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Mohammed et al.

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(54) **SECURITY SOLUTION ORCHESTRATION**

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(52) **U.S. Cl.**
CPC ***H04L 63/0263*** (2013.01); ***H04L 63/20*** (2013.01)

(58) **Field of Classification Search**
CPC H04L 63/0263; H04L 63/20
See application file for complete search history.

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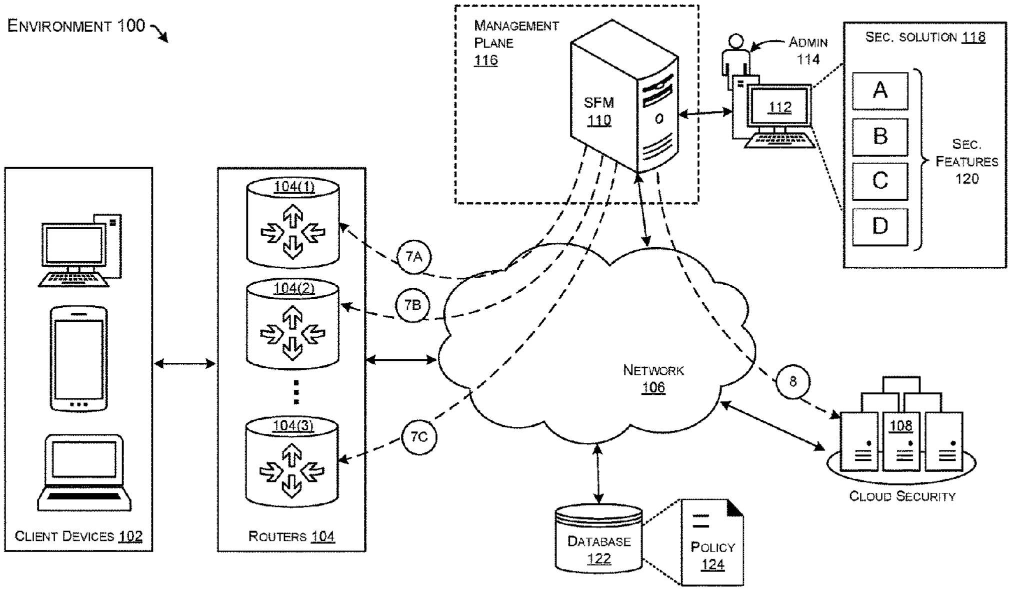
(74) *Attorney, Agent, or Firm* — Lee & Hayes, P.C.

(57) **ABSTRACT**

This disclosure describes techniques for orchestrating implementation of a security solution among network devices. The techniques include determining capabilities of routers of the network and capabilities of a cloud security service to perform security features of a security solution. Based at least in part on the capabilities, the techniques include configuring a router of the network to execute a first subset of the security features on data traffic of the network, and configuring the cloud security service to execute a second subset of the security features on the data traffic. The techniques may also include causing the security solution to be presented to a security administrator via a display, the display providing representations of the first subset and the second subset of the security features.

20 Claims, 11 Drawing Sheets



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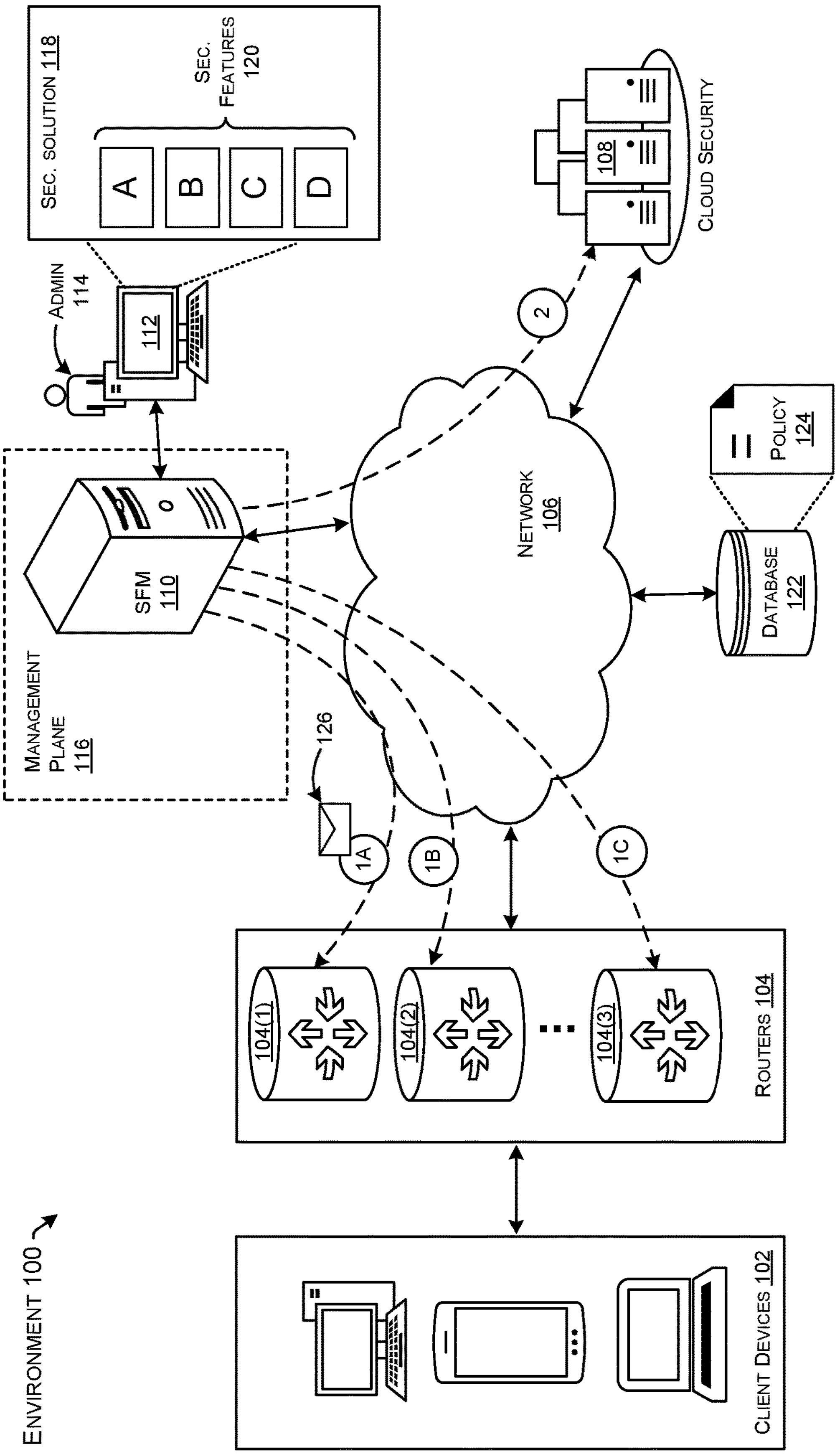
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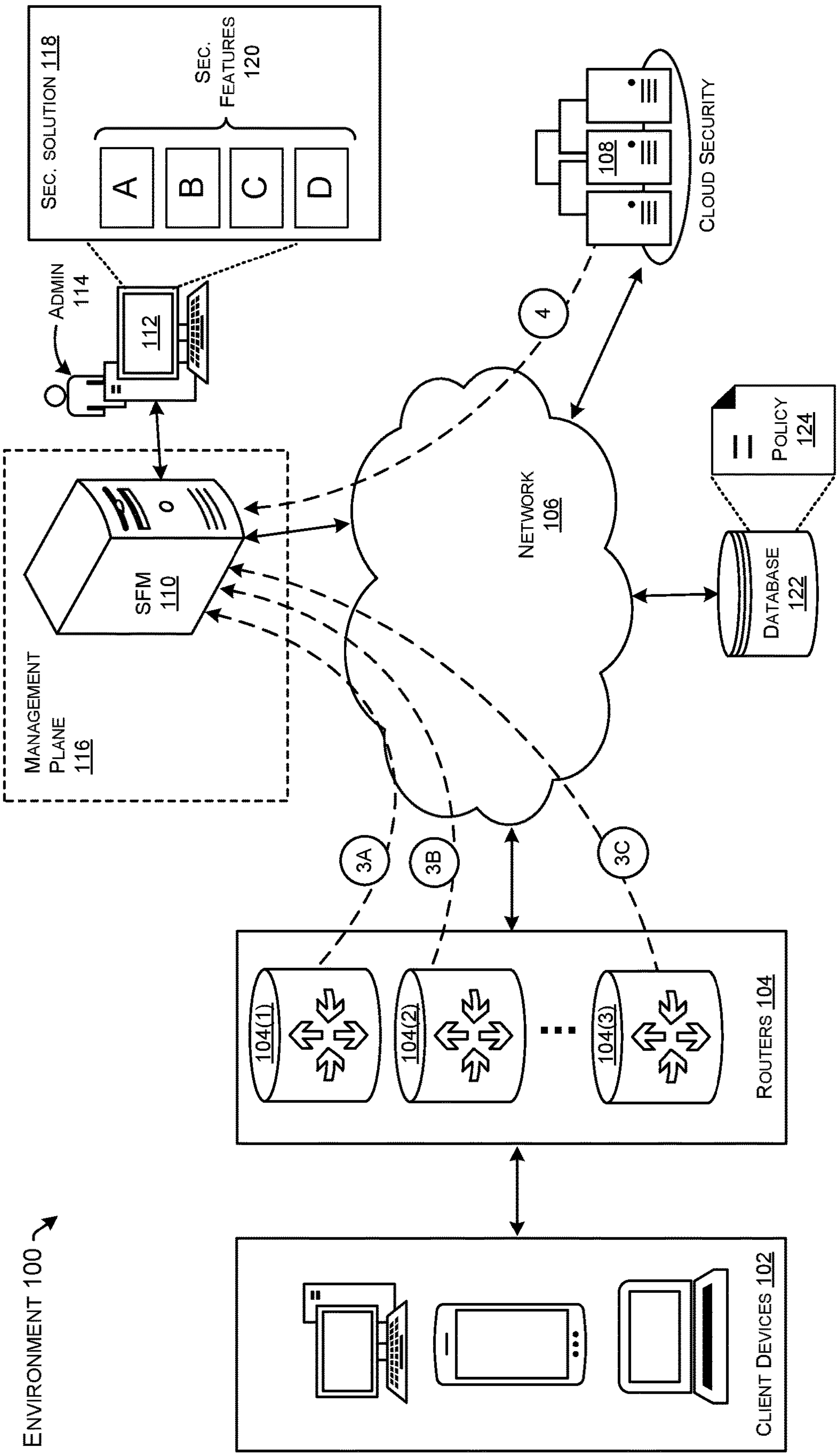
Client Devices 102
Routers 104
104(1)
104(2)
104(3)
1A
1B
1C
126
Management Plane 116
SFM 110
Network 106
Database 122
Policy 124
2
Cloud Security
108
Admin 114
112
Sec. Solution 118
Sec. Features 120
A
B
C
D

FIG. 1A


ENVIRONMENT 100
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ROUTERS 104
104(1)
104(2)
104(3)
3A
3B
3C
NETWORK 106
MANAGEMENT PLANE 116
SFM 110
112
ADMIN 114
SEC. SOLUTION 118
A
B
C
D
SEC. FEATURES 120
4
108
CLOUD SECURITY
DATABASE 122
POLICY 124

