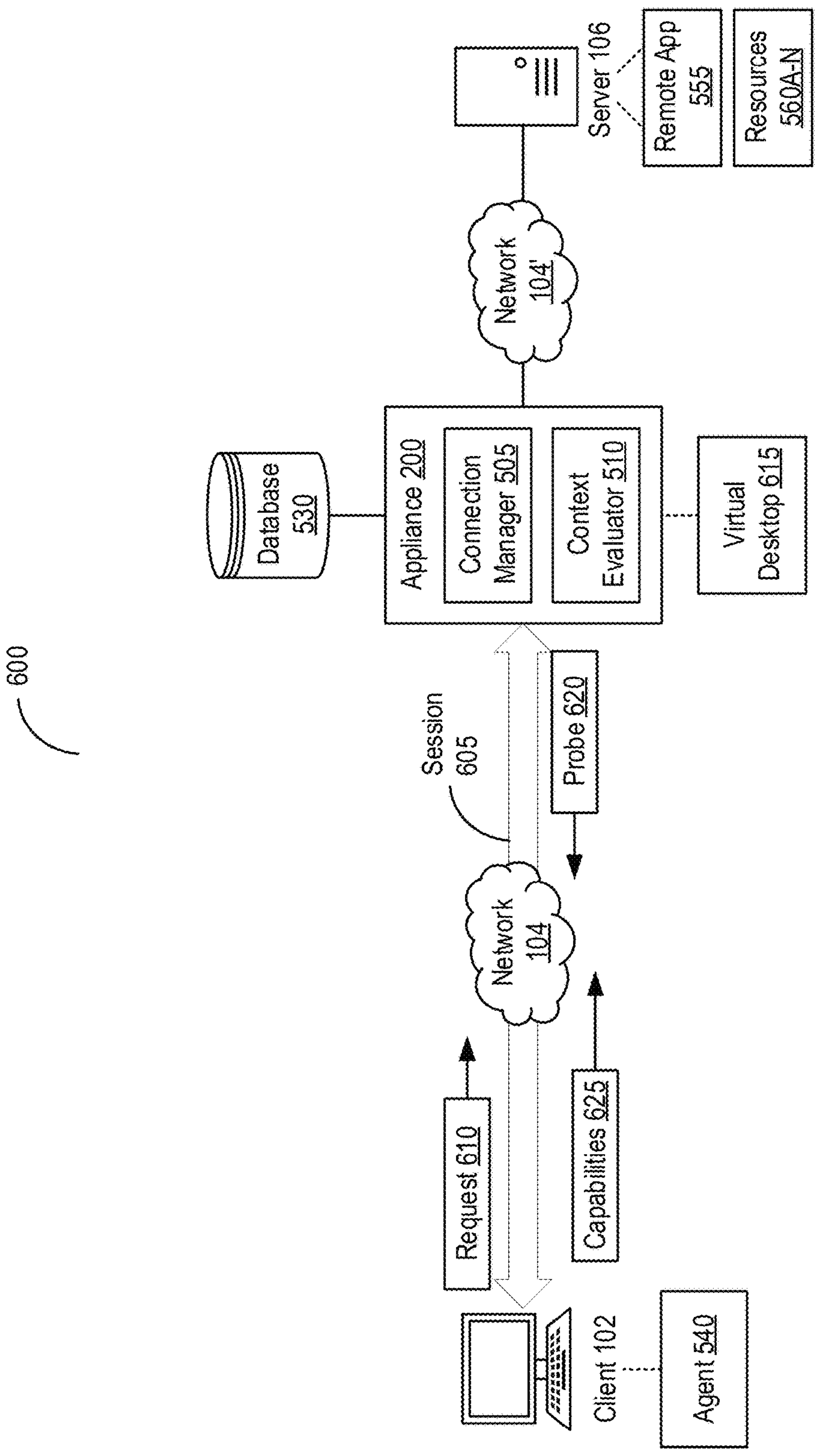

600
Client 102
Agent 540
Request 610
Capabilities 625
Network 104
Session 605
Probe 620
Database 530
Appliance 200
Connection Manager 505
Context Evaluator 510
Virtual Desktop 615
Network 104'
Server 106
Remote App 555
Resources 560A-N

FIG. 6A

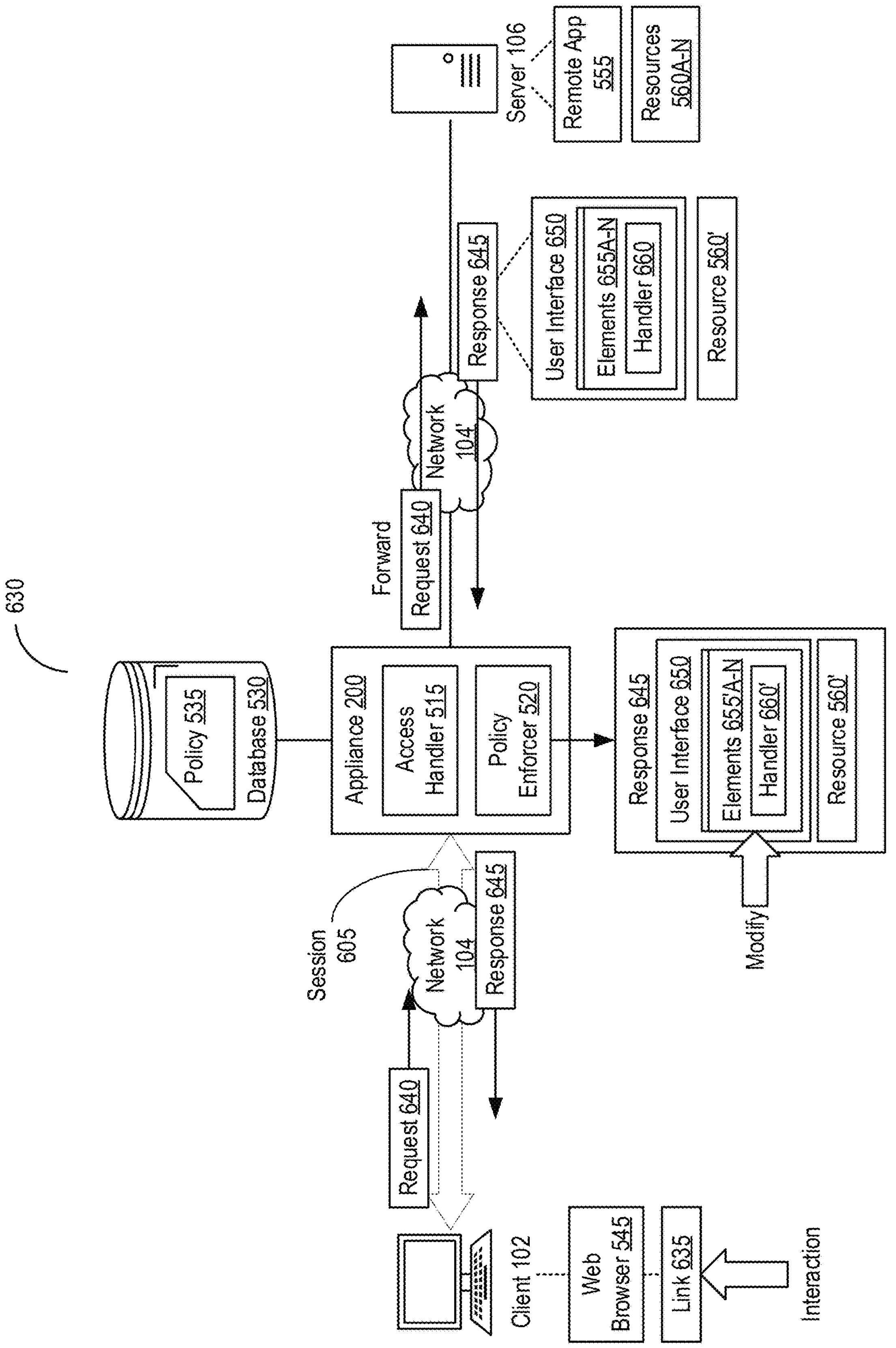

630
Client 102
Web Browser 545
Link 635
Interaction
Request 640
Session 605
Network 104
Response 645
Database 530
Policy 535
Appliance 200
Access Handler 515
Policy Enforcer 520
Response 645
User Interface 650
Elements 655'A-N
Handler 660'
Resource 560'
Modify
Forward
Request 640
Network 104'
Response 645
User Interface 650
Elements 655A-N
Handler 660
Resource 560'
Server 106
Remote App 555
Resources 560A-N

FIG. 6B

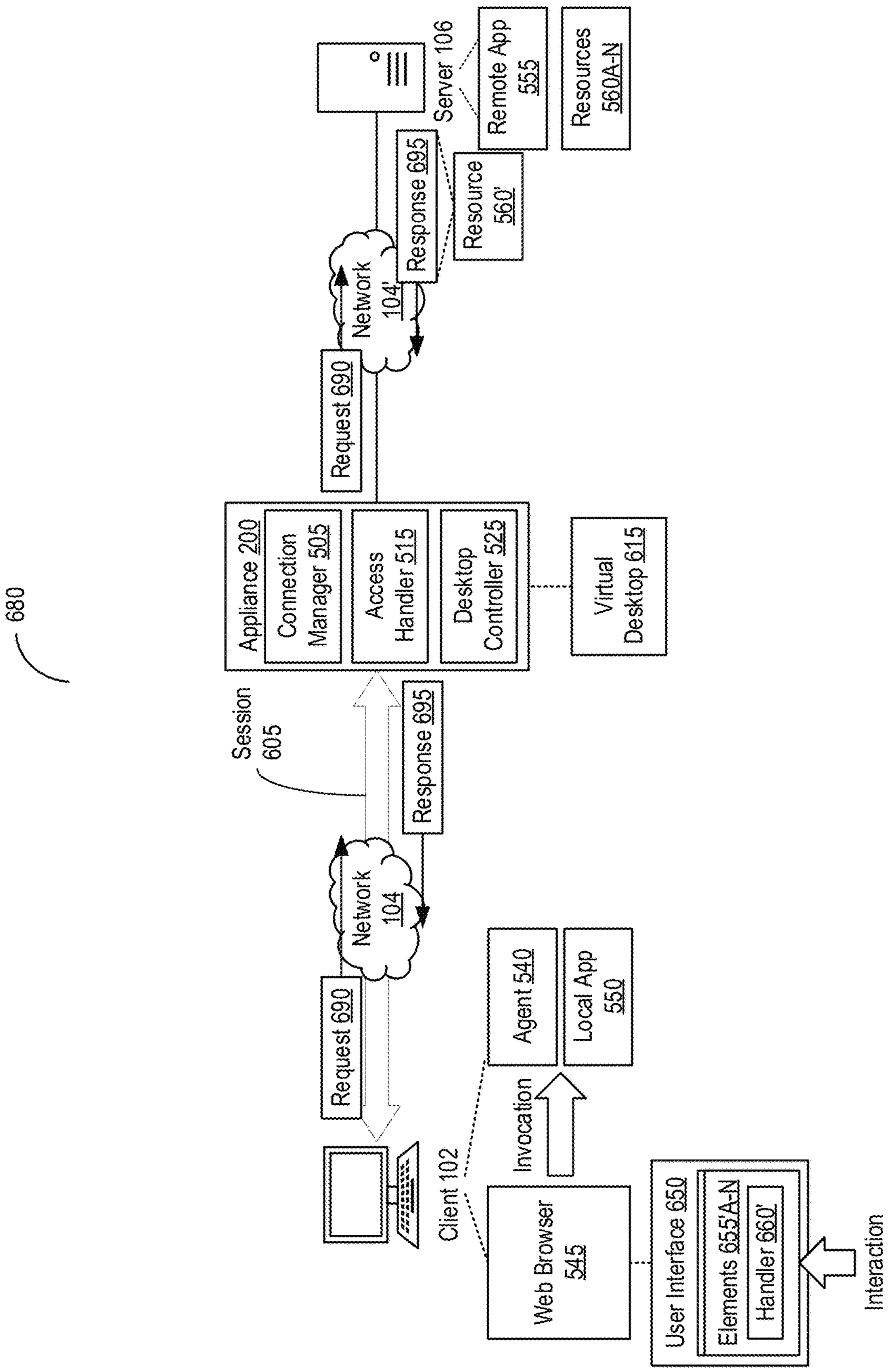

680
Client 102
Web Browser 545
User Interface 650
Elements 655'A-N
Handler 660'
Interaction
Invocation
Agent 540
Local App 550
Request 690
Network 104
Session 605
Response 695
Appliance 200
Connection Manager 505
Access Handler 515
Desktop Controller 525
Virtual Desktop 615
Request 690
Network 104'
Response 695
Server 106
Resource 560'
Remote App 555
Resources 560A-N

