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(54) # MID-LINK FORENSIC SYSTEM FOR REMOTE APPLICATION ENVIRONMENT BASED ON UNIQUE MARKERS

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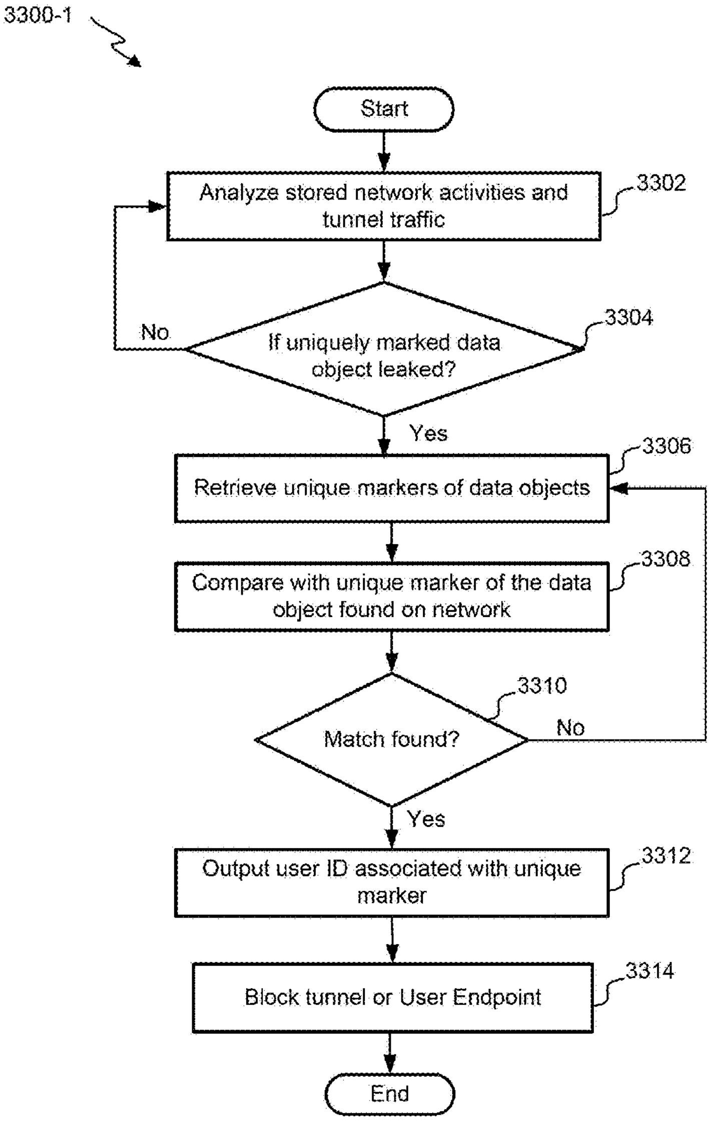
H04L 67/1396 (2022.01)

(52) **U.S. Cl.**
CPC *H04L 67/1396* (2022.05)

(57) **ABSTRACT**

The present disclosure provides an electronic inspection method and system comprising user endpoints, end-link servers belonging to a tenant, and a mid-link server. The mid-link server connects the user endpoints with an end-link server through tunnels. The mid-link server receives communication from the user endpoints through the tunnels, embeds a unique marker in data objects, store meta data of the unique markers in the meta database, match unique markers of the leaked data objects with unique markers stored in the database to identify the source of the leaked data objects and block the tunnel of user endpoint with leaked data objects.


3300-1
Start
Analyze stored network activities and tunnel traffic
3302
If uniquely marked data object leaked?
3304
No
Yes
Retrieve unique markers of data objects
3306
Compare with unique marker of the data object found on network
3308
Match found?
3310
No
Yes
Output user ID associated with unique marker
3312
Block tunnel or User Endpoint
3314
End

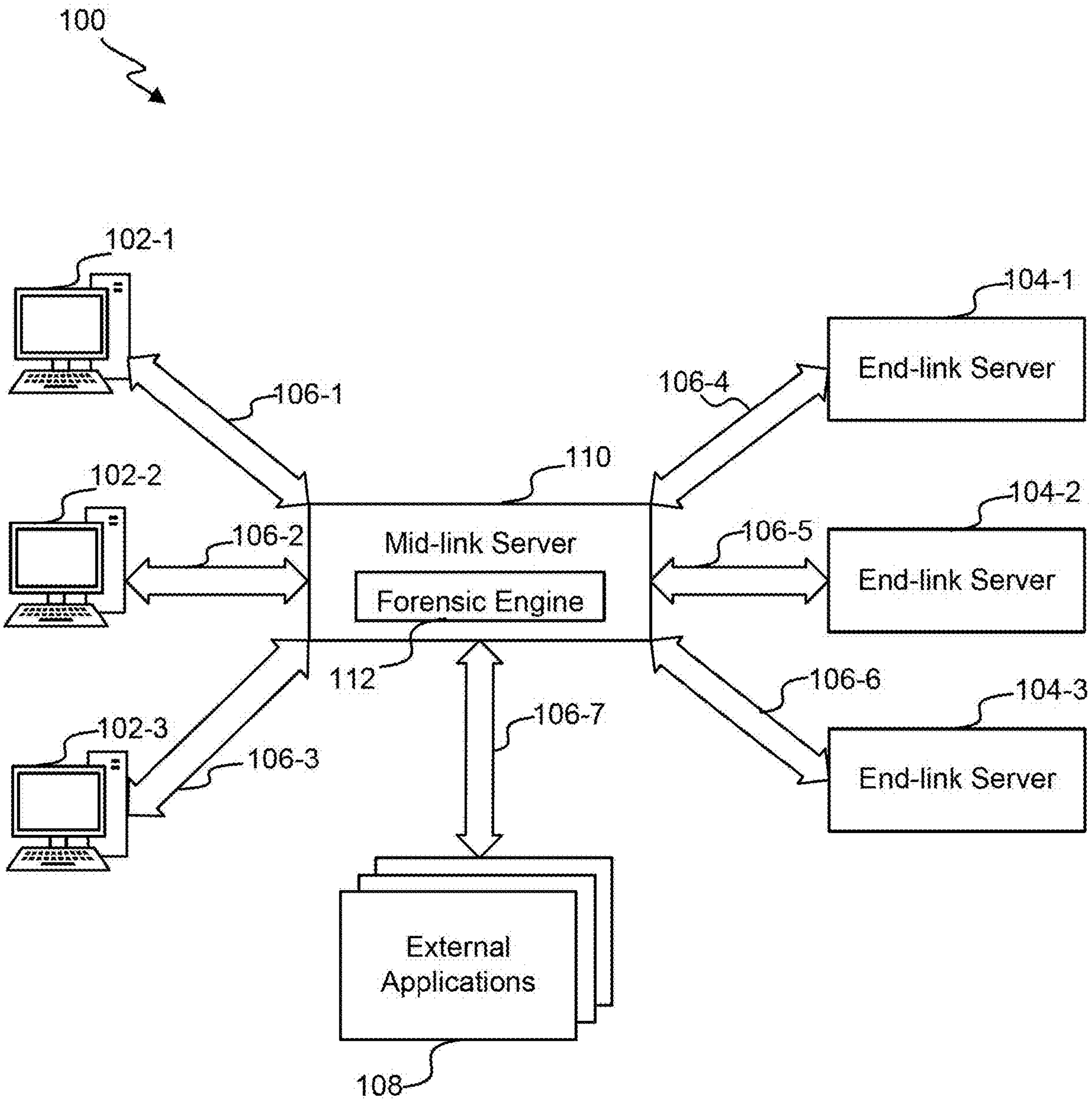
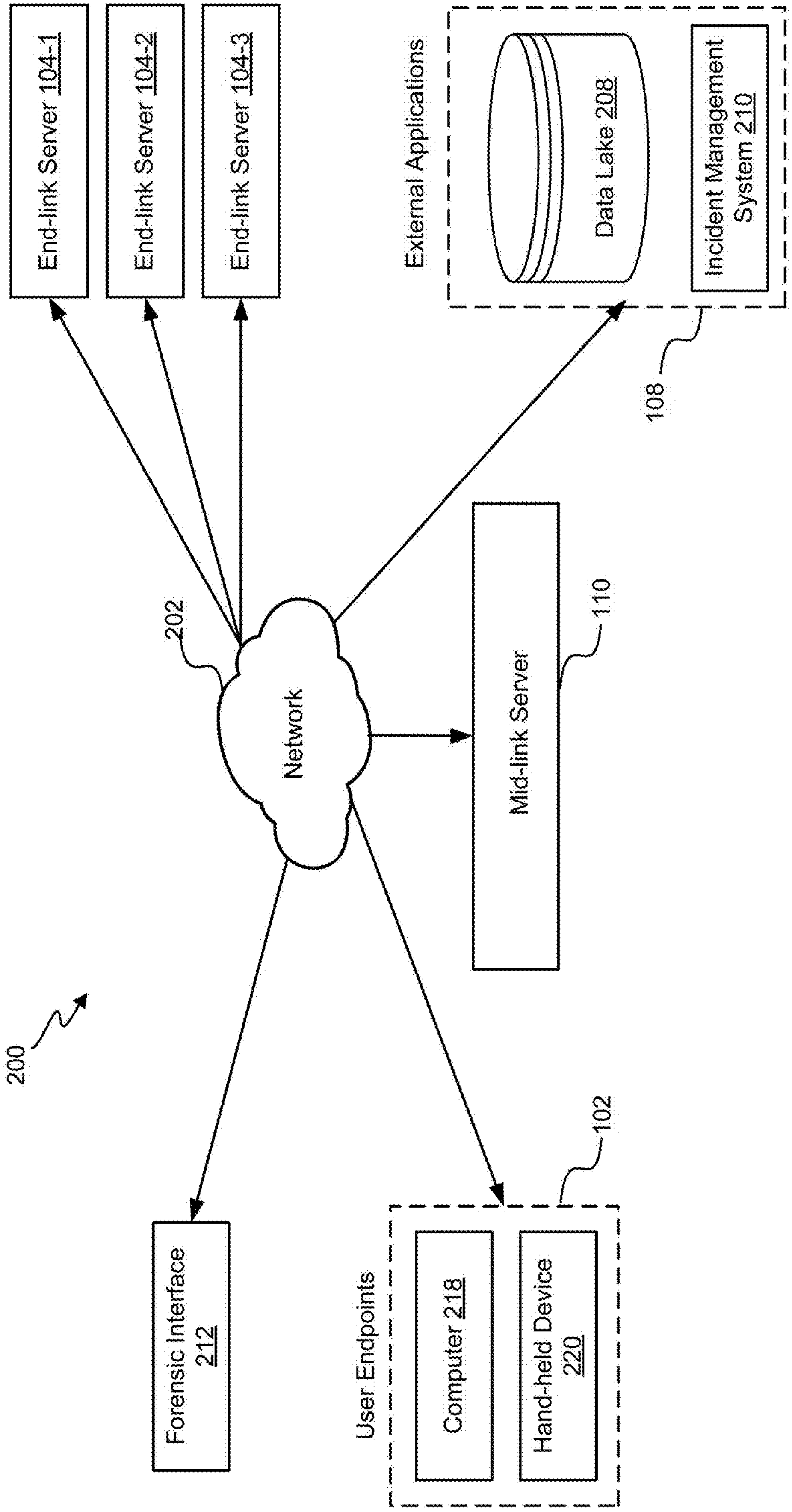

100
102-1
102-2
102-3
106-1
106-2
106-3
110
Mid-link Server
Forensic Engine
112
106-4
106-5
106-6
106-7
104-1
End-link Server
104-2
End-link Server
104-3
End-link Server
External Applications
108

FIG. 1



End-link Server 104-1
End-link Server 104-2
End-link Server 104-3
External Applications
Data Lake 208
Incident Management System 210
108
202
Network
110
Mid-link Server
200
102
Forensic Interface 212
User Endpoints
Computer 218
Hand-held Device 220

FIG. 2

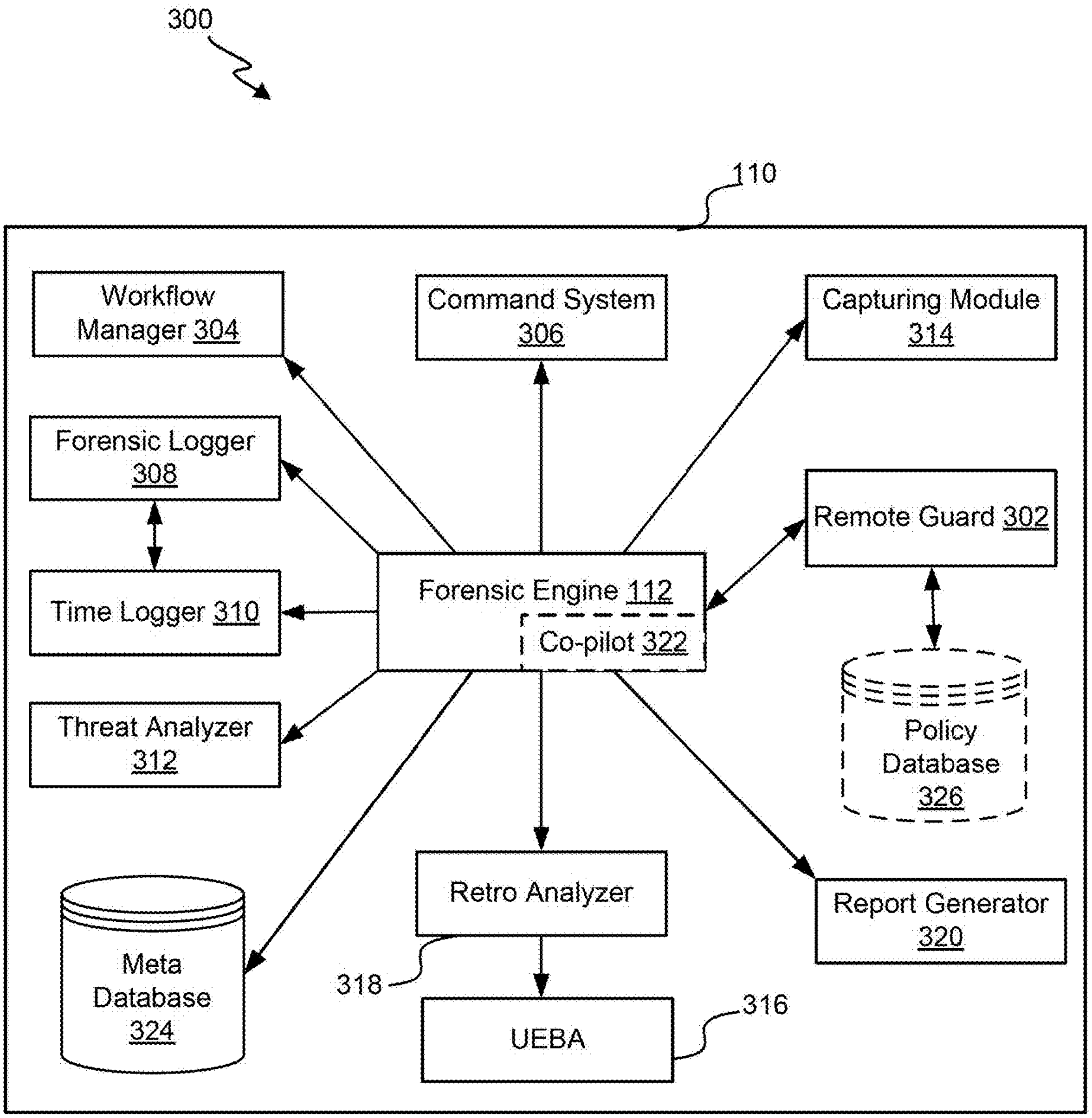

300
110
Workflow Manager 304
Command System 306
Capturing Module 314
Forensic Logger 308
Remote Guard 302
Time Logger 310
Forensic Engine 112
Co-pilot 322
Threat Analyzer 312
Policy Database 326
Meta Database 324
Retro Analyzer
318
UEBA
316
Report Generator 320

FIG. 3

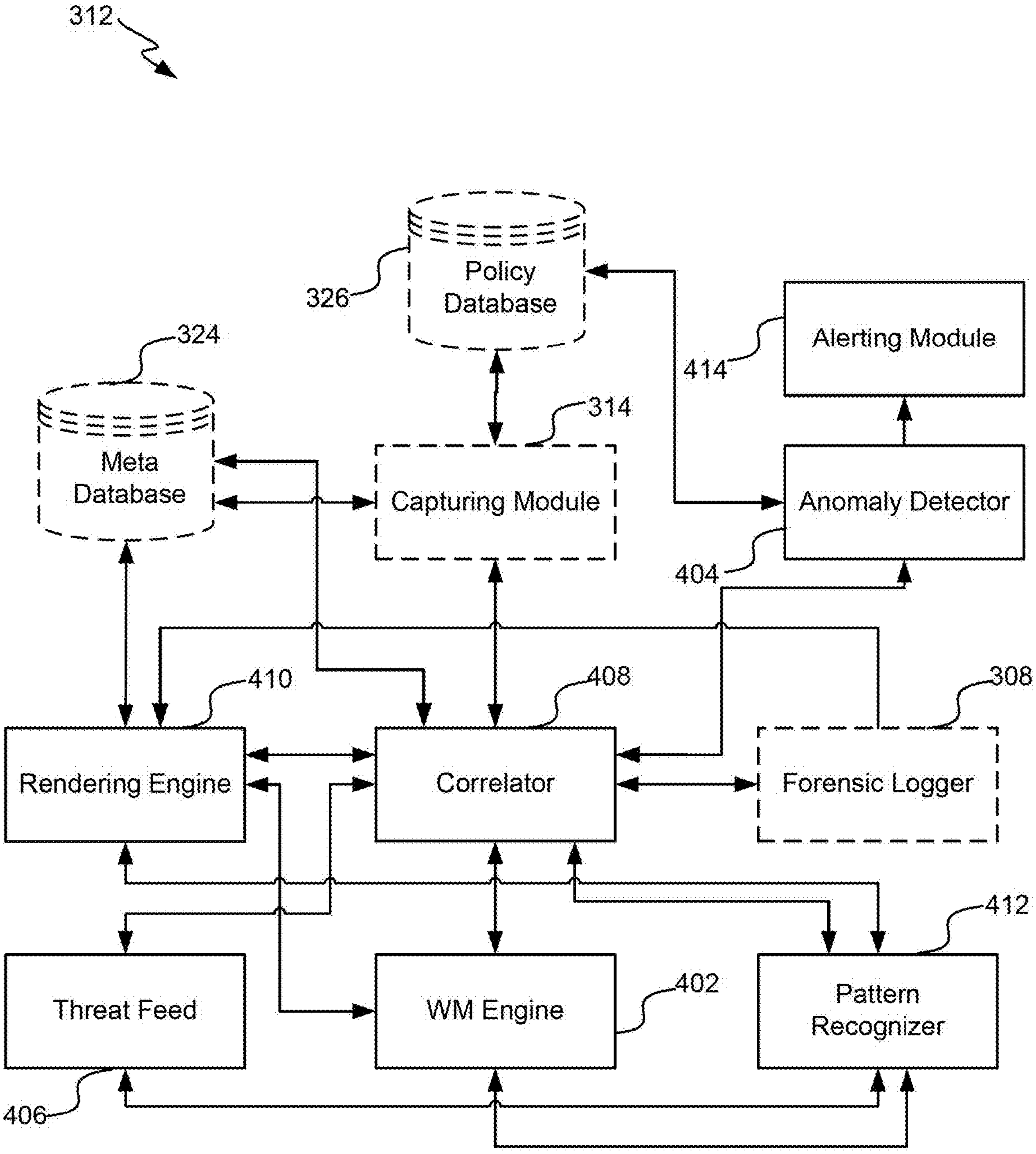

312
Policy Database
326
324
Meta Database
Alerting Module
414
314
Capturing Module
Anomaly Detector
404
410
408
308
Rendering Engine
Correlator
Forensic Logger
412
402
Threat Feed
WM Engine
Pattern Recognizer
406

FIG. 4

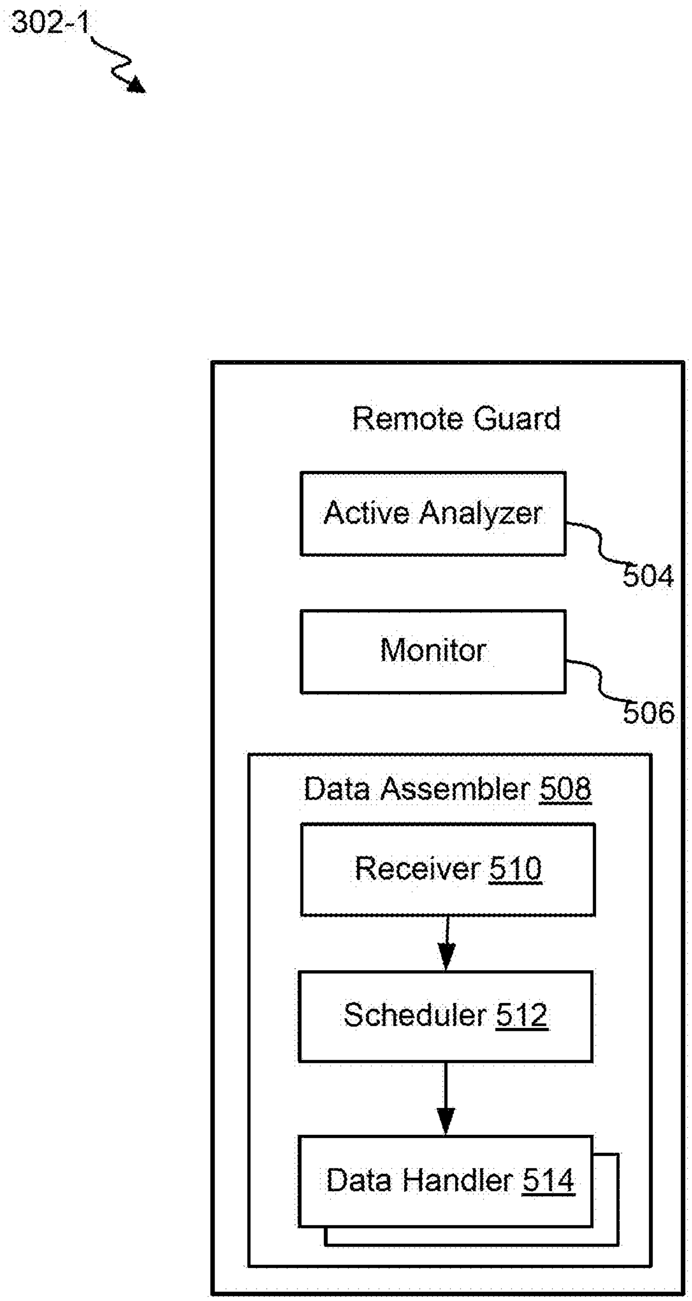

302-1
Remote Guard
Active Analyzer
504
Monitor
506
Data Assembler 508
Receiver 510
Scheduler 512
Data Handler 514