FIG. 1B

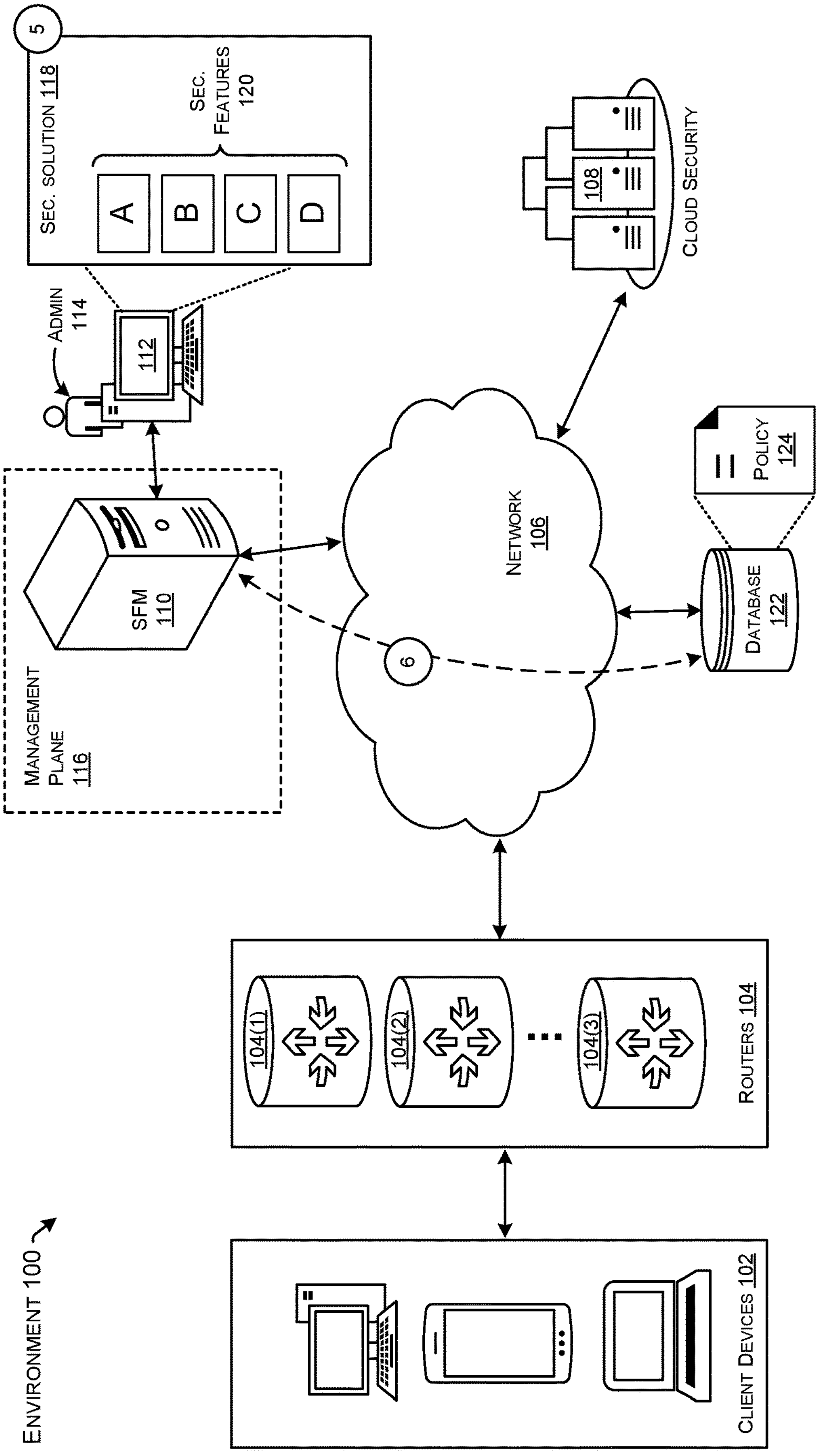
Environment 100
Client Devices 102
Routers 104
104(1)
104(2)
104(3)
Network 106
Cloud Security
108
Management Plane 116
SFM 110
Admin 114
112
Sec. Solution 118
Sec. Features 120
A
B
C
D
5
6
Database 122
Policy 124

FIG. 1C

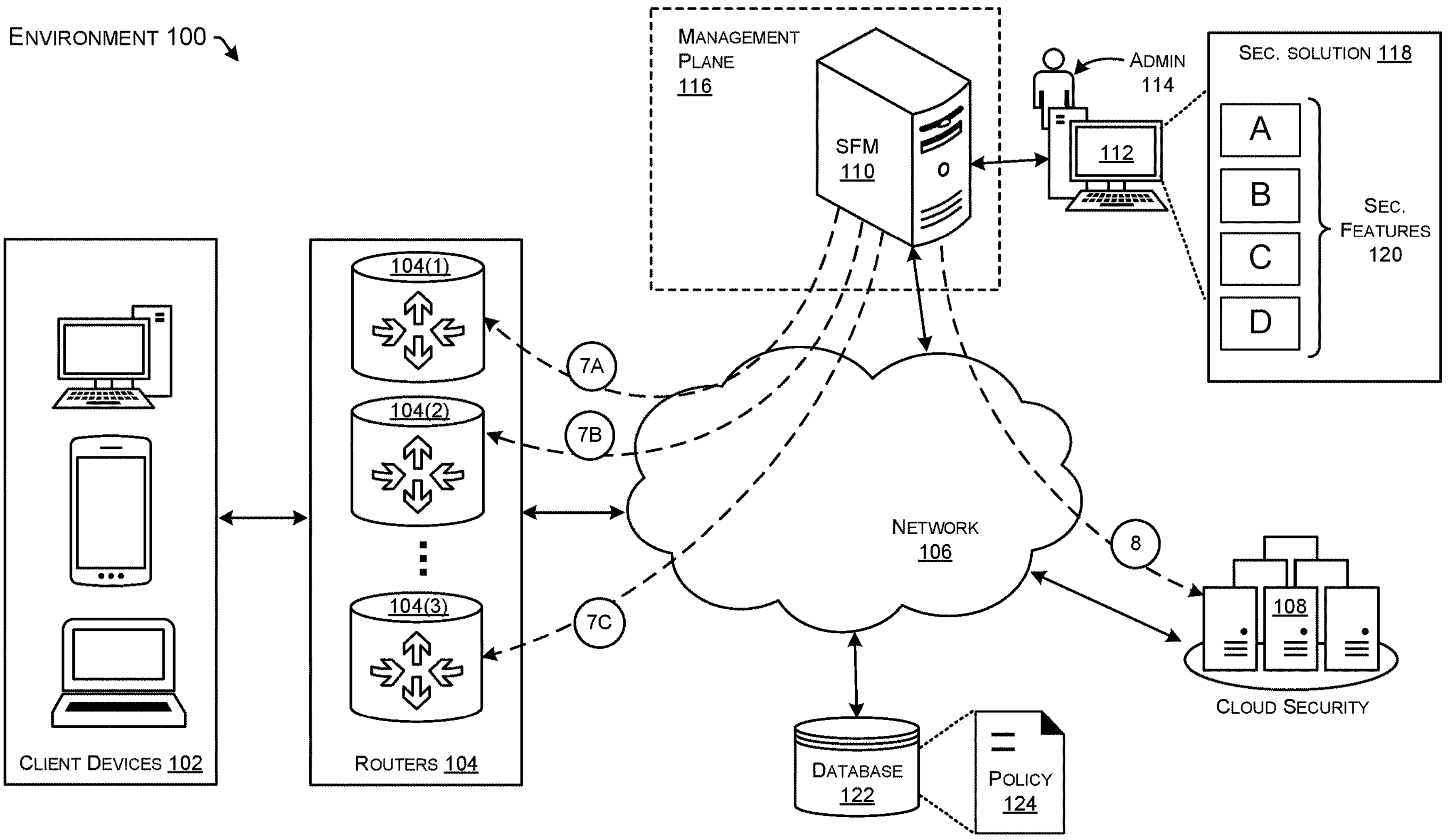
ENVIRONMENT 100
MANAGEMENT PLANE 116
SFM 110
ADMIN 114
112
SEC. SOLUTION 118
A
B
C
D
SEC. FEATURES 120
104(1)
104(2)
104(3)
7A
7B
7C
8
NETWORK 106
108
CLOUD SECURITY
DATABASE 122
POLICY 124
CLIENT DEVICES 102
ROUTERS 104

FIG. 1D

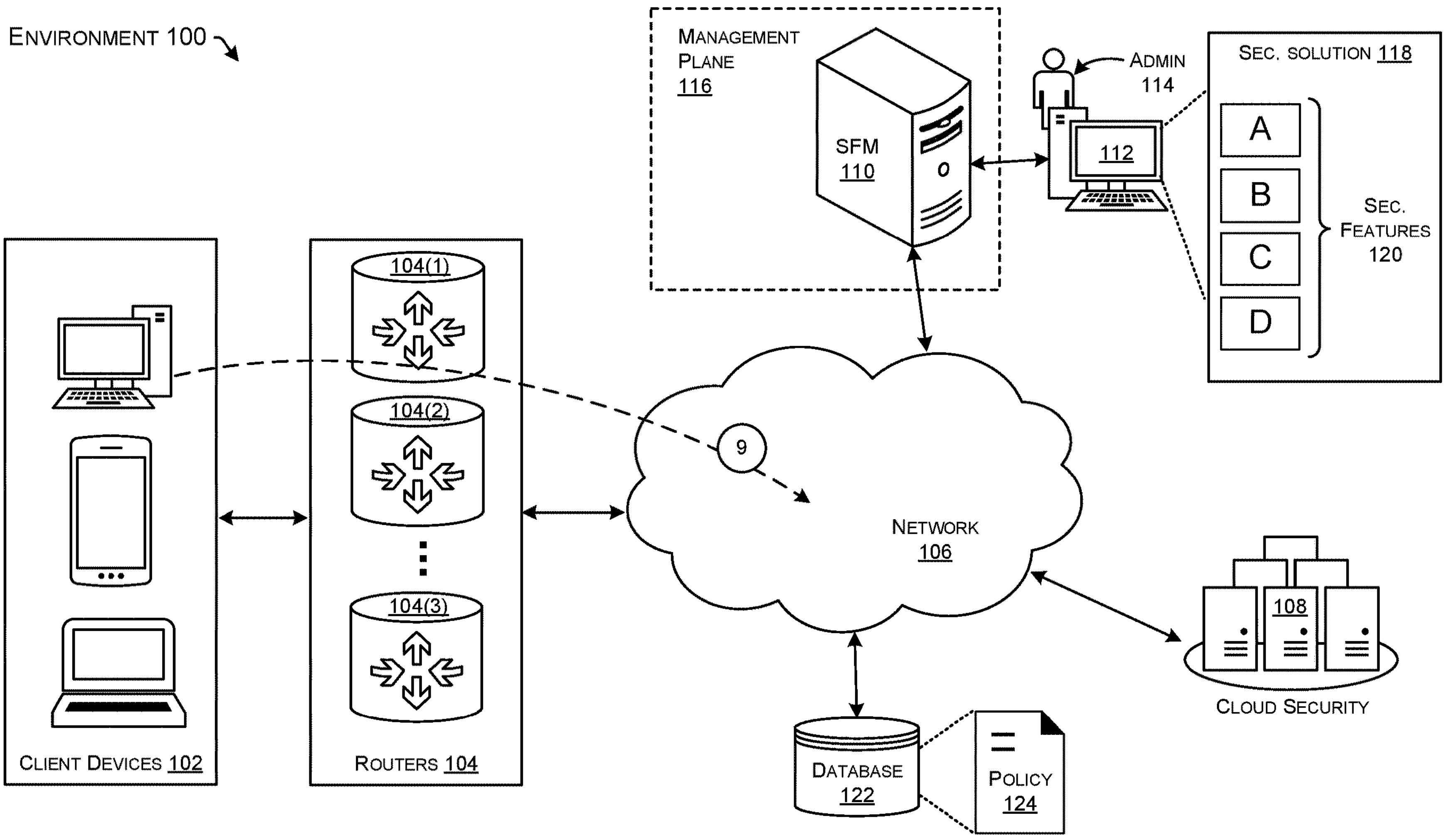
ENVIRONMENT 100
MANAGEMENT PLANE 116
SFM 110
ADMIN 114
112
SEC. SOLUTION 118
A
B
C
D
SEC. FEATURES 120
104(1)
104(2)
104(3)
9
NETWORK 106
108
CLOUD SECURITY
DATABASE 122
POLICY 124
CLIENT DEVICES 102
ROUTERS 104