FIG. 6C

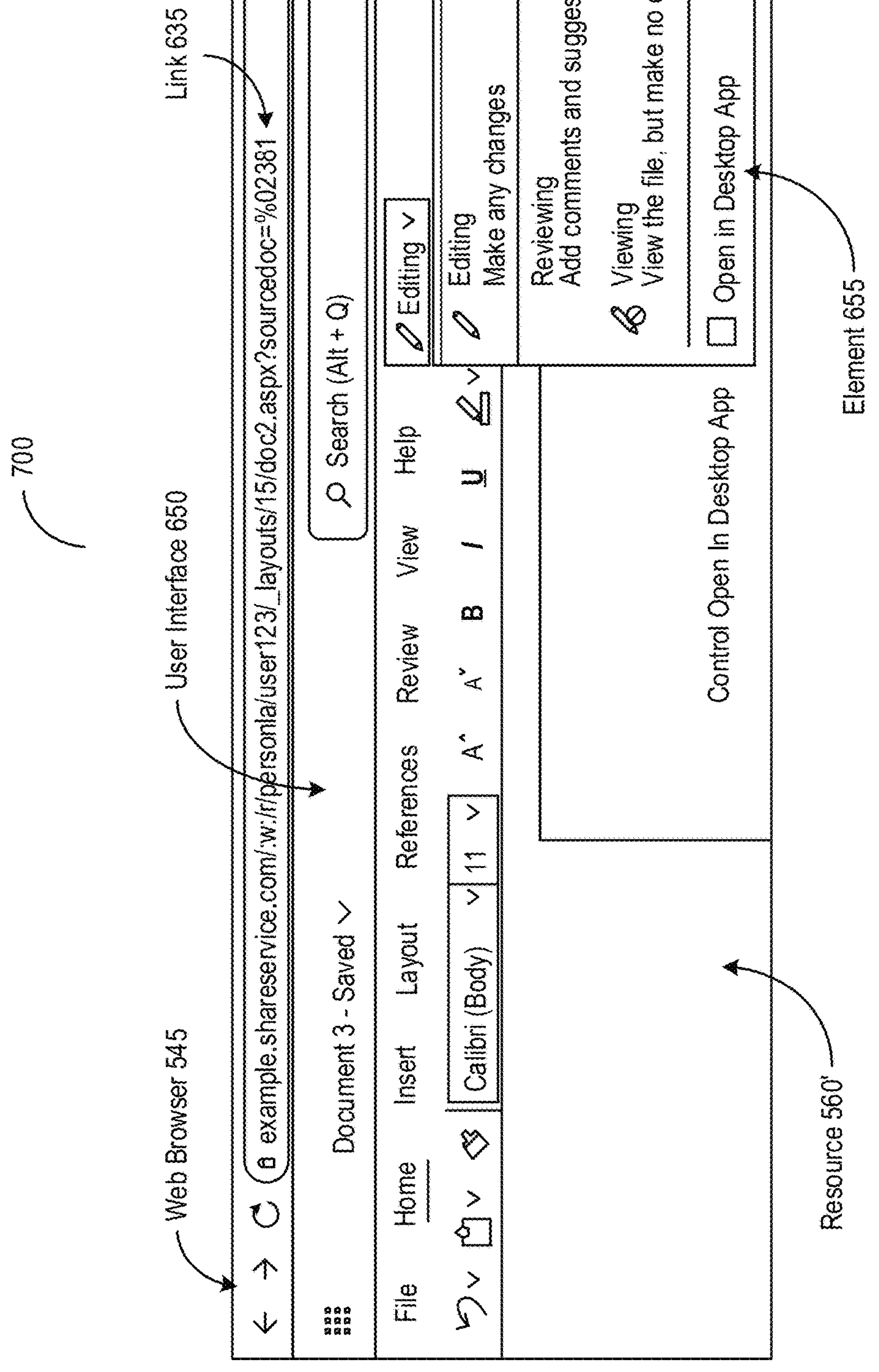

700
Link 635
User Interface 650
Web Browser 545
example.shareservice.com/:w:/r/personla/user123/_layouts/15/doc2.aspx?sourcedoc=%02381
Document 3 - Saved
Search (Alt + Q)
File
Home
Insert
Layout
References
Review
View
Help
Editing
Calibri (Body)
11
A
A
B
I
U
Editing
Make any changes
Reviewing
Add comments and suggest changes
Viewing
View the file, but make no changes
Open in Desktop App
Control Open In Desktop App
Element 655
Resource 560'

FIG. 7A

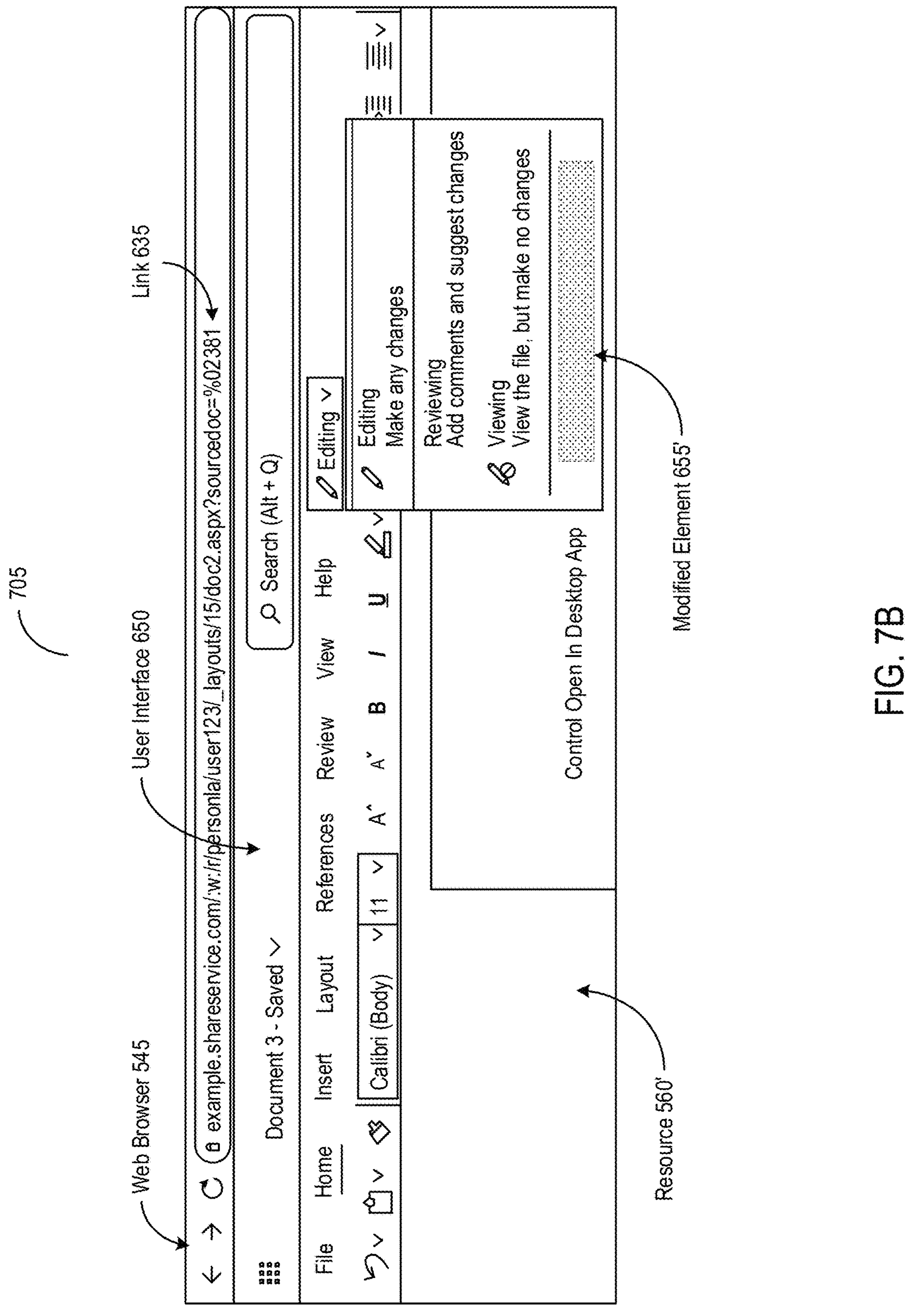

705
Web Browser 545
User Interface 650
Link 635
example.shareservice.com/:w:/r/personla/user123/_layouts/15/doc2.aspx?sourcedoc=%02381
Document 3 - Saved
Search (Alt + Q)
File
Home
Insert
Layout
References
Review
View
Help
Editing
Calibri (Body)
11
A
A
B
I
U
Editing
Make any changes
Reviewing
Add comments and suggest changes
Viewing
View the file, but make no changes
Control Open In Desktop App
Modified Element 655'
Resource 560'

FIG. 7B

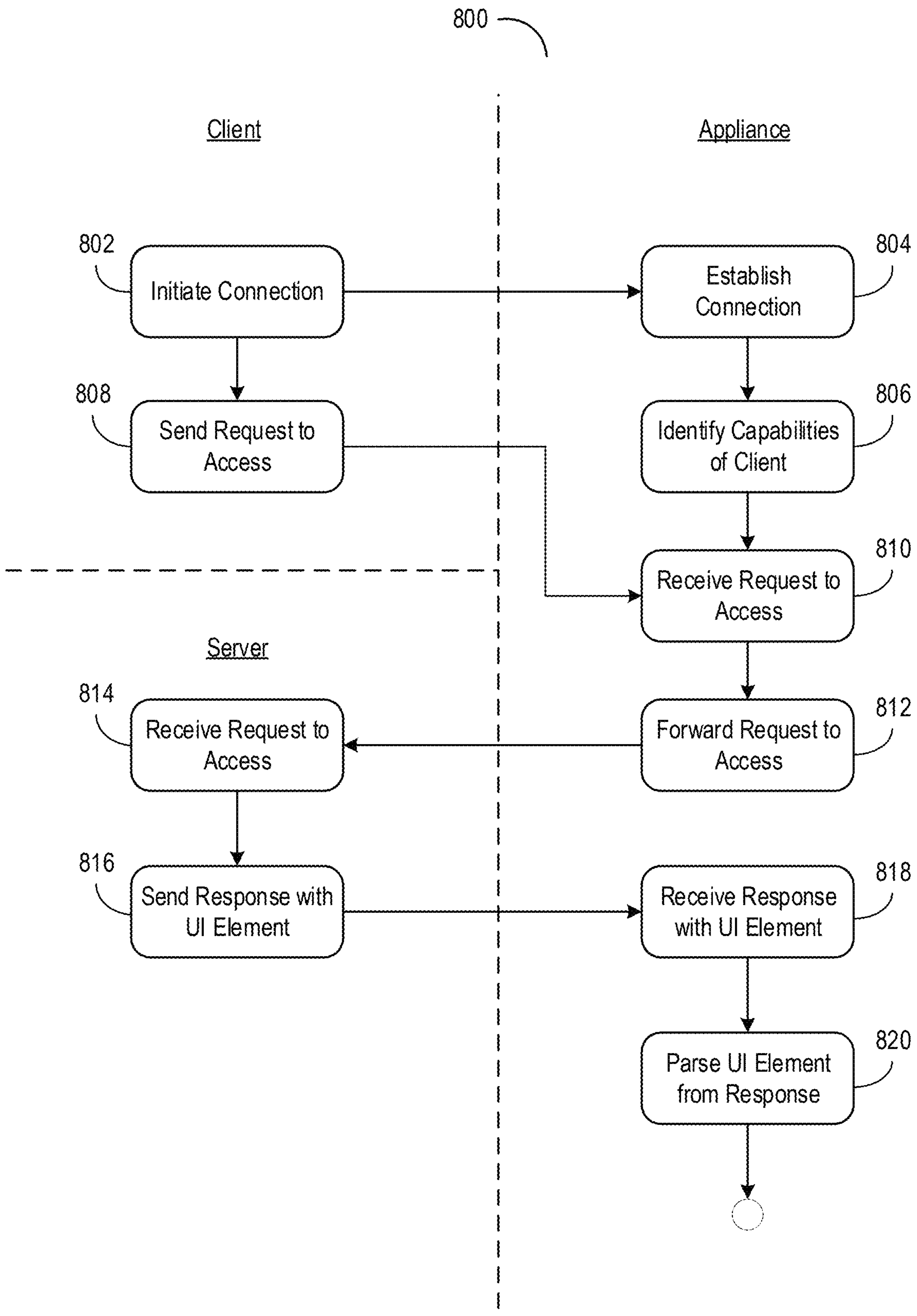

800
Client
Appliance
Server
802
Initiate Connection
804
Establish Connection
808
Send Request to Access
806
Identify Capabilities of Client
810
Receive Request to Access
814
Receive Request to Access
812
Forward Request to Access
816
Send Response with UI Element
818
Receive Response with UI Element
820
Parse UI Element from Response