FIG. 5

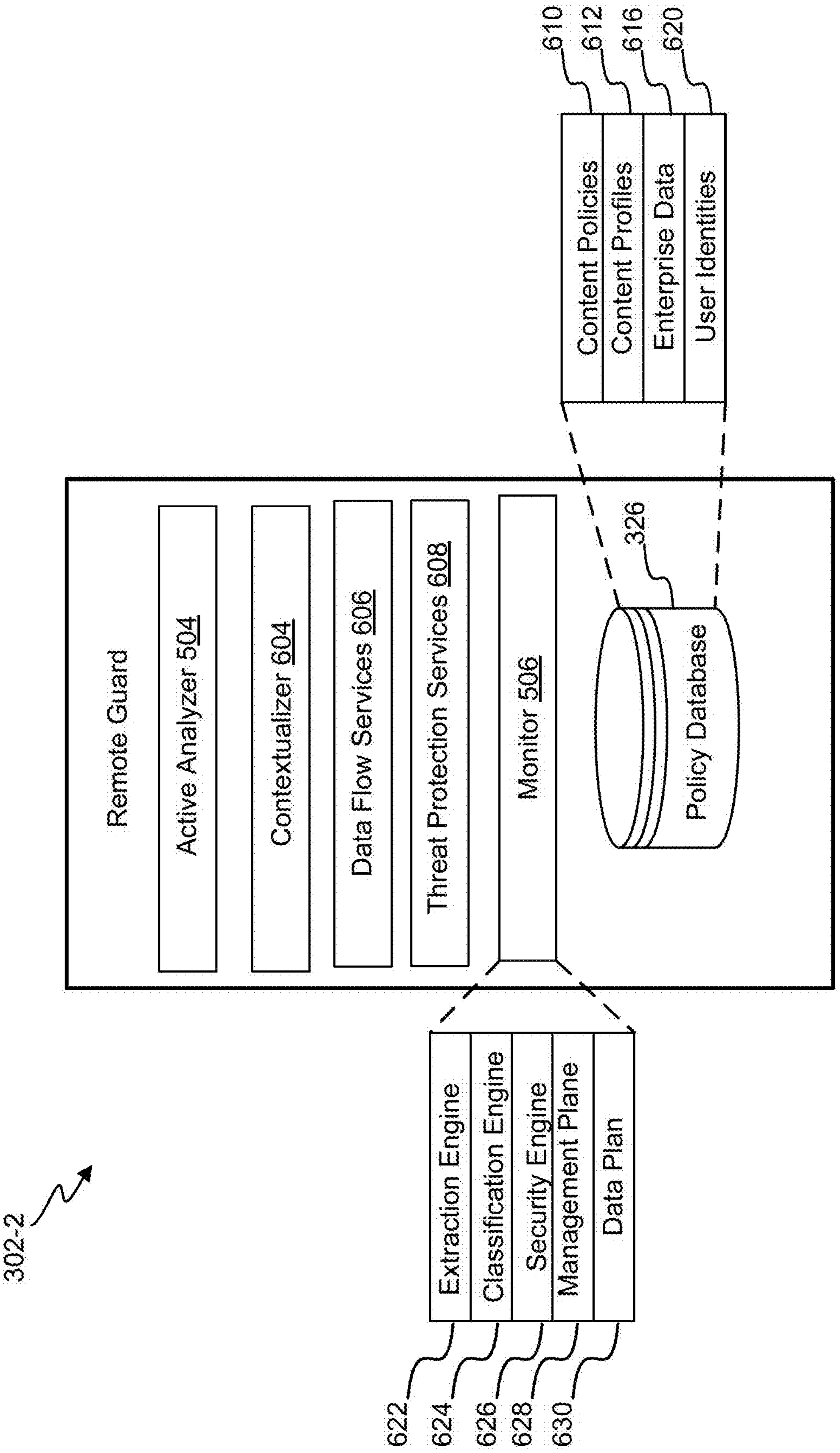

302-2
Remote Guard
Active Analyzer 504
Contextualizer 604
Data Flow Services 606
Threat Protection Services 608
Monitor 506
Policy Database
326
Content Policies
Content Profiles
Enterprise Data
User Identities
610
612
616
620
Extraction Engine
Classification Engine
Security Engine
Management Plane
Data Plan
622
624
626
628
630

FIG. 6

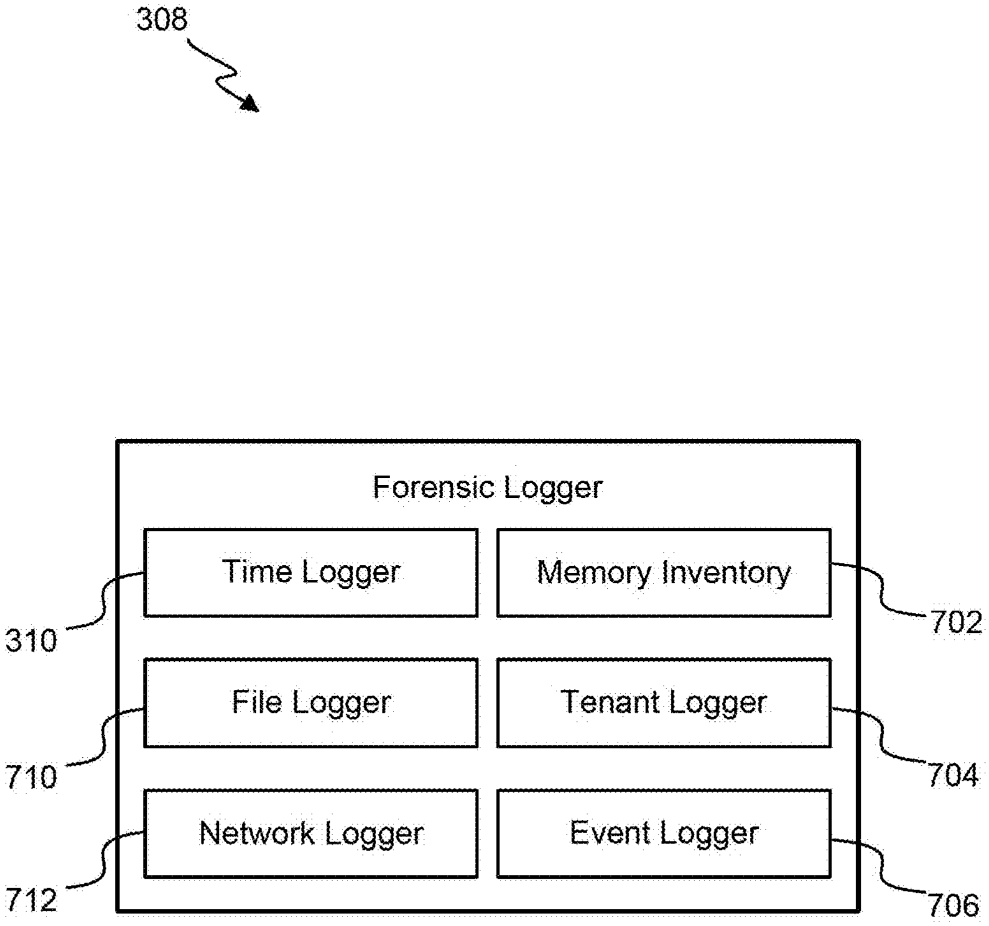

308
Forensic Logger
Time Logger
Memory Inventory
File Logger
Tenant Logger
Network Logger
Event Logger
310
710
712
702
704
706

FIG. 7

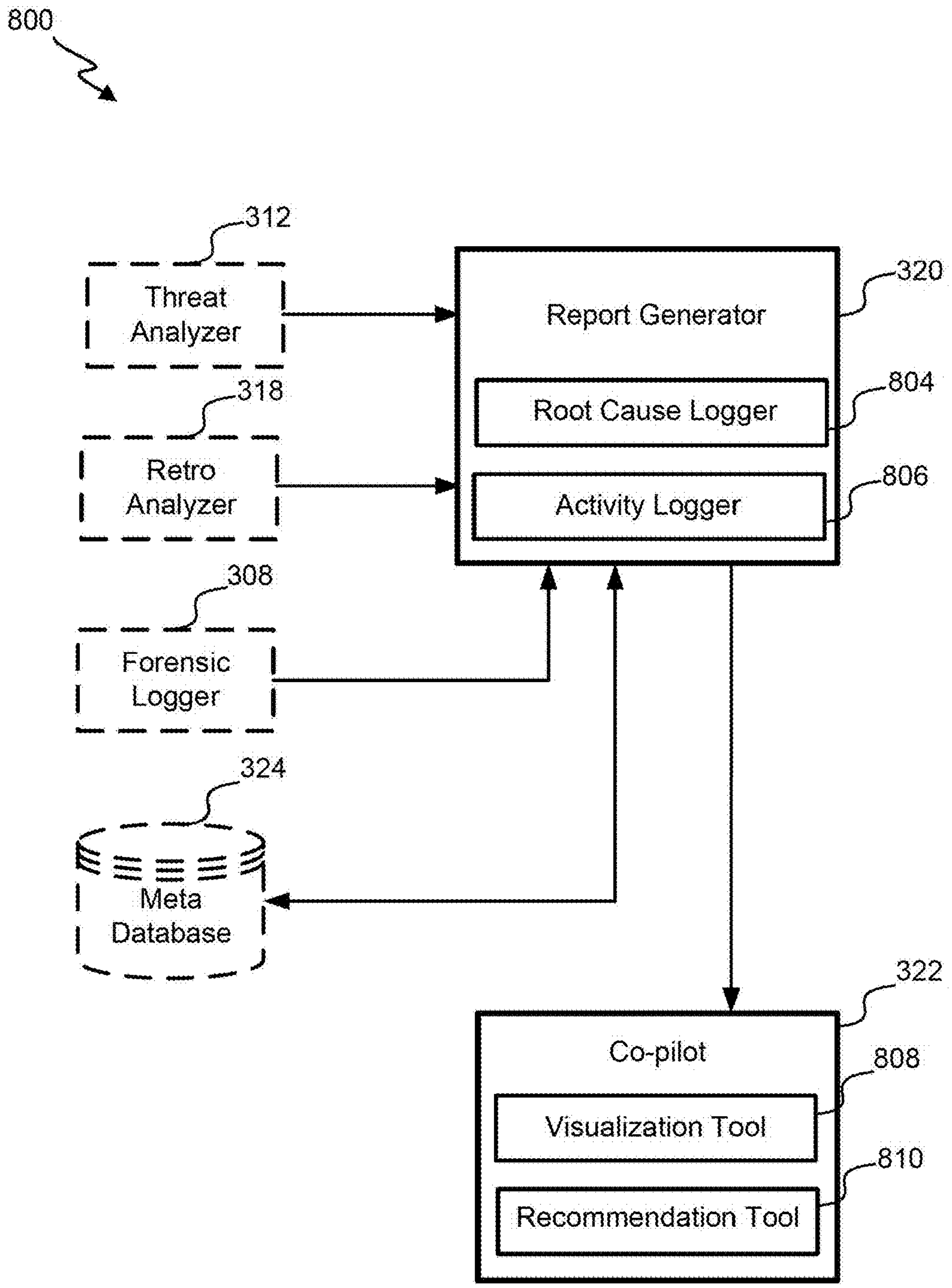

800
312
Threat Analyzer
318
Retro Analyzer
308
Forensic Logger
324
Meta Database
320
Report Generator
804
Root Cause Logger
806
Activity Logger
322
Co-pilot
808
Visualization Tool
810
Recommendation Tool

FIG. 8

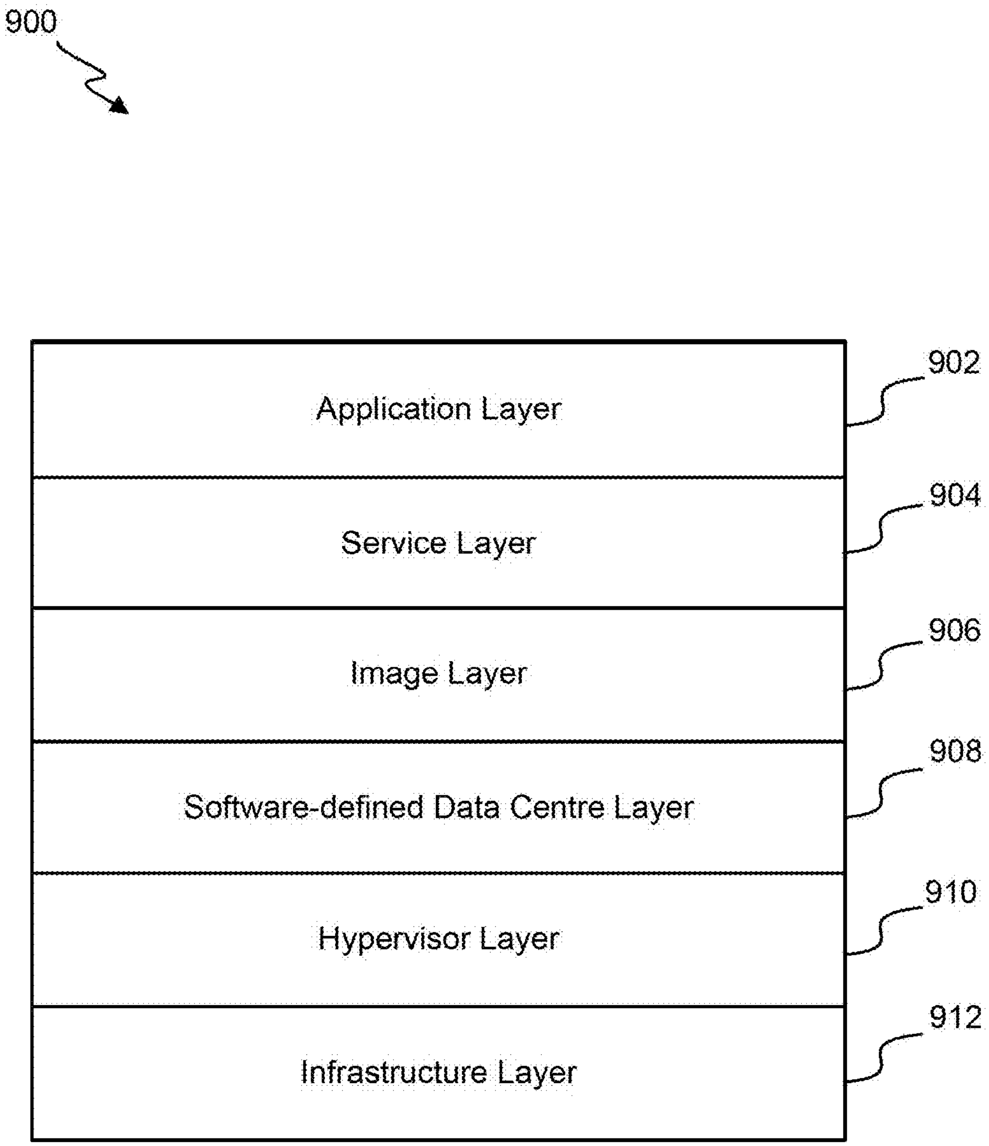
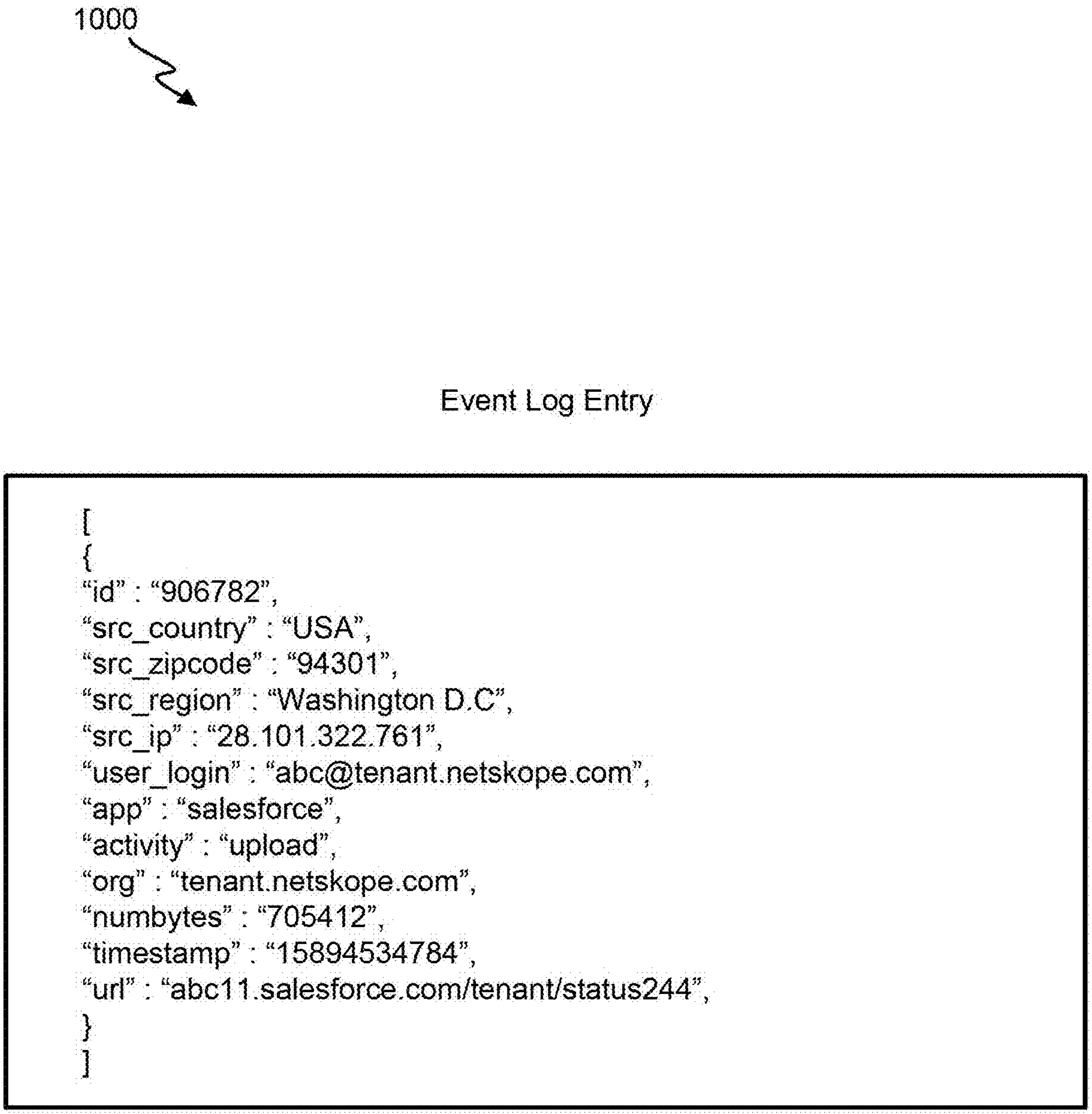

900
Application Layer
902
Service Layer
904
Image Layer
906
Software-defined Data Centre Layer
908
Hypervisor Layer
910
Infrastructure Layer
912

FIG. 9



Event Log Entry

```
[
{
"id" : "906782",
"src_country" : "USA",
"src_zipcode" : "94301",
"src_region" : "Washington D.C",
"src_ip" : "28.101.322.761",
"user_login" : "abc@tenant.netskope.com",
"app" : "salesforce",
"activity" : "upload",
"org" : "tenant.netskope.com",
"numbytes" : "705412",
"timestamp" : "15894534784",
"url" : "abc11.salesforce.com/tenant/status244",
}
]
```

FIG. 10

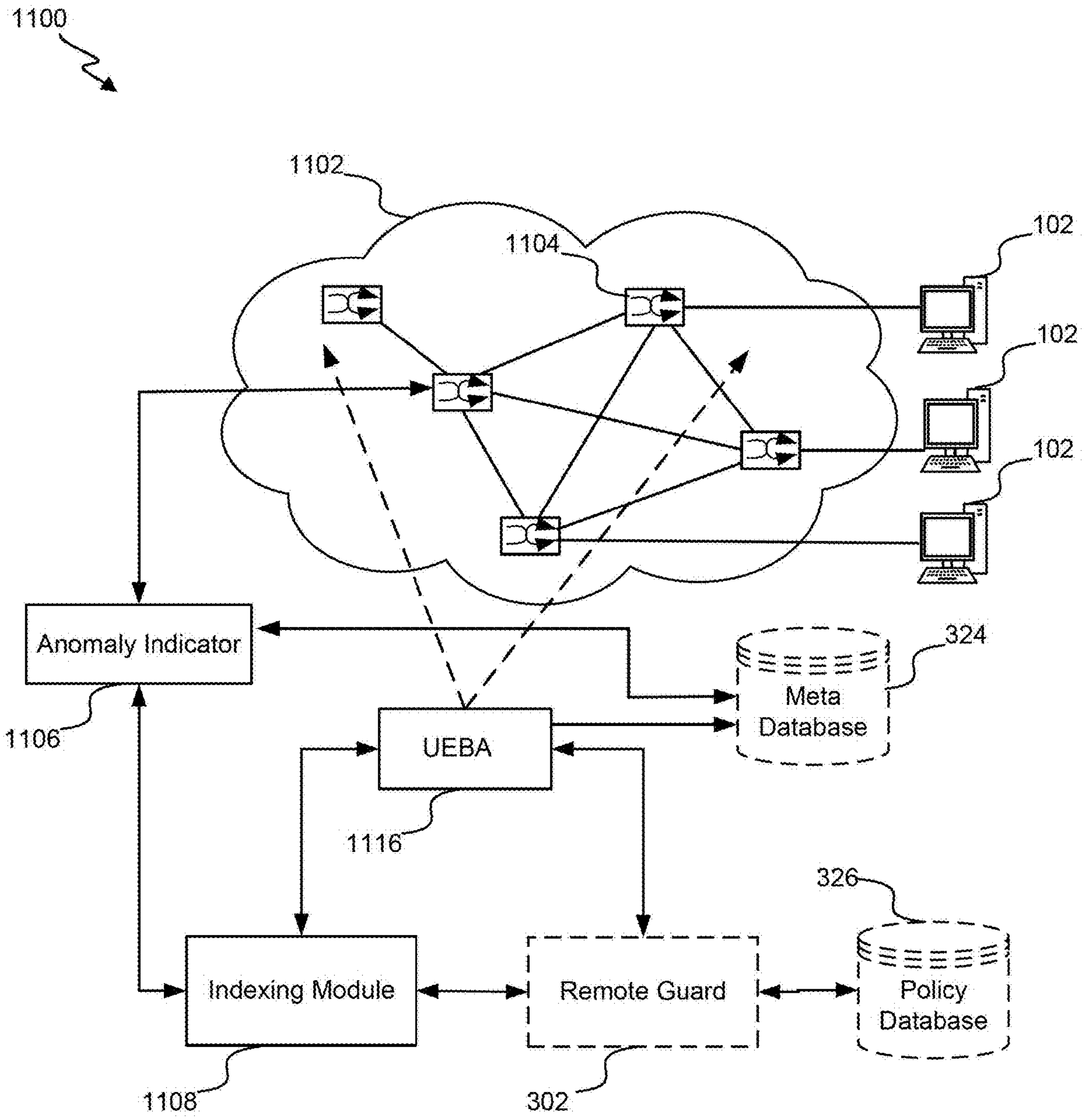

1100
1102
1104
102
102
102
Anomaly Indicator
1106
Meta Database
324
UEBA
1116
326
Indexing Module
Remote Guard
Policy Database
1108
302