FIG. 1E

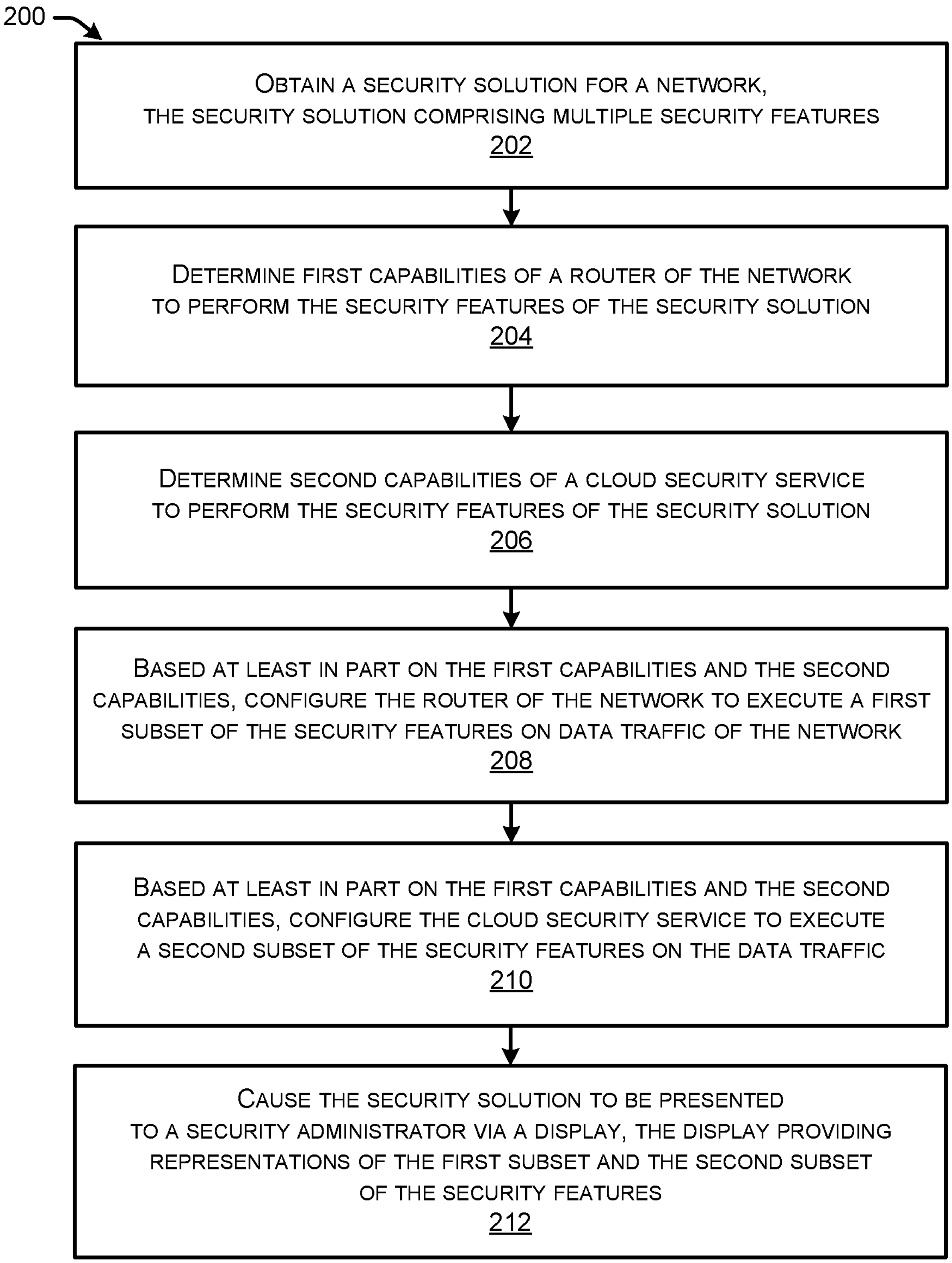
200
OBTAIN A SECURITY SOLUTION FOR A NETWORK, THE SECURITY SOLUTION COMPRISING MULTIPLE SECURITY FEATURES
202
DETERMINE FIRST CAPABILITIES OF A ROUTER OF THE NETWORK TO PERFORM THE SECURITY FEATURES OF THE SECURITY SOLUTION
204
DETERMINE SECOND CAPABILITIES OF A CLOUD SECURITY SERVICE TO PERFORM THE SECURITY FEATURES OF THE SECURITY SOLUTION
206
BASED AT LEAST IN PART ON THE FIRST CAPABILITIES AND THE SECOND CAPABILITIES, CONFIGURE THE ROUTER OF THE NETWORK TO EXECUTE A FIRST SUBSET OF THE SECURITY FEATURES ON DATA TRAFFIC OF THE NETWORK
208
BASED AT LEAST IN PART ON THE FIRST CAPABILITIES AND THE SECOND CAPABILITIES, CONFIGURE THE CLOUD SECURITY SERVICE TO EXECUTE A SECOND SUBSET OF THE SECURITY FEATURES ON THE DATA TRAFFIC
210
CAUSE THE SECURITY SOLUTION TO BE PRESENTED TO A SECURITY ADMINISTRATOR VIA A DISPLAY, THE DISPLAY PROVIDING REPRESENTATIONS OF THE FIRST SUBSET AND THE SECOND SUBSET OF THE SECURITY FEATURES
212

FIG. 2

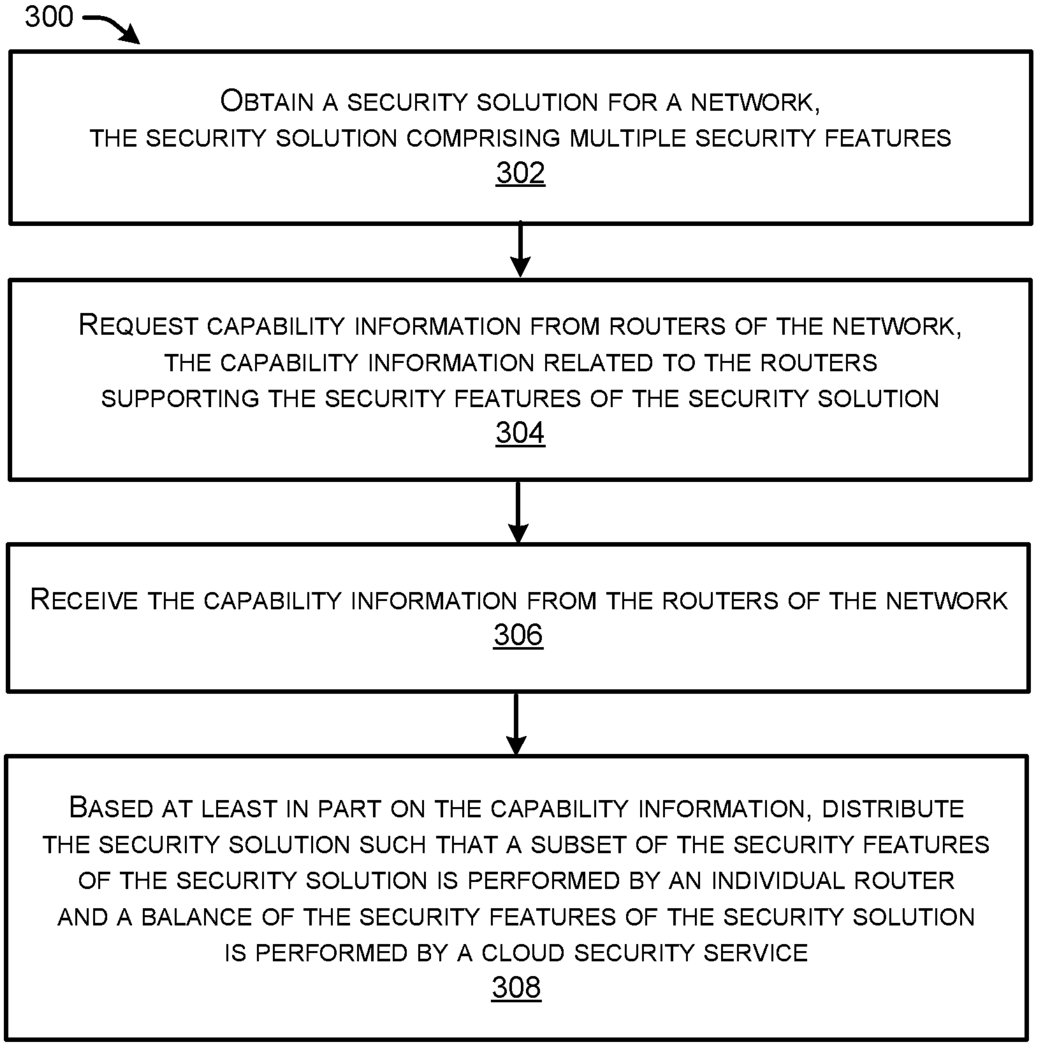
300
OBTAIN A SECURITY SOLUTION FOR A NETWORK, THE SECURITY SOLUTION COMPRISING MULTIPLE SECURITY FEATURES
302
REQUEST CAPABILITY INFORMATION FROM ROUTERS OF THE NETWORK, THE CAPABILITY INFORMATION RELATED TO THE ROUTERS SUPPORTING THE SECURITY FEATURES OF THE SECURITY SOLUTION
304
RECEIVE THE CAPABILITY INFORMATION FROM THE ROUTERS OF THE NETWORK
306
BASED AT LEAST IN PART ON THE CAPABILITY INFORMATION, DISTRIBUTE THE SECURITY SOLUTION SUCH THAT A SUBSET OF THE SECURITY FEATURES OF THE SECURITY SOLUTION IS PERFORMED BY AN INDIVIDUAL ROUTER AND A BALANCE OF THE SECURITY FEATURES OF THE SECURITY SOLUTION IS PERFORMED BY A CLOUD SECURITY SERVICE
308

FIG. 3

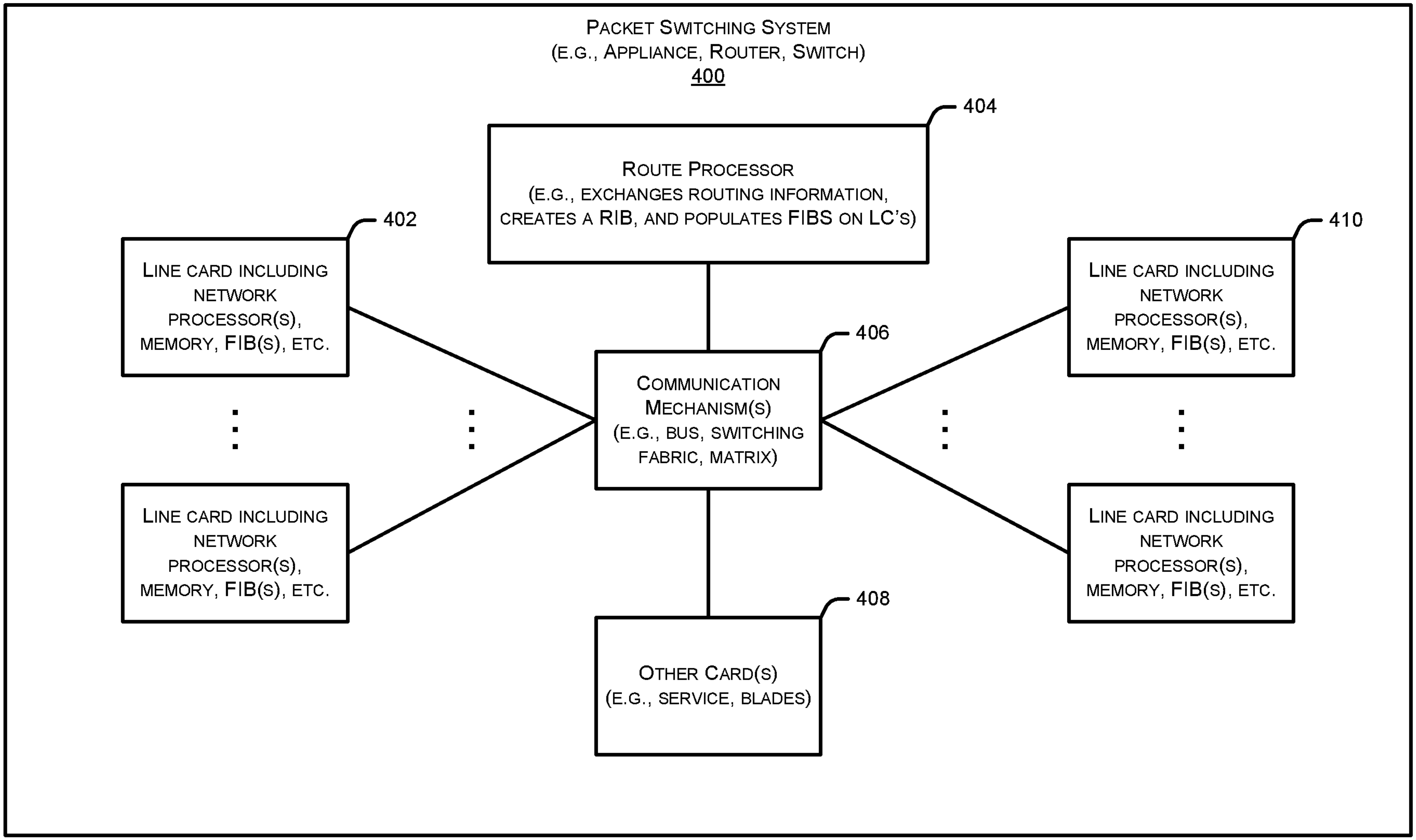
PACKET SWITCHING SYSTEM
(E.G., APPLIANCE, ROUTER, SWITCH)
400
404
ROUTE PROCESSOR
(E.G., EXCHANGES ROUTING INFORMATION, CREATES A RIB, AND POPULATES FIBS ON LC'S)
402
LINE CARD INCLUDING NETWORK PROCESSOR(S), MEMORY, FIB(S), ETC.
LINE CARD INCLUDING NETWORK PROCESSOR(S), MEMORY, FIB(S), ETC.
406
COMMUNICATION MECHANISM(S)
(E.G., BUS, SWITCHING FABRIC, MATRIX)
410
LINE CARD INCLUDING NETWORK PROCESSOR(S), MEMORY, FIB(S), ETC.
LINE CARD INCLUDING NETWORK PROCESSOR(S), MEMORY, FIB(S), ETC.
408
OTHER CARD(S)
(E.G., SERVICE, BLADES)