FIG. 8A

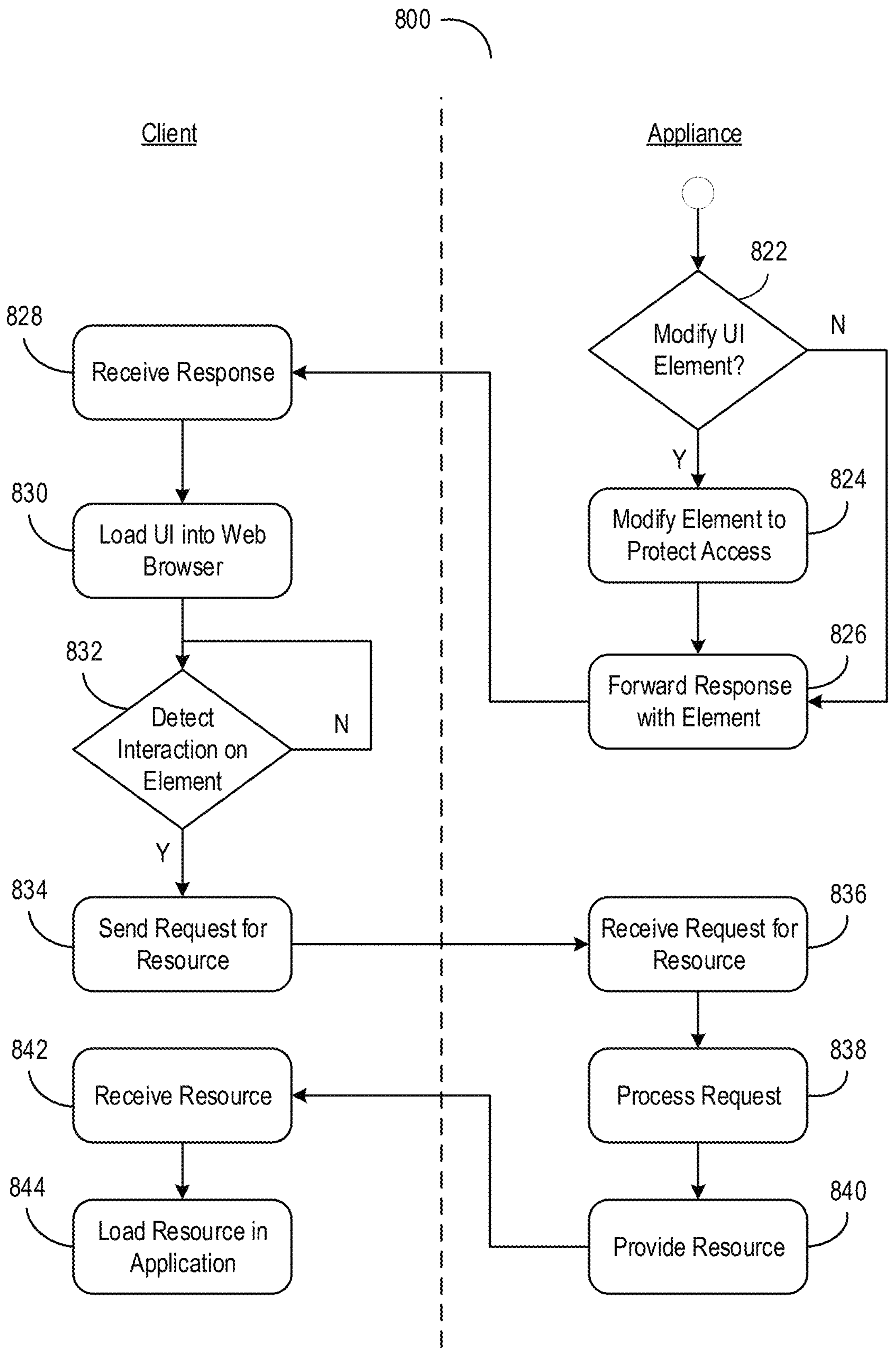

800
Client
Appliance
822
Modify UI Element?
N
Y
824
Modify Element to Protect Access
826
Forward Response with Element
828
Receive Response
830
Load UI into Web Browser
832
Detect Interaction on Element
N
Y
834
Send Request for Resource
836
Receive Request for Resource
838
Process Request
840
Provide Resource
842
Receive Resource
844
Load Resource in Application

FIG. 8B

CONTROL OF CLIENT ACCESS TO SERVER-HOSTED RESOURCES

FIELD OF THE DISCLOSURE

The present application generally relates to network communications. In particular, the present application relates to systems and methods for controlling client access to server-hosted resources.

BACKGROUND

A client may rely on a resource hosted on a server. The client may attempt to access the resource by sending a request to the server. The server may return a response in connection with the request to the client to provide the resource.

BRIEF SUMMARY

This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This summary is not intended to identify key features or essential features, nor is it intended to limit the scope of the claims included herewith.

In a networked environment, a web browser running on a client may access a resource (e.g., a document or other file) hosted on a server using a web application. To access, the web browser may receive a link (e.g., a uniform resource locator (URL)) referencing the resource on the server. When a user interaction (e.g., a click) with the link is detected, the web browser may send a request for the resource from the server. The request may also identify the web application to be used to open the resource. The server may provide both the web application and the resource to the web browser on the client. The web browser on the client may in turn load and present the web browser with the contents of the resource.

While this setup allows for the retrieval of the file, controlling of the client's access to the resource on the server in accordance with a security policy may be insufficient or wholly lacking. There are may be many approaches to addressing the issue of enforcing security policies in this environment. A first approach to handling this issue may be to have an administrator associated with an enterprise, to which the client belongs, may configure web applications to enforce the access controls. Under this approach, however, it may be difficult or impossible to enforce security policies on clients accessing the resources from outside the enterprise. This may be because such clients may be relying on the native applications within the virtual desktop and not the web applications. Furthermore, the administrator the enterprise may lack control over devices outside the enterprise.

A second approach may include use of a uniform resource identifier (URI) protocol intercept in the agent (e.g., the web browser) to enforce access controls. The drawback to this approach may be that one particular type of agent may be specifically configured to use the URI protocol, and other types of agents may thus be not covered by any access controls. As such, to enforce such controls, any links to the resources may have to be accessed through the agent. A third approach may entail registering protocol handlers for processing corresponding types of data with the operating system. While this approach enables enforcing of access control across multiple types of agents, the approach may not be applicable to certain types of operating systems.

Furthermore, if the registration is overwritten, the registration may have to be repeated to re-register the protocol handler.

In addition, a fourth approach may involve installation of an extension on the agent to enforce the security policies. The extension may not be able to have visibility into an inline frame on a webpage, and as such may have limited applicability. A fifth approach may be to include protections in local applications on the client or the native application within the virtual desktop. The number of applications to which the protection can be added, however, may be limited, thereby reducing the utility of the application. A sixth approach may entail use of a computer-vision based technique in the agent or the application to carry out the access controls. But this approach may be computationally expensive, consuming significant amounts of computing resources and thereby reducing the overall performance of the client.

To address these and other technical challenges, a gateway intermediary to the client and the server may modify user interface elements on the application while accessing the resources hosted on the server. To that end, the gateway (also referred herein as an appliance) may be configured with security policies specifying access controls based on the context or capabilities associated with the client attempting to access the resources hosted on the server. Upon connecting with the client, the gateway may scan the client for the capabilities associated with the client using the agent on the client. The capabilities may include various factors, for example: a device profile of the client, protections enabled for local applications, a management status indicating whether the client belongs to an enterprise, and protocol handlers on the client, among others. The capabilities may be used by the gateway to determine which controls to apply in accordance with the security policies.

From the connection, the gateway may receive a request for the resource on the server from the client. The request may be generated by the client in response to a user interaction with a link (e.g., a URL) referencing the resource. The link may have been provided to the client from the server, the gateway, or another source, and may include the reference to the resource itself and the application to be used to access the resource. For instance, the link may contain a substring identifying the application and another substring identifying a file to be opened using the application. Upon receipt, the gateway may forward and direct the request to the server. The server may in turn process the request and generate a response including one or more elements defined for a user interface of the application for accessing the resource. Each element may, for example, correspond to a document object model (DOM) tree element, and may include a protocol handler defining a functionality of the element. Once generated, the server may transmit the response to the gateway.

With receipt, the gateway may parse the response to identify the elements for the user interface of the application. For each element, the gateway may check the capabilities of the client with the security policy to determine whether the element and the protocol handler therein in the response is to be modified. The security policy may specify that that for certain factors of capabilities, the protocol handler or the element is to be disabled, removed, hidden, replaced, or otherwise changed. For example, if the protocol handler for the application is in the element, the security policy may specify that the original protocol handler is to be replaced with a protocol handler of the gateway to access the resource. If the client is identified as not managed by the enterprise and the application is accessible in the virtual desktop, the security policy may specify that the client is to launch the virtual desktop to access the resource. If the client is identified as not managed and the virtual desktop is not available, the security policy may specify that a graphical user interface element for accessing a file in a web application is to be hidden. In this way, the user may be prevented from viewing the element and may not be able to trigger the functionality. In some cases, the policy may specify that a parent or ancestor element of the graphical user interface element for accessing may be hidden, disabled, or removed.

Continuing on, if the client is identified as managed, the security policy may also permit the accessing of the file with an application local to the client. If the client is identified as not managed and the virtual desktop is not used to access the resource, the security policy may specify that the element for "open using desktop application" may be disabled, removed, or hidden. If the client is identified as attempting to access the resource through the virtual desktop and the native application is available within the virtual desktop (e.g., on a disk image), the security policy may specify that the application native to the virtual desktop is to be installed to access the resource. If the client is identified as attempting to access the resource through a web application and there is no native application for opening the resource, the security policy may specify that the virtual desktop is to be launched to access. The security policy may specify a whole host of other risk factors associated with the capabilities of the client to define the countermeasures to be taken.

In accordance with the security policy, the gateway may maintain or modify the elements of the response. Upon completion of the check, the gateway may forward the response to the client. The client in turn may receive and load the elements for the user interface of the application as defined in the response. When a user interaction with an element for opening the resource in an application is detected, the client may process the interaction in accordance with the protocol handler in the element of the user interface. In processing, the client may extract arguments identifying the application and the resource to be accessed, and pass the arguments from the agent to the protocol handler. The processing may be modified in accordance with the security policy.

If the protocol handler has been maintained to execute a native application local to the application as the client is identified as managed, the client may launch the native application. The native application may fetch the resource from the server, and open and load the resource. If the protocol handler has been modified to launch a virtual desktop as the client is identified as not managed, the client may initiate a request to launch the virtual desktop to open an application to access the resource. The gateway may facilitate the establishment of the virtual desktop. With the establishment of the virtual desktop, the client may send a request for the resource through the virtual desktop supported by the gateway. Upon receipt, the client may launch a native application within the virtual desktop to load the resource.

By modifying the elements of the user interface for the application, the gateway may protect and control access to the resources hosted on the server, thereby improving the security of the overall network including the server and the integrity of the resources thereon. In this manner, the gateway may also widen the applicability of the security policy for access controls beyond the limitations in the other enumerated approaches. Since the security of the resources may be maintained outside the enterprise, the gateway may further increase the availability of the resources of the server

beyond the clients associated with the enterprise. The gateway therefore may enhance the utility of the resources, the servers, and the clients.

Aspects of the present disclosure are directed to systems, methods, and non-transitory computer readable media for protecting access to a server. A device intermediary to a client and a server may identify a capability of the client to protect access to the server via an application. The device may determine that an element of a user interface provided by the application to the client is to be modified based at least on the capability. The device may modify, responsive to the determination, the element of the user interface to further protect access to the server in accordance with the capability. The device may provide the modified element to the client for the user interface of the application.

In some embodiments, the device may establish a session between the client and the server to provide the client access to a resource via the application hosted on the server, in response to an interaction with the modified element. In some embodiments, the device may in associate the capability of the client with a modification to be performed on the user interface element of the user interface for the application.

In some embodiments, the device may determine a risk score for the client in protecting access to the server via the application. In some embodiments, the device may determine that the element is to be modified, responsive to the risk score being above a threshold. In some embodiments, the device may identify the capability including at least one of: a device profile of the client, an application profile of the application, a network profile of a network with which the client is connected, or a configuration of a handler on the client.

In some embodiments, the device may identify, in a response from the server to the client, a handler defining a function of the element to access a second server different from the server. In some embodiments, the device may modify a handler defining a function of the element by at least one of removal, hiding, disabling, or replacing the handler. In some embodiments, the device may configure the element of the user interface of the application hosted on the server to further protect access to a resource hosted on the server by at least one of removal, hiding, disabling, or replacing the element.

In some embodiments, the device may forward, from the server to the client, a response including the modified element of the user interface for the application. In some embodiments, the device may provide, responsive to an invocation of the modified user interface element, the client access to a resource via the application hosted on the server.

BRIEF DESCRIPTION OF THE DRAWING FIGURES

Objects, aspects, features, and advantages of embodiments disclosed herein will become more fully apparent from the following detailed description, the appended claims, and the accompanying drawing figures in which like reference numerals identify similar or identical elements. Reference numerals that are introduced in the specification in association with a drawing figure may be repeated in one or more subsequent figures without additional description in the specification in order to provide context for other features, and not every element may be labeled in every figure. The drawing figures are not necessarily to scale, emphasis instead being placed upon illustrating embodiments, principles, and concepts. The drawings are not intended to limit the scope of the claims included herewith.

FIG. **1**A is a block diagram of a network computing system, in accordance with an illustrative embodiment;

FIG. **1**B is a block diagram of a network computing system for delivering a computing environment from a server to a client via an appliance, in accordance with an illustrative embodiment;

FIG. **1**C is a block diagram of a computing device, in accordance with an illustrative embodiment;

FIG. **2** is a block diagram of an appliance for processing communications between a client and a server, in accordance with an illustrative embodiment;

FIG. **3** is a block diagram of a virtualization environment, in accordance with an illustrative embodiment;

FIG. **4** is a block diagram of a cluster system, in accordance with an illustrative embodiment;

FIG. **5** is a block diagram of an embodiment of a system for protecting access by clients to server-hosted resources in accordance with an illustrative embodiment;

FIG. **6**A is a block diagram of an embodiment of a process for probing capabilities of a client in the system for protecting access in accordance with an illustrative embodiment;

FIG. **6**B is a block diagram of an embodiment of a process for modifying elements in the system for protecting access in accordance with an illustrative embodiment;

FIG. **6**C is a block diagram of an embodiment of a process for invoking elements in the system for protecting access in accordance with an illustrative embodiment;

FIG. **7**A is a screenshot of an example display of a user interface of a web application in the system for protecting access in accordance with an illustrative embodiment;

FIG. **7**B is a screenshot of an example display of a user interface of a web application with a modified interface element in the system for protecting access in accordance with an illustrative embodiment; and

FIGS. **8**A and **8**B are flow diagrams of an embodiment of a method of protecting access by clients to server-hosted resources in accordance with an illustrative embodiment.

The features and advantages of the present solution will become more apparent from the detailed description set forth below when taken in conjunction with the drawings, in which like reference characters identify corresponding elements throughout. In the drawings, like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements.

DETAILED DESCRIPTION

For purposes of reading the description of the various embodiments below, the following descriptions of the sections of the specification and their respective contents may be helpful:

Section A describes a network environment and computing environment which may be useful for practicing embodiments described herein;

Section B describes embodiments of systems and methods for delivering a computing environment to a remote user;

Section C describes embodiments of systems and methods for virtualizing an application delivery controller;

Section D describes embodiments of systems and methods for providing a clustered appliance architecture environment; and

Section E describes embodiments of systems and methods for protecting access by clients to server-hosted resources.