FIG. 11

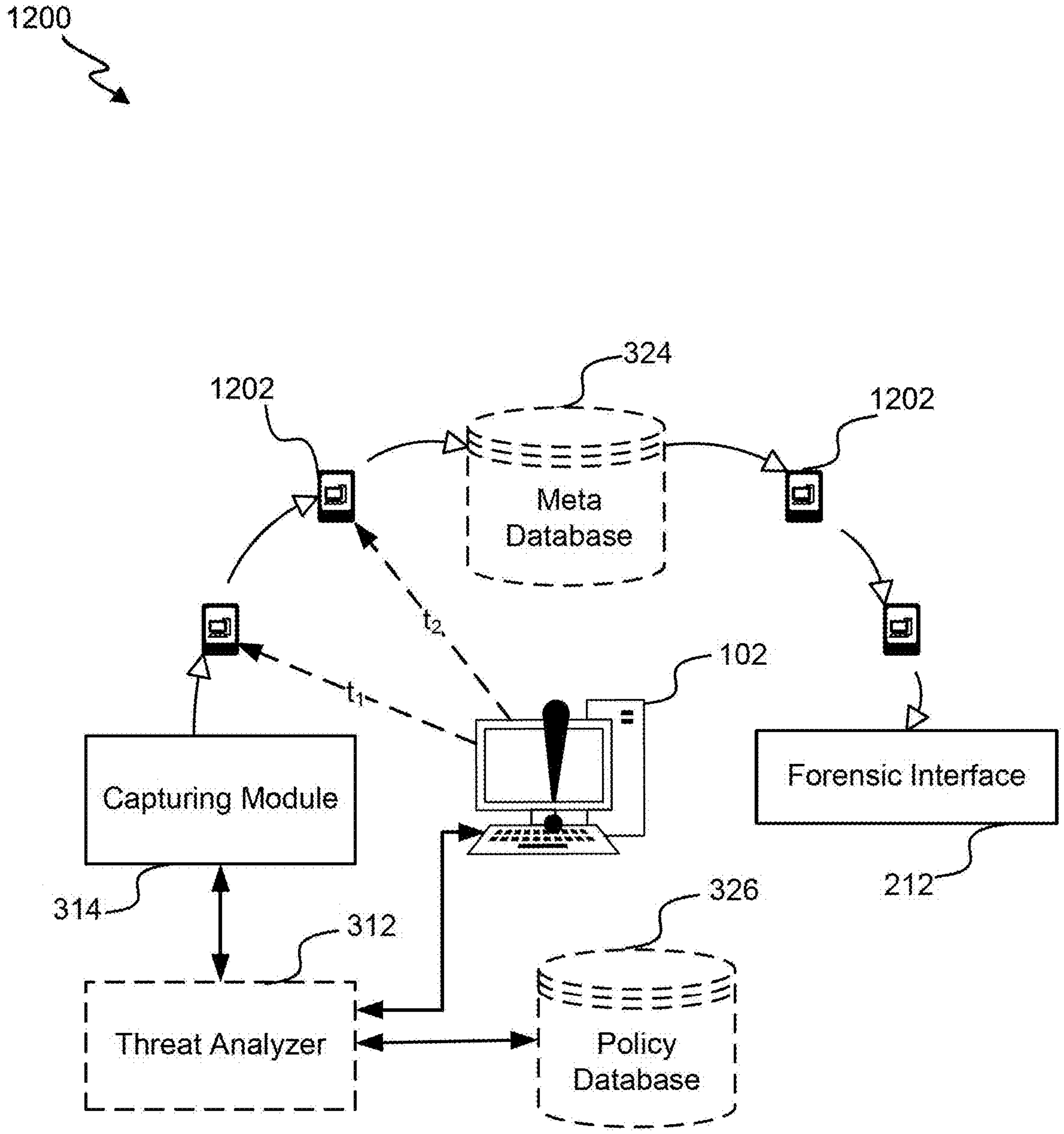
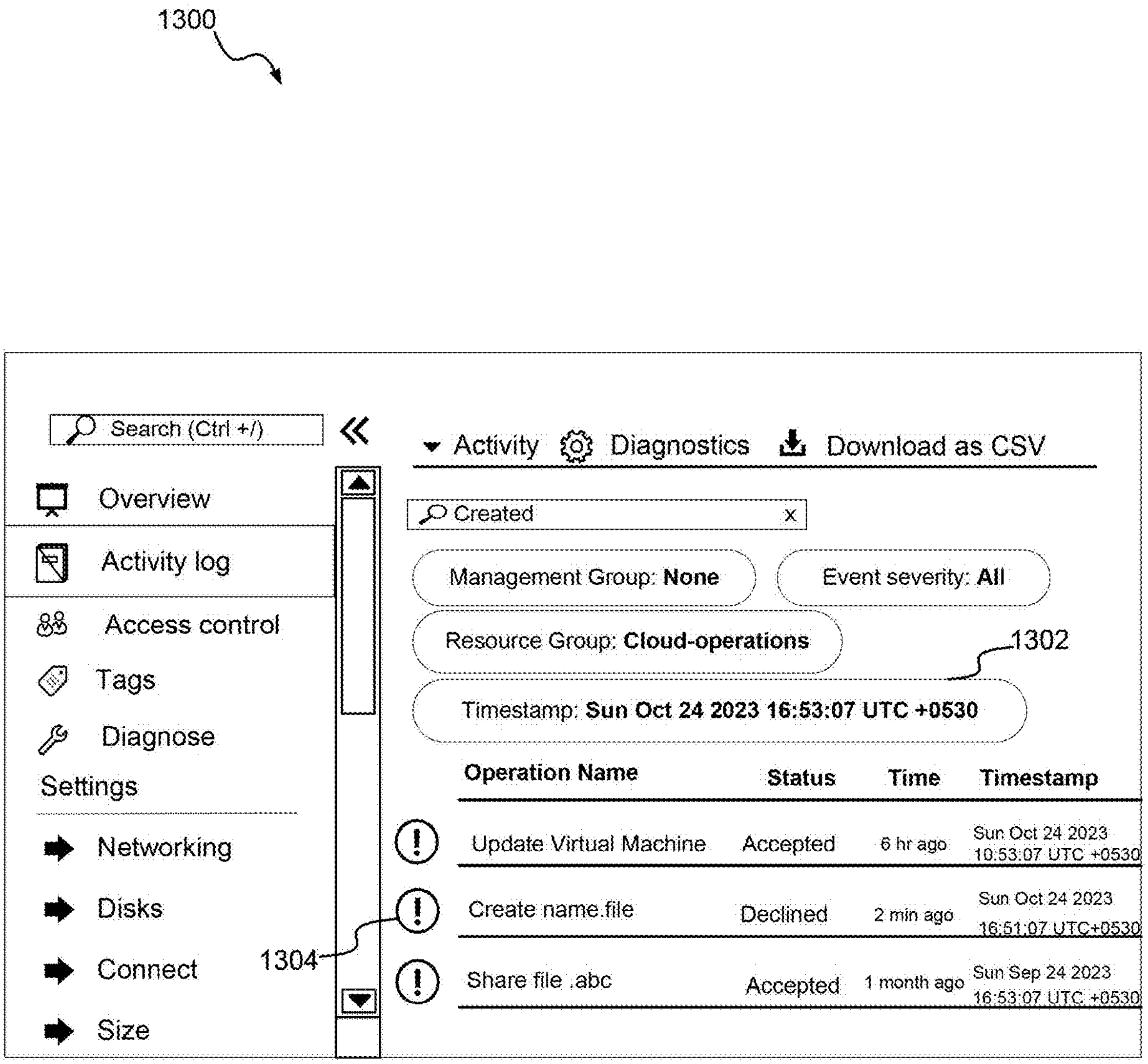

1200
1202
324
1202
Meta Database
t2
t1
102
Capturing Module
Forensic Interface
314
312
326
212
Threat Analyzer
Policy Database

FIG. 12



Management Group: **None**

Event severity: **All**

Resource Group: **Cloud-operations**

Timestamp: **Sun Oct 24 2023 16:53:07 UTC +0530**

	Operation Name	Status	Time	Timestamp
(!)	Update Virtual Machine	Accepted	6 hr ago	Sun Oct 24 2023 10:53:07 UTC +0530
(!)	Create name.file	Declined	2 min ago	Sun Oct 24 2023 16:51:07 UTC+0530
(!)	Share file .abc	Accepted	1 month ago	Sun Sep 24 2023 16:53:07 UTC +0530

FIG. 13

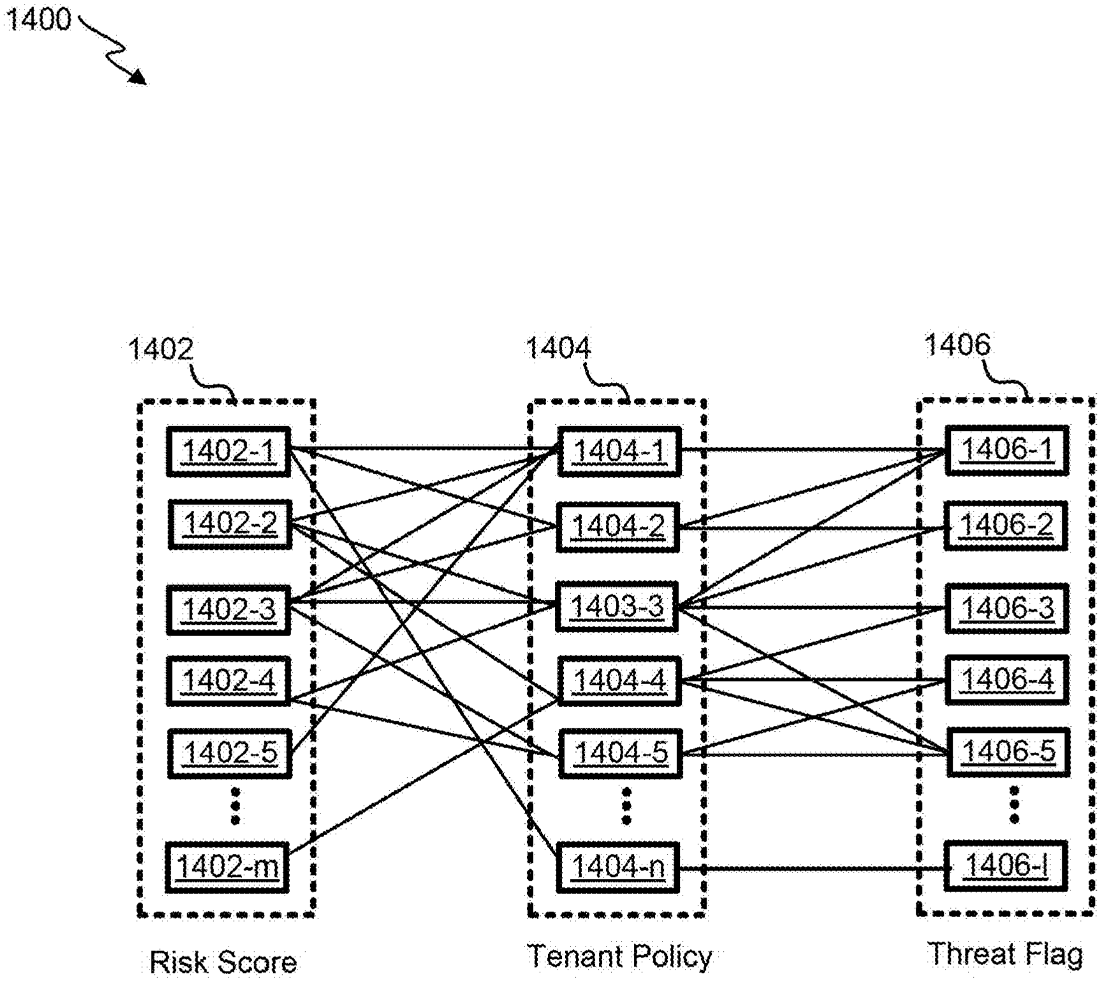
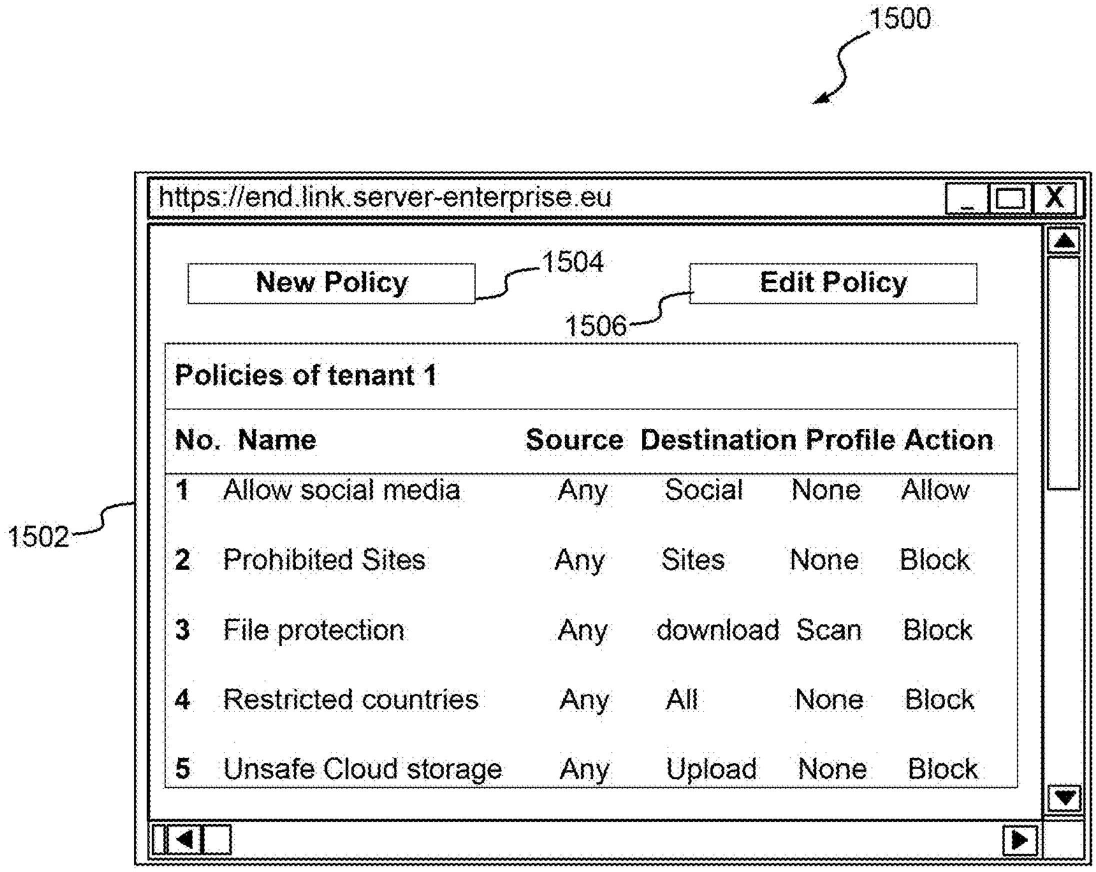

1400
1402
1404
1406
1402-1
1402-2
1402-3
1402-4
1402-5
1402-m
1404-1
1404-2
1403-3
1404-4
1404-5
1404-n
1406-1
1406-2
1406-3
1406-4
1406-5
1406-l
Risk Score
Tenant Policy
Threat Flag

FIG. 14



Policies of tenant 1

No.	Name	Source	Destination	Profile	Action
1	Allow social media	Any	Social	None	Allow
2	Prohibited Sites	Any	Sites	None	Block
3	File protection	Any	download	Scan	Block
4	Restricted countries	Any	All	None	Block
5	Unsafe Cloud storage	Any	Upload	None	Block

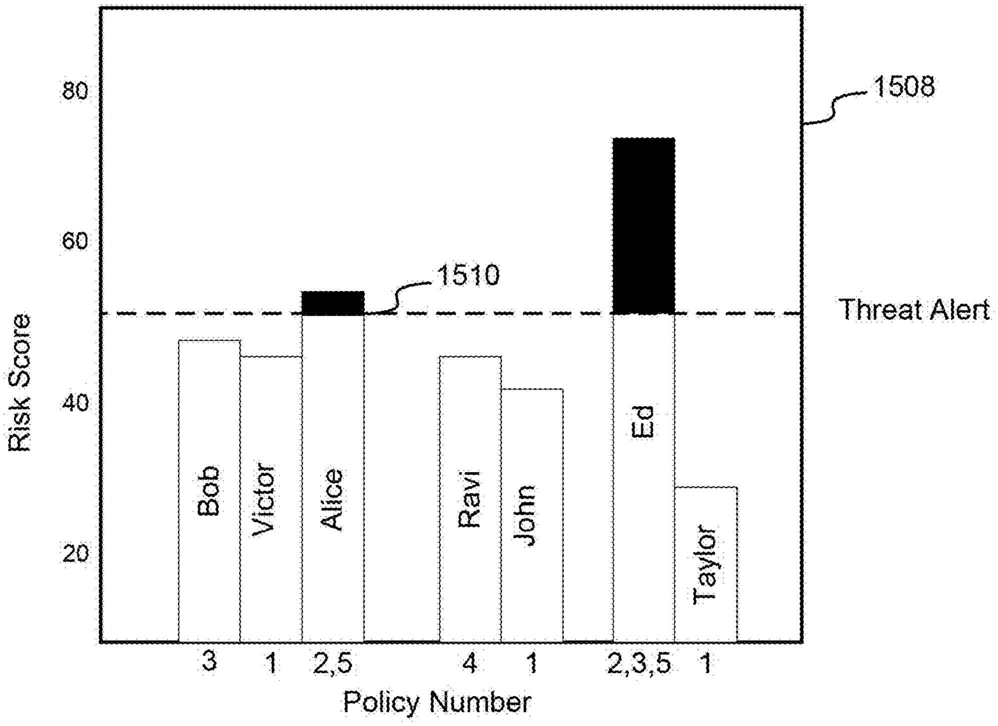
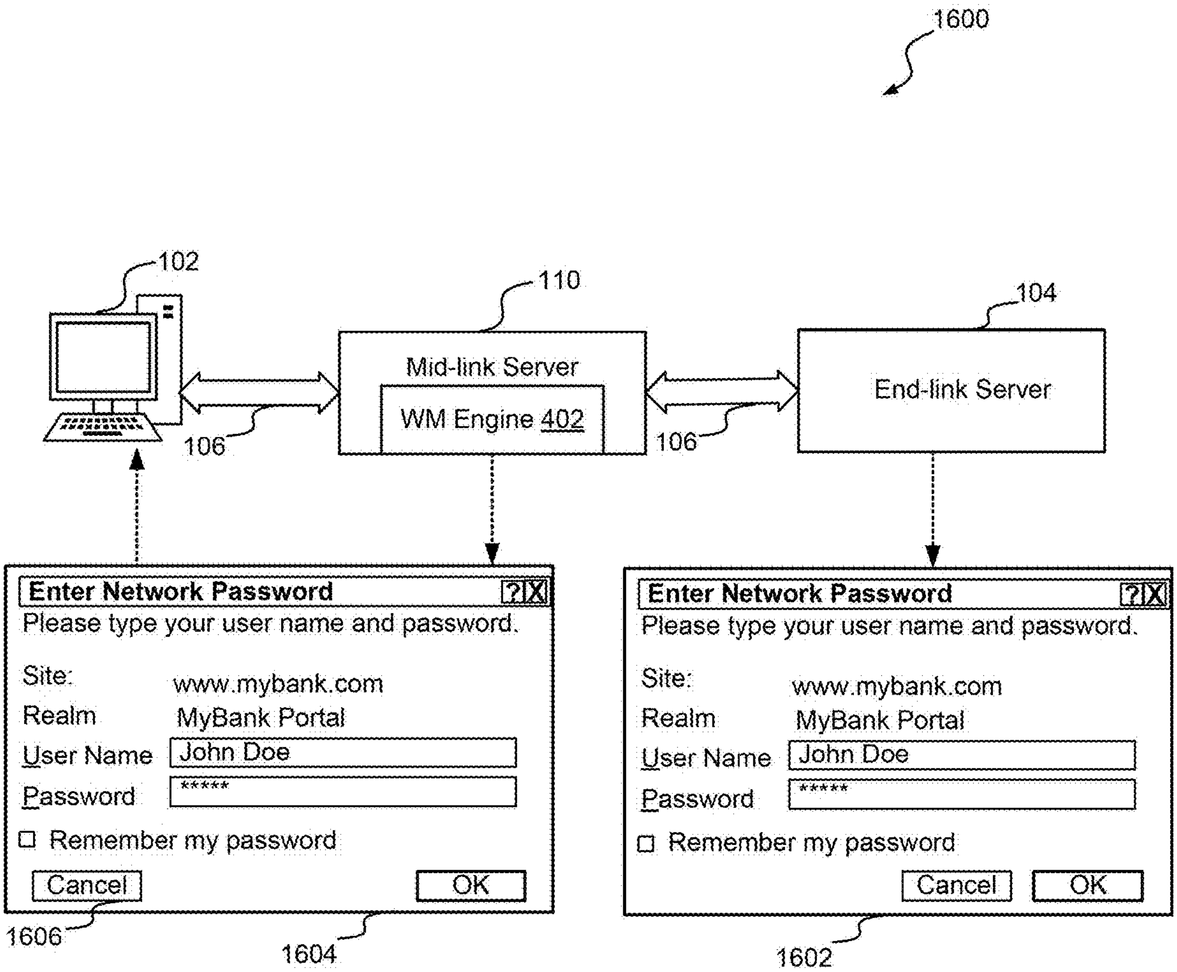


FIG. 15



Enter Network Password ?X
Please type your user name and password.

Site: www.mybank.com
Realm MyBank Portal
User Name John Doe
Password *****

□ Remember my password

Cancel OK

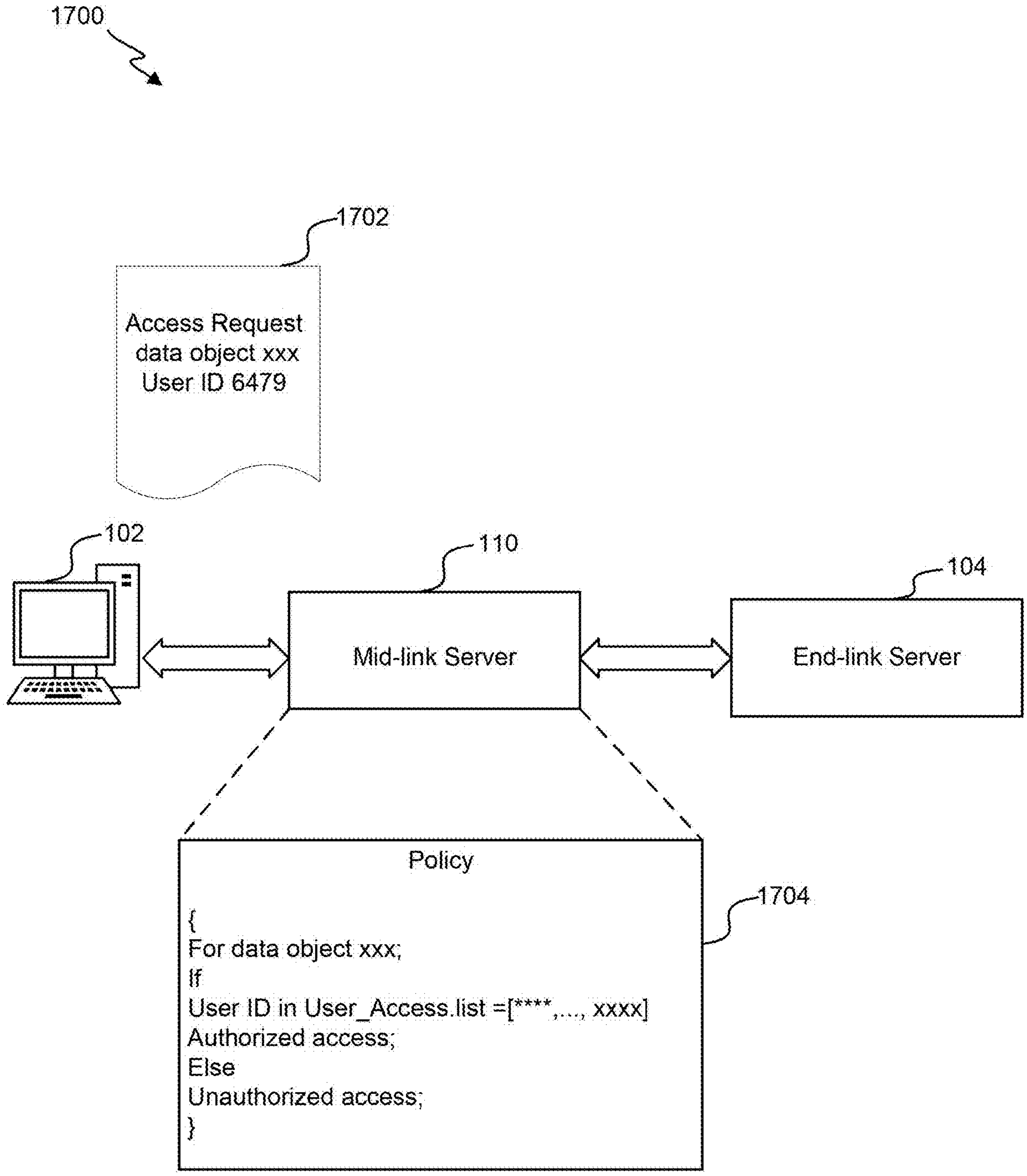
Enter Network Password ?X
Please type your user name and password.