FIG. 4

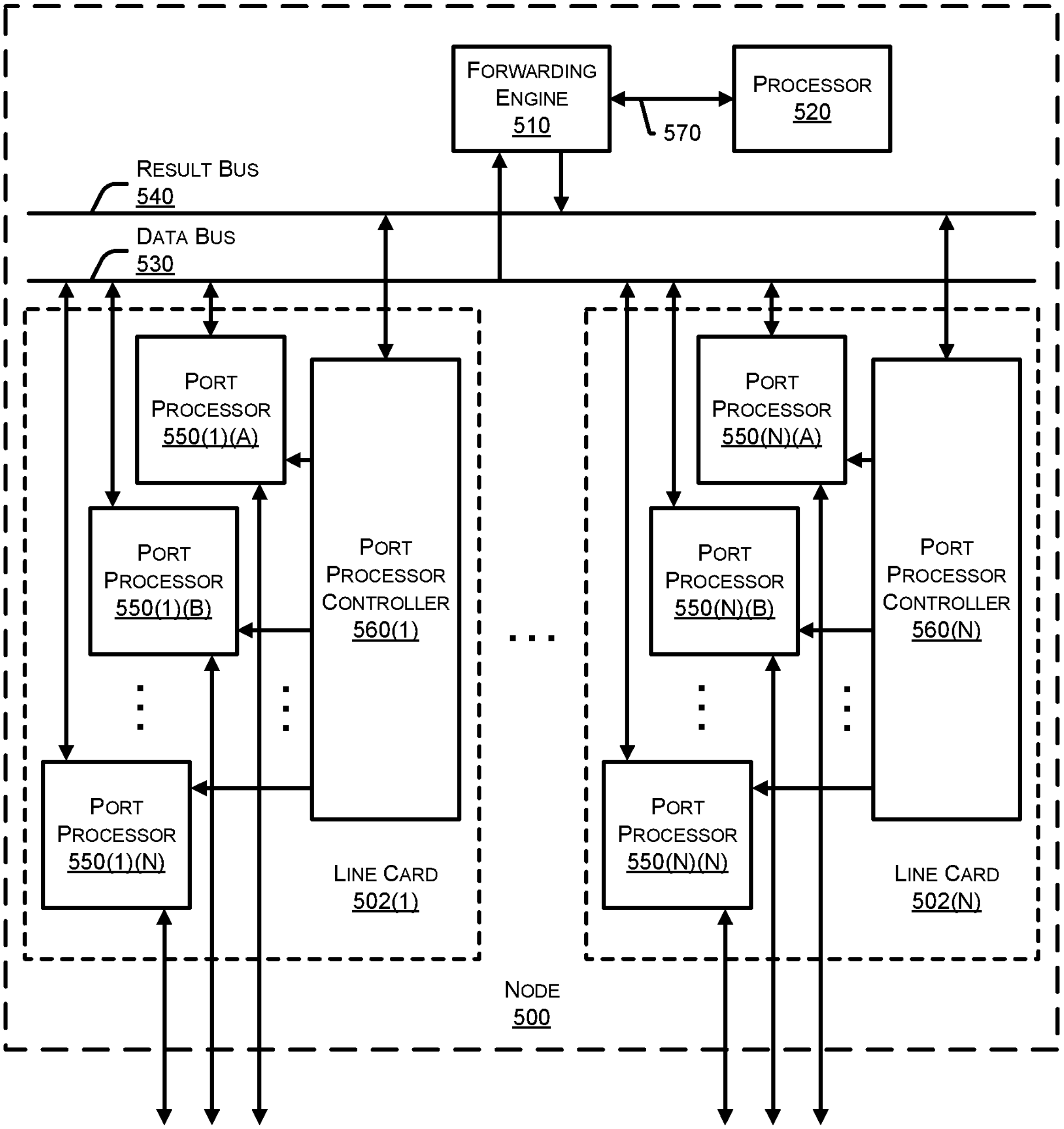
FORWARDING ENGINE 510
PROCESSOR 520
570
RESULT BUS 540
DATA BUS 530
PORT PROCESSOR 550(1)(A)
PORT PROCESSOR 550(1)(B)
PORT PROCESSOR 550(1)(N)
PORT PROCESSOR CONTROLLER 560(1)
LINE CARD 502(1)
PORT PROCESSOR 550(N)(A)
PORT PROCESSOR 550(N)(B)
PORT PROCESSOR 550(N)(N)
PORT PROCESSOR CONTROLLER 560(N)
LINE CARD 502(N)
NODE 500

FIG. 5

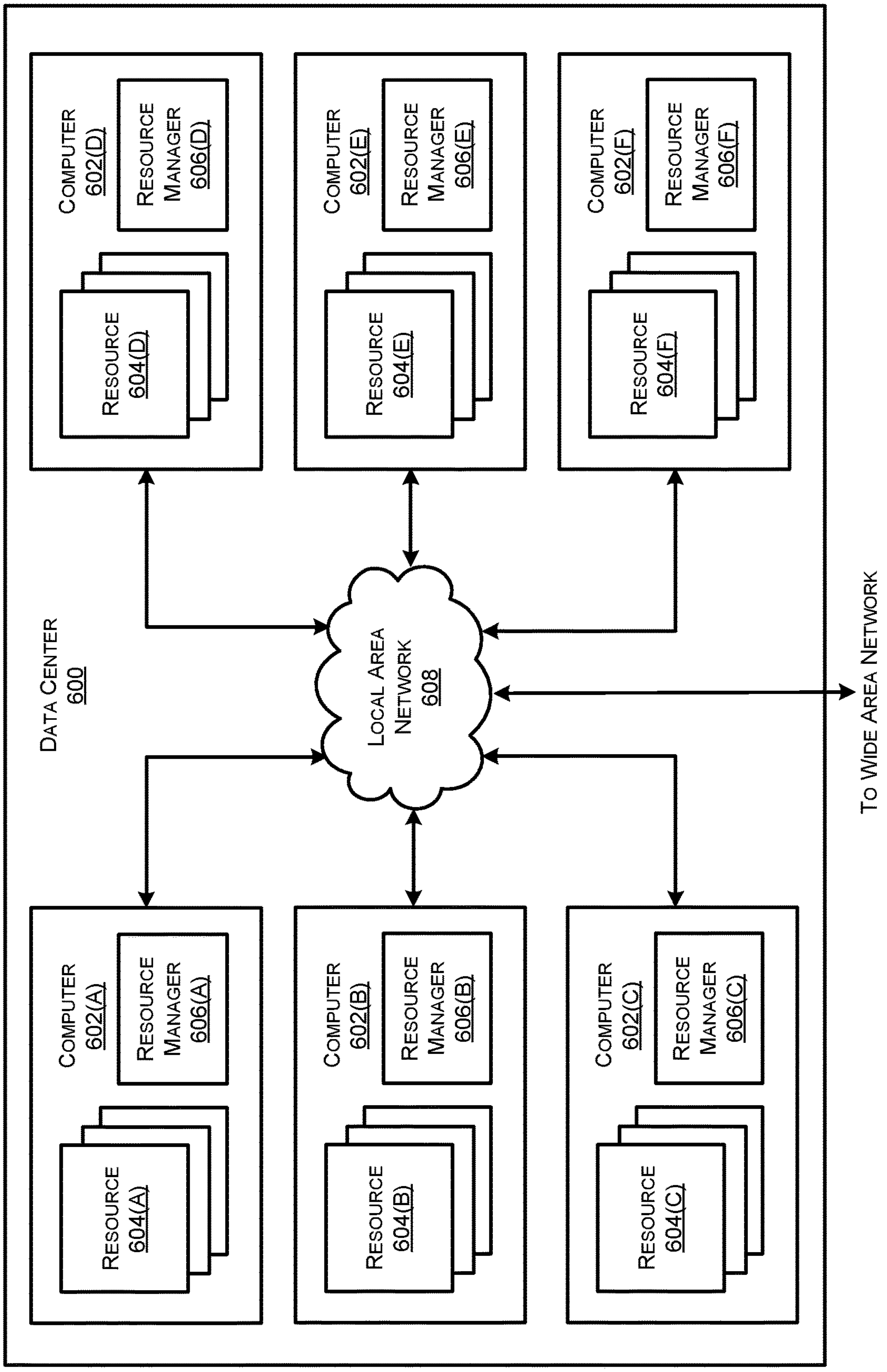
Data Center
600
Computer
602(A)
Resource
604(A)
Resource
Manager
606(A)
Computer
602(B)
Resource
604(B)
Resource
Manager
606(B)
Computer
602(C)
Resource
604(C)
Resource
Manager
606(C)
Local Area
Network
608
Computer
602(D)
Resource
604(D)
Resource
Manager
606(D)
Computer
602(E)
Resource
604(E)
Resource
Manager
606(E)
Computer
602(F)
Resource
604(F)
Resource
Manager
606(F)
To Wide Area Network