A. Network and Computing Environment

Referring to FIG. **1**A, an illustrative network environment **100** is depicted. Network environment **100** may include one or more clients **102**(**1**)-**102**(*n*) (also generally referred to as local machine(s) **102** or client(s) **102**) in communication with one or more servers **106**(**1**)-**106**(*n*) (also generally referred to as remote machine(s) **106** or server(s) **106**) via one or more networks **104**(**1**)-**104**(*n*) (generally referred to as network(s) **104**). In some embodiments, a client **102** may communicate with a server **106** via one or more appliances **200**(**1**)-**200**(*n*) (generally referred to as appliance(s) **200** or gateway(s) **200**).

Although the embodiment shown in FIG. **1**A shows one or more networks **104** between clients **102** and servers **106**, in other embodiments, clients **102** and servers **106** may be on the same network **104**. The various networks **104** may be the same type of network or different types of networks. For example, in some embodiments, network **104**(**1**) may be a private network such as a local area network (LAN) or a company Intranet, while network **104**(**2**) and/or network **104**(*n*) may be a public network, such as a wide area network (WAN) or the Internet. In other embodiments, both network **104**(**1**) and network **104**(*n*) may be private networks. Networks **104** may employ one or more types of physical networks and/or network topologies, such as wired and/or wireless networks, and may employ one or more communication transport protocols, such as transmission control protocol (TCP), internet protocol (IP), user datagram protocol (UDP) or other similar protocols.

As shown in FIG. **1**A, one or more appliances **200** may be located at various points or in various communication paths of network environment **100**. For example, appliance **200** may be deployed between two networks **104**(**1**) and **104**(**2**), and appliances **200** may communicate with one another to work in conjunction to, for example, accelerate network traffic between clients **102** and servers **106**. In other embodiments, the appliance **200** may be located on a network **104**. For example, appliance **200** may be implemented as part of one of clients **102** and/or servers **106**. In an embodiment, appliance **200** may be implemented as a network device such as NetScaler® products sold by Citrix Systems, Inc., of Fort Lauderdale, FL.

As shown in FIG. **1**A, one or more servers **106** may operate as a server farm **38**. Servers **106** of server farm **38** may be logically grouped, and may either be geographically co-located (e.g., on premises) or geographically dispersed (e.g., cloud based) from clients **102** and/or other servers **106**. In an embodiment, server farm **38** executes one or more applications on behalf of one or more of clients **102** (e.g., as an application server), although other uses are possible, such as a file server, gateway server, proxy server, or other similar server uses. Clients **102** may seek access to hosted applications on servers **106**.

As shown in FIG. **1**A, in some embodiments, appliances **200** may include, be replaced by, or be in communication with, one or more additional appliances, such as WAN optimization appliances **205**(**1**)-**205**(*n*), referred to generally as WAN optimization appliance(s) **205**. For example, WAN optimization appliance **205** may accelerate, cache, compress or otherwise optimize or improve performance, operation, flow control, or quality of service of network traffic, such as traffic to and/or from a WAN connection, such as optimizing Wide Area File Services (WAFS), accelerating Server Message Block (SMB) or Common Internet File System (CIFS). In some embodiments, appliance **205** may be a performance enhancing proxy or a WAN optimization controller. In one embodiment, appliance **205** may be implemented as CloudBridge® products sold by Citrix Systems, Inc., of Fort Lauderdale, FL.

Referring to FIG. **1**B, an example network environment **100'** for delivering and/or operating a computing network environment on a client **102** is shown. As shown in FIG. **1**B, a server **106** may include an application delivery system **190** for delivering a computing environment, application, and/or data files to one or more clients **102**. Client **102** may include client agent **120** and computing environment **15**. Computing environment **15** may execute or operate an application **16**, that accesses, processes, or uses a data file **17**. Computing environment **15**, application **16**, and/or data file **17** may be delivered to the client **102** via appliance **200** and/or the server **106**.

Appliance **200** may accelerate delivery of all or a portion of computing environment **15** to a client **102**, for example by the application delivery system **190**. For example, appliance **200** may accelerate delivery of a streaming application and data file processable by the application from a data center to a remote user location by accelerating transport layer traffic between a client **102** and a server **106**. Such acceleration may be provided by one or more techniques, such as: 1) transport layer connection pooling, 2) transport layer connection multiplexing, 3) transport control protocol buffering, 4) compression, 5) caching, or (6) other techniques. Appliance **200** may also provide load balancing of servers **106** to process requests from clients **102**, act as a proxy or access server to provide access to the one or more servers **106**, provide security and/or act as a firewall between a client **102** and a server **106**, provide Domain Name Service (DNS) resolution, provide one or more virtual servers or virtual internet protocol servers, and/or provide a secure virtual private network (VPN) connection from a client **102** to a server **106**, such as a secure socket layer (SSL) VPN connection and/or provide encryption and decryption operations.

Application delivery system **190** may deliver computing environment **15** to a user (e.g., client **102**), remote or otherwise, based on authentication and authorization policies applied by policy engine **195**. A remote user may obtain a computing environment and access to server stored applications and data files from any network-connected device (e.g., client **102**). For example, appliance **200** may request an application and data file from server **106**. In response to the request, application delivery system **190** and/or server **106** may deliver the application and data file to client **102**, for example via an application stream to operate in computing environment **15** on client **102**, or via a remote-display protocol or otherwise via remote-based or server-based computing. In an embodiment, application delivery system **190** may be implemented as any portion of the Citrix Workspace Suite™ by Citrix Systems, Inc., such as XenApp® or XenDesktop®.

Policy engine **195** may control and manage the access to, and execution and delivery of, applications. For example, policy engine **195** may determine the one or more applications a user or client **102** may access and/or how the application should be delivered to the user or client **102**, such as a server-based computing, streaming or delivering the application locally to the client **102** for local execution.

For example, in operation, a client **102** may request execution of an application (e.g., application **16'**) and application delivery system **190** of server **106** determines how to execute application **16'**, for example based upon credentials received from client **102** and a user policy applied by policy engine **195** associated with the credentials. For example, application delivery system **190** may enable client **102** to receive application-output data generated by execution of the application on a server **106**, may enable client **102** to execute the application locally after receiving the application from server **106**, or may stream the application via network **104** to client **102**. For example, in some embodiments, the application may be a server-based or a remote-based application executed on server **106** on behalf of client **102**. Server **106** may display output to client **102** using a thin-client or remote-display protocol, such as the Independent Computing Architecture (ICA) protocol by Citrix Systems, Inc., of Fort Lauderdale, FL. The application may be any application related to real-time data communications, such as applications for streaming graphics, streaming video and/or audio or other data, delivery of remote desktops or workspaces or hosted services or applications, for example infrastructure as a service (IaaS), workspace as a service (WaaS), software as a service (SaaS) or platform as a service (PaaS).

One or more of servers **106** may include a performance monitoring service or agent **197**. In some embodiments, a dedicated one or more servers **106** may be employed to perform performance monitoring. Performance monitoring may be performed using data collection, aggregation, analysis, management and reporting, for example by software, hardware or a combination thereof. Performance monitoring may include one or more agents for performing monitoring, measurement and data collection activities on clients **102** (e.g., client agent **120**), servers **106** (e.g., agent **197**) or appliances **200** and/or **205** (agent not shown). In general, monitoring agents (e.g., **120** and/or **197**) execute transparently (e.g., in the background) to any application and/or user of the device. In some embodiments, monitoring agent **197** includes any of the product embodiments referred to as EdgeSight by Citrix Systems, Inc., of Fort Lauderdale, FL.

The monitoring agents **120** and **197** may monitor, measure, collect, and/or analyze data on a predetermined frequency, based upon an occurrence of given event(s), or in real time during operation of network environment **100**. The monitoring agents may monitor resource consumption and/or performance of hardware, software, and/or communications resources of clients **102**, networks **104**, appliances **200** and/or **205**, and/or servers **106**. For example, network connections such as a transport layer connection, network latency, bandwidth utilization, end-user response times, application usage and performance, session connections to an application, cache usage, memory usage, processor usage, storage usage, database transactions, client and/or server utilization, active users, duration of user activity, application crashes, errors, or hangs, the time required to log-in to an application, a server, or the application delivery system, and/or other performance conditions and metrics may be monitored.

The monitoring agents **120** and **197** may provide application performance management for application delivery system **190**. For example, based upon one or more monitored performance conditions or metrics, application delivery system **190** may be dynamically adjusted, for example periodically or in real-time, to optimize application delivery by servers **106** to clients **102** based upon network environment performance and conditions.

In described embodiments, clients **102**, servers **106**, and/or appliances **200** and **205** may be deployed as and/or executed on any type and form of computing device, such as any desktop computer, laptop computer, or mobile device capable of communication over at least one network and performing the operations described herein. For example, clients **102**, servers **106** and/or appliances **200** and **205** may each correspond to one computer, a plurality of computers, or a network of distributed computers such as computer **101** shown in FIG. **1**C.

As shown in FIG. **1**C, computer **101** may include one or more processor(s) **103**, volatile memory **122** (e.g., RAM), non-volatile memory **128** (e.g., one or more hard disk drives (HDDs) or other magnetic or optical storage media, one or more solid state drives (SSDs) such as a flash drive or other solid state storage media, one or more hybrid magnetic and solid state drives, and/or one or more virtual storage volumes, such as a cloud storage, or a combination of such physical storage volumes and virtual storage volumes or arrays thereof), user interface (UI) **123**, one or more communication interface(s) **118**, and communication bus **150**. User interface **123** may include graphical user interface (GUI) **124** (e.g., a touchscreen, a display, etc.) and one or more input/output (I/O) device(s) **126** (e.g., a mouse, a keyboard, etc.). Non-volatile memory **128** stores operating system **115**, one or more application(s) **116**, and data **117** such that, for example, computer instructions of operating system **115** and/or application(s) **116** are executed by processor(s) **103** out of volatile memory **122**. Data may be entered using an input device of GUI **124** or received from I/O device(s) **126**. Various elements of computer **101** may communicate via communication bus **150**. Computer **101** as shown in FIG. **1**C is shown merely as an example, as clients **102**, servers **106**, and/or appliances **200** and **205** may be implemented by any computing or processing environment and with any type of machine or set of machines that may have suitable hardware and/or software capable of operating as described herein.

Processor(s) **103** may be implemented by one or more programmable processors executing one or more computer programs to perform the functions of the system. As used herein, the term "processor" describes an electronic circuit that performs a function, an operation, or a sequence of operations. The function, operation, or sequence of operations may be hard coded into the electronic circuit or soft coded by way of instructions held in a memory device. A "processor" may perform the function, operation, or sequence of operations using digital values or using analog signals. In some embodiments, the "processor" can be embodied in one or more application specific integrated circuits (ASICs), microprocessors, digital signal processors, microcontrollers, field programmable gate arrays (FPGAs), programmable logic arrays (PLAs), multi-core processors, or general-purpose computers with associated memory. The "processor" may be analog, digital, or mixed-signal. In some embodiments, the "processor" may be one or more physical processors or one or more "virtual" (e.g., remotely located or "cloud") processors.

Communication interface(s) **118** may include one or more interfaces to enable computer **101** to access a computer network such as a LAN, a WAN, or the Internet through a variety of wired and/or wireless or cellular connections.

In described embodiments, a first computing device **101** may execute an application on behalf of a user of a client computing device (e.g., a client **102**), may execute a virtual machine, which provides an execution session within which applications execute on behalf of a user or a client computing device (e.g., a client **102**), such as a hosted desktop session, may execute a terminal services session to provide a hosted desktop environment, or may provide access to a computing environment including one or more of: one or more applications, one or more desktop applications, and one or more desktop sessions in which one or more applications may execute.

B. Appliance Architecture

FIG. **2** shows an example embodiment of appliance **200**. As described herein, appliance **200** may be implemented as a server, gateway, router, switch, bridge, or other type of computing or network device. As shown in FIG. **2**, an embodiment of appliance **200** may include a hardware layer **206** and a software layer **205** divided into a user space **202** and a kernel space **204**. Hardware layer **206** provides the hardware elements upon which programs and services within kernel space **204** and user space **202** are executed and allow programs and services within kernel space **204** and user space **202** to communicate data both internally and externally with respect to appliance **200**. As shown in FIG. **2**, hardware layer **206** may include one or more processing units **262** for executing software programs and services, memory **264** for storing software and data, network ports **266** for transmitting and receiving data over a network, and encryption processor **260** for encrypting and decrypting data such as in relation to Secure Socket Layer (SSL) or Transport Layer Security (TLS) processing of data transmitted and received over the network.

An operating system of appliance **200** allocates, manages, or otherwise segregates the available system memory into kernel space **204** and user space **202**. Kernel space **204** is reserved for running kernel **230**, including any device drivers, kernel extensions or other kernel related software. As known to those skilled in the art, kernel **230** is the core of the operating system, and provides access, control, and management of resources and hardware-related elements of application. Kernel space **204** may also include a number of network services or processes working in conjunction with cache manager **232**.

Appliance **200** may include one or more network stacks **267**, such as a TCP/IP-based stack, for communicating with client(s) **102**, server(s) **106**, network(s) **104**, and/or other appliances **200** or **205**. For example, appliance **200** may establish and/or terminate one or more transport layer connections between clients **102** and servers **106**. Each network stack **267** may include a buffer for queuing one or more network packets for transmission by appliance **200**.

Kernel space **204** may include cache manager **232**, packet engine **240**, encryption engine **234**, policy engine **236** and compression engine **238**. In other words, one or more of processes **232**, **240**, **234**, **236**, and **238** run in the core address space of the operating system of appliance **200**, which may reduce the number of data transactions to and from the memory and/or context switches between kernel mode and user mode, for example since data obtained in kernel mode may not need to be passed or copied to a user process, thread, or user level data structure.

Cache manager **232** may duplicate original data stored elsewhere or data previously computed, generated, or transmitted to reduce the access time of the data. In some embodiments, the cache manager **232** may be a data object in memory **264** of appliance **200**, or may be a physical memory having a faster access time than memory **264**.