Site: www.mybank.com
Realm MyBank Portal
User Name John Doe
Password *****

□ Remember my password

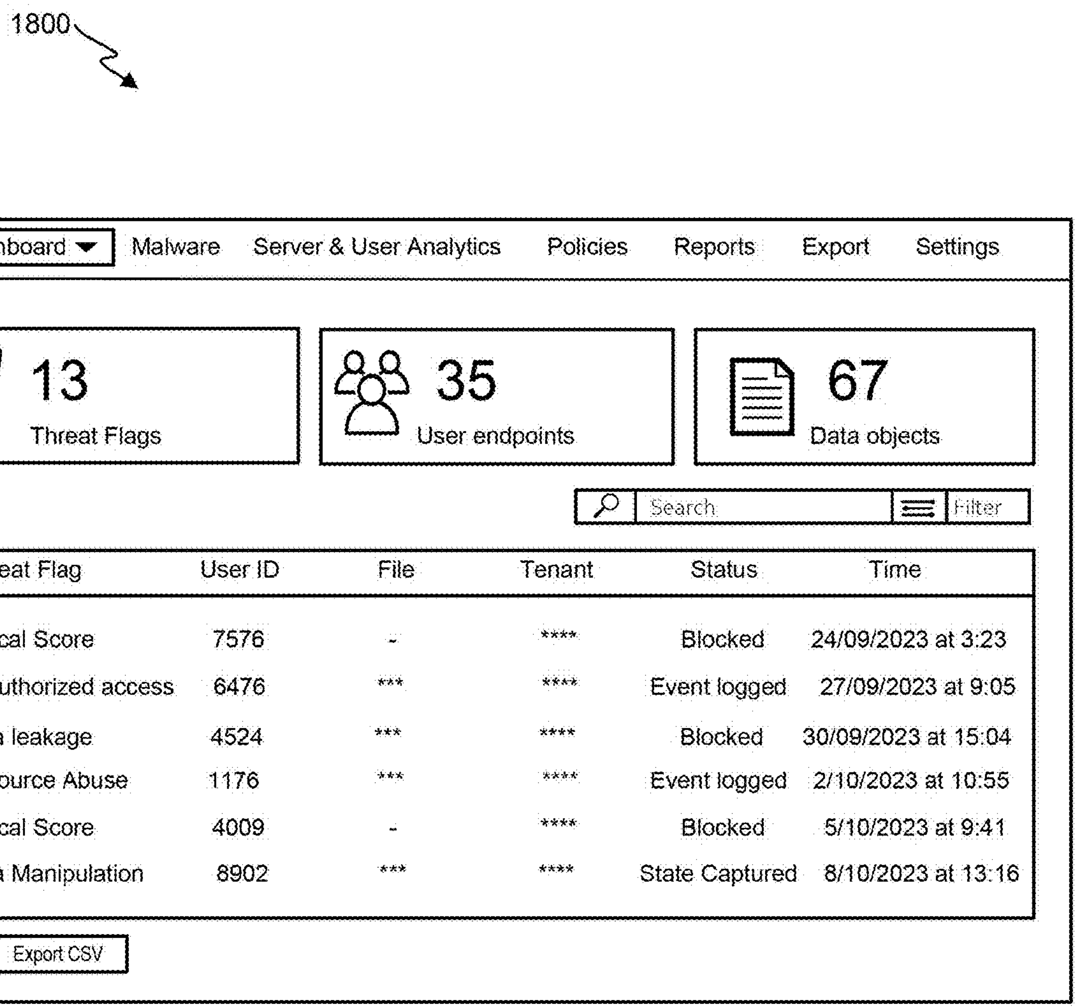
Cancel OK

FIG.16



```
{
For data object xxx;
If
User ID in User_Access.list =[****,..., xxxx]
Authorized access;
Else
Unauthorized access;
}
```

FIG. 17



Threat Flag	User ID	File	Tenant	Status	Time
Critical Score	7576	-	****	Blocked	24/09/2023 at 3:23
Unauthorized access	6476	***	****	Event logged	27/09/2023 at 9:05
Data leakage	4524	***	****	Blocked	30/09/2023 at 15:04
Resource Abuse	1176	***	****	Event logged	2/10/2023 at 10:55
Critical Score	4009	-	****	Blocked	5/10/2023 at 9:41
Data Manipulation	8902	***	****	State Captured	8/10/2023 at 13:16

FIG. 18

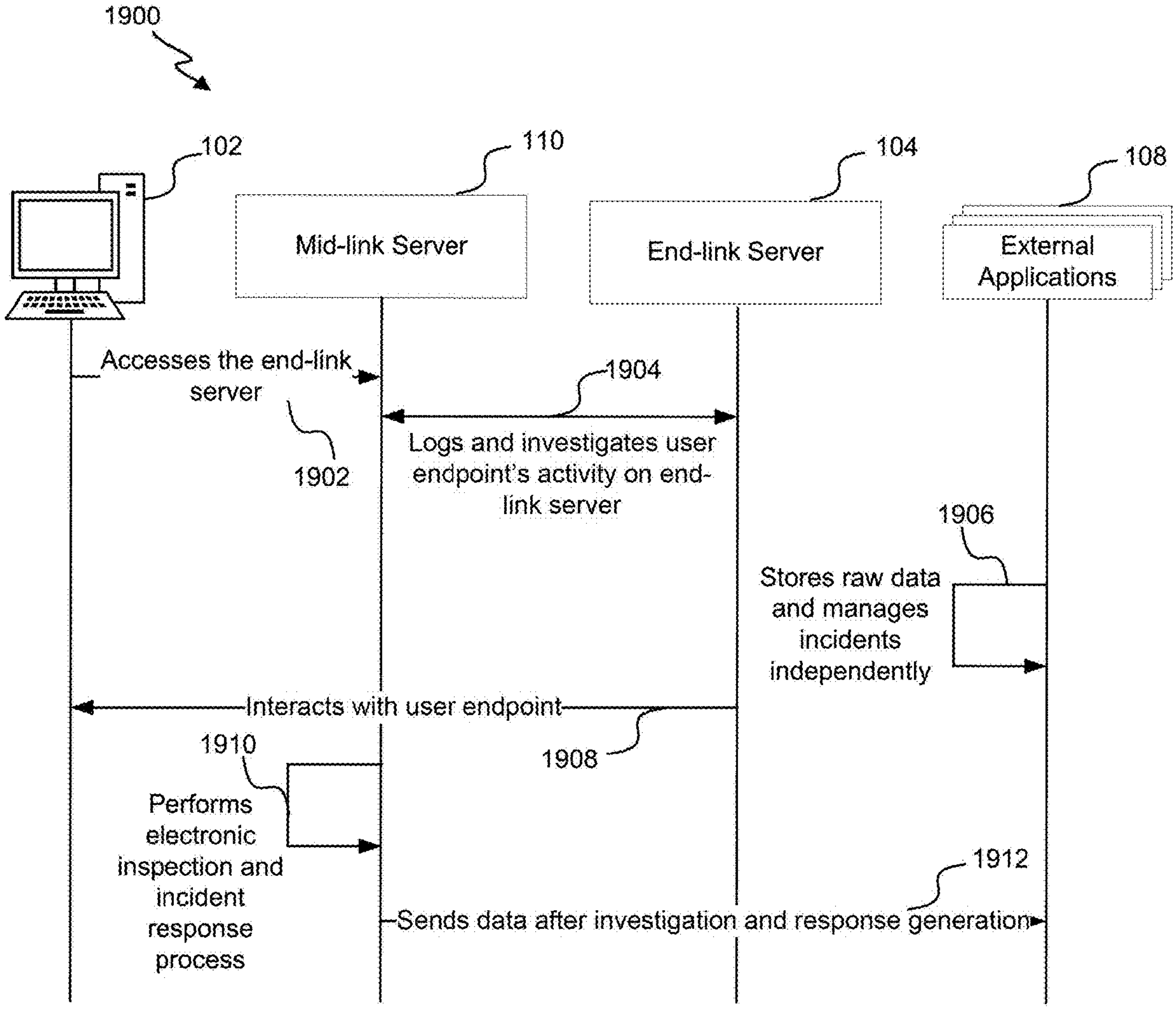

1900
102
110
Mid-link Server
104
End-link Server
108
External Applications
Accesses the end-link server
1902
1904
Logs and investigates user endpoint's activity on end-link server
1906
Stores raw data and manages incidents independently
Interacts with user endpoint
1908
1910
Performs electronic inspection and incident response process
1912
Sends data after investigation and response generation

FIG. 19

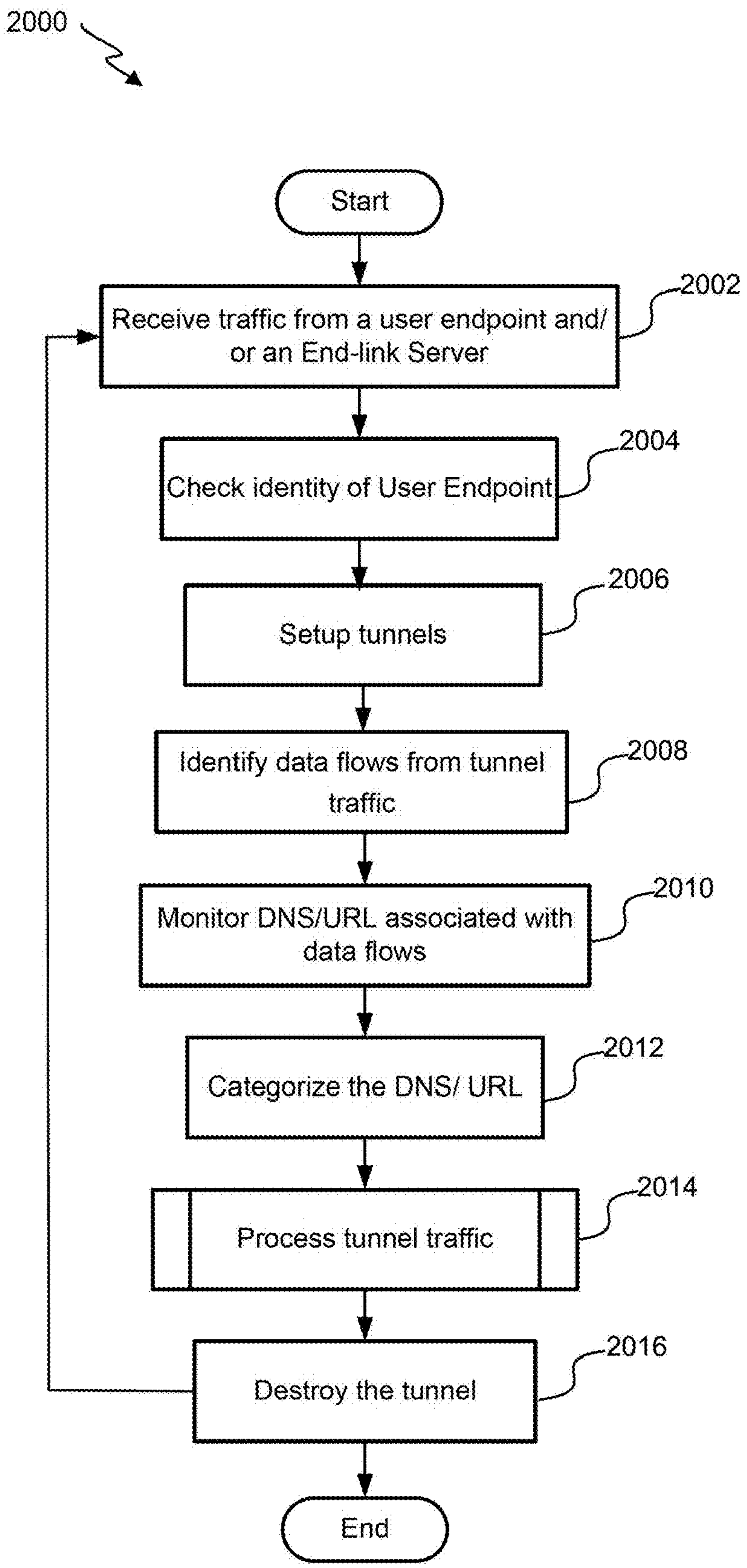

2000
Start
Receive traffic from a user endpoint and/ or an End-link Server
2002
Check identity of User Endpoint
2004
Setup tunnels
2006
Identify data flows from tunnel traffic
2008
Monitor DNS/URL associated with data flows
2010
Categorize the DNS/ URL
2012
Process tunnel traffic
2014
Destroy the tunnel
2016
End

FIG. 20

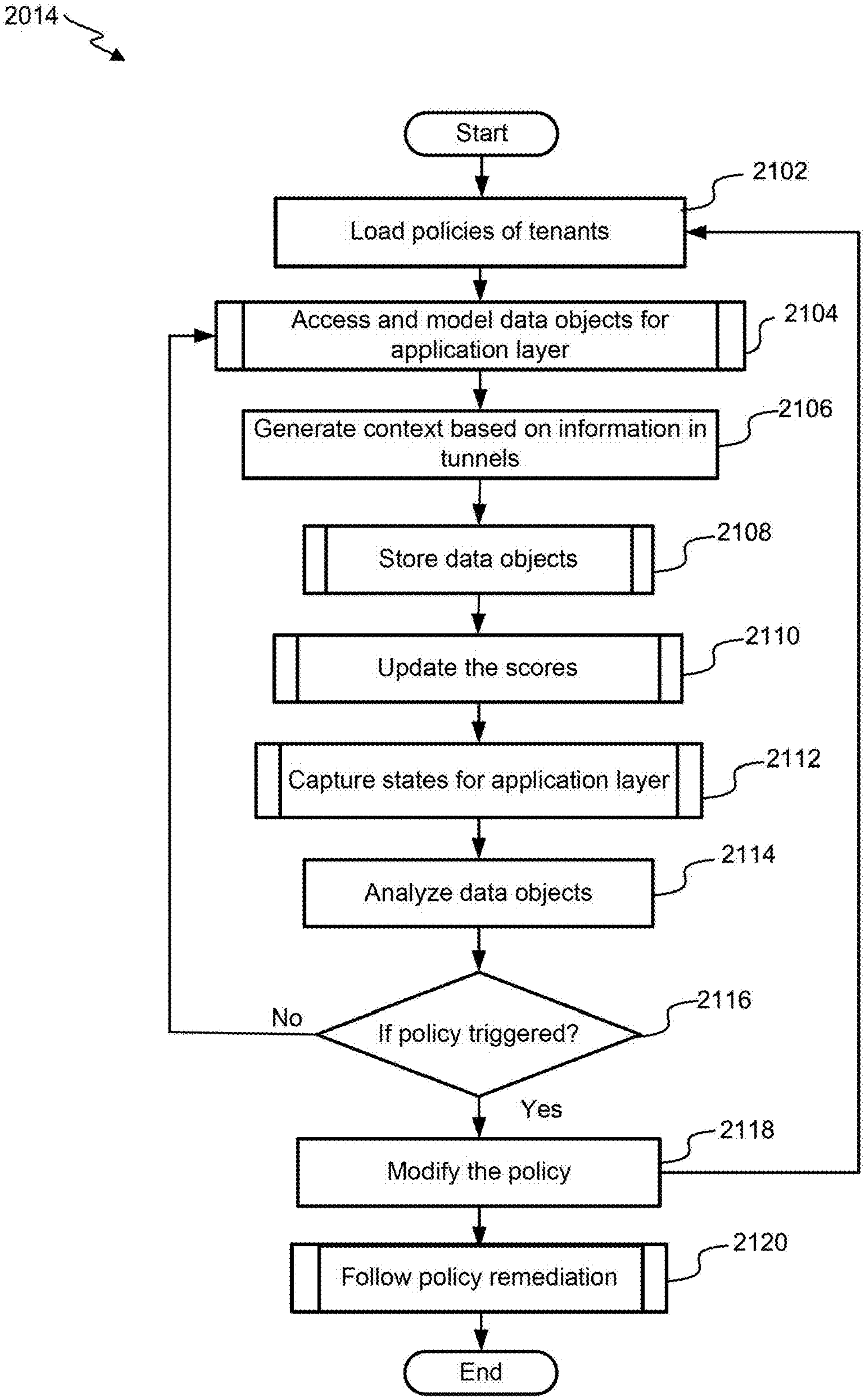

2014
Start
Load policies of tenants
2102
Access and model data objects for application layer
2104
Generate context based on information in tunnels
2106
Store data objects
2108
Update the scores
2110
Capture states for application layer
2112
Analyze data objects
2114
No
If policy triggered?
2116
Yes
Modify the policy
2118
Follow policy remediation
2120
End

FIG. 21

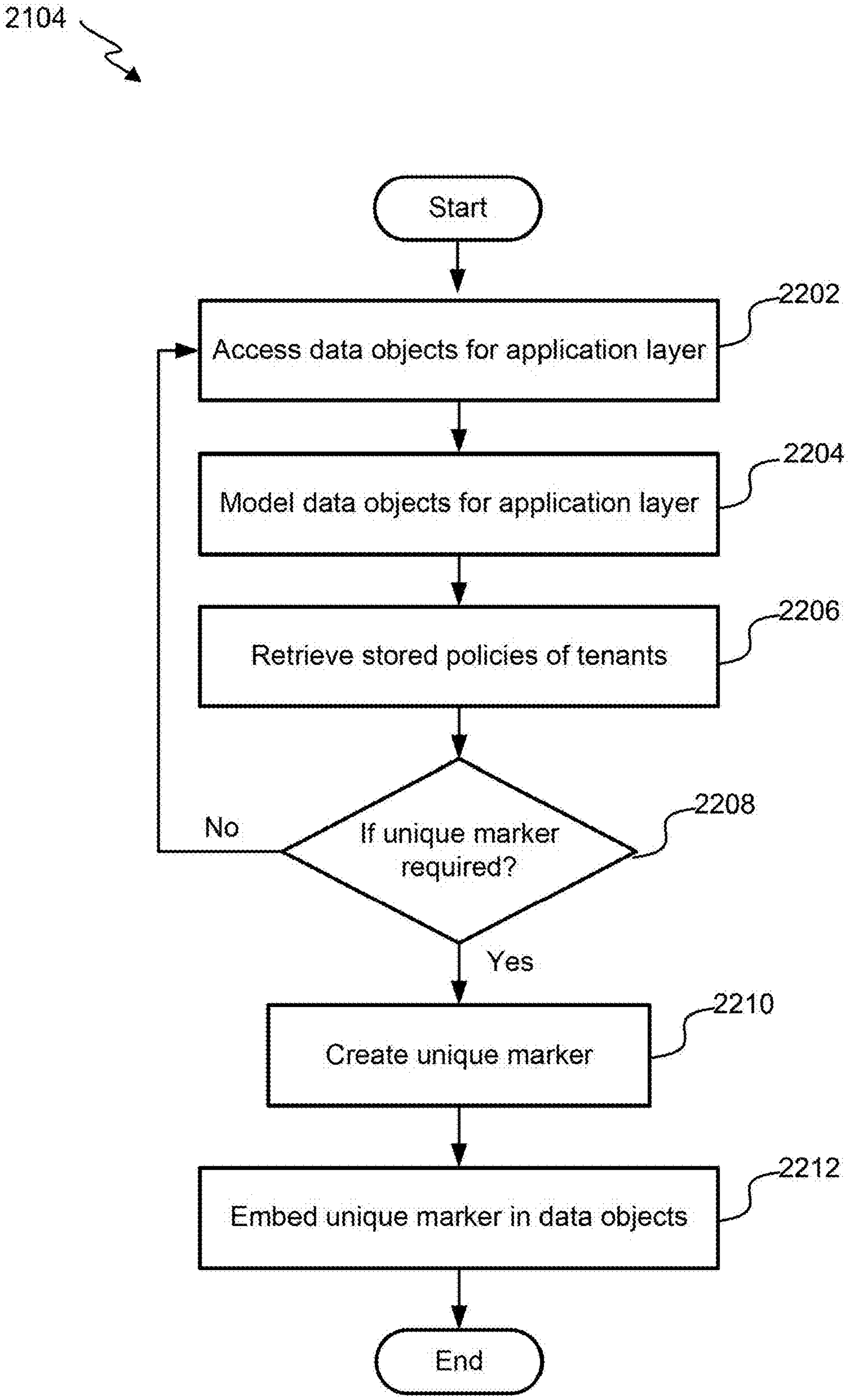

2104
Start
Access data objects for application layer
2202
Model data objects for application layer
2204
Retrieve stored policies of tenants
2206
If unique marker required?
2208
No
Yes
Create unique marker
2210
Embed unique marker in data objects
2212
End

FIG. 22

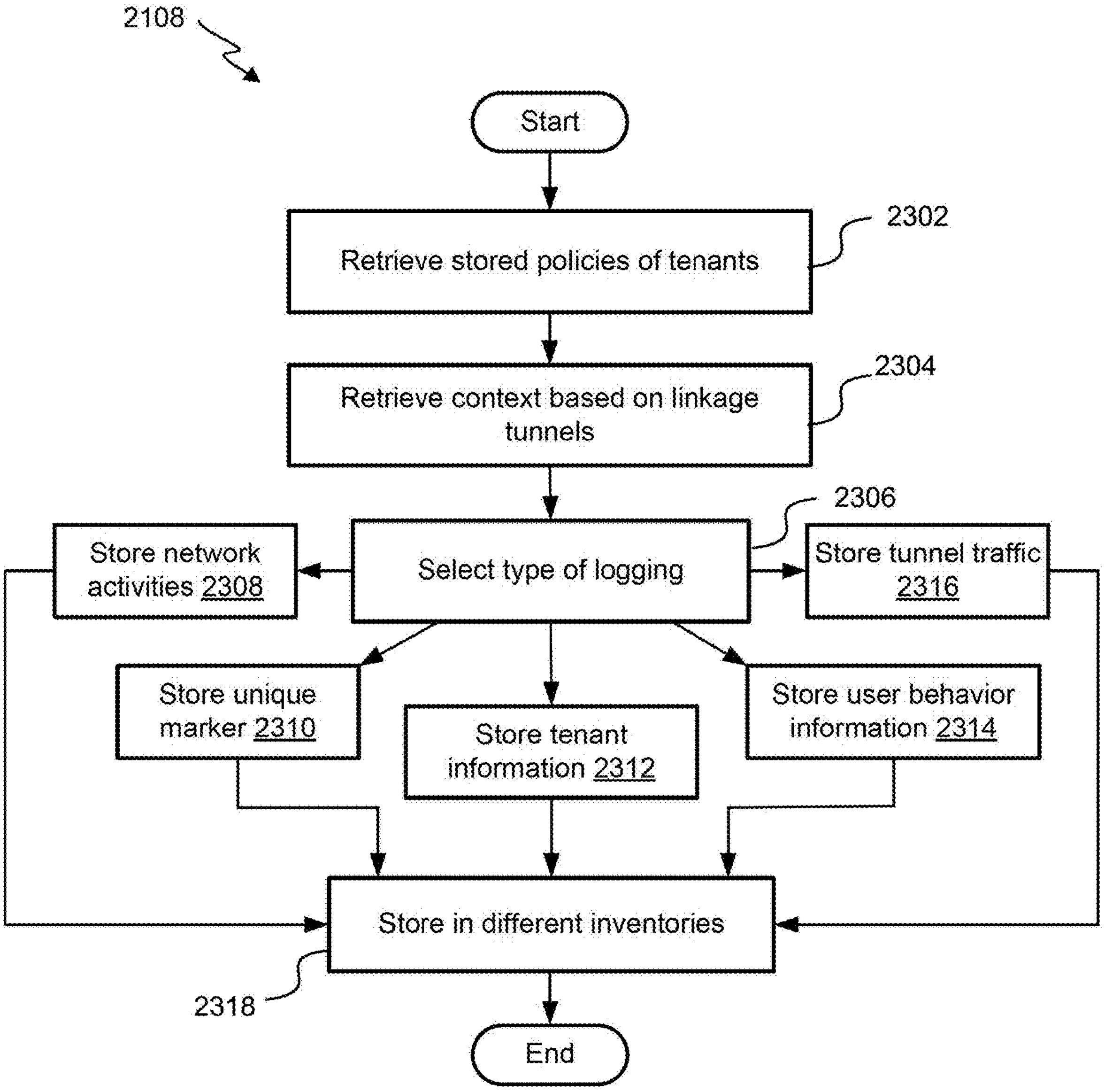

2108
Start
Retrieve stored policies of tenants
2302
Retrieve context based on linkage tunnels
2304
Select type of logging
2306
Store network activities 2308
Store tunnel traffic 2316
Store unique marker 2310
Store tenant information 2312
Store user behavior information 2314
Store in different inventories
2318
End