FIG. 6

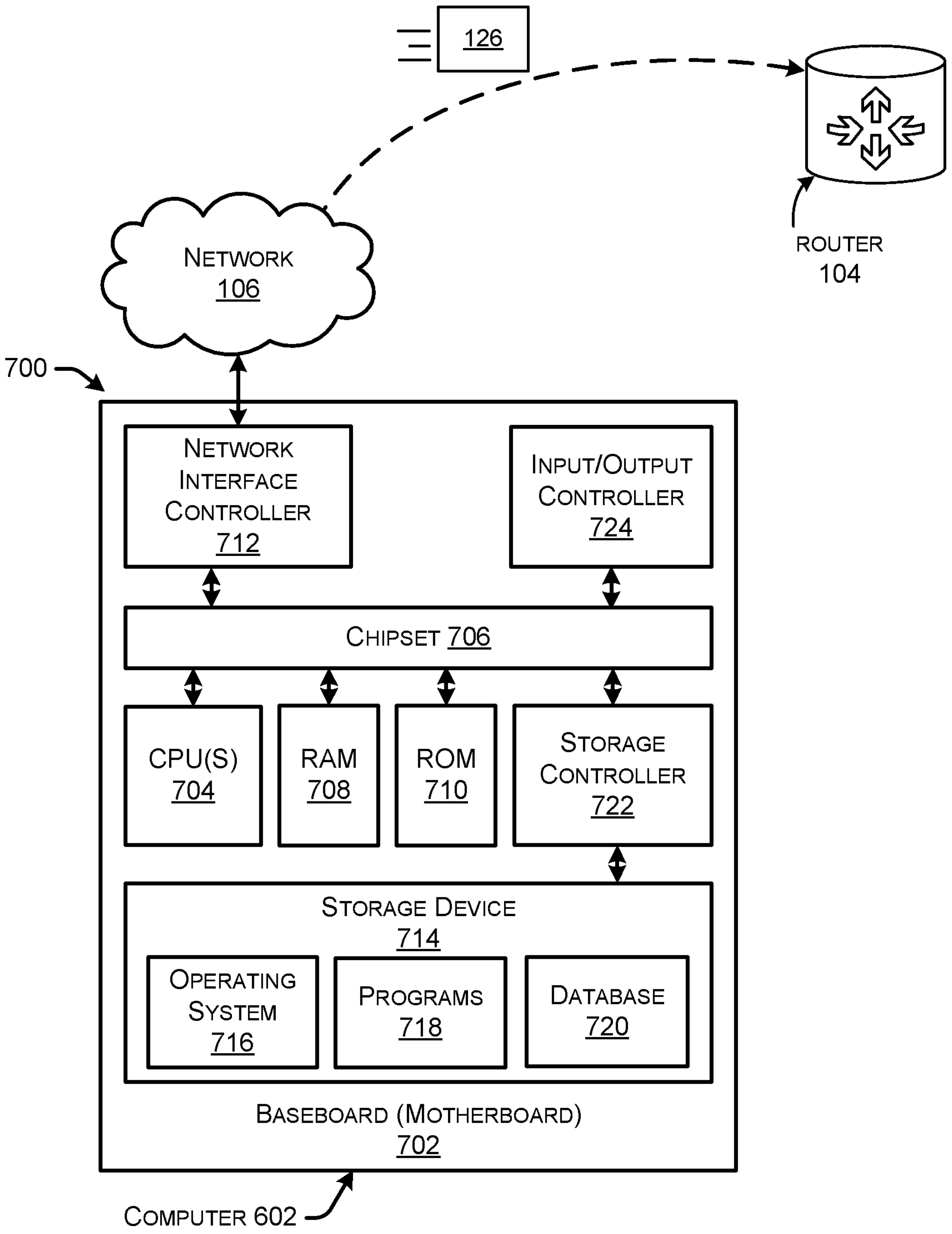
126
NETWORK
106
ROUTER
104
700
NETWORK
INTERFACE
CONTROLLER
712
INPUT/OUTPUT
CONTROLLER
724
CHIPSET 706
CPU(S)
704
RAM
708
ROM
710
STORAGE
CONTROLLER
722
STORAGE DEVICE
714
OPERATING
SYSTEM
716
PROGRAMS
718
DATABASE
720
BASEBOARD (MOTHERBOARD)
702
COMPUTER 602

FIG. 7

SECURITY SOLUTION ORCHESTRATION

TECHNICAL FIELD

The present disclosure relates generally to orchestrating implementation of security policy across computing devices of a network, thereby improving performance of the network.

BACKGROUND

Network environments are growing in complexity and scale to handle the ever-increasing demands on computer systems in the modern world. Additionally, cloud computing provides users with access to computing resources to fulfill users' computing resource needs. In some examples, service providers can manage and provide cloud computing resources to users to fulfill their needs without the users having to invest in and maintain their own computing infrastructure. Cloud computing often involves the use of networks of data centers which house servers, routers, and other devices that provide computing resources to users such as compute resources, networking resources, storage resources, database resources, application resources, and so forth. Managing network security across network components within an organization, while also integrating with work flow performed by external cloud computing resources, can be lead to administrative challenges in terms of efficiency of resource use, data management, and network security.

BRIEF DESCRIPTION OF THE DRAWINGS

The detailed description is set forth below with reference to the accompanying figures. In the figures, the left-most digit(s) of a reference number identifies the figure in which the reference number first appears. The use of the same reference numbers in different figures indicates similar or identical items. In some cases, parentheticals are utilized after a reference number to distinguish like elements. Use of the reference number without the associated parenthetical is generic to the element. The systems depicted in the accompanying figures are not to scale and components within the figures may be depicted not to scale with each other.

FIGS. **1A-1E** illustrate component diagrams with example environment in which techniques related to orchestrating a security solution may be employed as part of communications between network devices, in accordance with the present concepts.

FIGS. **2** and **3** illustrate flow diagrams of example methods for the orchestration of a security solution as a part of communications among network devices, in accordance with the present concepts.

FIG. **4** illustrates a block diagram illustrating an example packet switching system that can be utilized to implement various aspects of the technologies disclosed herein.

FIG. **5** illustrates a block diagram illustrating certain components of an example node that can be utilized to implement various aspects of the technologies disclosed herein.

FIG. **6** illustrates a computing system diagram illustrating a configuration for a data center that can be utilized to implement aspects of the technologies disclosed herein.

FIG. **7** is a computer architecture diagram showing an illustrative computer hardware architecture for implementing a computing device that can be utilized to implement aspects of the various technologies presented herein.

DESCRIPTION OF EXAMPLE EMBODIMENTS

Overview

This disclosure describes, at least in part, a method that may be implemented by a server device communicatively coupled to network devices (e.g., a router) and cloud services (e.g., a cloud security service). The method may include obtaining a security solution for a network. In some examples, the security solution comprising multiple security features. The method may include determining first capabilities of a router of the network to perform the security features of the security solution. The method may also include determining second capabilities of a cloud security service to perform the security features of the security solution. Based at least in part on the first capabilities and the second capabilities, the method may include configuring the router of the network to execute a first subset of the security features on data traffic of the network and configuring the cloud security service to execute a second subset of the security features on the data traffic. The method may further include causing the security solution to be presented to a security administrator via a display. In some examples, the display may provide representations of the first subset and the second subset of the security features.

This disclosure also describes, at least in part, another method that may be implemented by a server device communicatively coupled to network devices (e.g., a router) and cloud services (e.g., a cloud security service). The method may include obtaining a security solution for a network. In some examples, the security solution comprising multiple security features. The method may include requesting capability information from routers of the network. The capability information may be related to the routers supporting the security features of the security solution, for instance. The method may also include receiving the capability information from the routers of the network. Based at least in part on the capability information, the method may include distributing the security solution such that a subset of the security features of the security solution is performed by an individual router and a balance of the security features of the security solution is performed by a cloud security service.

Additionally, the techniques described herein may be performed by a system and/or device having non-transitory computer-readable media storing computer-executable instructions that, when executed by one or more processors, performs the method described above.

Example Embodiments

This disclosure describes techniques for orchestrating implementation of a network security solution across computing devices of a network. An overall security solution for an organization may include multiple separate security features or components. The multiple security features may reside on or be applied at different devices in the network. Efficient orchestration of a security solution may include security feature discovery to determine which components of the network are capable of implementing the different security features. Discovery of the device capabilities may then be used to efficiently distribute the multiple security features of the overall security solution among the network devices, for more efficient use of computing resources. Furthermore, a management interface or portal may then be provided for the overall security solution, providing improved user experience in implementation of a security policy.

Generally, a computing network may consist of physical devices of an organization and also cloud devices and/or services. An example use case for orchestrating implementation of a security solution across computing devices of a network may include distribution of a security policy across software-defined wide area network (SDWAN) SDWAN computing devices (e.g., network edges) and a cloud provider security stack. Service discovery in the system of physical devices of the organization may help inform the implementation of an overall security solution. For instance, one security feature may be a firewall, which may be applied at a particular device (e.g., router) in the network. However, a more holistic and/or efficient solution would also be informed by service discovery relative to the cloud devices. For instance, another security feature may include threat inspection, which may be applied relative to multiple devices, including components of a cloud security provider.

Unfortunately, needing to understand the service capabilities in both the relatively local devices and also the cloud computing devices requires security expertise in both environments, which may currently be accessed via different management portals. For instance, a current migration path for secure access service edge (SASE) in software-defined wide area network (SDWAN) deployment may require a security administrator to handle security policies through two different portals: an SDWAN management plane and also a cloud security provider portal. This may produce a pain point for the administrator, as this can cause inconsistency in the security policy enforcement across the network. In some cases, a user may have to manually configure one or more security policies separately on different portals. Such practice can lead to user error and/or duplication of policies (e.g., enforcing the same policy(ies) or security features on an edge device as well as at the cloud portal). Furthermore, this practice may also require a user to be familiar with multiple different cloud provider portals.

Ultimately, lack of orchestration for an overall security solution may produce inconsistency in a security stack across the network. With more customers migrating towards SASE, this problematic scenario may become more common. Coordinated service discovery on routers in the network and cloud discovery may be used to distribute service usage across the network devices and the cloud. The example use case may include providing a single management interface/portal to define and manage the security policy. Thus, security solution orchestration may provide improved utilization of the network resources, while also improving ease-of-use for customers.

To summarize, a more efficient technique for security solution orchestration across a complex network is provided. The disclosed techniques improve network security with more efficient resource utilization by smartly distributing the security stack. A network security administrator may be provided a simplified portal, possibly even a single pane view for implementing a security stack for the network. The disclosed techniques can help avoid security policy duplication and/or inconsistent security policies or practices. In some implementations, the disclosed techniques may provide an easier SASE migration path for customers.

Although the examples described herein may refer to a router, an edge device, and/or a cloud computing device, the techniques can generally be applied to any device in a network. Further, the techniques are generally applicable for any network of devices managed by any entity where virtual resources are provisioned. In some instances, the techniques may be performed by software-defined networking (SDN), and in other examples, various devices may be used in a system to perform the techniques described herein. The devices by which the techniques are performed herein are a matter of implementation, and the techniques described are not limited to any specific architecture or implementation.

The techniques described herein may provide various improvements and efficiencies with respect to network communications. For instance, the techniques described herein may reduce the amount of computational resource use, storage, dropped data, latency, and other issues experienced in networks due to lack of network resources, overuse of network resources, issues with timing of network communications, and/or improper routing of data. By improving network communications across a network, overall performance by servers and virtual resources may be improved.

Certain implementations and embodiments of the disclosure will now be described more fully below with reference to the accompanying figures, in which various aspects are shown. However, the various aspects may be implemented in many different forms and should not be construed as limited to the implementations set forth herein. The disclosure encompasses variations of the embodiments, as described herein. Like numbers refer to like elements throughout.

FIGS. **1**A-**1**E collectively illustrate an example environment **100** in accordance with the present security solution orchestration concepts. Example environment **100** may include client devices **102**, routers **104**, a network **106** (e.g., computing network, cloud computing network), a cloud security service **108**, and/or a security feature manager **110**. In some cases, parentheticals are utilized after a reference number to distinguish like elements. Use of the reference number without the associated parenthetical is generic to the element. For instance, three routers **104** are depicted, including router **104**(**1**), router **104**(**2**), and router **104**(**3**). As used herein, "network **106**" may be viewed as one or more networks which may include any of the devices of environment **100**. The scenario depicted in FIGS. **1**A-**1**E may be viewed as applying security solution orchestration concepts toward the implementation of a security policy over the network.

A wide variety of implementations are contemplated for security feature manager **110**. For example, security feature manager **110** may be manifest as one device or multiple devices. Security feature manager **110** may be on-premise at an organization or available as a cloud service. In the example shown in FIGS. **1**A-IE, security feature manager **110** may be viewed as a SDWAN controller. For instance, security feature manager **110** may be located on a server device, and may be accessible via a display **112** by an administrator **114**. The administrator **114** may be able to interact with, use, and/or direct security feature manager **110** to communicate with the network via a management plane **116** (e.g., SDWAN management plane). The administrator **114** may work with security feature manager **110** to implement a security solution **118** for the network, for example. The security solution **118** may include one or more security features **120**, depicted as "A," "B," "C," and "D." In some examples, representations of the security solution **118** and/or one or more of the security features **120** may be visible on the display **112**, as suggested in FIGS. **1**A-IE. Environment **100** may also include a database **122**, which may contain a policy **124**.

Security feature manager **110** may be communicatively coupled to various other devices, such as routers **104** and/or cloud security service **108**, via the network **106**. Within the example environment **100**, the security feature manager **110**, routers **104**, client devices **102**, cloud security service **108**, database **122**, and/or other devices may exchange communications (e.g., packets) via a network connection(s) to cloud computing network **106** and/or each other, generally indicated by double arrows. For instance, network connections may be transport control protocol (TCP) network connections or any network connection (e.g., information-centric networking (ICN)) that enables security feature manager **110** to exchange packets with other devices via computing network **106**. The network connections represent, for example, data paths between security feature manager **110** and other devices. It should be appreciated that the term "network connection" may also be referred to as a "network path." The suggestion of a cloud computing network in this example is not meant to be limiting. Other types of networks are contemplated in accordance with security solution orchestration concepts.