Policy engine **236** may include a statistical engine or other configuration mechanism to allow a user to identify, specify, define or configure a caching policy and access, control and management of objects, data or content being cached by appliance **200**, and define or configure security, network traffic, network access, compression or other functions performed by appliance **200**.

Encryption engine **234** may process any security related protocol, such as SSL or TLS. For example, encryption engine **234** may encrypt and decrypt network packets, or any portion thereof, communicated via appliance **200**, may setup or establish SSL, TLS or other secure connections, for example between client **102**, server **106**, and/or other appliance **200** or **205**. In some embodiments, encryption engine **234** may use a tunneling protocol to provide a VPN between a client **102** and a server **106**. In some embodiments, encryption engine **234** is in communication with encryption processor **260**. Compression engine **238** compresses network packets bi-directionally between clients **102** and servers **106** and/or between one or more appliances **200**.

Packet engine **240** may manage kernel-level processing of packets received and transmitted by appliance **200** via network stack **267** to send and receive network packets via network ports **266**. Packet engine **240** may operate in conjunction with encryption engine **234**, cache manager **232**, policy engine **236**, and compression engine **238**, for example to perform encryption/decryption, traffic management such as request-level content switching and request-level cache redirection, and compression and decompression of data.

User space **202** is a memory area or portion of the operating system used by user mode applications or programs otherwise running in user mode. A user mode application may not access kernel space **204** directly and uses service calls in order to access kernel services. User space **202** may include graphical user interface (GUI) **210**, a command line interface (CLI) **212**, shell services **214**, health monitor **216**, and daemon services **218**. GUI **210** and CLI **212** enable a system administrator or other user to interact with and control the operation of appliance **200**, such as via the operating system of appliance **200**. Shell services **214** include programs, services, tasks, processes or executable instructions to support interaction with appliance **200** by a user via the GUI **210** and/or CLI **212**.

Health monitor **216** monitors, checks, reports, and ensures that network systems are functioning properly and that users are receiving requested content over a network, for example by monitoring activity of appliance **200**. In some embodiments, health monitor **216** intercepts and inspects any network traffic passed via appliance **200**. For example, health monitor **216** may interface with one or more of encryption engine **234**, cache manager **232**, policy engine **236**, compression engine **238**, packet engine **240**, daemon services **218**, and shell services **214** to determine a state, status, operating condition, or health of any portion of the appliance **200**. Further, health monitor **216** may determine whether a program, process, service, or task is active and currently running, check status, error or history logs provided by any program, process, service, or task to determine any condition, status or error with any portion of appliance **200**. Additionally, health monitor **216** may measure and monitor the performance of any application, program, process, service, task, or thread executing on appliance **200**.

Daemon services **218** are programs that run continuously or in the background and handle periodic service requests received by appliance **200**. In some embodiments, a daemon service may forward the requests to other programs or processes, such as another daemon service **218** as appropriate.

As described herein, appliance **200** may relieve servers **106** of much of the processing load caused by repeatedly opening and closing transport layers connections to clients **102** by opening one or more transport layer connections with each server **106** and maintaining these connections to allow repeated data accesses by clients via the Internet (e.g., "connection pooling"). To perform connection pooling, appliance **200** may translate or multiplex communications by modifying sequence numbers and acknowledgment numbers at the transport layer protocol level (e.g., "connection multiplexing"). Appliance **200** may also provide switching or load balancing for communications between the client **102** and server **106**.

As described herein, each client **102** may include client agent **120** for establishing and exchanging communications with appliance **200** and/or server **106** via a network **104**. Client **102** may have installed and/or execute one or more applications that are in communication with network **104**. Client agent **120** may intercept network communications from a network stack used by the one or more applications. For example, client agent **120** may intercept a network communication at any point in a network stack and redirect the network communication to a destination desired, managed, or controlled by client agent **120**, for example to intercept and redirect a transport layer connection to an IP address and port controlled or managed by client agent **120**. Thus, client agent **120** may transparently intercept any protocol layer below the transport layer, such as the network layer, and any protocol layer above the transport layer, such as the session, presentation or application layers. Client agent **120** can interface with the transport layer to secure, optimize, accelerate, route, or load-balance any communications provided via any protocol carried by the transport layer.

In some embodiments, client agent **120** is implemented as an Independent Computing Architecture (ICA) client developed by Citrix Systems, Inc., of Fort Lauderdale, FL. Client agent **120** may perform acceleration, streaming, monitoring, and/or other operations. For example, client agent **120** may accelerate streaming an application from a server **106** to a client **102**. Client agent **120** may also perform end-point detection/scanning and collect end-point information about client **102** for appliance **200** and/or server **106**. Appliance **200** and/or server **106** may use the collected information to determine and provide access, authentication and authorization control of the client's connection to network **104**. For example, client agent **120** may identify and determine one or more client-side attributes, such as: the operating system and/or a version of an operating system, a service pack of the operating system, a running service, a running process, a file, presence or versions of various applications of the client, such as antivirus, firewall, security, and/or other software.

C. Systems and Methods for Providing Virtualized Application Delivery Controller

Referring now to FIG. **3**, a block diagram of a virtualized environment **300** is shown. As shown, a computing device **302** in virtualized environment **300** includes a virtualization layer **303**, a hypervisor layer **304**, and a hardware layer **307**. Hypervisor layer **304** includes one or more hypervisors (or virtualization managers) **301** that allocates and manages access to a number of physical resources in hardware layer **307** (e.g., physical processor(s) **321** and physical disk(s) **328**) by at least one virtual machine (VM) (e.g., one of VMs **306**) executing in virtualization layer **303**. Each VM **306** may include allocated virtual resources such as virtual processors **332** and/or virtual disks **342**, as well as virtual resources such as virtual memory and virtual network interfaces. In some embodiments, at least one of VMs **306** may include a control operating system (e.g., **305**) in communication with hypervisor **301** and used to execute applications for managing and configuring other VMs (e.g., guest operating systems **310**) on device **302**.

In general, hypervisor(s) **301** may provide virtual resources to an operating system of VMs **306** in any manner that simulates the operating system having access to a physical device. Thus, hypervisor(s) **301** may be used to emulate virtual hardware, partition physical hardware, virtualize physical hardware, and execute virtual machines that provide access to computing environments. In an illustrative embodiment, hypervisor(s) **301** may be implemented as a XEN hypervisor, for example as provided by the open source Xen.org community. In an illustrative embodiment, device **302** executing a hypervisor that creates a virtual machine platform on which guest operating systems may execute is referred to as a host server. In such an embodiment, device **302** may be implemented as a XEN server as provided by Citrix Systems, Inc., of Fort Lauderdale, FL.

Hypervisor **301** may create one or more VMs **306** in which an operating system (e.g., control operating system **305** and/or guest operating system **310**) executes. For example, the hypervisor **301** loads a virtual machine image to create VMs **306** to execute an operating system. Hypervisor **301** may present VMs **306** with an abstraction of hardware layer **307**, and/or may control how physical capabilities of hardware layer **307** are presented to VMs **306**. For example, hypervisor(s) **301** may manage a pool of resources distributed across multiple physical computing devices.

In some embodiments, one of VMs **306** (e.g., the VM executing control operating system **305**) may manage and configure other of VMs **306**, for example by managing the execution and/or termination of a VM and/or managing allocation of virtual resources to a VM. In various embodiments, VMs may communicate with hypervisor(s) **301** and/or other VMs via, for example, one or more Application Programming Interfaces (APIs), shared memory, and/or other techniques.

In general, VMs **306** may provide a user of device **302** with access to resources within virtualized computing environment **300**, for example, one or more programs, applications, documents, files, desktop and/or computing environments, or other resources. In some embodiments, VMs **306** may be implemented as fully virtualized VMs that are not aware that they are virtual machines (e.g., a Hardware Virtual Machine or HVM). In other embodiments, the VM may be aware that it is a virtual machine, and/or the VM may be implemented as a paravirtualized (PV) VM.

Although shown in FIG. **3** as including a single virtualized device **302**, virtualized environment **300** may include a plurality of networked devices in a system in which at least one physical host executes a virtual machine. A device on which a VM executes may be referred to as a physical host and/or a host machine. For example, appliance **200** may be additionally or alternatively implemented in a virtualized environment **300** on any computing device, such as a client **102**, server **106**, or appliance **200**. Virtual appliances may provide functionality for availability, performance, health monitoring, caching and compression, connection multiplexing and pooling and/or security processing (e.g., firewall, VPN, encryption/decryption, etc.), similarly as described in regard to appliance **200**.

In some embodiments, a server may execute multiple virtual machines **306**, for example on various cores of a multi-core processing system and/or various processors of a multiple processor device. For example, although generally shown herein as "processors" (e.g., in FIGS. **1**C, **2**, and **3**), one or more of the processors may be implemented as either single- or multi-core processors to provide a multi-threaded, parallel architecture and/or multi-core architecture. Each processor and/or core may have or use memory that is allocated or assigned for private or local use that is only accessible by that processor/core, and/or may have or use memory that is public or shared and accessible by multiple processors/cores. Such architectures may allow work, task, load, or network traffic distribution across one or more processors and/or one or more cores (e.g., by functional parallelism, data parallelism, flow-based data parallelism, etc.).

Further, instead of (or in addition to) the functionality of the cores being implemented in the form of a physical processor/core, such functionality may be implemented in a virtualized environment (e.g., **300**) on a client **102**, server **106**, or appliance **200**, such that the functionality may be implemented across multiple devices, such as a cluster of computing devices, a server farm, or network of computing devices, etc. The various processors/cores may interface or communicate with each other using a variety of interface techniques, such as core to core messaging, shared memory, kernel APIs, etc.

In embodiments employing multiple processors and/or multiple processor cores, described embodiments may distribute data packets among cores or processors, for example to balance the flows across the cores. For example, packet distribution may be based upon determinations of functions performed by each core, source and destination addresses, and/or whether: a load on the associated core is above a predetermined threshold; the load on the associated core is below a predetermined threshold; the load on the associated core is less than the load on the other cores; or any other metric that can be used to determine where to forward data packets based in part on the amount of load on a processor.

For example, data packets may be distributed among cores or processes using receive-side scaling (RSS) in order to process packets using multiple processors/cores in a network. RSS generally allows packet processing to be balanced across multiple processors/cores while maintaining in-order delivery of the packets. In some embodiments, RSS may use a hashing scheme to determine a core or processor for processing a packet.

The RSS may generate hashes from any type and form of input, such as a sequence of values. This sequence of values can include any portion of the network packet, such as any header, field or payload of network packet, and include any tuples of information associated with a network packet or data flow, such as addresses and ports. The hash result or any portion thereof may be used to identify a processor, core, engine, etc., for distributing a network packet, for example via a hash table, indirection table, or other mapping technique.

D. Systems and Methods for Providing a Distributed Cluster Architecture

Although shown in FIGS. **1**A and **1**B as being single appliances, appliances **200** may be implemented as one or more distributed or clustered appliances. Individual computing devices or appliances may be referred to as nodes of the cluster. A centralized management system may perform load balancing, distribution, configuration, or other tasks to allow the nodes to operate in conjunction as a single computing system. Such a cluster may be viewed as a single virtual appliance or computing device. FIG. **4** shows a block diagram of an illustrative computing device cluster or appliance cluster **400**. A plurality of appliances **200** or other computing devices (e.g., nodes) may be joined into a single cluster **400**. Cluster **400** may operate as an application server, network storage server, backup service, or any other type of computing device to perform many of the functions of appliances **200** and/or **205**.

In some embodiments, each appliance **200** of cluster **400** may be implemented as a multi-processor and/or multi-core appliance, as described herein. Such embodiments may employ a two-tier distribution system, with one appliance if the cluster distributing packets to nodes of the cluster, and each node distributing packets for processing to processors/cores of the node. In many embodiments, one or more of appliances **200** of cluster **400** may be physically grouped or geographically proximate to one another, such as a group of blade servers or rack mount devices in a given chassis, rack, and/or data center. In some embodiments, one or more of appliances **200** of cluster **400** may be geographically distributed, with appliances **200** not physically or geographically co-located. In such embodiments, geographically remote appliances may be joined by a dedicated network connection and/or VPN. In geographically distributed embodiments, load balancing may also account for communications latency between geographically remote appliances.

In some embodiments, cluster **400** may be considered a virtual appliance, grouped via common configuration, management, and purpose, rather than as a physical group. For example, an appliance cluster may comprise a plurality of virtual machines or processes executed by one or more servers.

As shown in FIG. **4**, appliance cluster **400** may be coupled to a client-side network **104** via client data plane **402**, for example to transfer data between clients **102** and appliance cluster **400**. Client data plane **402** may be implemented a switch, hub, router, or other similar network device internal or external to cluster **400** to distribute traffic across the nodes of cluster **400**. For example, traffic distribution may be performed based on equal-cost multi-path (ECMP) routing with next hops configured with appliances or nodes of the cluster, open-shortest path first (OSPF), stateless hash-based traffic distribution, link aggregation (LAG) protocols, or any other type and form of flow distribution, load balancing, and routing.

Appliance cluster **400** may be coupled to a second network **104'** via server data plane **404**. Similarly to client data plane **402**, server data plane **404** may be implemented as a switch, hub, router, or other network device that may be internal or external to cluster **400**. In some embodiments, client data plane **402** and server data plane **404** may be merged or combined into a single device.

In some embodiments, each appliance **200** of cluster **400** may be connected via an internal communication network or black plane **406**. Black plane **406** may enable inter-node or inter-appliance control and configuration messages, for inter-node forwarding of traffic, and/or for communicating configuration and control traffic from an administrator or user to cluster **400**. In some embodiments, black plane **406** may be a physical network, a VPN or tunnel, or a combination thereof.