FIG. 23

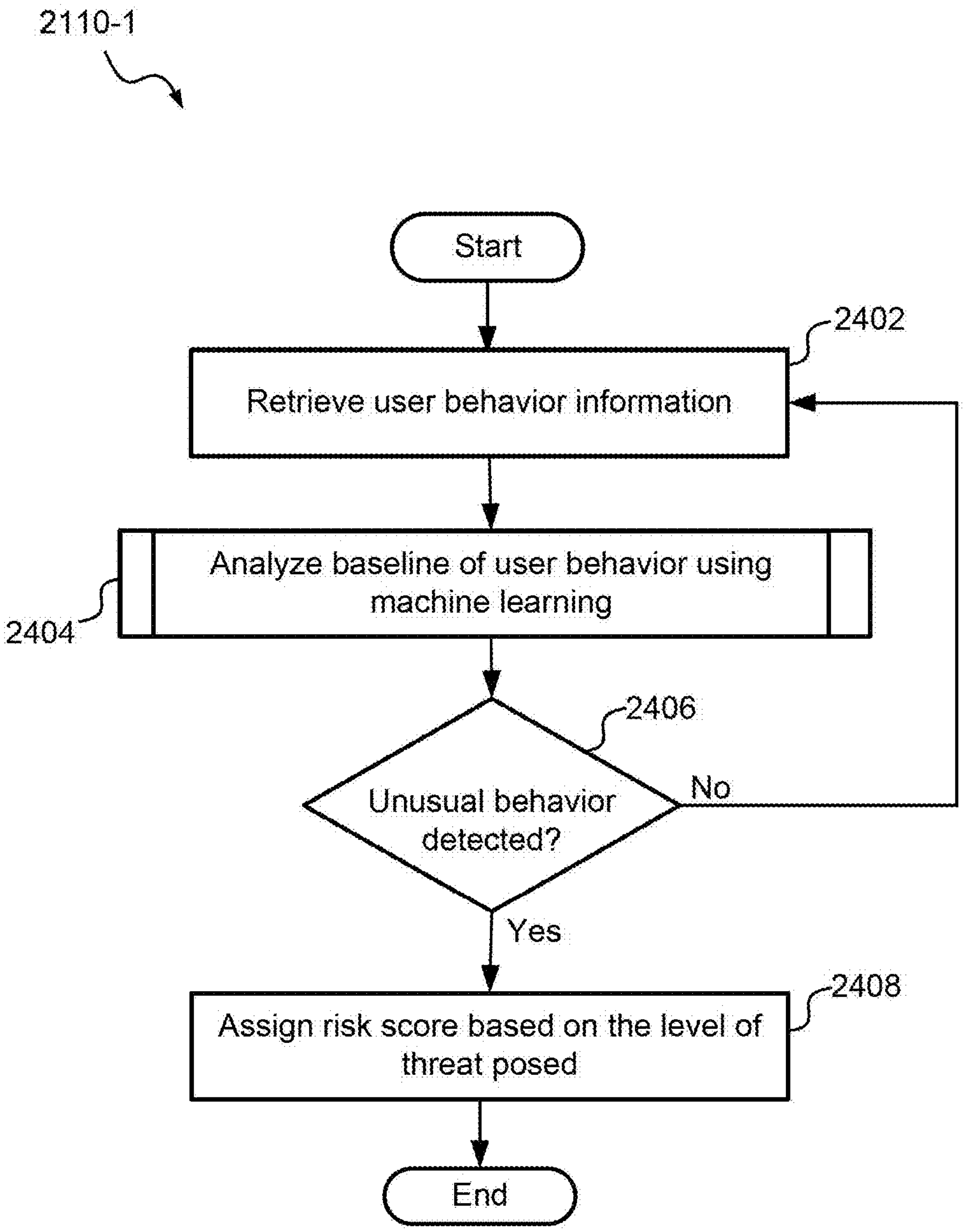

2110-1
Start
2402
Retrieve user behavior information
2404
Analyze baseline of user behavior using machine learning
2406
Unusual behavior detected?
No
Yes
2408
Assign risk score based on the level of threat posed
End

FIG. 24

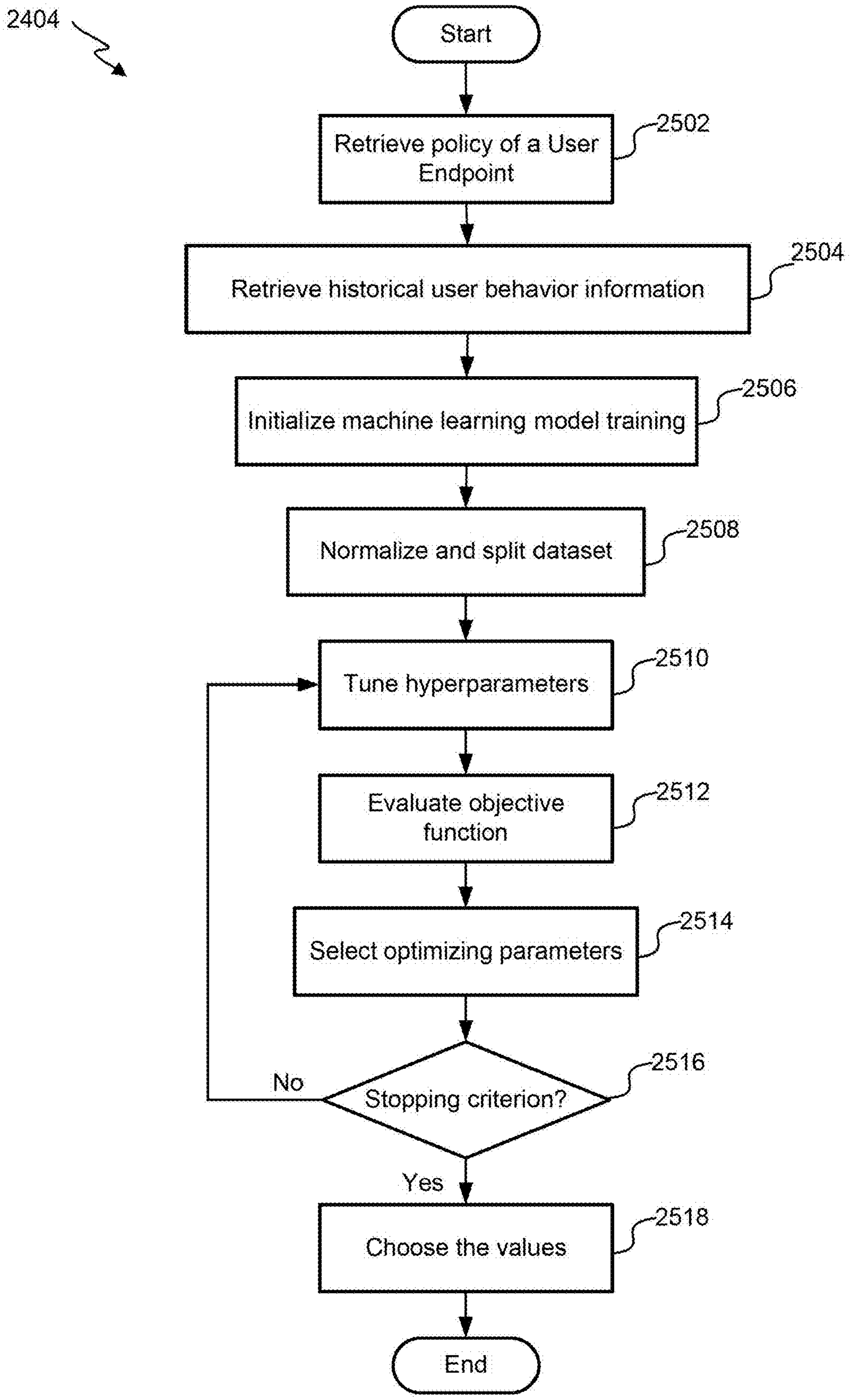

2404
Start
Retrieve policy of a User Endpoint
2502
Retrieve historical user behavior information
2504
Initialize machine learning model training
2506
Normalize and split dataset
2508
Tune hyperparameters
2510
Evaluate objective function
2512
Select optimizing parameters
2514
Stopping criterion?
2516
No
Yes
Choose the values
2518
End

FIG. 25

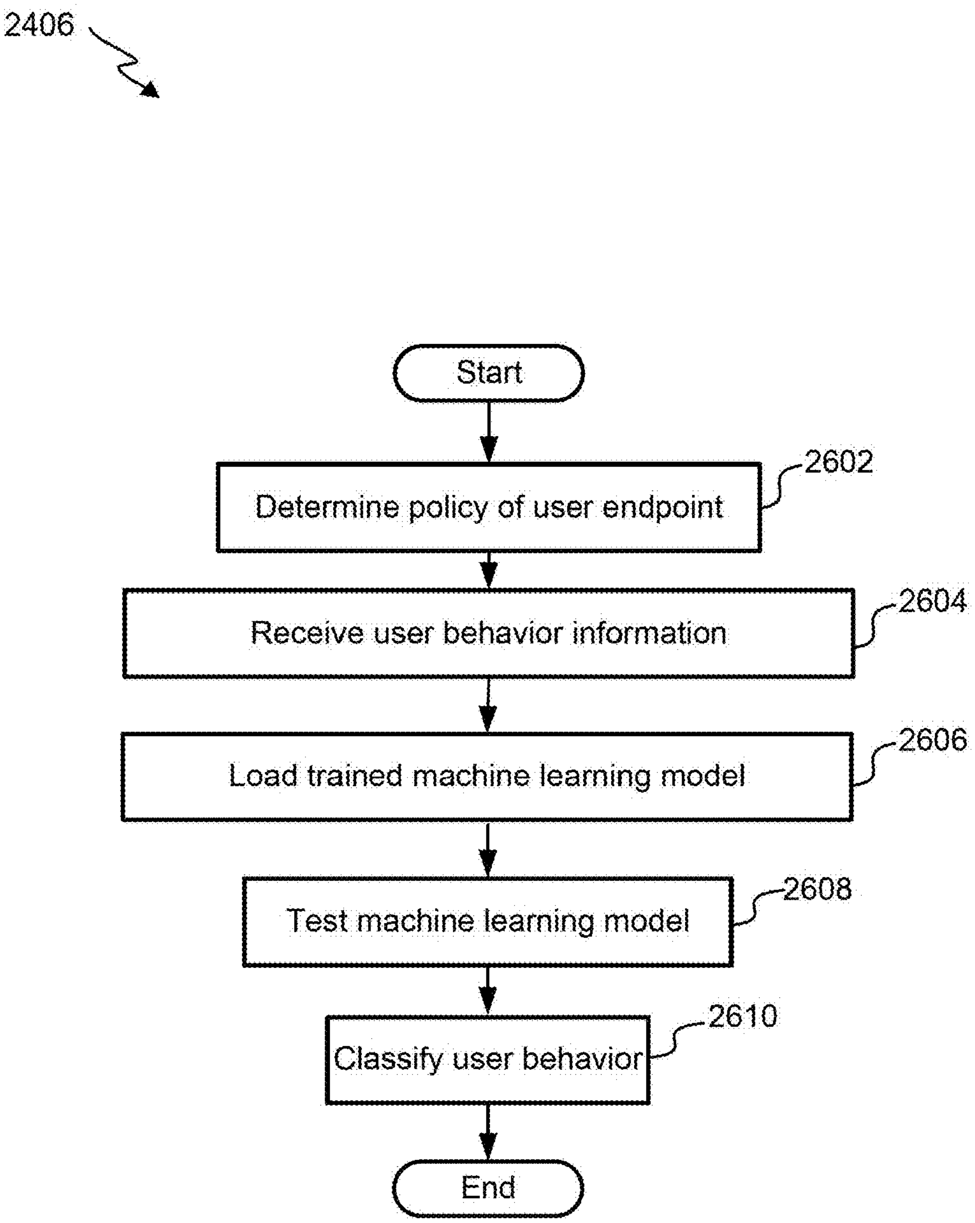

2406
Start
Determine policy of user endpoint
2602
Receive user behavior information
2604
Load trained machine learning model
2606
Test machine learning model
2608
Classify user behavior
2610
End

FIG. 26

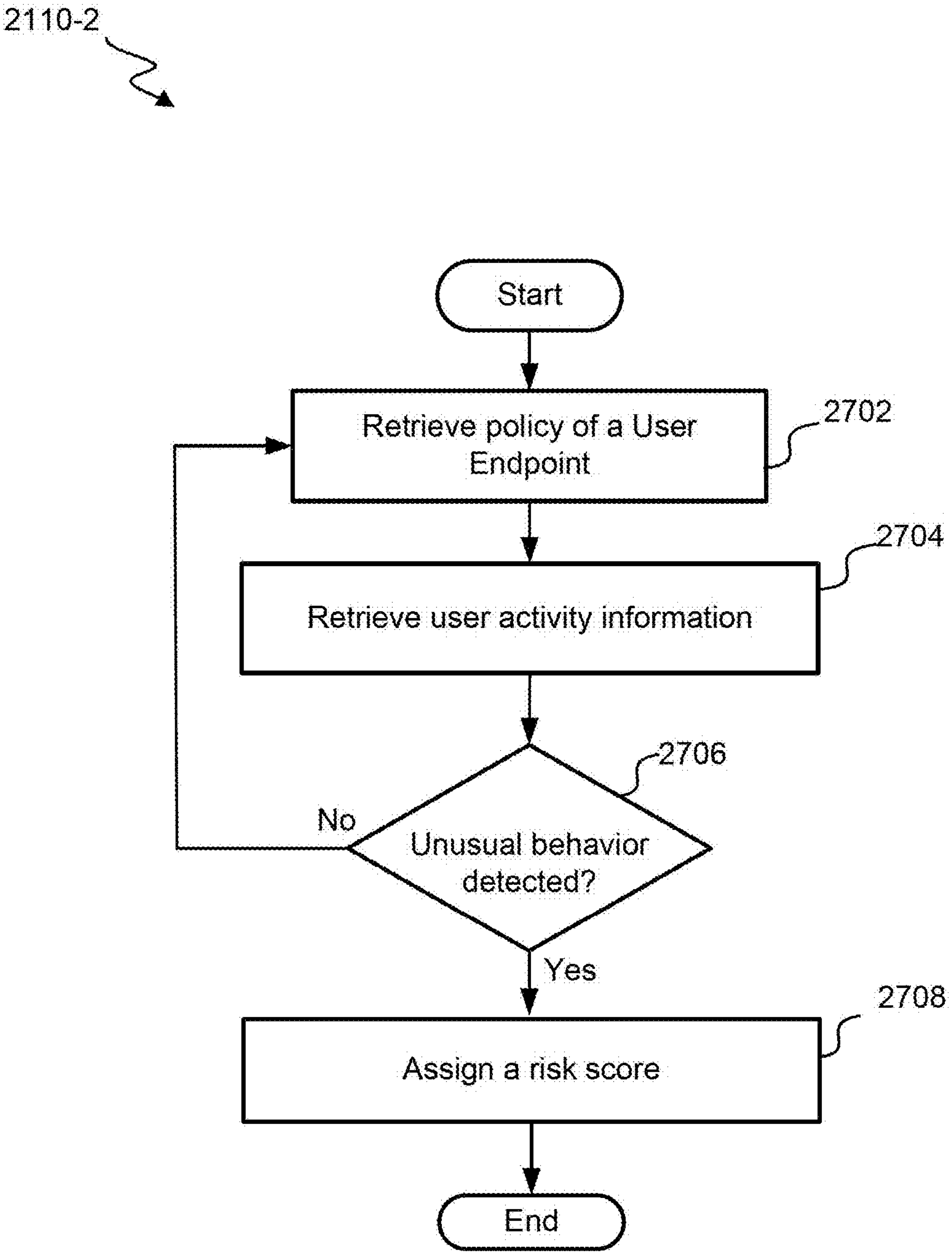

2110-2
Start
Retrieve policy of a User Endpoint
2702
Retrieve user activity information
2704
Unusual behavior detected?
2706
No
Yes
Assign a risk score
2708
End

FIG. 27

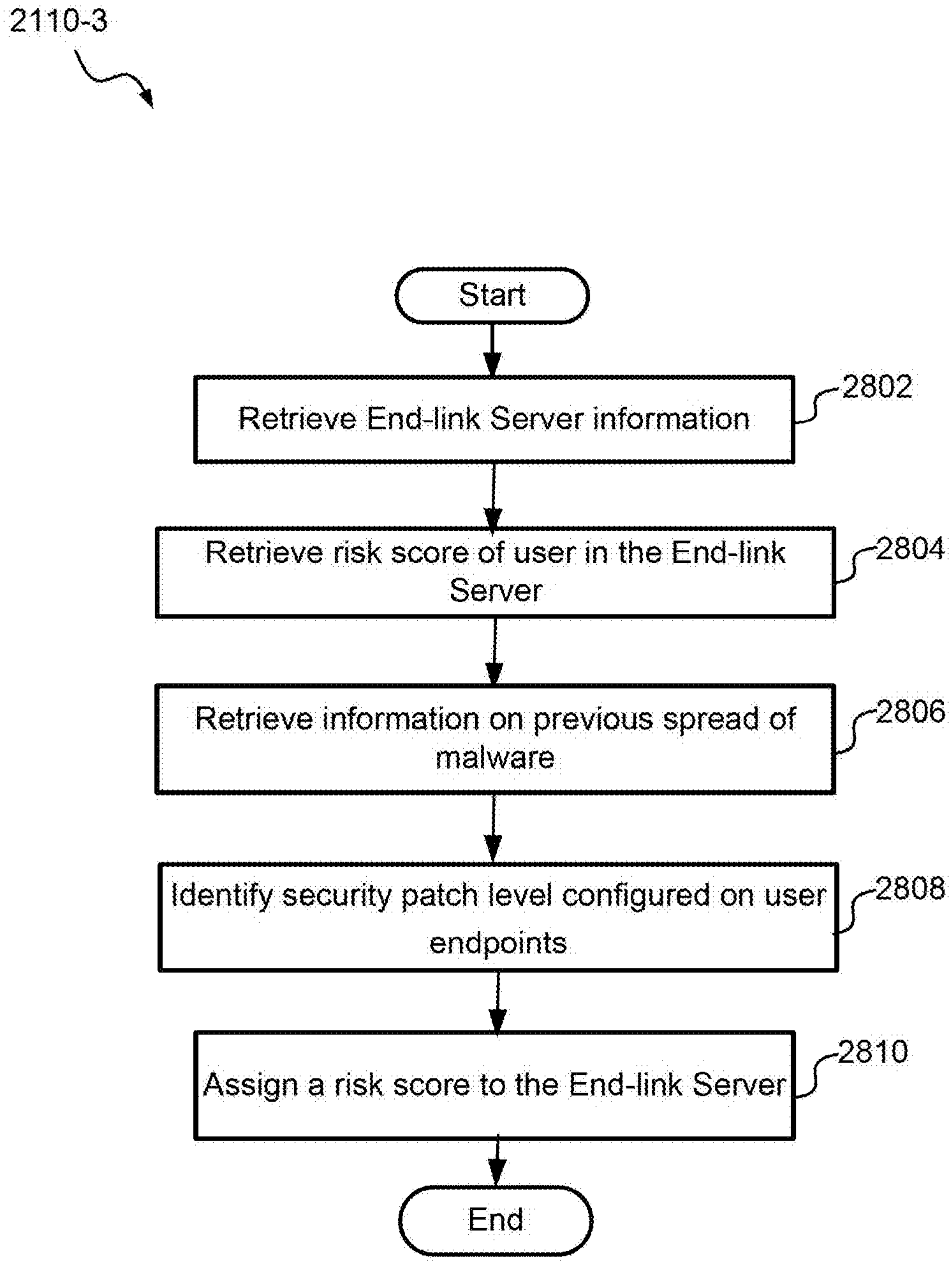

2110-3
Start
Retrieve End-link Server information
2802
Retrieve risk score of user in the End-link Server
2804
Retrieve information on previous spread of malware
2806
Identify security patch level configured on user endpoints
2808
Assign a risk score to the End-link Server
2810
End

FIG.28

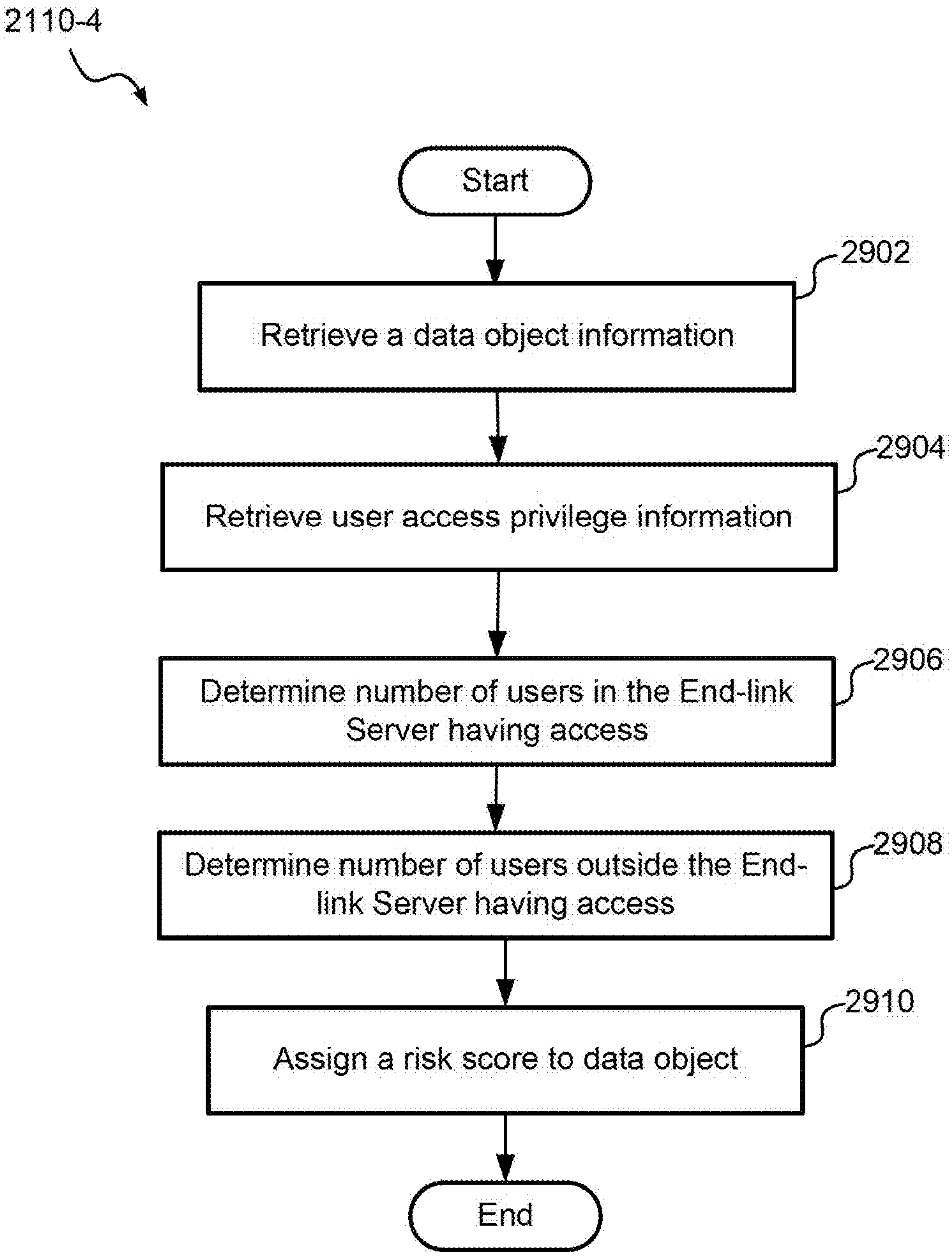

2110-4
Start
Retrieve a data object information
2902
Retrieve user access privilege information
2904
Determine number of users in the End-link Server having access
2906
Determine number of users outside the End-link Server having access
2908
Assign a risk score to data object
2910
End