FIGS. **1A-1E** show several examples of communications between security feature manager **110** and various other devices of the network. The communications are indicated with dashed, numbered lines. The communications may be viewed as illustrating an example security solution orchestration scenario. For example, security feature manager **110** may be using security solution orchestration concepts to implement the overall security solution **118** for the network **106**.

Referring to FIG. **1**A, at "Step **1**A," security feature manager **110** may send a request **126** (e.g., inquiry) to router **104**(**1**). The request **126** may be a request for information from router **104**(**1**). For example, security feature manager **110** may be interested in discovering the capabilities of router **104**(**1**) with respect to the security solution **118**. More specifically, security feature manager **110** may be interested in discovering whether router **104**(**1**) is capable of performing any of security features **120**. In some examples, the request **126** may be an application programming interface (API) call (e.g., communication channel) sent by the security feature manager **110** from the management plane **116**. The API call may be sent within an encrypted control plane, for instance.

Steps **1**B and **1**C may be similar to Step **1**A, in that security feature manager **110** may send requests for information to routers **104**(**2**) and **104**(**3**), for instance. In some examples, an SDWAN deployment may include different kinds of routers with different capabilities and/or resources. Any given security feature **120** may require particular types or amounts of computing resources, such as a type of central processing unit (CPU) and/or an amount of available memory, etc. Therefore, security feature manager **110** may wish to discover the particular capabilities of any individual routers **104** in the network.

At "Step **2**," in some cases, security feature manager **110** may also send a request to cloud security service **108**. The request to cloud security service **108** may also be accomplished via an API call from the SDWAN management plane **116**.

Referring to FIG. **1**B, in some examples, Steps "**3**A," "**3**B," "**3**C," and/or "**4**" may represent responses to the requests for information that were sent out by security feature manager **110**. For instance, at Step **3**A, router **104**(**1**) may send information to security feature manager **110** regarding capabilities for performing one or more security features **120** of the security solution **118**. Further, Step **4** may represent cloud security service **108** sending information to security feature manager **110** regarding capabilities for performing one or more security features **120** of the security solution **118**. The responses in Steps **3**A, **3**B, **3**C, and/or **4** may be manifest as a list of security features **120** that each respective device/service supports, for instance. The information regarding the supported security features may be sent to the SDWAN management plane **116** via API calls. Therefore, security feature manager **110** may learn supported security features from various devices in the network, such as routers **104** and cloud security service **108**.

In some example SDWAN solutions, two modes may be utilized for end host security deployments, including on-box integrated security (e.g., capabilities on a router) and cloud-delivered security, provided by a cloud security service. The on-box security solution may have basic features, such as firewall and/or domain name service (DNS) redirection. The on-box security solution may also have advanced security features, such as web filtering, threat inspection, file inspection, etc. The capability of an on-premise router to process one or more advanced security features may depend on resource availability at the router. Resource availability at the router may in turn depend on various qualities of the router itself, such as remote access memory (RAM), hard disk space, number of cores, etc. Additionally, some security features of an overall security solution may be performed by a cloud security providers, like Umbrella, zScaler, Netskope, etc. Therefore, when considering implementation of an overall security solution, knowledge of the capabilities of any routers in the network as well as knowledge of the capabilities of a cloud service provider may be helpful. As shown in the example in FIG. **1**B, security solution orchestration concepts may allow this knowledge to be collected and presented to an administrator in one place, rather than the administrator having to log in to different portals to manage aspects of a security policy at different locations/devices, such as at routers vs. at a cloud service provider.

Referring to FIG. **1**A, at "Step **5**," in some cases, security feature manager **110** may use the information gathered through Steps **1**A-**4** to effect the security solution **118** on the network **106**. For example, security feature manager **110** may use the information received in Steps **3**A, **3**B, **3**C, and/or **4** to intelligently distribute the security stack between the routers **104** and/or cloud security service **108**. The distribution of a security solution **118** may include determination of which device/service of a network may be configured to run any given security feature **120** of the security solution **118**, based on the discovered capabilities of the device/service. A determination may include deciding that a device has the capability to perform a particular security feature **120**, or may include deciding that a device does not have the capability to perform a particular security feature **120**, for instance. Example instances of distribution of security solution **118** will now be provided with reference to FIG. **1**C.

In one example instance of distribution of security solution **118**, a customer may desire four security features **120**, which may include a Firewall (A), DNS Security (B), Unified Threat Defense (C) and a secure sockets layer (SSL) Proxy (D). In this example, in Step **3**A, security feature manager **110** may have discovered that router **104**(**1**) has capability to run only the security features **120** A and B, the firewall and DNS security. Router **104**(**1**) may not have enough computing resource to run other security features **120**, such as C (the Unified Threat Defense) or D (the SSL Proxy). Stated another way, security feature manager **110** may have discovered that router **104**(**1**) has capability to run a subset of the security features **120**. Additionally, security feature manager **110** may have discovered via Step **4** that cloud security service **108** supports security features **120**B, C, and D. Stated another way, cloud security service **108** supports a different subset of the security features **120** than the subset supported by router **104**(**1**). Therefore, in this example instance, at Step **5**, security feature manager **110** may determine that security features **120** A and B (e.g., a first subset) are to be run on router **104**(**1**), while security features **120** C and D (e.g., a second subset) will be provided by the cloud security service **108**.

Continuing with the example instance a distribution of security solution **118**, security feature manager **110** may have discovered that router **104**(**2**) supports security features A and C. Therefore, at Step **5**, security feature manager **110** may determine that security features **120** A and C are to be run on router **104**(**2**), while security features **120** B and D will be provided by the cloud security service **108** for traffic that travels through router **104**(**2**). Furthermore, security feature manager **110** may have discovered that router **104**(**3**) supports security features A, C, and D. Therefore, at Step **5**, security feature manager **110** may determine that security features **120** A, C, and D are to be run on router **104**(**3**), while security feature **120** B will be provided by the cloud security service **108** for traffic that travels through router **104**(**3**).

The example instances of distribution of security solution **118** provided here are not meant to be limiting. Note that in a different example instance, security feature manager **110** may discover the same capabilities among the routers **104** and cloud security service **108** as described above, but may instead determine that routers **104**(**1**) and **104**(**2**) will only run the security feature **120** A, the Firewall, while cloud security service **108** handles the remaining security features **120**-B, C, and D. Such a determination would be in keeping with the discovered capabilities of the devices, as described above. In some examples, different distributions may be driven by additional information, known or discovered, about the network or about a security policy.

In some examples, the process of security feature manager **110** using the information gathered through Steps **1**A-**4** to effect the security solution **118** on the network **106** may be coordinated at least in part by security administrator **114** via display **112**. For instance, security feature manager **110** may present at least some of the information gathered through Steps **1**A-**4** on display **112**. The information may be presented in a single view/pane, in some examples. The presentation may include representations of one or more of the security features **120**, for instance. In some implementations, the presentation may allow the security administrator **114** to select certain security features **120** and/or devices. For instance, the security administrator **114** may be able to make a selection indicating that router **104**(**1**) should be configured to run security features **120** A and B, while security features **120** C and D will be provided by the cloud security service **108** for traffic passing through router **104**(**1**). The selection may be made relative to a selectable representation of one or more security features, for instance. As such, the security feature manager **110** may enable the security administrator **114** to make inputs regarding the distribution of overall security solution **118** without the security administrator **114** having to log in to different portals, such as an SDWAN management plane (e.g., for the routers) and also a separate portal for the cloud security service.

At “Step **6**,” in some cases, security feature manager **110** and/or security administrator **114** may seek additional information regarding an overall security solution **118** for the network. For example, security feature manager **110** may access a database **122** for a security policy **124** related to the network **106** and/or related to the security solution **118**. Additional information, such as information included in a policy **124**, may affect a distribution determination for security features **120**. For instance, security policy **124** may inform security feature manager **110** and/or security administrator **114** of the which security features **120** are desired by a customer. In another instance, the security policy **124** may inform security feature manager **110** and/or security administrator **114** of more specific requests, such as a request for a particular security feature **120** to be performed at a particular location, etc. Note that the order of the Steps shown in FIGS. **1**A-**1**E is not meant to be limiting. In some examples, Step **6** may be performed before the other example Steps, and/or may represent security feature manager **110** obtaining security solution **118**, for instance. Also, in some examples, Step **6** may be viewed as security feature manager **110** receiving new or additional information, which may come from any network device. For instance, security feature manager **110** may receive an updated security policy. In response, security feature manager **110** may adjust a distribution of an overall security solution **118**.

Referring to FIG. 1D, at Steps “7A,” “7B.” “7C,” and/or “**8**,” in some cases, security feature manager **110** may send instructions to devices of the network regarding implementation of security solution **118**. For example, security feature manager **110** may send information regarding the distribution of the security features **120**. Security feature manager **110** may send configuration instructions regarding the distribution of the security features **120**, for instance. In one example, Step **7**A may include security feature manager **110** sending configuration instructions to router **104**(**1**) to run security features A and B. Additionally in this example, Step **8** may include security feature manager **110** sending configuration instructions to cloud security service **108** to run security features C and D for traffic passing through router **104**(**1**). As such, in this example, security feature manager **110** has intelligently distributed (configured) security features **120** A and B on router **104**(**1**) and security features **120** C and D on the cloud security provider, via the SDWAN management plane.

Finally, at “Step **9**),” in some cases, an instance of data traffic may originate from a client device **102** and pass through router **104**(**1**) on the way out to the broader network **106**. In some examples, the data traffic may travel through the cloud, while in other examples the data traffic may travel directly from router **104**(**1**) to a client device. In keeping with the example distribution of security features **120** described above, security features **120** A and B will be performed on the data traffic by router **104**(**1**), while security features **120** C and D will be performed on the data traffic by cloud security service **108**. Note that the cloud security service **108** is expected to be able to enforce the distributed security stack, as configured, based on tunnel identification (tunnel IDs) or another identification mechanism for any given router **104**. Stated another way, although the portion of security solution **118** enforced by the cloud security service **108** may vary for data flows from different routers **104**, the cloud security service **108** should be able to determine which security features **120** to run based on identifying the router **104**. Thus, security solution orchestration concepts allow intelligent distribution of security solution **118**, smartly matching the capabilities of devices in a network, while preventing duplication of security features **120** for any given data traffic. Furthermore, even though enforcement of individual security features **120** may be happening at different places (on box, or at the cloud security service, or both), with security solution orchestration based at least in part on router resource, data traffic from any given router **104** is able to have the same, consistent security stack applied.

To summarize, the security solution orchestration techniques described herein may help optimize resource utilization by distributing a security stack across devices of a network, thereby improving network performance. The techniques may provide a solution that accomplishes capability discovery for both on-premise devices and also cloud service(s). The techniques include a convenient presentation (e.g., a single pane) of the capabilities to a security administrator so that a security stack may be smartly distributed over the network. The orchestration may help avoid duplication of security features and/or inconsistent policy implementation. Thus, security solution orchestration techniques may provide an easier SASE migration path for customers.

FIGS. **2** and **3** illustrate flow diagrams of example methods **200** and **300** that include functions that may be performed at least partly by a security feature manager, such as security feature manager **110** described relative to FIGS. **1**A-IE. The logical operations described herein with respect to FIGS. **2** and **3** may be implemented (1) as a sequence of computer-implemented acts or program modules running on a computing system and/or (2) as interconnected machine logic circuits or circuit modules within the computing system. In some examples, the method(s) **200** and/or **300** may be performed by a system comprising one or more processors and one or more non-transitory computer-readable media storing computer-executable instructions that, when executed by the one or more processors, cause the one or more processors to perform the method(s) **200** and/or **300**.

The implementation of the various devices and/or components described herein is a matter of choice dependent on the performance and other requirements of the computing system. Accordingly, the logical operations described herein are referred to variously as operations, structural devices, acts, or modules. These operations, structural devices, acts, and modules may be implemented in software, in firmware, in special purpose digital logic, and any combination thereof. It should also be appreciated that more or fewer operations might be performed than shown in the FIGS. **2** and **3** and described herein. These operations may also be performed in parallel, or in a different order than those described herein. Some or all of these operations may also be performed by components other than those specifically identified. Although the techniques described in this disclosure is with reference to specific devices, in other examples, the techniques may be implemented by less devices, more devices, different devices, or any configuration of devices and/or components.