E. Systems and Methods for Protecting Access by Clients to Server-Hosted Resources

Referring now to FIG. **5**, depicted is a system **500** for protecting access by clients to server-hosted resources. In overview, the system **500** may include one or more clients **102A-102**N (hereinafter generally referred to as clients **102**), one or more servers **106A-106**N (hereinafter generally referred to as servers **106**), and at least one appliance **200** deployed between the clients **102** and the servers **106**. The system **500** may include at least one network **104** to communicatively couple the clients **102** with the appliance **200** and at least one network **104'** to communicatively couple the appliance **200** with the servers **106**. The appliance **200** may include at least one connection manager **505**, at least one context evaluator **510**, at least one access handler **515**, at least one policy enforcer **520**, at least one desktop controller **525**, and at least one database **530**, among others. The database **530** may store, maintain, or otherwise include at least one policy **535**. At least one of the clients **102** may include at least one agent **540**, at least one web browser **545**, and at least one local application **550**, among others. In some embodiments, the agent **540** may be an instance of the client agent **102** detailed above. At least one of the servers **106** may include at least one remote application **555** and a set of resources **560**A-N (hereinafter referred generally as resources **560**).

The systems and methods of the present solution may be implemented in any type and form of device, including clients, servers and/or appliances **200**. As referenced herein, a "server" may sometimes refer to any device in a client-server relationship, e.g., an appliance **200** in a handshake with a client device **102**. The present systems and methods may be implemented in any intermediary device or gateway, such as any embodiments of the appliance or devices **200** described herein. Some portion of the present systems and methods may be implemented as part of a packet processing engine and/or virtual server of an appliance, for instance. The systems and methods may be implemented in any type and form of environment, including multi-core appliances, virtualized environments and/or clustered environments described herein.

Referring now to FIG. **6**A, depicted is a block diagram a process **600** for probing capabilities of the client **102** in the system **500** for protecting access. The process **600** may correspond to or include operations performed in the system **500** to initiate a connection with the appliance **200**. Under the process **600**, the agent **540** executing on the client **102** may initiate and establish a session **605** with the appliance **200** over the network **104**. The session **605** may be for encrypting and securing communications between the client **102** and the appliance **200** to access the server **106**. The session **605** may facilitate the provision of the remote application **555** or the resources **560** from the server **106** to the client **102**. In some embodiments, the session **605** may facilitate the provision of the remote application **555** or the resources **560** via a virtual desktop **615** supported by the appliance **200**. For example, the agent **540** may establish the session **605** to retrieve a workspace or a remote desktop supported by the appliance **200** to access cloud-based resources in the network **104'**, such as the remote application **555** and the resources **560** on the server **106**. Access by the client **102** to the remote application **555** and the resources **560** may be controlled by the appliance **200** as detailed herein below.

To initiate the session, the agent **540** may provide, send, or otherwise transmit a request **610** to connect with the appliance **200**. The request **610** may identify the appliance **200** with which to establish the session. In some embodiments, the request **610** may identify the remote application **555** or the resources **560** to be accessed via the agent **540** on the client **102**. In some embodiments, the request **610** may include an indicator whether the virtual desktop **615** is to be provided over the session **610** or may identify the virtual desktop **615** itself to be accessed via the session **605**. The request **610** may identify the client **102**, a user of the client **102** (e.g., an account identifier), and authentication credentials for the user, among others. In some embodiments, the agent **540** may generate the request **610**, in conjunction with the launching of the agent **540** on the client **102**. For example, upon opening the agent **540**, a user of the client **102** (e.g., an account identifier) and authentication credentials for the user into a user interface of the agent **540** to login to the appliance **200**. Using the input, the agent **540** may generate the request **610** to include the identifier for the user and the authentication credentials. With the generation of the request **610**, the agent **540** may send the request **610** to the appliance **200**. In some embodiments, the agent **540** may transmit the request **610** without user input.

The connection manager **505** on the appliance **200** may in turn retrieve, identify, or otherwise receive the request **610** from the client **102**. Upon receipt, the connection manager **505** may complete the establishment of the session **605** between the client **102** and the appliance **200**. In some embodiments, the connection manager **505** may parse the request **610** to identify the applications **555** or the resources **560** to be accessed at the agent **540**. The connection manager **505** may provide the client **102** access to the applications **555** or the resources **560** through the session **605**. The remote application **555** may include or correspond to a resource, a program, or executable hosted on the server **106** or otherwise accessible via the appliance **200**. The remote application **555** may include a variety of applications, such as word processor, an image editor, a video editor, a web browser, and an electronic mail agent, among others. In some embodiments, the remote application **555** may be a web application to be loaded via the web browser **545**. In some embodiments, the remote application **555** may be a virtualized application (e.g., Software as a Service (SaaS) application) to be loaded via the virtual desktop **615**. The resources **560** may include data accessible via the remote application **555** or another application on the client **102**, such as the web browser **545** or the local application **550**. The data in the resources **560** may include, for example, text, image, video, audio, and other data, or any combination thereof. In some embodiments, to signal completion of establishment, the connection manager **505** may return, send, or otherwise transmit an acknowledgment response to the client **102**.

In some embodiments, the connection manager **505** may check whether the identifier for the user and the authentication credentials in the request **610** matches with the identifier for the user and the authentication credentials maintained by the appliance **200**. The connection manager **505** may parse the request **610** to identify the identifier (e.g., account identifier) for the user of the client **102** and the authentication credentials. The connection manager **505** may check the identifier for the user and the authentication credentials in the request **610** with the identifier for the user and the authentication credentials maintained by the appliance **200**. If the identifier for the user and the authentication credential are validated from the check, the connection manager **505** may proceed to establish the session **605**. Otherwise, if not validated, the connection manager **505** may refrain from establishing the session **605**, send a response indicating failure to validate the identifier for the user and the authentication credential to the client **102**, and repeat the process again.

In some embodiments, the connection manager **505** may provide the virtual desktop **615** via the session **605** for the agent **540**. The provision may be in response to the request **610** indicating that the virtual desktop **615** is to be provided. In some embodiments, the connection manager **505** may select an already existing virtual desktop **615**. The existing virtual desktop **615** may be identified using the identifier in the request **610** or using the remote application **555** and the resources **560** identified in the request **610**. In some embodiments, the connection manager **505** may instantiate, launch, or otherwise create the virtual desktop **615**. The virtual desktop **615** may be in accordance with a communications protocol for the provision of the remote application **555** and the resources **560** from the server **106** to the client **102**, such as the Remote Desktop Protocol (RDP) or the Independent Computing Architecture (ICA), among others.

With the establishment of the session **605**, the context evaluator **510** on the appliance **200** may provide, send, or otherwise transmit a probe **620** to the client **102** to determine or identify one or more capabilities **625** (sometimes herein referred to as context) associated with the client **102**. In some embodiments, the identification of the capabilities **625** may be sent by the client **102** with the initial request **610**. In some embodiments, the context evaluator **510** may transmit the probe **620** in response to establishment of the session **605**. In some embodiments, the context evaluator **510** may have visibility to the capabilities **625** associated with the client **102** via the agent **540** and the session **605**. The probe **620** sent by the context evaluator **510** may specify which type of capabilities **625** are to be identified.

The capabilities **625** may identify or include, for example: a device profile of the client **102**; an application profile of the local application **550** or the remote application **555** to be used to access the resources **560**; a network profile of the network **104** to which the client **102** belongs or is accessing the appliance **200**; and a configuration of a protocol handler on the client **102**, among others. The device profile may identify a device type of the client **102**, such as one of mobile phone, laptop, desktop, or smart television. The device profile may identify a management status of the client **102**, such as whether the client **102** is a personal device (also herein referred to as a "bring your own device" (BYOD)) or managed by an administrator of an enterprise (also herein referred to as a "managed device"). The device profile may identify whether the client **102** has launched the virtual desktop **615** in the session **605**.

In addition, the application profile may include an identifier for the application, such as the local application **550** or the remote application **555**. The application profile may identify which types of files (e.g., resources **560**) can be opened using the application. The application profile may also identify a security or application protection feature provided by the application, such as anti-keylogging function, an anti-screenshot feature, or data exfiltration prevention, among others. The network profile may identify whether the network **104** is a secure network (e.g., a virtual private network (VPN), intranet, enterprise network, or branch office network) or a public network (e.g., the Internet), among others. The configuration of the protocol handler may identify which protocol handler (e.g., on the web browser **545**) is to be used to handle accessing of the remote application **555** or the resources **560**.

The agent **540** on the client **120** may in turn retrieve, identify, or otherwise receive the probe **620** from the appliance **200**. Upon receipt, the agent **540** may gather, obtain, or identify the capabilities **625** to be identified as specified by the probe **620** from the client **102**. In gathering, the agent **540** may inspect the client **102** to determine the device profile for the client **102**. For instance, the agent **540** may access an operating system on the client **102** to retrieve device type and management status. The agent **540** may also identify the application profile for the local application **550** capable of accessing the resources **650**. In addition, the agent **540** may identify the application profile for the remote application **555** through the session **605** (e.g., via the virtual desktop **615**). The agent **540** may further determine the network profile by accessing the network **104** to which the client **102** is connected. The agent **540** may also identify which protocol handlers are configured to handle the accessing the remote applications **555** or the resources **560** (e.g., from scanning the web browser **545**). With the gathering, the agent **540** may return, send, or transmit the identifications of the capabilities **625** to the appliance **200**.

In sending the probe **620**, the context evaluator **510** may in turn retrieve or otherwise identify the identification of the capabilities **625** from the client **102**. Upon receipt, the context evaluator **510** may store the identification of the capabilities **625** onto the database **530**. In some embodiments, the context evaluator **510** may associate the capabilities **625** with the client **102**, the agent **540** on the client **102**, the session **605** established between the client **102** and the appliance **200**, or the virtual desktop **615** provided to the client **102**. The context evaluator **510** may store the association with respect to the capabilities **625** on the database **530**. The context evaluator **510** may maintain the capabilities **625** and the associations during the duration of the session **605**.

In some embodiments, the context evaluator **510** may generate or determine a risk score for the client **102** using the associated capabilities **625**. The risk score may identify or indicate a degree or potential of a security threat posed by the client **102** in accessing the server **106**, including the resources **560** thereon. Certain combinations of device profiles, application profiles, network profiles, configurations of protocol handlers, and other factors may lead to a higher security than other combinations. In some embodiments, the context evaluator **510** may determine the risk score in accordance with a function. The function may assign various values or weights to different capabilities **625**, and the combination of these values and weights as specified by the function may yield the risk score. Upon determination, the context evaluator **510** may store and maintain the risk score onto the database **530**. In some embodiments, the context evaluator **510** may store an association between the risk score with the client **102**, the agent **540** on the client **102**, the session **605** established between the client **102** and the appliance **200**, or the virtual desktop **615** provided to the client **102**.

Referring now to FIG. **6**B, depicted is a block diagram of a process **630** for modifying elements in the system **500** for protecting access. The process **630** may correspond to or include operations performed in the system **500** to request and retrieve resources **560** on the server **106**. The web browser **545** on the client **102** may access and load webpages for presentation. Each webpage may include a script in accordance with a markup language, such as Hypertext Markup Language (HTML) (e.g., HTML5) or Extensible Markup Language (XML). In some embodiments, the web browser **545** may be within the virtual desktop **615** provided to the agent **540** by the appliance **200**. In some embodiments, the web browser **545** may be outside the virtual desktop **615** and local to the client **102**. When outside the virtual desktop **615**, the web browser **545** may access the appliance **200** via the session **605**.

Under the process **630**, the web browser **545** on the client **102** may retrieve, identify, or otherwise receive at least one link **635** for accessing at least one resource **560** on the server **106**. The link **635** may identify or include an identifier (e.g., a URL) referencing the resource **560** and the remote application **555** (or the local application **550**) with which to access the resource **560**. In some embodiments, the link **635** may also identify the appliance **200** via which access the resource **560** and the server **106** on which the resource **560** is hosted. For example, the link **635** may include a substring corresponding to the server **106**, another substring corresponding to the remote application **555**, and another substring corresponding to the resource **560**. The link **635** may be received from any source, such the appliance **200** during the session **605**, the server **106** via the appliance **200**, or another device communicatively coupled with the client **102**. For example, the web browser **545** may access a document management service to retrieve a webpage including the link **635**. The link **635** may be located in an element of the webpage, such as a body element, a paragraph element, and an inline frame, among others. The link **635** may reference a document corresponding to one of the resources **560** on the server **106** and may identify the remote application **555** with which to access the resource **560**. The web browser **545** may then display the webpage on the client **102**.

The web browser **545** may provide, send, or otherwise transmit a request **640** to access the resource **560** to the appliance **200**. The request **640** may be generated in accordance with an HTML web request to retrieve the resource **560**. With receipt, the web browser **545** may monitor for an interaction with the link **635**. Upon detection of the link **635**, the web browser **545** may generate the request **640** using the link **635**. The request **640** may include the identifier from the link **635**, including referencing the resource **560** and the remote application **555** with which to access the resource **560**. In some embodiments, the request **640** may include the identifier referencing the appliance **200** and the server **106**. With the generation, the web browser **545** may transmit the request **640** to the appliance **200**. When the web browser **545** is separated from the virtual desktop **615**, the web browser **545** may direct the request **640** to the appliance **200** through the session **605**. When the web browser **545** is within the virtual desktop **615**, the web browser **545** may provide the request **640** to the agent **540** to forward the request **640** to the appliance **200** through the session **605**.