FIG.29

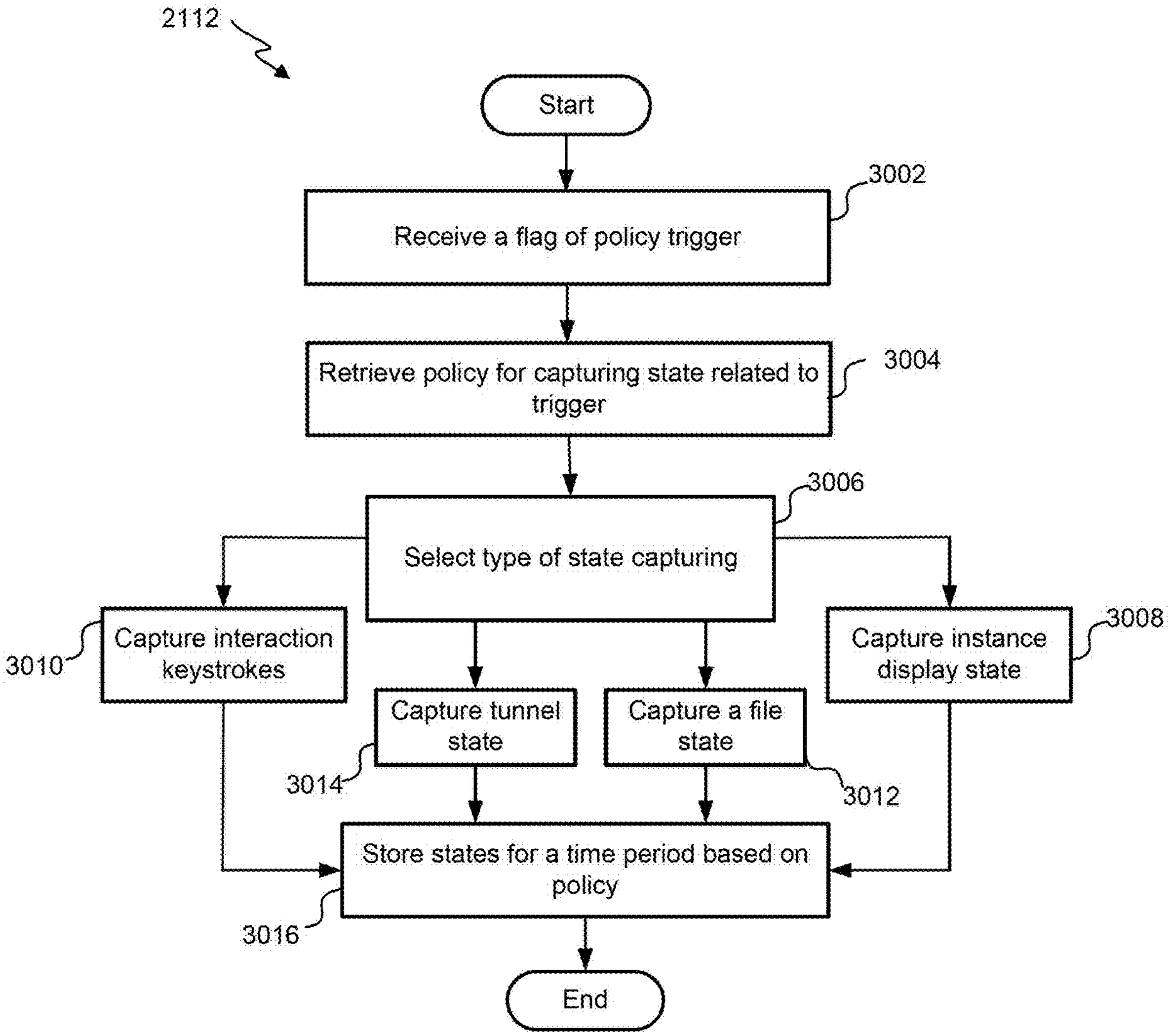

2112
Start
Receive a flag of policy trigger
3002
Retrieve policy for capturing state related to trigger
3004
Select type of state capturing
3006
Capture interaction keystrokes
3010
Capture tunnel state
3014
Capture a file state
3012
Capture instance display state
3008
Store states for a time period based on policy
3016
End

FIG. 30

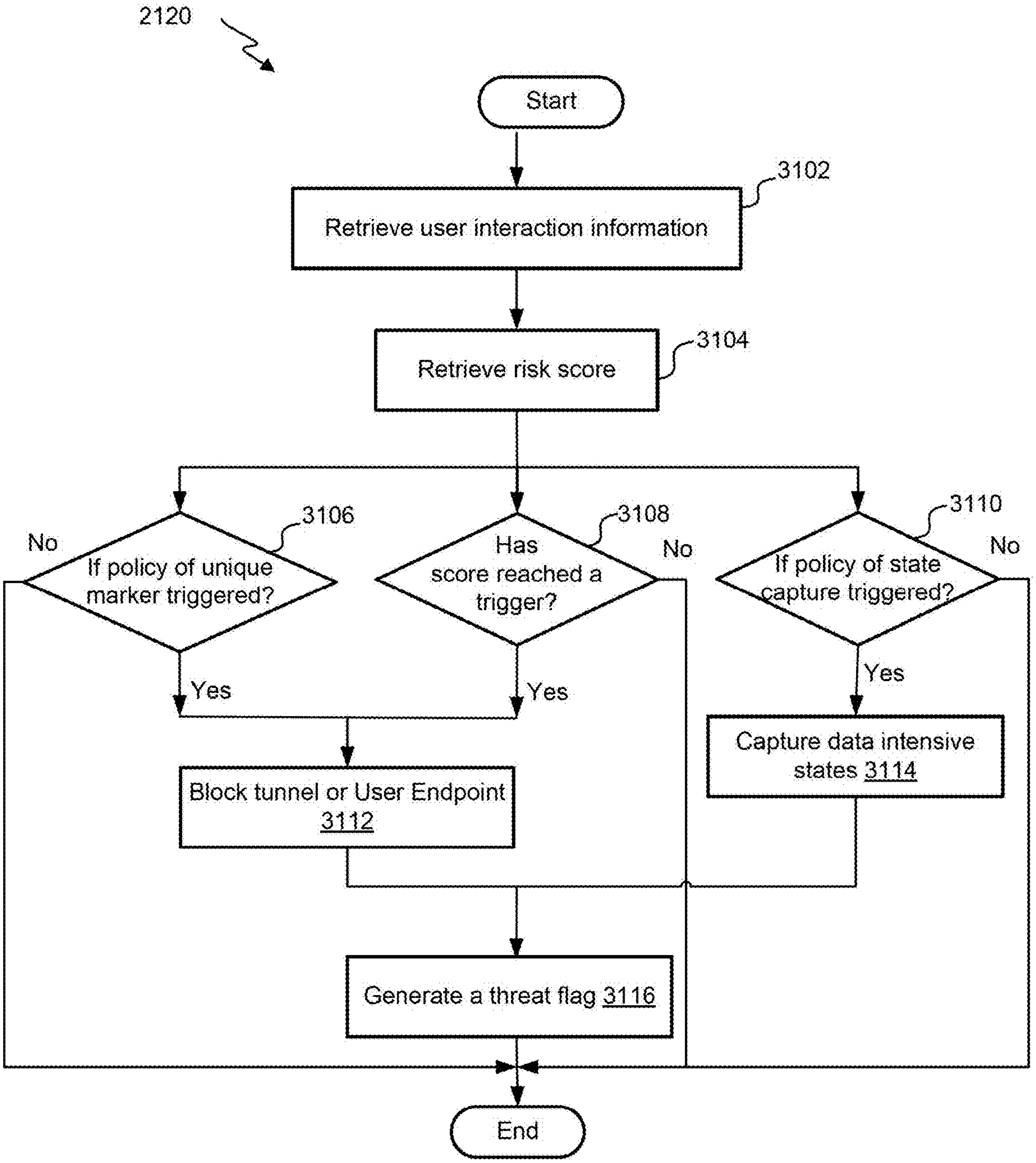

2120
Start
Retrieve user interaction information
3102
Retrieve risk score
3104
If policy of unique marker triggered?
3106
No
Yes
Has score reached a trigger?
3108
No
Yes
If policy of state capture triggered?
3110
No
Yes
Block tunnel or User Endpoint 3112
Capture data intensive states 3114
Generate a threat flag 3116
End

FIG. 31

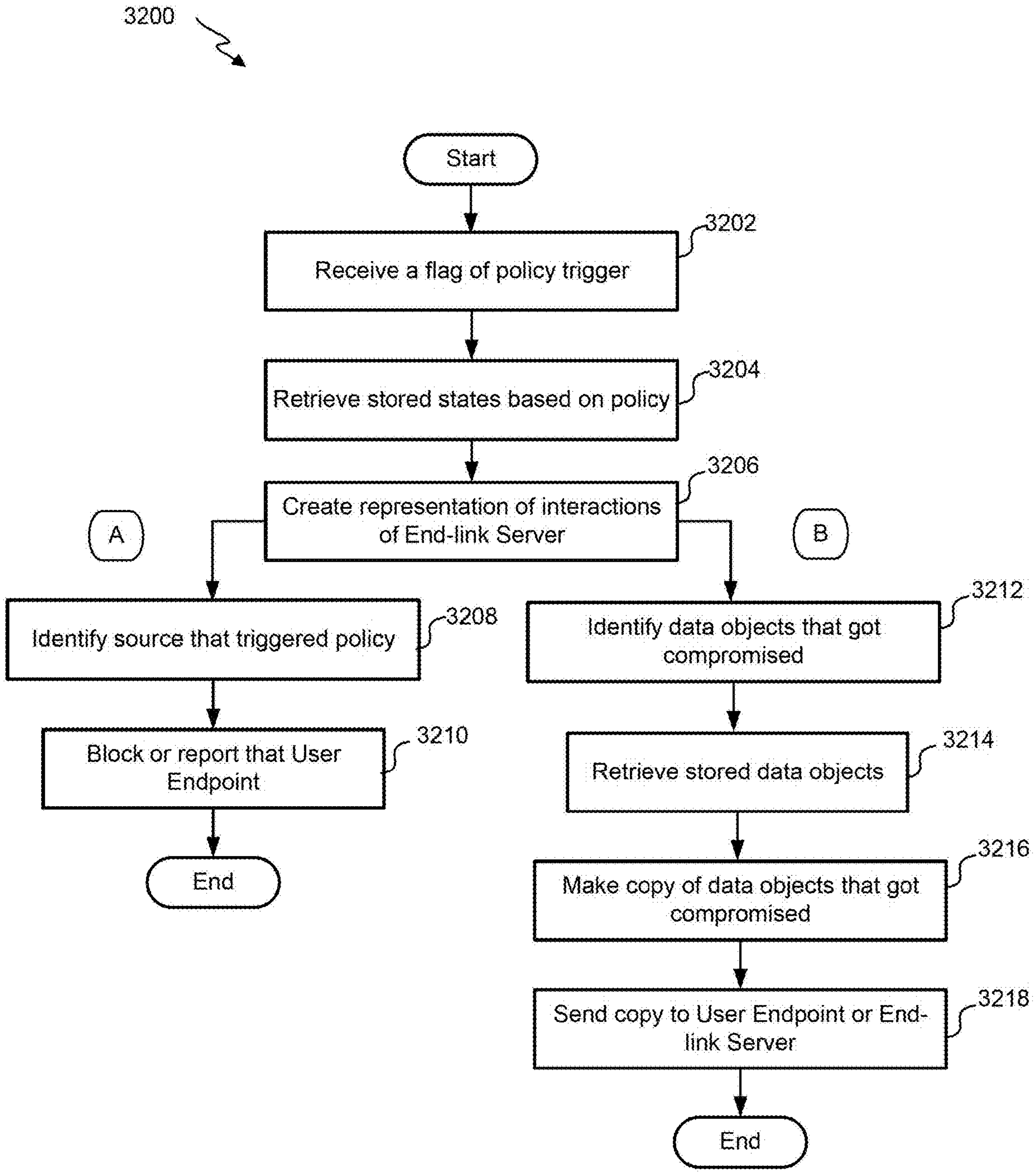

3200
Start
Receive a flag of policy trigger
3202
Retrieve stored states based on policy
3204
Create representation of interactions of End-link Server
3206
A
B
Identify source that triggered policy
3208
Block or report that User Endpoint
3210
End
Identify data objects that got compromised
3212
Retrieve stored data objects
3214
Make copy of data objects that got compromised
3216
Send copy to User Endpoint or End-link Server
3218
End

FIG. 32

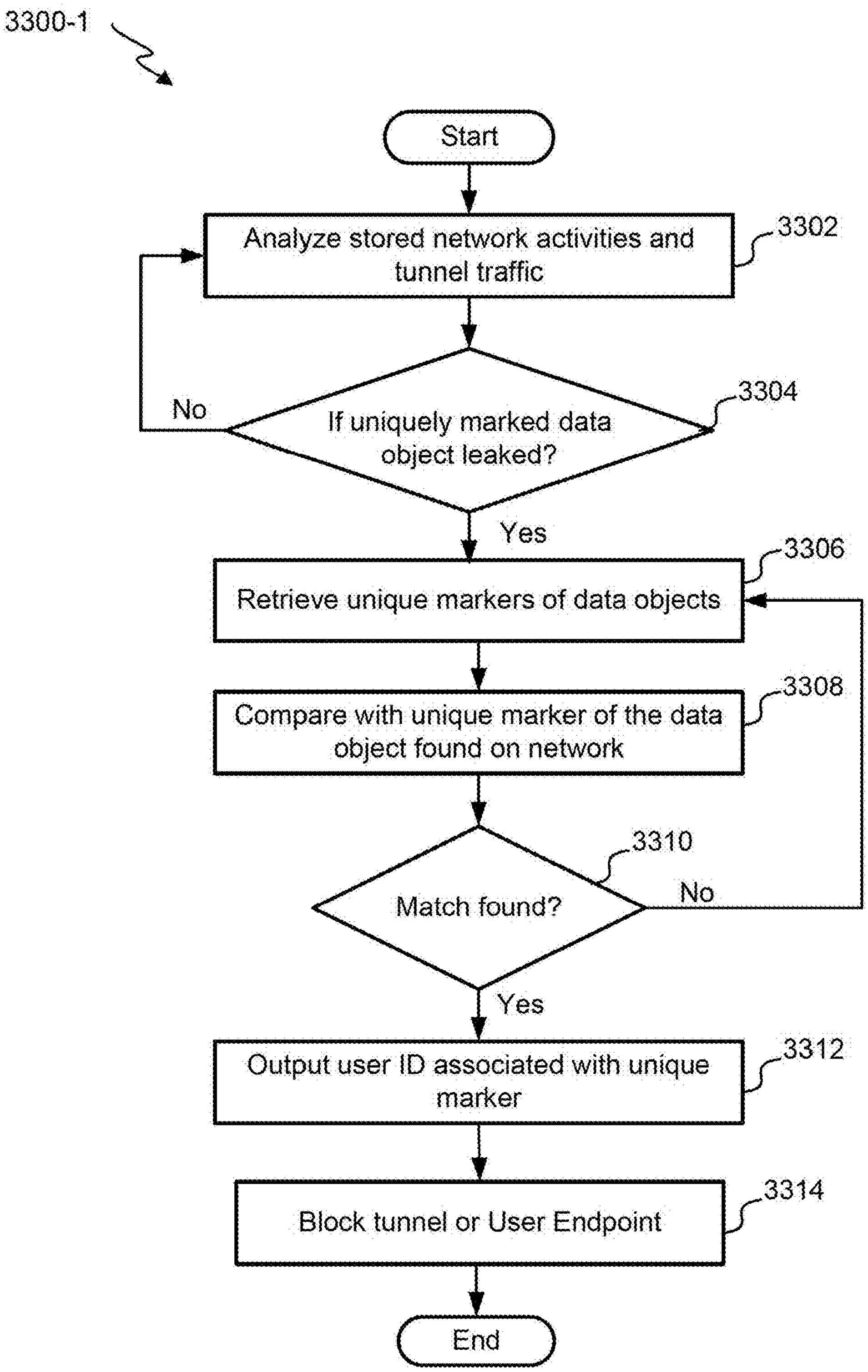

3300-1
Start
Analyze stored network activities and tunnel traffic
3302
If uniquely marked data object leaked?
3304
No
Yes
Retrieve unique markers of data objects
3306
Compare with unique marker of the data object found on network
3308
Match found?
3310
No
Yes
Output user ID associated with unique marker
3312
Block tunnel or User Endpoint
3314
End

FIG. 33

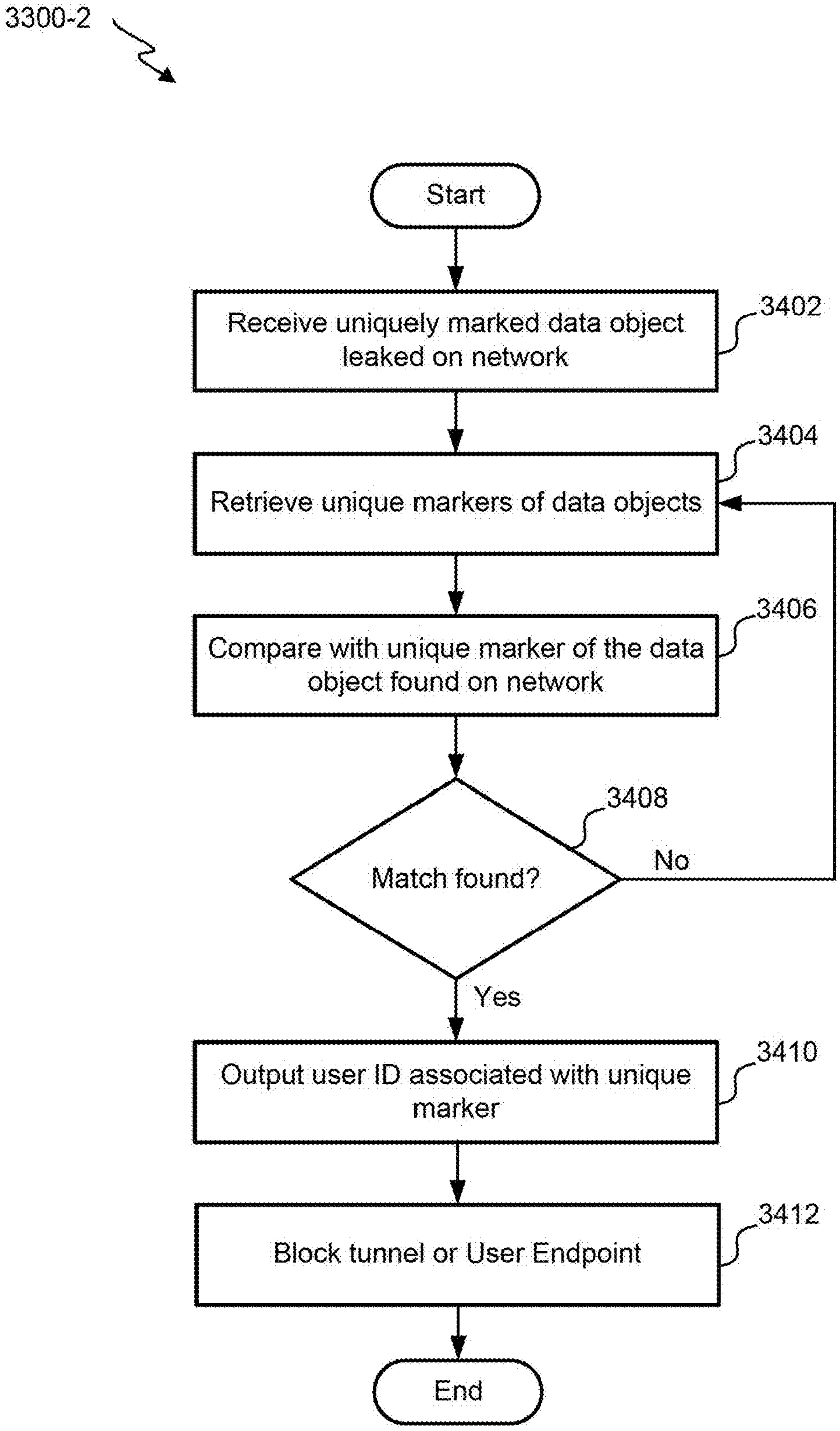

3300-2
Start
Receive uniquely marked data object leaked on network
3402
Retrieve unique markers of data objects
3404
Compare with unique marker of the data object found on network
3406
Match found?
3408
No
Yes
Output user ID associated with unique marker
3410
Block tunnel or User Endpoint
3412
End

FIG. 34

MID-LINK FORENSIC SYSTEM FOR REMOTE APPLICATION ENVIRONMENT BASED ON UNIQUE MARKERS

PRIORITY

[0001] This application is a continuation of U.S. patent application Ser. No. 18/424,701, titled "MID-LINK FORENSIC SYSTEM FOR REMOTE APPLICATION ENVIRONMENT," filed Jan. 26, 2024, which is incorporated by reference for all purposes.

BACKGROUND

[0002] This disclosure relates in general to internet security systems and, but not by way of limitation, to user access control amongst other things.

[0003] Generally, cloud services are increasingly used for various business functions, including customer relationship management (CRM) software, accounting, security, etc. As businesses rely on the cloud services for data creation, editing, and storage, new challenges arise, such as the risk of users losing sensitive corporate data. Also, due to easy Internet access from multiple devices, information of enterprises is exposed to unsecured networks. Thus, the enterprises are prone to theft or hacking and potential data leak with external parties. As the number of cloud services grows, data can leak in several ways in enterprise, such as unauthorized file attachments, cloud-based storage, or improper collaboration with external parties. Moreover, the data leaks can lead to business losses, internal investigations, or reputation management, etc.

[0004] Further, enterprises want to control user activities on computing devices that are used for work. However, traditional information technology (IT) and network architecture approaches offer limited control over data protection. The chaotic spread of bring your own device (BYOD) policies makes locking down of the computing devices problematic. Also, data loss prevention (DLP) solutions currently available in the market are exposed to evolving threats. Cloud storage, for example, poses a significant risk to the enterprises, as continuous synchronization occurs between endpoints and the cloud services without oversight. Cloud-based computing on BYOD devices creates issues that conventional security systems find difficult to handle.

SUMMARY

[0005] The present disclosure provides an electronic inspection method and system comprising user endpoints, end-link servers belonging to a tenant, and a mid-link server. The mid-link server connects the user endpoints with an end-link server through the tunnels. The mid-link server models an interaction in the tunnels using a model of an application layer. The mid-link server receives a communication from the user endpoints through the tunnels, differentiates between a data object, and stores the data object based on a plurality of policies and context developed. The mid-link analyzes the model and the data object in the tunnels and determines the context according to a policy. The mid-link server performs electronic inspection between a plurality of end-link servers and a plurality of user endpoints by inspecting the data object from the plurality of tunnels.