FIG. **2** illustrates a flow diagram of an example method **200** for network devices to perform security solution orchestration techniques. Method **200** may be performed by a server device communicatively coupled to other network devices, such as one or more routers (e.g., routers **104**), and/or a cloud security service (e.g., cloud security service **108**), for instance.

At **202**, method **200** may include obtaining a security solution for a network. In some examples, the security solution may comprise multiple security features. For instance, the security solution may represent a desired security stack that is to be applied to data traffic over the network. The security features of the stack may include any of a number of example security features, such as a firewall, DNS Security, DNS redirection, web filtering, threat inspection, file inspection, Unified Threat Defense, SSL Proxy, etc.

At **204**, method **200** may include determining first capabilities of a router of the network. The capabilities may correspond to the router's own capability to perform any or all of the security features of the security solution. For instance, the capabilities may refer to whether any particular security feature is supported by the router. In some examples, the router may not have the computing resources to support a particular security feature. The method **200** may include determining the first capabilities of the router to perform the security features by sending a request to the router to discover the capabilities of the router, for example. The discovery of the first capabilities may be performed via API calls over an SDWAN management plane, for instance.

At **206**, method **200** may include determining second capabilities of a cloud security service. The capabilities may correspond to the capability of the cloud security service to perform any or all of the security features of the security solution.

At **208**, based at least in part on the first capabilities and the second capabilities, method **200** may include configuring the router of the network to execute a first subset of the security features on data traffic of the network. For example, the first subset of the security features may include a firewall implemented at/by the router. The configuring of the router may be performed via the SDWAN management plane.

At **210**, based at least in part on the first capabilities and the second capabilities, method **200** may include configuring the cloud security service to execute a second subset of the security features on the data traffic. In some examples, the first subset and the second subset may combine to make a complete security solution. For instance, the individual security features that make up the first subset, when combined with the individual security features that make up the second subset, may constitute the overall security solution with no overlap in individual security features. Furthermore, any given router in the network may be configured to perform a different subset of the security features of the security solution, but for data traffic from each router, the cloud security service may be configured to perform the balance of the security features of the security solution. Stated another way, the same discrete list of security features may be performed on data traffic from any given router to which the security solution is meant to apply, while different subsets of the security features may be performed in different places, depending on the discovered capabilities of any given router. Therefore, the method **200** may also include determining third capabilities of another (second) router of the network to perform the security features of the security solution. In this instance, based at least in part on the first capabilities and the third capabilities, the method **200** may include configuring the second router of the network to execute a third subset of the security features on data traffic of the network. In at least some cases, the third subset of the security features may include at least one different individual security feature than the first subset.

At **212**, method **200** may include causing the security solution to be presented to a security administrator via a display. In some examples, the display may provide representations of the first subset and the second subset of the security features. For instance, the display may be available to a security administrator to be able to view information regarding the security features, the overall security solution, the capabilities of any of the network devices, the capabilities of the cloud security service, the distribution of the security features among the network devices and/or the cloud security service, views of the security features individually or as sets or subsets of features, selectable views of any of the above elements, etc. The security solution may be presented via a display in a way that provides a holistic, or overall, view of the security solution in one convenient place, rather than the security administrator having to access information regarding routers and a cloud service in different management systems.

FIG. **3** illustrates a flow diagram of an example method **300** for network devices to perform security solution orchestration techniques. Method **300** may be performed by a server device communicatively coupled to other network devices, such as one or more routers (e.g., routers **104**), and/or a cloud security service (e.g., cloud security service **108**), for instance.

At **302**, method **300** may include obtaining a security solution for a network. In some examples, the security solution may comprise multiple security features.

At **304**, method **300** may include requesting capability information from routers of the network. For example, the capability information may be related to whether the routers support the security features of the security solution.

At **306**, method **300** may include receiving the capability information from the routers of the network. In some examples, the requesting the and receiving the capability information may be performed via API calls over an SDWAN management plane. Method **300** may also include causing the capability information related to the routers supporting the security features to be displayed to a security administrator.

At **308**, based at least in part on the capability information, method **300** may include distributing the security solution such that a subset of the security features of the security solution is performed by an individual router, while a balance of the security features of the security solution is performed by a cloud security service. In some examples, the subset of the security features of the security solution may comprise different individual security features for different individual routers of the network. Method **300** may include distributing the security solution such that a different subset of the security features of the security solution is performed by a different individual router. Additionally, the security solution applied to data traffic from the individual router and the different individual router may comprise the same overall list, or stack, of security features, without overlap of any security features.

FIG. **4** illustrates a block diagram illustrating an example packet switching device (or system) **400** that can be utilized to implement various aspects of the technologies disclosed herein. In some examples, packet switching device(s) **400** may be employed in various networks, such as, for example, network **106** as described with respect to FIGS. **1A-1E**. For instance, packet switching device **400** may represent one of routers **104**.

In some examples, a packet switching device **400** may comprise multiple line card(s) **402**, **410**, each with one or more network interfaces for sending and receiving packets over communications links (e.g., possibly part of a link aggregation group). The packet switching device **400** may also have a control plane with one or more processing elements **404** for managing the control plane and/or control plane processing of packets associated with forwarding of packets in a network. The packet switching device **400** may also include other cards **408** (e.g., service cards, blades) which include processing elements that are used to process (e.g., forward/send, drop, manipulate, change, modify, receive, create, duplicate, apply a service) packets associated with forwarding of packets in a network. The packet switching device **400** may comprise hardware-based communication mechanism **406** (e.g., bus, switching fabric, and/or matrix, etc.) for allowing its different entities **402**, **404**, **408** and **410** to communicate. Line card(s) **402**, **410** may typically perform the actions of being both an ingress and/or an egress line card **402**, **410**, in regard to multiple other particular packets and/or packet streams being received by, or sent from, packet switching device **400**.

FIG. **5** illustrates a block diagram illustrating certain components of an example node **500** that can be utilized to implement various aspects of the technologies disclosed herein. In some examples, node(s) **500** may be employed in various networks, such as, for example, network **106** as described with respect to FIGS. **1A-1E**.

In some examples, node **500** may include any number of line cards **502** (e.g., line cards **502**(**1**)-(N), where N may be any integer greater than 1) that are communicatively coupled to a forwarding engine **510** (also referred to as a packet forwarder) and/or a processor **520** via a data bus **530** and/or a result bus **540**. Line cards **502**(**1**)-(N) may include any number of port processors **550**(**1**)(A)-(N)(N) which are controlled by port processor controllers **560**(**1**)-(N), where N may be any integer greater than 1. Additionally, or alternatively, forwarding engine **510** and/or processor **520** are not only coupled to one another via the data bus **530** and the result bus **540**, but may also communicatively coupled to one another by a communications link **570**.

The processors (e.g., the port processor(s) **550** and/or the port processor controller(s) **560**) of each line card **502** may be mounted on a single printed circuit board. When a packet or packet and header are received, the packet or packet and header may be identified and analyzed by node **500** (also referred to herein as a router) in the following manner. Upon receipt, a packet (or some or all of its control information) or packet and header may be sent from one of port processor(s) **550**(**1**)(A)-(N)(N) at which the packet or packet and header was received and to one or more of those devices coupled to the data bus **530** (e.g., others of the port processor(s) **550**(**1**)(A)-(N)(N), the forwarding engine **510** and/or the processor **520**). Handling of the packet or packet and header may be determined, for example, by the forwarding engine **510**. For example, the forwarding engine **510** may determine that the packet or packet and header should be forwarded to one or more of port processors **550**(**1**)(A)-(N)(N). This may be accomplished by indicating to corresponding one(s) of port processor controllers **560**(**1**)-(N) that the copy of the packet or packet and header held in the given one(s) of port processor(s) **550**(**1**)(A)-(N)(N) should be forwarded to the appropriate one of port processor(s) **550**(**1**)(A)-(N)(N). Additionally, or alternatively, once a packet or packet and header has been identified for processing, the forwarding engine **510**, the processor **520**, and/or the like may be used to process the packet or packet and header in some manner and/or may add packet security information in order to secure the packet. On a node **500** sourcing such a packet or packet and header, this processing may include, for example, encryption of some or all of the packet's or packet and header's information, the addition of a digital signature, and/or some other information and/or processing capable of securing the packet or packet and header. On a node **500** receiving such a processed packet or packet and header, the corresponding process may be performed to recover or validate the packet's or packet and header's information that has been secured.

FIG. **6** is a computing system diagram illustrating a configuration for a data center **600** that can be utilized to implement aspects of the technologies disclosed herein. The example data center **600** shown in FIG. **6** includes several computers **602**A-**602**F (which might be referred to herein singularly as "a computer **602**" or in the plural as "the computers **602**") for providing computing resources. In some examples, the resources and/or computers **602** may include, or correspond to, any type of networked device described herein, such as a server device representing security feature manager **110**. Although, computers **602** may comprise any type of networked device, such as servers, switches, routers, hubs, bridges, gateways, modems, repeaters, access points, hosts, etc.

The computers **602** can be standard tower, rack-mount, or blade server computers configured appropriately for providing computing resources. In some examples, the computers **602** may provide computing resources **604** including data processing resources such as virtual machine (VM) instances or hardware computing systems, database clusters, computing clusters, storage clusters, data storage resources, database resources, networking resources, and others. Some of the computers **602** can also be configured to execute a resource manager **606** capable of instantiating and/or managing the computing resources. In the case of VM instances, for example, the resource manager **606** can be a hypervisor or another type of program configured to enable the execution of multiple VM instances on a single computer **602**. Computers **602** in the data center **600** can also be configured to provide network services and other types of services.

In the example data center **600** shown in FIG. **6**, an appropriate local area network (LAN) **608** is also utilized to interconnect the computers **602**A-**602**F. It should be appreciated that the configuration and network topology described herein has been greatly simplified and that many more computing systems, software components, networks, and networking devices can be utilized to interconnect the various computing systems disclosed herein and to provide the functionality described above. Appropriate load balancing devices or other types of network infrastructure components can also be utilized for balancing a load between data centers **600**, between each of the computers **602**A-**602**F in each data center **600**, and, potentially, between computing resources in each of the computers **602**. It should be appreciated that the configuration of the data center **600** described with reference to FIG. **6** is merely illustrative and that other implementations can be utilized.

In some examples, the computers **602** may each execute one or more application containers and/or virtual machines to perform techniques described herein. For instance, the containers and/or virtual machines may serve as server devices, user devices, and/or routers in the network **106**.

In some instances, the data center **600** may provide computing resources, like application containers, VM instances, and storage, on a permanent or an as-needed basis. Among other types of functionality, the computing resources provided by a cloud computing network may be utilized to implement the various services and techniques described above. The computing resources **604** provided by the cloud computing network can include various types of computing resources, such as data processing resources like application containers and VM instances, data storage resources, networking resources, data communication resources, network services, and the like.

Each type of computing resource **604** provided by the cloud computing network can be general-purpose or can be available in a number of specific configurations. For example, data processing resources can be available as physical computers or VM instances in a number of different configurations. The VM instances can be configured to execute applications, including web servers, application servers, media servers, database servers, some or all of the network services described above, and/or other types of programs. Data storage resources can include file storage devices, block storage devices, and the like. The cloud computing network can also be configured to provide other types of computing resources **604** not mentioned specifically herein.

The computing resources **604** provided by a cloud computing network may be enabled in one embodiment by one or more data centers **600**(which might be referred to herein singularly as "a data center **600**" or in the plural as "the data centers **600**"). The data centers **600** are facilities utilized to house and operate computer systems and associated components. The data centers **600** typically include redundant and backup power, communications, cooling, and security systems. The data centers **600** can also be located in geographically disparate locations. One illustrative embodiment for a data center **600** that can be utilized to implement the technologies disclosed herein will be described below with regards to FIG. **7**.

FIG. **7** shows an example computer architecture **700** for a computer **602** capable of executing program components for implementing the functionality described above. The computer architecture **700** shown in FIG. **7** illustrates a conventional server computer, workstation, desktop computer, laptop, tablet, network appliance, e-reader, smartphone, and/or other computing device, and can be utilized to execute any of the software components presented herein. The computer **602** may, in some examples, correspond to a physical device described herein (e.g., server device, router, etc.), and may comprise networked devices such as servers, switches, routers, hubs, bridges, gateways, modems, repeaters, access points, etc. For instance, computer **602** may correspond to a server device representing security feature manager **110**.