The access handler **515** on the appliance **200** may in turn retrieve, identify, or otherwise receive the request **640** from the client **102**. In some embodiments, the access handler **515** may intercept the request **640** while directed to the server **106**. The access handler **515** may parse the request **640** to extract or identify the identifier referencing the resource **560** and the remote application **555**. In some embodiments, the access handler **515** may also identify the identifier referencing the server **106** on which the resource **560** is hosted from the request **640**. From the parsing, the access handler **515** may select or identify the server **106** to which to forward the request **640** based on the identifier referencing the server **106**. In some embodiments, the access handler **515** may identify the server **106** based on the remote application **555** identified in the request **640**. With the identification, the access handler **515** may forward, send, or otherwise transmit the request **640** to the server **106**.

The server **106** may retrieve, identify, or otherwise receive the request **640** forwarded by the appliance **200** from the client **102**. Upon receipt, the server **106** may parse the request **640** to extract or identify the identifier referencing the resource **560** and the remote application **555**. From the parsing, the server **106** may find, select, or otherwise identify the resource **560** identified in the request **640** (denoted as resource **560'**). As discussed above, the resource **560** may include data, text, image, video, audio, other data, or any combination thereof. The server **106** may also identify the remote application **555** with which to access the resource **560'**. In some embodiments, the server **106** may use the identifier from the request **640** to identify the remote application **555**. The remote application **555** may be a web application to be provided and loaded on the web browser **545** on the client **102**.

With the identification of the remote application **555**, the server **106** may also identify a user interface **650** for the remote application **555**. The remote application **555** may have the user interface **650** via which to detect an invocation (e.g., in the form of a user input) and run various processes or functions in response to the invocation. The user interface **650** may identify or include one or more elements **655**A-N (hereinafter generally referred to as elements **655**). Each element **655** may correspond to a component of the user interface **650** to run a corresponding function in response to an invocation to the element **655**. At least one of the elements **655** may contain or include at least one handler **660** (sometimes herein referred to as a protocol handler). The handler **660** may specify or define the function for the element **655** in response to the invocation. In some embodiments, the handler **660** may specify that the element **655** is to modify, access, or otherwise perform a corresponding operation on the resource **560'**. For example, the handler **660** for at least one of the elements **655** may specify that the resource **560'** is to be opened using a desktop application, such as one native to the virtual desktop **615** or the local application **550**. The handler **660** may specify that one or more arguments are to be passed to the desktop application to access the resource **560'**.

As the remote application **555** is a web application, the user interface **650** may be in the form of a webpage. The webpage constituting the remote application **555** may include a script in accordance with a markup language, such as HTML or XML. Each element **655** may correspond to a document objection model (DOM) tree element on the webpage. For example, the DOM tree element for the element **655** may include a head element, a body element, an image element, an inline frame element, a script element, and an object element, among others. The DOM tree elements corresponding to the elements **655** may be arranged in a hierarchy (e.g., a tree structure) in the webpage for the user interface **650** of the remote application **555**. The handler **660** included in the element **655** may correspond to a script or a set of instructions within the DOM element corresponding to the element **655**.

With the identifications, the server **106** may produce or generate at least one response **645** to send to the appliance **200**. The response **645** may include a script in accordance with a HTML web response to provide the requested resource **560'**. The server **106** may include the user interface **650**, including the elements **655** and the handlers **660** therein, into the response **645**. The server **106** may also include the resource **560'** identified by the request **640** into the response **645**. The server **106** may include the identifier for the appliance **200** or the client **102** from which the request **640** originated into the request **640**. Upon generation, the server **106** may return, send, or otherwise transmit the response **645** to the appliance **200**.

The access handler **515** on the appliance **200** may retrieve, identify, or otherwise receive the response **645** from the server **106**. With receipt, the access handler **515** may parse the response **645** to extract or identify the user interface **650**. From parsing, the access handler **515** may also identify the elements **655** in the user interface **650**. In some embodiments, the access handler **515** may identify at least one element **655** for accessing the resource **560'** via the desktop location. The identified element **655** may have the label text "Open in Desktop App." The access handler **515** may identify the handler **660** from at least one of the elements **655**. With the identifications, the access handler **515** may provide one or more of the elements **655** to the policy enforcer **520** to check against the policy **535** to protect access to the server **106**.

In conjunction, the policy enforcer **520** may store and maintain the policy **535** onto the database **530**. The policy **535** may define or specify one or more rules to control, regulate, or protect the accessing of the resources **560'** on the server **106** from the client **102**, through the virtual desktop **615** via the agent **540** or the web browser **545**, based on the capabilities **625**. The rule may specify a modification to the one or more elements **655** or one or more handlers **660** in the user interface **650**, depending on a set (or combination) of capabilities **625** associated with the client **102**. The modification may include removal, disabling, hiding, or replacement of the identified element **655** or the handler **660** in the user interface **650**. The policy **535** may be set or configured by an administrator of the appliance **200**, the remote application **555**, the server **106**, or the network **104** or **104'** among others.

The rules of the policy **535** may specify various modifications based on the capabilities **625** associated with the client **102**. If the capabilities **625** indicates that the client **102** is a managed device, the policy **535** may maintain the element **655** for accessing of the resource **560** via the local application **550**. If the capabilities **625** indicates that the client **102** is a personal device and is not using the virtual desktop **615**, the policy **535** may specify that an element **655** for accessing the resource **560** via the local application **550** is to be disabled. The policy **535** may also specify that the element **655** (or the handler **660**) is to be replaced with another element **655** to access the resource **560** through the virtual desktop **615**. In some embodiments, the policy **535** may specify that a parent element (e.g., a parent DOM tree element) or a grandparent element (e.g., the parent or the parent DOM tree element) to which the element **655** is a child element is to be disabled, replaced, or hidden. The policy **535** may also include the substitute element **655** to replace the original element **655**.

Continuing on, if the capabilities **625** indicates that the client **102** is a personal device and is using the virtual desktop **615**, the policy **535** may specify that an element **655** for accessing the resource **560** via the local application **550** is to be disabled, removed, or hidden. If the capabilities **625** indicates that the client **102** is attempting to access the resource **560** through the virtual desktop **615** and another application is available within the virtual desktop **615**, the policy **535** may specify that an element **655** (or the handler **660**) for accessing the resource **560** via the local application **550** is to be modified to access the resource **560** via the application in the virtual desktop **615**. If the capabilities **625** indicates that the client **102** is accessing through the web application as no local application **550** to access the resource **560** is installed on the client **102**, the policy **535** may specify that the element **655** (or the handler **660**) is to be modified that the virtual desktop **615** is to be launched to access the resource **560**.

The rules of the policy **535** may specify modifications based on other factors. For example, if the handler **660** is the default protocol handler (e.g., as provided by the remote application **555**), the policy **535** may specify that the handler **660** is to be disabled, hidden, or replaced with another handler **660**. For example, the default protocol handler (e.g., "ms-word," "ms-powerpoint," and "ms-excel") may specify accessing of the resource **560'** via the originally specified service outside of the server **106** or the appliance **200**. The new handler **660** may specify that the resource **560'** is to be accessed via the appliance **200**.

In some embodiments, the rules of the policy **535** may specify the modifications based on the risk score determined using the capabilities **625** associated with the client **102**. The policy **535** may define or identify a threshold value for the risk value at which to perform the modification. If the risk score is above threshold value, the policy **535** may specify that the element **655** (or the handler **660**) for accessing the resource **560** via the local application **550** is disabled, removed, or hidden. If the risk score is below threshold value, the policy **535** may specify that the element **655** (or the handler **660**) for accessing the resource **560'** via the local application **550** is maintained.

The policy enforcer **520** on the appliance **200** may identify or determine whether one or more of the elements **655** (or one or more of the handlers **660**) are to be modified. The determination may be based on the capabilities **625** associated with the client **102** in accordance with the policy **535**. The policy enforcer **520** may check the capabilities **625** against the specifications as defined in the rules of the policy **535**. In some embodiments, the policy enforcer **520** may also use the other factors (e.g., the handler **660** in the response **645** and the risk score) in checking against the policy **535**. By checking with the policy **535**, the policy enforcer **520** may find or identify the rule specified for the capabilities **625**.

If the rule indicates the element **655** (or handler **660**) is to be maintained, the policy enforcer **520** may determine that the corresponding handler **660** is to be maintained. In some embodiments, if the risk score is below the threshold value specified by the policy **535**, the policy enforcer **520** may determine that the corresponding handler **660** is to be maintained. Conversely, if the rule indicates the element **655** (or handler **660**) is to be modified, the policy enforcer **520** may determine that the corresponding element **655** is to be modified. In some embodiments, if the risk score is above the threshold value specified by the policy **535**, the policy enforcer **520** may determine that the corresponding handler **660** is to be modified. In some embodiments, the policy enforcer **520** may associate the capabilities **625** with the modification as specified by the policy **535** to be performed on the element **655** or the handler **660** in the user interface **650**.

When the element **655** is determined to be modified, the policy enforcer **520** may modify the element **655** to further protect access to the server **106**. The modification may be in accordance with the capabilities **625** associated with the client **102** as specified by the policy **535**. When the policy **535** specifies removal, the policy enforcer **520** may remove or delete the identified element **655**. When the policy **535** specifies hiding, the policy enforcer **520** may set a visibility property of the element **655** to null, transparent, or otherwise hidden. When the policy **535** specifies disabling, the policy enforcer **520** may disable invocation of the element **655**. When the policy **535** specifies replacing, the policy enforcer **520** may change or substitute the element **655** originally in the response **645** with the element **655** provided by the policy **535**. From modifying, the policy enforcer **520** may configure the element **655** to produce, yield, or otherwise generate a corresponding modified element **655'** in accordance with the policy **535**.

In some embodiments, the policy enforcer **520** may modify the handler **660** in the element **655'** determined to be modified. The policy enforcer **520** may extract or identify the handler **660** included in the element **655'** from the response **645** received from the server **106**. The handler **660** may be originally defined to access the resource **560'** via another server besides the server **106**. For instance, the default handler **660** may identify that the client **102** is to access the resource **560'** via the document management service different from the server **106**. With the identification, the policy enforcer **520** may modify the handler **660'** in accordance with the policy **535**.

When the policy **535** specifies removal, the policy enforcer **520** may remove or delete the identified handler **660**. When the policy **535** specifies hiding, the policy enforcer **520** may set a visibility property of the handler **660** to null, transparent, or otherwise hidden. When the policy **535** specifies disabling, the policy enforcer **520** may disable the invocation of the handler **660**. When the policy **535** specifies replacing, the policy enforcer **520** may change or substitute the handler **660** originally in the response **645** with the handler **660** provided by the policy **535**. From modifying, the policy enforcer **520** may configure the handler **660** to produce, yield, or otherwise generate a corresponding modified handler **660'** in accordance with the policy **535**.

With the determination, the policy enforcer **520** may forward, send, or otherwise transmit the response **645** from the server **106** to the client **102**. If any modifications were performed, the response **645** may include the modified element **655'** with the modified handler **660'** of the user interface **650** for the remote application **555** (e.g., as depicted). If no modifications were made, the response **645** may include the original elements **655** with the original handler **660** of the user interface **650** for the remote application **555**. When the web browser **545** is within the virtual desktop **615**, the policy enforcer **520** may provide the response **645** via the virtual desktop **615** for the session **605**. When the web browser **545** is outside the virtual desktop **615**, the policy enforcer **520** may provide the response **645** via the session **605** or connection over the network **104**.

The web browser **545** on the client **102** may in turn retrieve, identify, or otherwise receive the response **645** from the appliance **200**. Upon receipt, the web browser **545** may execute and process the response **645** in accordance with the script (e.g., HTML). The web browser **545** may load the user interface **650** of the remote application **555** (e.g., in the form of a web application) for presentation. The web browser **545** may also load the requested resource **560'** in the response **645** for display. In processing, the web browser **545** may parse the response **645** to extract or identify the user interface **650**. From the user interface **650**, the web browser **545** may identify the one or more elements **655** for presentation.

Referring now to FIG. 6C, depicted is a block diagram of a process **680** for invoking elements in the system **500** for protecting access. The process **680** may correspond to or include operations performed in the system **500** once a modified element **655'** is invoked. Under the process **680**, the web browser **545** may monitor for an invocation on the elements **655'** (or the element **655**) of the user interface **650** for the remote application **555**. The element **655'** may have been a replacement of the element **655** originally in the response **695**, as opposed to a disabling, removal, or hiding of the element **655**. The invocation may correspond to a user interaction by the user of the client **102**. Upon detection on the element **655'**, the web browser **545** may process the invocation in accordance with the function as defined by the handler **660'** in the element **655'**. The element **655'** may be to access the resource **560'** via another application outside the web browser **545**, such as the application native to the virtual desktop **615** or the local application **550** on the client

102. The handler **660'** in the element **655'** may identify which application outside the remote application **555** in the web browser **545** is to be called to access the resource **560**.

When the function in the handler **660'** specifies invocation of the local application **550** on the client **102**, the web browser **545** may call or invoke the local application **550**. The local application **550** may be outside the virtual desktop **615**. In accordance with the handler **660'**, the web browser **545** may pass the specified arguments to the local application **550** to access the resource **560'** from the server **106**. The local application **550** may be native to the client **102**, and may have access to the session **605** between the client **102** and the appliance **200**. The arguments may include an identifier (e.g., URL) for the resource **560'** on the server **106**. In some embodiments, the arguments may include an identifier for the remote application **555** to be used to access the resource **560'**. The passing may be facilitated by an operating system on the client **102**. Upon passing, the local application **550** may provide, transmit, or otherwise send a request **690** for the resource **560'**. The request **690** may include the identifier referencing the resource **560'**.

The access handler **515** on the appliance **200** may in turn retrieve, identify, or otherwise receive the request **690** from the client **102**. In some embodiments, the access handler **515** may intercept the request **690** while directed to the server **106**. The access handler **515** may parse the request **690** to extract or identify the identifier referencing the resource **560'**. With the identification, the access handler **515** may forward, send, or otherwise transmit the request **690** to the server **106**.