[0006] In an embodiment, the present disclosure provides a method for the electronic inspection between a plurality of end-link servers of a plurality of tenants and a plurality of user endpoints by a mid-link server. In one step, the mid-link server is configured between an interaction of the plurality of user endpoints and the plurality of end-link servers. The mid-link server receives a communication at the mid-link server passing between the plurality of end-link servers and the plurality of user endpoints using a plurality of tunnels. Each of the plurality of tenants includes the plurality of user endpoints, and the mid-link server is configured between the plurality of user endpoints and the plurality of end-link servers. The mid-link server models a plurality of interactions in the plurality of tunnels using a model of an application layer hosted by the mid-link server. The mid-link server differentiates between a data object within the model of the application layer and analyzes the model and the data object within the plurality of tunnels based on a plurality of policies. The mid-link server determines a context that is a function of the data object and the model. The mid-link server triggers a policy of the plurality of policies based on the context; and stores the data object and the plurality of interactions upon the triggering of the policy of the plurality of policies.

[0007] In another embodiment, a system for electronic inspection is defined between the plurality of end-link servers of the plurality of tenants and the plurality of user endpoints with the mid-link server. A tunnel between the user endpoint and the mid-link server and another tunnel between the end-link server and the mid-link server. The tunnel is configured to transmit traffic from the user endpoint and the end-link server to the mid-link server. The mid-link server receives a communication by passing between the plurality of end-link servers and the plurality of user endpoints using a plurality of tunnels. Each of the plurality of tenants includes the plurality of user endpoints and the mid-link server is positioned between an interaction of the plurality of user endpoints and the plurality of end-link servers. The mid-link server models a plurality of interactions in the plurality of tunnels using a model of an application layer hosted by the mid-link server. The mid-link server differentiates between a data object within the model of the application layer and analyzes the model and the data object within the plurality of tunnels according to a plurality of policies. The mid-link server determines a context that is a function of the data object and the model. The mid-link server triggers a policy of the plurality of policies based on the context; and storing the data object and the plurality of interactions upon the triggering of the policy of the plurality of policies.

[0008] In yet another embodiment, a computer-readable media is discussed having computer-executable instructions embodied thereon that when executed by one or more processors, facilitate a method for an electronic inspection system between a plurality of end-link servers of a plurality of tenants and a plurality of user endpoints by a mid-link server. The mid-link server receives a communication by passing between the plurality of end-link servers and the plurality of user endpoints using a plurality of tunnels. Each of the plurality of tenants includes the plurality of user endpoints and the mid-link server is positioned between an interaction of the plurality of user endpoints and the plurality of end-link servers. The mid-link server models a plurality of interactions in the plurality of tunnels using a model of an application layer hosted by the mid-link server. The mid-link server differentiates between a data object within the model

of the application layer and analyzes the model and the data object within the plurality of tunnels according to a plurality of policies. The mid-link server determines a context that is a function of the data object and the model. The mid-link server triggers a policy of the plurality of policies based on the context; and storing the data object and the plurality of interactions upon the triggering of the policy of the plurality of policies.

[0009] Further areas of applicability of the present disclosure will become apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating various embodiments, are intended for purposes of illustration only and are not intended to necessarily limit the scope of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The embodiments of the disclosure will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the disclosure, which, however, should not be taken to limit the disclosure to the specific embodiments, but are for explanation and understanding only:

[0011] FIG. **1** shows a block diagram of an electronic inspection system for providing a multi-tenant security and logging;

[0012] FIG. **2** shows a block diagram of an embodiment of the electronic inspection system for inspection of an end-link server over a network;

[0013] FIG. **3** represents a block diagram of an embodiment of a mid-link server that performs electronic inspection of the end-link server;

[0014] FIG. **4** shows a block diagram of a threat analyzer employed at the mid-link server to detect security threats and incidents in the end-link server;

[0015] FIG. **5** shows a block diagram of a remote guard of the mid-link server;

[0016] FIG. **6** shows a block diagram of the remote guard that can be used as another embodiment of the present disclosure;

[0017] FIG. **7** shows a block diagram of a forensic logger;

[0018] FIG. **8** shows a block diagram of a report generator interacting with a co-pilot of the mid-link server;

[0019] FIG. **9** shows a block diagram of a cloud OSI model for the end-link server;

[0020] FIG. **10** shows an event log entry generated by the forensic logger;

[0021] FIG. **11** shows an enterprise environment subjected to be analyzed by a retro analyzer;

[0022] FIG. **12** shows an exemplary method of capturing states of activities on the end-link server;

[0023] FIG. **13** shows a GUI acquired by a capturing module of the mid-link server;

[0024] FIG. **14** shows mapping between risk scores of user endpoints, respective policies and resulting threat flags;

[0025] FIG. **15** shows a GUI representation of a tenant policy and graphical representation of the risk scores of each user endpoint along with the policies that were breached;

[0026] FIG. **16** shows a representation of embedding of a unique marker in a data object using a model of an application layer at the mid-link server;

[0027] FIG. **17** shows a flow diagram of policy enforcement by the mid-link server;

[0028] FIG. **18** shows a dashboard for a forensic interface for electronic inspection;

[0029] FIG. **19** shows a swim lane diagram for flow of instructions in the electronic inspection system;

[0030] FIG. **20** shows a flowchart of steps involved in setting up tunnels for communication via the mid-link server;

[0031] FIG. **21** shows a flowchart of processing tunnel traffic with the mid-link server;

[0032] FIG. **22** shows a flowchart of accessing and modelling data objects using the model of the application layer at the mid-link server;

[0033] FIG. **23** shows a flowchart of storing the data objects based on policies using the mid-link server;

[0034] FIG. **24** shows a flowchart of scoring user behavior based on the threat posed by an unusual behavior of user endpoint;

[0035] FIG. **25** shows a flowchart comprising of method of training a machine learning algorithm of FIG. **24**;

[0036] FIG. **26** shows a flowchart for classification of user behavior using the machine learning algorithm of FIG. **24**;

[0037] FIG. **27** shows a flowchart of scoring of the user behavior according to the rules;

[0038] FIG. **28** shows a flowchart of an exemplary method of assigning a risk score to the end-link servers;

[0039] FIG. **29** shows a flowchart of assigning the risk score to the data objects within a tunnel;

[0040] FIG. **30** shows a flowchart illustrating a method of capturing states for the model of the application layer based on policy;

[0041] FIG. **31** shows a flowchart illustrating the remediation steps of the mid-link server as dictated by the policies;

[0042] FIG. **32** shows a flowchart of method of electronic inspection through captured states;

[0043] FIG. **33** shows a flowchart of method of electronic inspection through unique markers carried out by the mid-link server; and

[0044] FIG. **34** shows a flowchart that comprises a method of electronic inspection through unique markers carried out by a forensic investigator.

[0045] In the appended figures, similar components and/or features may have the same reference label. Further, various components of the same type may be distinguished by following the reference label by a dash and a second label that distinguishes among the similar components. If only the first reference label is used in the specification, the description is applicable to any one of the similar components having the same first reference label irrespective of the second reference label.

DETAILED DESCRIPTION

[0046] The ensuing description provides preferred exemplary embodiment only, and is not intended to limit the scope, applicability, or configuration of the disclosure. The ensuing description on the preferred exemplary embodiments will provide those skilled in the art with an enabling description for implementing a preferred exemplary embodiment. It is understood that various changes may be made in the function and arrangement of elements without departing from the spirit and scope as set forth in the appended claims.

[0047] Referring first to FIG. **1**, a block diagram of an electronic inspection system **100** for providing a multi-tenant security and logging in an embodiment is shown. The electronic inspection system **100** includes user endpoints **102** (**102-1**, **102-2**, **102-3**), end-link servers **104** (**104-1**, **104-2**, **104-3**), tunnels **106** (**106-1**, **106-2**, **106-3**, **106-4**, **106-5**, **106-6**, **106-7**), external applications **108**, and a forensic engine **112** configured in a mid-link server **110**. A user endpoint **102** is a user device or a client device such as smartphone, tablet, a personal computer (PC), an Internet of Things (IoT) device, or any other computing device designed to communicate with an end-link server **104** via encryption links. The user endpoint **102** consists of any popular operating system (OS) that runs local and remote software applications, for example a Software as a Service (SaaS) application can run using a local web browser. The user endpoint **102** accesses remote content and processing within an enterprise (i.e., behind the firewall) across public and/or private networks.

[0048] The end-link servers **104** are software solutions that are SaaS applications or local applications, which are hosted and maintained by third-party vendors and provided to users over a network such as the Internet. The end-link server **104** includes content sites such as websites, streaming content, application websites etc., in order to provide different services to the user endpoint **102**. The end-link server **104** also permits the user endpoint **102** to upload and download content from the content sites.

[0049] Through the tunnels **106**, the user endpoint **102** routes some interaction to the mid-link server **110** that inspects a controlled software environment for the user endpoint **102** to interact with the end-link server **104**. The traffic in the tunnel **106** includes information of websites, web applications, streaming, browsing, web activities, activities performed on the mobile application or in-app activities, online transactions, and other activities. Communications in the tunnels **106** occur over a variety of networks, e.g., private networks, a virtual private network (VPN), a multiprotocol label switching (MPLS) circuit, or Internet via protocols. Examples of protocols include EDGE, 3G, long-term evolution (LTE), Wi-Fi, and WiMAX, and may use approximate application programming interfaces (APIs) and data interchange formats.

[0050] Various data interchange formats are applicable e.g., representational state transfer (REST), JavaScript object notation (JSON), extensible markup language (XML) etc. Additionally, a variety of authorization techniques, such as username/password, open authorization (OAuth), Kerberos, SecureID, digital certificates, and more, are used to secure communications through tunnels **106**. At the end of the electronic inspection process, the mid-link server **110** tear-down the tunnels **106** if they are no longer in use. If a new communication is received, the tunnel **106** is established again by the mid-link server **110**.

[0051] The mid-link server **110** for the electronic inspection system **100** resides as a "man-in-the-middle" and intentionally takes over some or all of the processing, application execution, and/or the content sites at the end-link server **104** and the user endpoint **102** interaction. The mid-link server **110** stores a data object, performs an electronic inspection, provides incident recovery process, and responds to any threat/incident via the forensic engine **112**. The forensic engine **112** connected with the end-link server **104** can be leveraged to scan the logs and configuration of the end-link server **104** to see if there were any detected issues, correlations, and/or analytics from the threat and other engines.

[0052] The mid-link server **110** accesses different types of data depending upon the kind of security threat or policy breach. Data of an application layer in the mid-link server **110** is referred as "data objects" from here on. The data objects are formulated by activities of the user endpoint **102** and the end-link server **104**, and from traffic in the tunnels **106**. The data objects comprise of data that is generated by application running on the end-link server **104**, accessed from a storage or a database, exchange through a protocol in the tunnels **106**, or generated and consumed by the user endpoints **102** and tenants connected with the mid-link server **110**. The data objects include files, folders, browser displays, video streams, water marks, and state captures at the user endpoint **102** and/or the end-link server **104**.

[0053] The forensic engine **112** provides detection, inspection, and recovery against a threat/incident on the end-link server **104**. The forensic engine **112** further provides API visibility and a graphical user interface (GUI) for a forensic investigator to perform electronic inspection of an incident itself. The end-link server **104** is inspected by the mid-link server **110** for a policy-controlled experience. For example, the content sites at the end-link server **104** may have specific applications disabled, filtered, or modified by the mid-link server **110**. In such a case, the user endpoint **102** behaves differently than if it were to directly connect to the content sites of the end-link server **104**. For example, the policy may specify access to a website based on the risk determined by the policy breach.

[0054] The mid-link server **110** also exports its data in raw or processed form to the external applications **108**. The external applications **108** are independently operated and maintained by the enterprise and are available in any enterprise. The purpose of exporting the data to the external applications **108** is to enable the user to manage and investigate the data on its own and to make a backup log or permanent storage for the mid-link server **110**.

[0055] Referring next to FIG. **2**, a block diagram of an embodiment of the electronic inspection system **100** for inspection of the end-link server **104** over a network **202** is shown. The electronic inspection system **100** includes the network **202** that is either public or private, a forensic interface **212**, the user endpoints **102** (e.g., a computer **218**, a handheld device **220**), end-link servers **104** (**104-1**, **104-2**, **104-3**), the mid-link server **110**, and the external applications **108**. The external applications **108** are independently managed by the enterprise and includes a data lake **208** and an incident management system **210**.

[0056] The data lake **208** is a centralized and flexible repository that allows enterprises to store large amounts of structured and unstructured data of any size. Unlike traditional databases that require structured data with predefined schemas, the data lake **208** contains raw data of all types, including text, images, states, videos, etc. The data lakes **208** are commonly used for advanced analytics, machine learning, and data mining. The data lakes **208** often integrate data catalogs or metadata management system to manage and store data independently.

[0057] The incident management system **210** is an independent application used by enterprises to identify, respond to, and resolve incidents effectively. The incident management system **210** maintains the safety of users, protect assets, and ensure business continuity. Features of the incident management system **210** include incident identification, classification, response planning, response coordination, and communication. The incident management system **210** further includes incident tracking, documentation and reporting, incident resolution and recovery, post-analysis incidents, training, and operating the system to handle more such incidents.

[0058] The network **202** is any internet network providing a connection between the user endpoints **102**, the end-link servers **104**, the forensic interface **212** and the mid-link server **110**. The forensic investigator analyzes the security of the application. The forensic investigator can be any third party software or personnel hired by the enterprise to examine the incident or status of security in the application. The artifacts collected by the mid-link server **110** are exported to the external applications **108** if the forensic investigator wants, for further analysis in the incident management system **210** and/or storing in the data lake **208**.

[0059] The mid-link server **110** supports multi-tenancy so that functionality and data of different enterprises are isolated while running on the same infrastructure. For example, the user endpoint **102** can be connected to a number of the end-link servers **104** that have many tenants of its own kept separate by the mid-link server **110**. Even though tenants share resources with other tenants outside their enterprise, different tenants are not aware of each other, and their data is kept separate.

[0060] The mid-link server **110** also provides visibility and access of a threat vector across multiple tenants that are facing a risk of getting compromised. The threat vector represents a known threat that has occurred at the end-link server **104** of some other tenant. The mid-link server **110** provides the information and precautionary measures to the tenants, so the tenants prepare themselves against any future encounter with the threat vector. The details of the visibility of known threats are explained in later sections.

[0061] The mid-link server **110** creates a model of the application layer that records the data objects and creates a context. Through the policies and the context, the interactions and the data objects are modelled and stored using the model of the application layer. The modelling of data objects, interactions, and browser data includes rendering using the model of the application layer at the mid-link server **110**.

[0062] The modelling provides security and visualization of the interactions and the data objects for the model of the application layer. The interactions are created from the communications between the user endpoint **102** and the end-link server **104**. Notice that the model of the application layer provides an instantaneous depiction or view of the interactions between the user endpoint **102** and the end-link server **104**. On the other hand, the context pulls additional information of the tenants and establishes relationships between the tenants and the data objects in the tunnels **106**.

[0063] Referring next to FIG. **3**, a block diagram **300** of an embodiment of the mid-link server **110** that performs the electronic inspection of the end-link server **104** is shown. The mid-link server **110** includes the forensic engine **112** with a co-pilot **322** configured within. The mid-link server **110** includes a remote guard **302**, a workflow manager **304**, a command system **306**, a forensic logger **308**, and a threat analyzer **312**. The mid-link server **110** further includes a capturing module **314**, a user entity behavior analyzer (UEBA) **316**, a retro analyzer **318**, a report generator **320**, and a meta database **324**.

[0064] The remote guard **302** is configured within the mid-link server **110**, to aid the electronic inspection in case of event escalation. The remote guard **302** enables the mid-link server **110** to identify and manage the use of the end-link server **104**, regardless of whether the end-link servers **104** are managed or unmanaged. The remote guard **302** prevents sensitive data from being exfiltrated from the tunnels **106** by risky insiders or malicious cybercriminals and stops malicious insiders from copying sensitive content from business email to personal email accounts. The use of the remote guard **302** empowers the mid-link server **110** by providing graph-based detections and visualizations to expose hidden risks and security gaps. When risky configurations or policy drifts are detected, the remote guard **302** generates a flag and remediation instructions.

[0065] The workflow manager **304** designs and ensures the smooth execution of events or incidents in various stages following an incident response (IR) process. The IR process comprises of four stages, namely: detection and reporting, triage and analysis, containment and neutralization and post-incident activity. The command system **306** enables the commands that are scripts of tasks for inspection of the end-link server **104**. The command system **306** locks down or makes applications receive operations for the incident. The forensic logger **308** comprises of a time logger **310** and other loggers. The forensic logger **308** tracks specific actions and records them for a timeline. The threat analyzer **312** is an engine that takes data and input of the users and systems from the meta database **324**, a policy database **326**, and other modules, for inspection and to raise a threat flag. The capturing module **314** captures multiple types of states, based on the policies, at different instances to monitor the activity of the user endpoint **102** or the tenant.

[0066] The UEBA **316** uses machine learning algorithms to create a baseline of user behavior patterns and assign scores to the user endpoint **102**. The UEBA **316** is integrated within the retro analyzer **318** that scans history of user activities and assigns scores to the end-link servers **104**, the user endpoints **102**, and the data objects present within the tunnels **106**. The report generator **320** creates reports based on actions taken during inspection process, to aid the enterprise or the forensic investigator. Similarly, the co-pilot **322** employes visualization tools and uses artificial intelligence to guide and recommend some actions to the forensic investigator at the forensic interface **212**. The meta database **324** stores scores of the data objects, the user endpoints **102**, the tenants and the end-link servers **104**. The meta database **324** stores unique markers of the data objects, generated by the threat analyzer **312**, and states of activities on the application layer model, captured by the capturing module **314**. The policy database **326** stores policies and rules of the user endpoints **102** and tenants, user identities and data of the enterprise etc. The policy database **326** of the remote guard **302** helps in policy enforcement at the mid-link server **110**. In some implementations, the policy database **326** can be relational database management systems (RDBMSs), object-oriented database management systems (OODBMSs), distributed file systems (DFS), no-schema database, or any other data storing systems or computing devices.

[0067] Referring next to FIG. **4**, a block diagram of an embodiment of the threat analyzer **312** of the mid-link server **110** and its mechanism of detecting, correlating, and analyzing the threat is shown. The threat analyzer **312** includes a water marking (WM) engine **402**, an anomaly detector **404**, a threat feed **406**, a correlator **408**, a rendering engine **410**, a pattern recognizer **412**, and an alerting module **414**. The threat analyzer **312** interacts with the capturing module **314**, the meta database **324**, the policy database **326**, and the forensic logger **308** of the mid-link server **110** to analyze and alert the user regarding an incoming threat.

[0068] The threat analyzer **312** of the mid-link server **110** is the main component used to investigate and analyze security incidents that have occurred within the end-link server **104**. The primary function of the threat analyzer **312** is to gather relevant data objects, process the data objects, and provide insights into the incidents. The threat analyzer **312** collects the data objects from various sources within the end-link server **104** like the forensic logger **308** and the meta database **324**. The sources of collecting the data objects include a risk score, a log, user activity records, network traffic, and system configuration data. Take an example where a user calls after their SaaS application on the end-link server **104** has been compromised or they think it has. The organization can leverage the forensic engine **112** connected with the end-link server **104** to scan the logs and configuration of the SaaS application and see if there were any detected issues from the threat and other engines.

[0069] The rendering engine **410** of the threat analyzer **312** in the forensic engine **112** models multiple interactions and data objects from the tunnels **106**. The rendering engine **410** models browser data for the application layer model by decrypting the website security protocols. The rendering engine **410** is connected to the WM engine **402** along with the pattern recognizer **412** and the correlator **408** of the threat analyzer **312**. The rendering engine **410** also takes input from the meta database **324** and the forensic logger **308** of the mid-link server **110**.

[0070] The WM engine **402** refers to a "watermarking engine" that embeds a unique marker in the data objects being modelled. The WM engine **402** renders the data objects that are sensitive as instructed by the policy. The unique markers created by the WM engine **402** are stored in the meta database **324** corresponding to the ID of each data object and the user who accesses it. The WM engine **402** is connected to the rendering engine **410**, the correlator **408**, and the pattern recognizer **412**. In this way when the data object is leaked to the network **202**, the threat analyzer **312** matches the unique marker of the leaked data object with the stored unique markers. The threat analyzer **312** retrieves the ID of the user endpoint **102** who has access to that data object. The mid-link server **110** takes further steps once the culprit is determined.

[0071] The correlator **408** determines the data from the end-link servers **104**, the user endpoints **102**, the tenants and the tunnels **106** to establish relationships and the context. The context provides intelligence to identify and differentiate data objects from the tunnels **106** in the correlator **408** with respect to the information and activities of each of the user endpoints **102**. For instance, the correlator **408** can link user login data with the data object access logs to determine if a user's actions are suspicious.

[0072] The context includes connection-specific information and builds relationship of the data objects with the user endpoints **102** and the tenants. The context further consists of information that is not categorized as a data object, such as information from the interactions. For example, in the case where the tenants are communicating over a network and information is being shared through a shared screen, the shared screen provides the context. The shared screen or content of the shared screen cannot be stored or analyzed as the data object. Similarly, the data generated or consumed by the interactions of the tenants across a multi-tenant environment is used as the context. The context provides a memory or stores the additional information in the interactions of tenants over a period of time. By using the context, the storing of the data objects in the forensic logger **308** becomes less frequent and lower memory is utilized. For example, a file that is present at various locations in the end-link server **104** but remains un-edited is now being saved once by the mid-link server **110**. Similarly, the data object that is being edited by multiple user endpoints **102** will be stored differently based on the context extracted from the tunnels **106**.

[0073] The anomaly detector **404** looks over the role and rules-based policy implementation. The main function of the anomaly detector **404** is to detect breach in policies. This involves identifying any activity like login times, multiple failed login attempts, or unauthorized access to sensitive data that is against the defined policies. It compares incoming data with a database of known attack signatures to identify common attack vectors.

[0074] The threat analyzer **312** incorporates the threat feed **406**, that is an intelligence feed formed by utilizing a pattern recognizer **412**. The threat feed **406** has the information of the known threats that have occurred at different tenants of the end-link server **104**. The threat feed **406** uses this information to create the threat vector. The Pattern recognizer **412** is a machine learning module, to recognize the known threats which provide real-time information about emerging threats and known malicious actors. The threat feed **406** provides transparency of the threat information across the end-link server **104** in different tenants facing a risk of getting compromised to combat the same threat timely. This integration allows for more accurate threat detection and identification. For example, Zoom™ is a tenant of the end-link server **104** and is attacked by malware. The threat feed **406** takes the information and attributes of the attack and the pattern recognizer **412** uses machine learning to create the threat vector of the attack. The threat vector is then communicated across the tenants by the mid-link server **110**. The threat vector alerts other tenants about the known threat lurching over the network **202**. In this way, the other tenants e.g., LinkedIn™ will be better prepared to fight that attack in future.

[0075] The alerting module **414** generates threat flags and notifications when it detects a potential security incident or a suspicious activity. The threat flags initiate the action that provides remedy for a breach and are sent to security analysts or administrators for further investigation. The threat analyzer **312** ensures that the relevant data is preserved for analysis purposes through the meta database **324**. For example, the threat analyzer **312** signals the capturing module **314** that when prompted, captures the state of the interaction or the user device at the time of the incident. The meta database **324** stored different kinds of objects such as memory dumps, a type of threat, states of the data objects, the interactions, network traffic captures, and the artifacts.

[0076] Referring next to FIG. **5**, a block diagram of the remote guard **302** of the mid-link server **110** is shown. The Remote guard **302-1** is an already existing SaaS Security Posture Management (SSPM) application integrated with the forensic engine **112**, or any other cloud posture management application. The remote guard **302-1** continuously checks security posture by comparing the end-link server **104** settings with security policies and industry benchmarks such as national institute of standards and technology (NIST), international organization of standardization (ISO) and more.