As shown in FIG. **7**, the computer **602** includes a baseboard **702**, or "motherboard," which is a printed circuit board to which a multitude of components or devices can be connected by way of a system bus or other electrical communication paths. In one illustrative configuration, one or more central processing units ("CPUs") **704** operate in conjunction with a chipset **706**. The CPUs **704** can be standard programmable processors that perform arithmetic and logical operations necessary for the operation of the computer **602**.

The CPUs **704** perform operations by transitioning from one discrete, physical state to the next through the manipulation of switching elements that differentiate between and change these states. Switching elements generally include electronic circuits that maintain one of two binary states, such as flip-flops, and electronic circuits that provide an output state based on the logical combination of the states of one or more other switching elements, such as logic gates. These basic switching elements can be combined to create more complex logic circuits, including registers, adders-subtractors, arithmetic logic units, floating-point units, and the like.

The chipset **706** provides an interface between the CPUs **704** and the remainder of the components and devices on the baseboard **702**. The chipset **706** can provide an interface to a RAM **708**, used as the main memory in the computer **602**. The chipset **706** can further provide an interface to a computer-readable storage medium such as a read-only memory ("ROM") **710** or non-volatile RAM ("NVRAM") for storing basic routines that help to startup the computer **602** and to transfer information between the various components and devices. The ROM **710** or NVRAM can also store other software components necessary for the operation of the computer **602** in accordance with the configurations described herein.

The computer **602** can operate in a networked environment using logical connections to remote computing devices and computer systems through a network, such as the networks **106** or **608**. The chipset **706** can include functionality for providing network connectivity through a network interface controller (NIC) **712**, such as a gigabit Ethernet adapter. The NIC **712** is capable of connecting the computer **602** to other computing devices over the network **106**. For instance, in the example shown in FIG. **7**, NIC **712** may help facilitate transfer of data, packets, and/or communications, such as requests **126**, over the network **106** with a router **104**. It should be appreciated that multiple NICs **712** can be present in the computer **602**, connecting the computer to other types of networks and remote computer systems.

The computer **602** can be connected to a storage device **714** that provides non-volatile storage for the computer. The storage device **714** can store an operating system **716**, programs **718**, requests **126**, information regarding capabilities of other devices, a security policy(ies) **124**, information about security features **120**, and/or other data. The storage device **714** can be connected to the computer **602** through a storage controller **722** connected to the chipset **706**, for example. The storage device **714** can consist of one or more physical storage units. The storage controller **722** can interface with the physical storage units through a serial attached SCSI ("SAS") interface, a serial advanced technology attachment ("SATA") interface, a fiber channel ("FC") interface, or other type of interface for physically connecting and transferring data between computers and physical storage units.

The computer **602** can store data on the storage device **714** by transforming the physical state of the physical storage units to reflect the information being stored. The specific transformation of physical state can depend on various factors, in different embodiments of this description. Examples of such factors can include, but are not limited to, the technology used to implement the physical storage units, whether the storage device **714** is characterized as primary or secondary storage, and the like.

For example, the computer **602** can store information to the storage device **714** by issuing instructions through the storage controller **722** to alter the magnetic characteristics of a particular location within a magnetic disk drive unit, the reflective or refractive characteristics of a particular location in an optical storage unit, or the electrical characteristics of a particular capacitor, transistor, or other discrete component in a solid-state storage unit. Other transformations of physical media are possible without departing from the scope and spirit of the present description, with the foregoing examples provided only to facilitate this description. The computer **602** can further read information from the storage device **714** by detecting the physical states or characteristics of one or more particular locations within the physical storage units.

In addition to the mass storage device **714** described above, the computer **602** can have access to other computer-readable storage media to store and retrieve information, such as policies, program modules, data structures, and/or other data. It should be appreciated by those skilled in the art that computer-readable storage media is any available media that provides for the non-transitory storage of data and that can be accessed by the computer **602**. In some examples, the operations performed by the network **106**, and or any components included therein, may be supported by one or more devices similar to computer **602**. Stated otherwise, some or all of the operations performed by the network **106**, and or any components included therein, may be performed by one or more computer devices **602** operating in a cloud-based arrangement.

By way of example, and not limitation, computer-readable storage media can include volatile and non-volatile, removable and non-removable media implemented in any method or technology. Computer-readable storage media includes, but is not limited to, RAM, ROM, erasable programmable ROM ("EPROM"), electrically-erasable programmable ROM ("EEPROM"), flash memory or other solid-state memory technology, compact disc ROM ("CD-ROM"), digital versatile disk ("DVD"), high definition DVD ("HD-DVD"), BLU-RAY, ternary content addressable memory (TCAM), and/or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other medium that can be used to store the desired information in a non-transitory fashion.

As mentioned briefly above, the storage device **714** can store an operating system **716** utilized to control the operation of the computer **602**. According to one embodiment, the operating system comprises the LINUX operating system. According to another embodiment, the operating system comprises the WINDOWS® SERVER operating system from MICROSOFT Corporation of Redmond, Washington. According to further embodiments, the operating system can comprise the UNIX operating system or one of its variants. It should be appreciated that other operating systems can also be utilized. The storage device **714** can store other system or application programs and data utilized by the computer **602**.

In one embodiment, the storage device **714** or other computer-readable storage media is encoded with computer-executable instructions which, when loaded into the computer **602**, transform the computer from a general-purpose computing system into a special-purpose computer capable of implementing the embodiments described herein. These computer-executable instructions transform the computer **602** by specifying how the CPUs **704** transition between states, as described above. According to one embodiment, the computer **602** has access to computer-readable storage media storing computer-executable instructions which, when executed by the computer **602**, perform the various processes described above with regards to FIGS. **1A-3**. The computer **602** can also include computer-readable storage media having instructions stored thereupon for performing any of the other computer-implemented operations described herein.

The computer **602** can also include one or more input/output controllers **724** for receiving and processing input from a number of input devices, such as a keyboard, a mouse, a touchpad, a touch screen, an electronic stylus, or other type of input device. Similarly, an input/output controller **724** can provide output to a display, such as a computer monitor, a flat-panel display, a digital projector, a printer, or other type of output device. It will be appreciated that the computer **602** might not include all of the components shown in FIG. **7**, can include other components that are not explicitly shown in FIG. **7**, or might utilize an architecture completely different than that shown in FIG. **7**.

As described herein, the computer **602** may comprise one or more devices, such as a server device, any device described above as part of network **106**, and/or other devices. The computer **602** may include one or more hardware processors **704**(processors) configured to execute one or more stored instructions. The processor(s) **704** may comprise one or more cores. Further, the computer **602** may include one or more network interfaces configured to provide communications between the computer **602** and other devices, such as the communications described herein as being performed by a router **104**, one or more devices representing a security feature manager **110**, devices associated with a cloud security service **108**, and/or other devices. In some examples, the communications may include data, packet, request, acknowledgment, security policy and/or other information transfer, for instance. The network interfaces may include devices configured to couple to personal area networks (PANs), wired and wireless local area networks (LANs), wired and wireless wide area networks (WANs), and so forth. For example, the network interfaces may include devices compatible with Ethernet, Wi-Fi™, and so forth.

The programs **718** may comprise any type of programs or processes to perform the techniques described in this disclosure in accordance with security solution orchestration techniques. For instance, the programs **718** may cause the computer **602** to perform techniques for communicating with other devices using any type of protocol or standard usable for determining connectivity. Additionally, the programs **718** may comprise instructions that cause the computer **602** to perform the specific techniques for the orchestration of a security solution.

While the invention is described with respect to the specific examples, it is to be understood that the scope of the invention is not limited to these specific examples. Since other modifications and changes varied to fit particular operating requirements and environments will be apparent to those skilled in the art, the invention is not considered limited to the example chosen for purposes of disclosure, and covers all changes and modifications which do not constitute departures from the true spirit and scope of this invention.

Although the application describes embodiments having specific structural features and/or methodological acts, it is to be understood that the claims are not necessarily limited to the specific features or acts described. Rather, the specific features and acts are merely illustrative of some embodiments that fall within the scope of the claims of the application.

What is claimed is:

1. A computer-implemented method comprising:

obtaining a security solution for a network, the security solution comprising multiple security features;

determining first capabilities of a router of the network to perform the security features of the security solution;

determining second capabilities of a cloud security service to perform the security features of the security solution;

based at least in part on the first capabilities and the second capabilities, configuring the router of the network to execute a first subset of the security features on data traffic of the network;

based at least in part on the first capabilities and the second capabilities, configuring the cloud security service to execute a second subset of the security features on the data traffic; and

causing the security solution to be presented to a security administrator via a display, the display providing representations of the first subset and the second subset of the security features.

2. The computer-implemented method of claim **1**, wherein the first subset of the security features includes a firewall implemented at the router.

3. The computer-implemented method of claim **1**, wherein the determining the first capabilities of the router of the network to perform the security features comprises sending a request to the router to discover the first capabilities of the router.

4. The computer-implemented method of claim **1**, further comprising:

determining the first subset and the second subset such that the first subset and the second subset complete the security solution.

5. The computer-implemented method of claim **1**, wherein the first subset and the second subset comprise the security solution without overlap of individual security features of the multiple security features.

6. The computer-implemented method of claim **1**, further comprising:

determining third capabilities of another router of the network to perform the security features of the security solution; and

based at least in part on the first capabilities and the third capabilities, configuring the another router of the network to execute a third subset of the security features on data traffic of the network.

7. The computer-implemented method of claim **6**, wherein the third subset of the security features includes at least one different individual security feature than the first subset.

8. The computer-implemented method of claim **1**, wherein the configuring the router and the configuring the cloud security service is performed via a software-defined wide area network (SDWAN) management plane.

9. A server device comprising:

one or more processors; and

one or more non-transitory computer-readable media storing computer-executable instructions that, when executed by the one or more processors, cause the one or more processors to:

obtain a security solution for a network, the security solution comprising multiple security features;

determine first capabilities of a router of the network to perform the security features of the security solution;

determine second capabilities of a cloud security service provider to perform the security features of the security solution;

based at least in part on the first capabilities and the second capabilities, configure the router of the network to execute a first subset of the security features on data traffic of the network;

based at least in part on the first capabilities and the second capabilities, configure the cloud security service provider to execute a second subset of the security features on the data traffic; and

cause the security solution to be presented to a security administrator via a display, the display including representations of the first subset and the second subset of the security features.

10. The server device of claim **9**, wherein the first subset of the security features includes a firewall implemented at the router.

11. The server device of claim **9**, wherein the determining the first capabilities of the router of the network to perform the security features comprises sending a request to the router to discover the first capabilities of the router.

12. The server device of claim **9**, wherein the computer-executable instructions further cause the one or more processors to:

determine the first subset and the second subset such that the first subset and the second subset complete the security solution.

13. The server device of claim **9**, wherein the first subset and the second subset comprise the security solution without overlap of individual security features of the multiple security features.

14. The server device of claim **9**, wherein the computer-executable instructions further cause the one or more processors to:

determine third capabilities of another router of the network to perform the security features of the security solution; and

based at least in part on the first capabilities and the third capabilities, configure the another router of the network to execute a third subset of the security features on data traffic of the network.

15. The server device of claim **14**, wherein the third subset of the security features includes at least one different individual security feature than the first subset.

16. The server device of claim **9**, wherein the configuring the router and the configuring the cloud security service is performed via a software-defined wide area network (SD-WAN) management plane.

17. A method comprising:

obtaining a security solution for a network, the security solution comprising multiple security features;

requesting capability information from routers of the network, the capability information related to the routers supporting the security features of the security solution;

receiving the capability information from the routers of the network; and

based at least in part on the capability information, distributing the security solution such that a subset of the security features of the security solution is performed by an individual router and a balance of the security features of the security solution is performed by a cloud security service.

18. The method of claim **17**, wherein the subset of the security features of the security solution comprises different individual security features for different individual routers of the network.

19. The method of claim **17**, further comprising:

distributing the security solution such that:

a different subset of the security features of the security solution is performed by a different individual router, and

the security solution applied to data traffic from the individual router and the different individual router comprises the same security features without overlap of security features.

20. The method of claim **17**, further comprising:

causing capability information related to the routers supporting the security features to be displayed to a security administrator.

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