The server **106** may retrieve, identify, or otherwise receive the request **690** forwarded by the appliance **200** from the client **102**. Upon receipt, the server **106** may parse the request **690** to extract or identify the identifier referencing the resource **560'**. From the parsing, the server **106** may find, select, or otherwise identify the resource **560'** identified in the request **690**. With the identification, the server **106** may return, send, or transmit a response **695** including the resource **560'** to the appliance **200**. The access handler **515** may retrieve, identify, or receive the response **695** from the server **106**. The access handler **515** may in turn forward the response **695** to the client **102**. The local application **550** on the client **102** may load the resource **560'** in the response **695**.

Conversely, when the function in the handler **660'** specifies invocation of an application in the virtual desktop **615**, the web browser **545** may call or invoke the agent **540**. An application within the virtual desktop **615** provided through the agent **540** may be used to access the resource **560'**. In accordance with the handler **660'**, the web browser **545** may pass the specified arguments to the agent **540**. The arguments may include an identifier for the remote application **555** within the virtual desktop **615** to be used to access the resource **560'**. The agent **540** may have access to the session **605** between the client **102** and the appliance **200**. The arguments may include an identifier (e.g., URL) for the resource **560'** on the server **106**. The passing may be facilitated by an operating system on the client **102**. Upon passage, the agent **540** may check or determine whether the virtual desktop **615** has been created for the session **605**. In determining, the agent **540** may inspect the session **605** to identify the virtual desktop **615**.

If a virtual desktop **615** has not been created, the agent **540** may request the connection manager **505** to instantiate the virtual desktop **615** in a similar manner as discussed above in connection with process **600**. In response to the interaction with the modified element **655'** and the passage of the arguments, the agent **540** may generate a request **690** to connect with the appliance **200**. The request **690** may identify that the virtual desktop **615** is to be created for the session **605**. Furthermore, the request **690** may identify the remote application **555** and the resources **560'** as identified in the arguments. The remote application **555** may be a virtualized application native to the virtual desktop **615**, and the request **690** may indicate that the remote application **555** is to be loaded onto the virtual desktop **615**. With the generation, the agent **540**, may transmit, provide, or otherwise send the request **690** to the appliance **200**.

The connection manager **505** on the appliance **200** may in turn retrieve, identify, or otherwise receive the request **690** from the client **102**. Upon receipt, the connection manager **505** may complete the establishment of the session **605** between the client **102** and the appliance **200**, if previously not established. In addition, the connection manager **505** may provide the virtual desktop **615** via the session **605** for the agent **540**. In some embodiments, the connection manager **505** may select an already existing virtual desktop **615**. In some embodiments, the connection manager **505** may instantiate, launch, or otherwise create the virtual desktop **615** for the client **102**. With the establishment of the session **605** and the provision of the virtual desktop **615**, the agent **540** may receive and load the virtual desktop **615** on the client **102**.

In conjunction, the desktop controller **525** on the appliance **200** may launch the remote application **555** identified by the request **690** within the virtual desktop **615** via which to access the resource **560'**. The desktop controller **525** may also parse the request **690** to extract or identify the identifier referencing the resource **560'** to be loaded in the remote application **555** within the virtual desktop **615**. From the parsing, the desktop controller **525** may select or identify the server **106** to which to forward the request **690** based on the identifier referencing the server **106**. In some embodiments, the desktop controller **525** may identify the server **106** based on the remote application **555** identified in the request **690**. With the identification, the desktop controller **525** may forward, send, or otherwise transmit the request **690** to the server **106**.

The server **106** may retrieve, identify, or otherwise receive the request **690** forwarded by the appliance **200** from the client **102**. Upon receipt, the server **106** may parse the request **690** to extract or identify the identifier referencing the resource **560'**. From the parsing, the server **106** may find, select, or otherwise identify the resource **560'** identified in the request **690**. With the identification, the server **106** may return, send, or transmit a response **695** including the resource **560'** to the appliance **200**. The desktop controller **525** may retrieve, identify, or receive the response **695** from the server **106**. The desktop controller **525** may in turn load the resource **560'** within the response **695** into the remote application **555** in the virtual desktop **615**. The desktop controller **525** may provide the remote application **555** with the resource **560'** to the client **102** via the virtual desktop **615** of the session **605**.

In this manner, the appliance **200** may protect and control access to the resources **560** hosted on the server **106** by modifying the elements **655** of the user interface **650** in accordance with the policy **535** and the capabilities **625** of the client **102**. The modification of the elements **655** may thus serve to improve the security of the server **106** and the data integrity of the resources **560** hosted thereon. Since the access controls defined by the policy **535** can be more widely applied, the appliance **200** may allow the resources **560** to be accessed by a greater number of clients **102** from disparate environments, while maintaining security over the data. The overall utility of the client **102** may also be improved, as the user of the client **102** can access the resources **560**, without being on a pre-approved network or having a managed device provided by an enterprise.

Referring now to FIG. **7**A, depicted is a screenshot of an example display **700** of a user interface **650** of a web application (e.g., the remote application **555**) in the system **500** for protecting access. As depicted, the display **700** may include the web browser **545** containing the link **635** to the resource **560'** and the user interface **650** of the remote application **555** in the form of the web application. The user interface **650** in the display **700** may include the element **655** without any modifications. In context of the system **500**, the policy enforcer **520** may have permitted the element **655** to be maintained in accordance with the policy **535** based on the capabilities **625** of the client **102**, in which the display **700** is presented.

Referring now to FIG. **7**B, depicted is a screenshot of an example display **705** of a user interface **650** of a web application (e.g., the remote application **555**) with a modified interface element **655'** in the system **500** for protecting access. As depicted, the display **705** may include the web browser **545** containing the link **635** to the resource **560'** and the user interface **650** of the remote application **555** in the form of the web application. The user interface **650** in the display **700** may include the element **655'** modified to be hidden (e.g., as depicted). In context of the system **500**, the policy enforcer **520** may have modified the element **655** in accordance with the policy **535** based on the capabilities **625** of the client **102**, in which the display **700** is presented.

Referring now to FIGS. **8**A and **8**B, depicted is a flow diagram for a method **800** of protecting access by clients to server-hosted resources. The functionalities of method **800** may be implemented using, or performed by, the components described in FIGS. **1**A-**6**C, such as the client **102**, the server **106**, and the appliance **200**. Under the method **800**, a client (e.g., the client **102**) may initiate connection (**802**). An appliance (e.g., the appliance **200**) may establish the connection (**804**). The appliance may identify the capabilities (e.g., the capabilities **625**) of the client (**806**). The client may send a request to access (**808**). The appliance may receive the request to access (**810**). The appliance may forward the request to access (**812**). A server (e.g., the server **106**) may receive the request to access (**814**). The server may send a response including a user interface element (e.g., the elements **655**) (**816**). The appliance may receive the response including the user interface element (**818**). The appliance may parse the user interface element from the response (**820**)

Moving on, the appliance may determine whether the user interface element is to be modified (**822**). If the user interface element is determined to be modified, the appliance may modify the element to protect access (**824**). The appliance may forward the response including the user interface element including any modifications (**826**). The client may receive the response including the user interface element (**828**). The client may load the user interface element on a web browser (e.g., the web browser **545**) (**830**). The client may detect an interaction on the user interface element (**832**). If the interaction is detected, the client may send a request for the resource (**834**). The appliance may receive the request for the resource (**836**). The appliance may process the request (**838**). The appliance may provide the requested resource (**840**). The client in turn may receive the resource (**842**). The client may load the resource in an application (e.g., the local application **550** or the remote application **555**).

Various elements, which are described herein in the context of one or more embodiments, may be provided separately or in any suitable subcombination. For example, the processes described herein may be implemented in hardware, software, or a combination thereof. Further, the processes described herein are not limited to the specific embodiments described. For example, the processes described herein are not limited to the specific processing order described herein and, rather, process blocks may be re-ordered, combined, removed, or performed in parallel or in serial, as necessary, to achieve the results set forth herein.

It should be understood that the systems described above may provide multiple ones of any or each of those components and these components may be provided on either a standalone machine or, in some embodiments, on multiple machines in a distributed system. The systems and methods described above may be implemented as a method, apparatus, or article of manufacture using programming and/or engineering techniques to produce software, firmware, hardware, or any combination thereof. In addition, the systems and methods described above may be provided as one or more computer-readable programs embodied on or in one or more articles of manufacture. The term "article of manufacture" as used herein is intended to encompass code or logic accessible from and embedded in one or more computer-readable devices, firmware, programmable logic, memory devices (e.g., EEPROMs, ROMs, PROMs, RAMs, SRAMs, etc.), hardware (e.g., integrated circuit chip, Field Programmable Gate Array (FPGA), Application Specific Integrated Circuit (ASIC), etc.), electronic devices, a computer readable non-volatile storage unit (e.g., CD-ROM, USB Flash memory, hard disk drive, etc.). The article of manufacture may be accessible from a file server providing access to the computer-readable programs via a network transmission line, wireless transmission media, signals propagating through space, radio waves, infrared signals, etc. The article of manufacture may be a flash memory card or a magnetic tape. The article of manufacture includes hardware logic as well as software or programmable code embedded in a computer readable medium that is executed by a processor. In general, the computer-readable programs may be implemented in any programming language, such as LISP, PERL, C, C++, C#, PROLOG, or in any byte code language such as JAVA. The software programs may be stored on or in one or more articles of manufacture as object code.

While various embodiments of the methods and systems have been described, these embodiments are illustrative and in no way limit the scope of the described methods or systems. Those having skill in the relevant art can effect changes to form and details of the described methods and systems without departing from the broadest scope of the described methods and systems. Thus, the scope of the methods and systems described herein should not be limited by any of the illustrative embodiments and should be defined in accordance with the accompanying claims and their equivalents.

It will be further understood that various changes in the details, materials, and arrangements of the parts that have been described and illustrated herein may be made by those skilled in the art without departing from the scope of the following claims.

We claim:

1. A method of protecting access to a server, comprising:

identifying, by a device intermediary to a client and a server, a capability of the client to protect access to the server via an application;

determining, by the device, that an element of a user interface provided by the application to the client is to be modified based at least on the capability;

modifying, by the device responsive to the determination, the element of the user interface to further protect access to the server in accordance with the capability; and

providing, by the device, the modified element to the client for the user interface of the application.

2. The method of claim **1**, further comprising establishing, by the device, a session between the client and the server to provide the client access to a resource via the application hosted on the server, in response to an interaction with the modified element.

3. The method of claim **1**, further comprising associating, by the device, the capability of the client with a modification to be performed on the user interface element of the user interface for the application.

4. The method of claim **1**, further comprising determining, by the device, a risk score for the client in protecting access to the server via the application, and wherein determining that the element is to be modified further comprises determining that the element is to be modified, responsive to the risk score being above a threshold.

5. The method of claim **1**, wherein identifying the capability further comprises identifying the capability including at least one of:

a device profile of the client, an application profile of the application, a network profile of a network with which the client is connected, or a configuration of a handler on the client.

6. The method of claim **1**, wherein determining that the element is to be modified further comprises identifying, in a response from the server to the client, a handler defining a function of the element to access a second server different from the server.

7. The method of claim **1**, wherein modifying the element further comprises modifying a handler defining a function of the element by at least one of removal, hiding, disabling, or replacing the handler.

8. The method of claim **1**, wherein modifying the element further comprises configuring the element of the user interface of the application hosted on the server to further protect access to a resource hosted on the server by at least one of removal, hiding, disabling, or replacing the element.

9. The method of claim **1**, wherein providing the modified element further comprises forwarding, from the server to the client, a response including the modified element of the user interface for the application.

10. The method of claim **1**, further comprising providing, by the device responsive to an invocation of the modified user interface element, the client access to a resource via the application hosted on the server.

11. A system for protecting access to a server, comprising:

a device intermediary to a client and a server, the device having one or more processors and a memory storing instructions which, when executed by the one or more processors, configure the device to:

identify a capability of the client to protect access to the server via an application;

determine that an element of a user interface provided by the application to the client is to be modified based at least on the capability;

modify, responsive to the determination, the element of the user interface to further protect access to the server in accordance with the capability; and

provide the modified element to the client for the user interface of the application.

12. The system of claim **11**, wherein the device is further configured to establish a session between the client and the server to provide the client access to a resource via the application hosted on the server, in response to an interaction with the modified element.

13. The system of claim **11**, wherein the device is further configured to:

determine a risk score for the client in protecting access to the server via the application, and determine that the element is to be modified, responsive to the risk score being above a threshold.

14. The system of claim **11**, wherein the device is further configured to identify the capability including at least one of:

a device profile of the client, an application profile of the application, a network profile of a network with which the client is connected, or a configuration of a handler on the client.

15. The system of claim **11**, wherein the device is further configured to modify a handler defining a function of the element by at least one of removal, hiding, disabling, or replacing the handler.

16. The system of claim **11**, wherein the device is further configured to provide, responsive to an invocation of the modified user interface element, the client access to a resource via the application hosted on the server.

17. The system of claim **11**, wherein the device is further configured to configure the element of the user interface of the application hosted on the server to further protect access to a resource hosted on the server by at least one of removal, hiding, disabling, or replacing the element.

18. A non-transitory computer readable medium storing program instructions for causing one or more processors intermediary to a client and a server to:

identify a capability of the client to protect access to the server via an application;

determine that an element of a user interface provided by the application to the client is to be modified based at least on the capability;

modify, responsive to the determination, the element of the user interface to further protect access to the server in accordance with the capability; and

provide the modified element to the client for the user interface of the application.

19. The non-transitory computer readable medium of claim **18**, wherein the program instructions further cause the one or more processors to:

determine a risk score for the client in protecting access to the server via the application, and determine that the element is to be modified, responsive to the risk score being above a threshold.

20. The non-transitory computer readable medium of claim **18**, wherein the program instructions further cause the one or more processors to modify a handler defining a function of the element by at least one of removal, hiding, disabling, or replacing the handler.

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