[0077] When risky configurations or policy drift are detected, the remote guard **302-1** generates alerts and remediation instructions. The remote guard **302-1** uses predefined security and compliance rules across industry benchmarks and standards, enables rapid deployment of security and compliance initiatives at the end-link server **104**. The remote guard **302-1** supports graph-based detections and visualizations support cross-application rules that stitch together the context between the end-link servers **104**. The remote guard **302-1** further provides visibility into connected and third-party services to expose and mitigate additional risk and defines custom rules and policies to fit specific needs of some enterprise. The third-party services include security service app firewall that controls input, output, and access from, to, or by an application, by monitoring and potentially blocking the input, output, or system service calls that do not meet the configured security services policy.

[0078] Many possible third-party services can be selected by the tenants for processing data flows of their users. The services selected for the tenant are referred to in the service chain for the tenant. A single tenant can have multiple service chains configured for different types of data packets and service chains can be reconfigured as the needs of a tenant evolve. Third-party services also include an IP network address translation (NAT). NAT can remap one IP address space into another by modifying network address information in the IP header of packets while they are in transit across a traffic routing device.

[0079] A comprehensive set of APIs enables easy integration into existing security and automation workflows to prevent business disruption, and unified view of flags and events from across the network **202**. The Remote guard **302-1** includes an active analyzer **504**, a monitor **506**, and a data assembler **508**. The data assembler **508** includes a receiver **510**, a scheduler **512**, and a data handler **514**.

[0080] The remote guard **302-1** includes the active analyzer **504** and the monitor **506** to identify, analyze and assemble the user endpoints **102** and the related set of policies. The data assembler **508** receives notifications of user events from the end-link server **104** at the receiver **510**, on behalf of the user endpoint **102**, or the administrator of the instance or account. The end-link servers **104** are also integrated with bots or scripts which generate updates to the objects in the remote applications via API calls. In an example, a sync application or download bot generates many potential API call events, such as 10,000 operations in one sequence, which produces a series of operations for a single user within the enterprise. The single queue leads to delays for the light-demand users, due to a single heavy-demand user. The Data assembler **508** receives these updates as notifications.

[0081] The receiver **510** acquires and evaluates the pushed notifications which trigger compliance checking of users and identification of power users. The receiver **510** sends notifications to the scheduler **512** which schedules processing to the data handler **514**. The data handler **514** processes the data stream in connection with the end-link server **104**. The remote guard **302-1** identifies the user endpoints **102** that generate more notifications than the number that can be processed. This alleviates the issue that would occur due to creating operations and scheduling work at the data handler **514** without information about the number of operations. As an overwhelming number of notifications would lead to head of line blocking and cause processing of the notifications of the user endpoints **102** to be delayed.

[0082] Referring next to FIG. **6**, a block diagram of the remote guard **302** that is used as another embodiment of the present disclosure. The remote guard **302-2** consists of the active analyzer **504**, a contextualizer **604**, data flow services **606**, threat protection services **608**, the monitor **506**, and the policy database **326**. The contextualizer **604** creates the context based on the information retrieved from the tunnels **106**. The contextualizer **604** uses the monitor **506** to inspect the end-link servers **104** and assemble the data objects. In an example, the identification of sensitive documents is based on prior inspection of the document. The user endpoints **102** usually manually tag documents as sensitive, and this manual tagging updates the document metadata with the unique marker in the end-link servers **104**. The policies can also label the data objects as sensitive. It is then possible to retrieve the document metadata from the end-link servers **104** exposed APIs and use them as an indicator of sensitivity.

[0083] The data flow services **606** in the remote guard **302-2** automatically forwards traffic from the user endpoint **102** to the end-link server **104** while ensuring that security and access policies are enforced. The data flow services **606** determines if the user endpoint **102** is looking to access the network **202** or the end-link server **104**. The data flow services **606** are configured to auto-route traffic which can be based on protocols, as well as can be application-specific. This also includes automatic installation of the user endpoint **102** and secure sockets layer (SSL) certificates during enrolment of the client device of the user endpoint **102** prior to accessing the end-link server **104**. Finally, the data flow services **606** provide visibility into application usage of the user endpoint **102** and supports a lightweight tunnel communication. For example, a lightweight tunnel can be HTTP-based. With the data flow services **606**, there is no requirement for proxy auto-configuration (PAC) files, an Internet protocol security (IPSec) VPN, authentication cookies, or the user endpoint **102** setup.

[0084] The threat protection services **608** scans the files for malicious entities and takes the steps to mediate the threat using third-party services. The threat protection services **608** includes a similarity calculator for determining the level of similarity between new and old values for file size, file name, file extension and other properties that represent file features. Also included in the threat protection services **608** is a determinator which utilizes the results of the similarity calculator for deciding which files need threat scanning. Also included in the threat protection services **608** is an alert generator for signaling that the file contains malware. One example of the threat protection services **608** is a native service implemented by the security service provider.

[0085] Another threat protection service **608** is IPsec, a suite of protocols used in VPNs to authenticate and encrypt the packets of data sent over an internet protocol network (IPN). Another threat protection service **608** is an app firewall that controls input, output, and access from, to, or by the application, by monitoring and potentially blocking the input, output, or system service calls that do not meet the configured security services policy. Another threat protection service **608** is a proxy analyzer that examines and classifies data files as sensitive or not using content evaluation techniques. The proxy analyzer can function as a firewall service in one implementation.

[0086] The monitor **506** of the remote guard **302-2** further includes an extraction engine **622**, a classification engine **624**, a security engine **626**, a management plane **628**, and a data plane **630**. The policy database **326** of the remote guard **302** includes content policies **610**, a content profile **612**, an enterprise data **616**, client's information **618**, and user identities **620**. The monitor **506** is one or more virtual computing devices and/or resources. For example, the monitor **506** is one or more Amazon™ elastic compute cloud (EC2) instances. The policy database **326** is Amazon™ sampling strategies and statistics training materials (S3TM) storage. Other computing-as service platforms such as Rackspace, Heroku or Force.com from Salesforce™ could be used in place of the remote guard **302-2** on direct physical computers or traditional virtual machines. Additionally, one or more engines are used, and one or more points of presence (POPs) are established to implement the security functions.

[0087] Examples of the computing devices are a workstation, a server, a computing cluster, a blade server, and a server farm, or any other data processing system or a computing device. The engines are communicably coupled to the databases via a different network connection. For example, the extraction engine **622** is coupled via the network **202** (e.g., the Internet), the classification engine **624** is coupled via a direct network link and the security engine **626** is coupled by yet a different network connection. These functions collectively provide a secure interface between the end-link server **104** and an enterprise network. Although the term "cloud application security broker" can be used to describe the remote guard **302-2**, more generally the system provides application visibility and control functions as well as security.

[0088] A control plane can be used along with or instead of the management plane **628** and the data plane **630**. The specific division of functionality between these groups is an implementation choice. Similarly, functionality is sometimes highly distributed across several points of presence (POPs) to improve locality, performance, and/or security. In one implementation, the data plane **630** is on premises or on the VPN and the management plane **628** of the remote guard **302-2** is located in the cloud services or with corporate networks, as described herein. For another secure network implementation, the POPs are distributed differently.

[0089] In an example, 35,000 end-link servers **104** are resident in libraries that intersect with servers in use by the computers, tablets, cell phones and smart watches in the enterprise network. The user endpoints **102** in the enterprise network include management clients with a web browser and the forensic interface **212** provided by the mid-link server **110**. The management clients are the personnel who are responsible for implementing policies using the remote guard **302-2** as per the requirement of the end-link server **104**. The forensic interface **212** administers the content policies **610**, according to one implementation. The remote guard **302-2** is the multi-tenant system, that allows the user of the management client to change the content policies **610** associated with their enterprise, according to some implementations.

[0090] In some implementations, APIs are provided for programmatically defining and/or updating policies. In such implementations, the management clients include one or more servers, pushing updates, and/or responding to pull requests for updates to the content policies **610**. Both systems can coexist; for example, some companies use a corporate identities directory to automate identification of the user endpoints **102** within the enterprise. These companies use corporate identities while using a web interface for tailoring policies to their needs. The management clients are assigned roles and access to the remote guard **302-2** data, controlled based on roles of access to the data objects like, read-only vs. read-write access.

[0091] The content profile **612** includes tenant and data object metadata, values associated with data object or with the data object ID and a series of data objects with the same data object ID and different data object hashes. The data object hashes include word count, character count, paragraph count, author, etc. as well as a deep hash of component section of the file, including core.xml, document.xml or another programming script.

[0092] The enterprise data **616** includes data of the enterprise, including but not limited to, intellectual property, non-public financials, strategic plans, customer lists, and personally identifiable information (PII) belonging to customers or employees. The enterprise data **616** further includes patient health data, source code, trade secrets, booking information, partner contracts, corporate plans, merger, and acquisition documents, and other confidential data. In particular, the term "data of the enterprise" refers to a document or a file, a folder, a webpage, image, or any other text-based document. The user identities **620** are the indicators that are provided by the remote guard **302-2** to the user endpoint **102**, in the form of a token, a unique identifier such as a universally unique identifier (UUID), or a public-key certificate. In some cases, the user identities **620** are linked to a specific user and a specific device. The same user can have a different user identity on their mobile phone and their computer.

[0093] In one implementation, a cryptographic certificate signed by the remote guard **302** is used as the user identities **620**. In other implementations, the user identities **620** are solely unique to the user or are identical across user devices. Embodiments also interoperate with single sign-on (SSO) solutions and/or corporate identity directories. Such embodiments may allow policies to be defined in the directory, e.g., either at the group or user level, using custom attributes. Hosted services configured with the mid-link server **110** are also configured to require traffic via the mid-link server **110**. This is done through setting an internet protocol (IP) range restrictions in the hosted service to the IP range of the system and/or integration between the system and SSO systems. For example, integration with an SSO solution can enforce client presence requirements before authorizing the sign-on. Other embodiments may use "proxy accounts" with the end-link server **104** vendor e.g., a dedicated account held by the mid-link server **110** that holds the only credentials to sign into the service.

[0094] In other embodiments, the user endpoint **102** encrypts the sign on credentials before passing the login to the end-link server **104**, indicating that the mid-link server **110** owns the password. The policy database **326** stores the client's information **618** that includes information from one or more tenants stored in form of tables of a database image used to form an on-demand database service (ODDS), which is implemented in many ways, such as a multi-tenant database system (MIDS). The database image includes one or more database objects.

[0095] In some implementations, the gathered data objects are processed and/or normalized. In some instances, the data object includes structured data and its functionality targets specific data constructs (entities, nodes, relationships etc.) provided by the end-link server **104**. Non-structured data, such as free text, is also provided by, and targeted back to the end-link server **104**. Both structured and non-structured data are capable of being aggregated by the contextualizer **604**. For instance, the assembled data objects are stored in a semi-structured data format like JSON, Binary JSON (BSON), XML, Avro or thrift object, which consists of string fields (or columns) and corresponding values of potentially different types like numbers, strings, arrays, objects, etc. JSON objects are nested, and the fields are multi-valued, e.g., arrays, nested arrays, etc.

[0096] The JSON objects are stored in the meta database **324** which stores the parsed JSON objects using key spaces that are equivalent to a database in structured query language (SQL). Each key space is divided into column families that are similar to tables and comprise of rows and sets of columns. In one implementation, the contextualizer **604** includes a metadata parser (omitted to improve clarity) that analyzes incoming metadata and identifies keywords, events, user IDs, locations, demographics, data object type, time stamps, and so forth within the data received. Parsing is the process of breaking up and analyzing a stream of text into keywords, or other meaningful elements called "targetable parameters."

[0097] A list of targeting parameters becomes input for further processing such as parsing or text mining, for instance, by a matching engine (not shown). Parsing extracts meaning from available metadata. In one implementation, tokenization operates as a first step of parsing to identify granular elements (e.g., tokens) within a stream of metadata. But parsing them goes on to use the context that the token is found in to determine the meaning and/or the kind of information being referenced. Parsing extracts metadata values and identifies property groups to be hashed for an incoming file. Because metadata analyzed by the contextualizer **604** are not homogenous (e.g., there are many different sources in many different formats), that employ at least one metadata parser for each end-link server **104**.

[0098] Referring next to FIG. **7** a block diagram of the forensic logger **308** is shown. The forensic logger **308** is a software tool or system used to record and to keep the log of information about activities performed at the end-link server **104** or on the network **202**. The forensic logger **308** generates an audit trail of events and actions including, for example, event logs, time stamps, file logs etc. The forensic logger **308** uses time stamps mapped to activities to put together a timeline. The timeline can be analyzed by the forensic investigator, or the forensic engine **112** can also do it with automation. The forensic logger **308** includes a memory inventory **702**, a tenant logger **704**, an event logger **706**, a time logger **310**, a file logger **710**, and a network logger **712**.

[0099] The memory inventory **702** captures information related to cloud infrastructure's memory usage. The memory usage includes details about the allocation and deallocation of memory resources, which helps in detecting anomalies and malicious activities.

[0100] In the multi-tenant environment, the tenant logger **704** maintains records of the tenant or client's activities and resources. The tenant logger **704** ensures isolation between tenants and provides insights into any tenant-specific security incidents or compliance violations.

[0101] The event logger **706** captures a wide range of events and activities of users of the end-link servers **104** across the network **202**. This includes user logins, configuration changes, application-specific events, and security-related incidents. An entry of event log that is a primary source of information for electronic inspection, is generated by the event logger **706**.

[0102] The time logger **310** records timestamps for various events and actions occurring within the network **202**. The time logger **310** establishes the sequence of events during the forensic investigation, ensuring the accuracy of timeline.

[0103] The file logger **710** keeps a record of the files that are stored and accessed on the end-link server **104**. The file logger **710** stores logs associated with file creation, modification, access, and deletion events. This information is required for tracking data breaches, unauthorized access, or data exfiltration.

[0104] The network logger **712** monitors the connections within the end-link server **104** and keeps track of traffic on the network **202**. The network logger **712** logs details of incoming and outgoing network requests, IP addresses, ports and protocols that helps in detecting suspicious and unauthorized network activity during forensic investigations. The forensic logger **308** is designed to work with cloud-native services and APIs provided by the end-link server **104**.

[0105] Referring next to FIG. **8**, a block diagram of the report generator **320** interacting within the co-pilot **322** of the mid-link server **110** is shown. The report generator **320** is employed to compose a detailed report containing details of the reasons and impact of a security threat or an incident. The report generator **320** includes a root cause logger **804** and an activity logger **806**. The activity logger **806** writes down the steps taken either by the threat analyzer **312**, the retro analyzer **318** or the forensic logger **308** at the mid-link server **110**, and each query made by the mid-link server **110**.

[0106] The root cause logger **804** fetches the incident relevant information from the meta database **324**. The root cause logger **804** deploys natural language processing (NLP) techniques to generate a text (.txt, .doc, .pdf) file. The text file contains details about the root cause of the incident or threat, reasons that lead to the incident and how the problem was tackled by the mid-link server **110**. The report generator **320** notes down the flow of instructions and the steps taken in the IR process. The report generator **320** sends out the text file to the co-pilot **322** that interacts with the forensic investigator.

[0107] A visualization tool **808** of the co-pilot **322** helps the forensic investigator better understand and interpret data by presenting data-driven stories, monitoring data changes and deriving meaningful insights from the data. The visualization tool **808** transforms raw data into visually appealing charts, graphs, and dashboards, allowing for intuitive data exploration. Using the visualization tool **808**, users, or the forensic investigator easily identifies patterns and outliers, facilitating insightful decision-making processes. A recommendation tool **810** in the co-pilot **322** provides recommendations and security measures using machine learning algorithms, to fight a particular malware attack in future or to prevent some kind of breach from happening again in future. The report created by the report generator **320** is visible at the forensic interface **212** for the help of the forensic investigator.

[0108] Referring next to FIG. **9**, that shows a block diagram of a cloud open systems interconnection (OSI) model **900** for the cloud computing environments in an embodiment. The cloud OSI model **900** for the cloud computing environment partitions the flow of data in a communication system into six layers of abstraction. The cloud OSI model **900** for the cloud computing environment includes, in order, the application layer **902**, a service layer **904**, an image layer **906**, a software-defined data center layer **908**, a hypervisor layer **910**, and an infrastructure layer **912**. The layers serve a class of functionality to the layer above it and are served by the layer below it. Classes of functionality are realized in software by various communication protocols.

[0109] The infrastructure layer **912** includes hardware, such as physical devices in a data center, that provides the foundation for the rest of the layers. The infrastructure layer **912** transmits and receives unstructured raw data between a device and a physical transmission medium. For example, the infrastructure layer **912** converts the digital bits into electrical, radio, or optical signals.

[0110] The hypervisor layer **910** performs virtualization, which allows the physical devices to be divided into virtual machines that are bin packed onto physical machines for efficiency. The hypervisor layer **910** provides virtualized computing, storage, and networking. For example, OpenStack® software that is installed on bare metal servers in a data center provides virtualization cloud capabilities. The OpenStack® software provides various infrastructure management capabilities to cloud operators and administrators and utilizes the infrastructure-as-Code concept for deployment and lifecycle management of a cloud data center. In the Infrastructure-as-Code concept, the infrastructure elements are described in definition files. Changes in the files are reflected in the configuration of data center hosts and cloud services.

[0111] The software-defined data center layer **908** provides resource pooling, usage tracking, and governance on top of the hypervisor layer **910**. The software-defined data center layer **908** enables the creation virtualization for the infrastructure-as-Code concept by using REST APIs. The management of block storage devices is virtualized, and the user endpoint **102** is provided with a self-service API to request and consume those resources without requiring any knowledge of where the storage is actually deployed or on what type of device. Various computing nodes may be balanced for storage.

[0112] The image layer **906** uses various operating systems and other pre-installed software components. Patch management is used to identify, acquire, install, and verify patches for products and systems. Patches are used to correct security and functionality problems in software. Patches are also used to add new features to operating systems, including security capabilities. The image layer **906** focuses on computing. The instances within the cloud computing environments are provided at the image layer **906**.

[0113] The service layer **904** provides middleware, such as functional components that applications use in tiers. In some examples, the middleware components include databases, load balancers, web servers, message queues, email services, or other notification methods. The middleware components are defined at the service layer **904** on top of particular images from the image layer **906**. Different cloud computing environment providers have different middleware components.

[0114] The application layer **902** interacts with software applications on a cloud that implements a communicating component. The application layer **902** is the layer that is closest to the user endpoint **102**. Functions of the application layer **902** include identifying communication partners, determining resource availability, and synchronizing communication. Applications within the application layer **902** include custom code that makes use of middleware defined in the service layer **904**.

[0115] Various features discussed above are performed at one or more layers of the cloud OSI model **900** for cloud computing environments. For example, the forensic investigation and the incident response is performed at the application layer **902**. Various scripts are updated across the service layer **904**, the image layer **906**, and the software-defined data center layer **908**. Further, APIs operate at the application layer **902**, that is at a web browser. The mid-link server **110** of the present disclosure performs the electronic inspection by rendering the model of the application layer **902** according to the policies and the context. The interactions between the user endpoint **102** and the end-link server **104** are modelled using the model of the application layer **902** at the mid-link server **110**.

[0116] Referring next to FIG. **10**, an event log entry **1000** generated by the forensic logger **308** is shown. The event log entry **1000** is in a JSON-style representation. The event log entry **1000** is not exhaustive of the fields that are logged but highlights the features. The event log entry **1000** indicates user-by-user and file-by-file data regarding interaction of the user endpoint **102** with one or more end-link servers **104**.

[0117] Referring next to FIG. **11**, a block diagram **1100** that schematically shows an enterprise environment that is subjected to be analyzed by the retro analyzer **318** is shown. The enterprise environment in this example is contained in a facility, such as an office or a campus, with the user endpoints **102**, and the enterprise network **1102** that has protected local packet communication. The user endpoints **102** are interconnected by switches **1104** in the enterprise network **1102**, while each of the switches **1104** connect the enterprise network **1102** to the network **202**, such as the Internet. The switches **1104** comprises of bridges, routers, or any other suitable type of network switching element. The UEBA **316** collects behavioral information from one or more sensors in the enterprise environment that are distributed within the enterprise network **1102**. The UEBA **316** then processes this information according to the policies defined in the policy database **326** and generates behavioral intelligence and baseline of user activity. Various commercially available products are used for this purpose.

[0118] An anomaly indicator **1106** of the retro analyzer **318**, receives behavioral intelligence from the UEBA **316**, as well as information from and regarding the user endpoints **102**. The behavioral information gives information about different data objects that are commonly accessed by separate tenants and the user endpoints **102** connected to the end-link server **104**. Any unusual activity is assigned a score based on the threat posed by that unusual behavior by an indexing module **1108**. The score is a metric associated with the user endpoints **102** and the metric is a data point or observation that indicates the unusual activity of the user endpoint **102**. The metric or the score quantifies the deviation of the user endpoints **102** from their baseline behavior. In this application, the terms “scores”, “risk scores” and “metrics” are used interchangeably.

[0119] The threat posed by the data objects includes the possibility of propagation of malware, viruses, ransomware or trojans etc. When such a compromised data object is uploaded to a cloud storage service or shared with others on the end-link server **104**, it infects the user endpoints **102** or the cloud infrastructure itself. This contamination of the compromised data object leads to widespread malware distribution. The compromised data objects are used in phishing attacks. For example, an attacker sends a malicious file via email or a shared link, tricking users into downloading and opening it, which leads to a malware infection or a theft of credentials. Attackers also use compromised data objects to launch distributed denial-of-service (DDoS) attacks from cloud resources.

[0120] Numerous algorithms are used to compute how much of a threat certain anomalous behavior poses. The score is computed against each of the policies triggered by user behavior. The policies are fetched from the policy database **326** of the remote guard **302**. Based on these inputs, the anomaly indicator **1106** computes and outputs the threat flags with respect to a total score and events in the enterprise environment.

[0121] The anomaly indicator **1106** analyzes numerous scores, like scores of the end-link servers **104** and data objects stored in the meta database **324**, to generate the threat flags. The flag is raised when the metric or the score indicates an increased unusual activity of the user endpoint **102**. If the score of the user endpoint **102** triggers a policy, the remote guard **302** modifies the policies to increase the frequency of logging the data objects for the user endpoint **102**.

[0122] The indexing module **1108** calculates the risk scores at varying levels of granularity in the network **202**. The total score value for an individual user is a weighted combination of a user rate of collaboration of the user, risk score of a user location of the user endpoint **102**, vulnerability characteristics of the user endpoint **102**, and a risk score of the user. The user's rate of collaboration depends on the number of the shared data objects a user is working on. The collaboration rate further depends on the access privileges applicable to the shared files. If the user endpoint **102** has written privileges over a shared data object, it increases the risk of malware spreading as compared to read-only privileges.

[0123] The risk score is assigned to the location based on historical interactions. The historical interactions can include the historical logs or historical data. For example, if the user endpoint **102** or tenant is in a location from where malware infected documents have regularly originated, such a location is given a low-risk score. The vulnerability characteristics of the user endpoint **102** are determined by the operating system and applications and services running on the user endpoint **102**. For example, if the user endpoint **102** has the older version of the operating system, the user endpoint **102** is assigned the low-risk score. The user risk score is calculated based on historical data and historical interactions such as previous malware detections and results from user-level security evaluations.

[0124] The risk score of the data object is calculated based on the shared information about the data object. For example, if the data object is shared outside the network **202**, it is assigned a high-risk score. If the data object is shared within the network **202**, it is assigned a low-risk score. The degree to which some file is shared internally or externally also impacts the data object risk score. The data object hygiene is further refined based on an analysis of data object write privileges and sharing amongst internal or external groups.

[0125] The indexing module **1108** calculates an external surface exposure value for the data object based on the identities of the external users sharing the data object. Note that the external users do not belong to the end-link server **104**, but they are given access to a shared data object by a user belonging to the end-link server **104**. The access privilege is a write privilege or a read-only privilege of the data object. The indexing module **1108** aggregates the external surface exposure for the data objects shared to external users to determine external surface exposure for the enterprise. In this application, some concepts are claimed and explained in the context of “data objects” or “files.” These concepts apply equally to “folder objects” or “folders.”

[0126] The user data object sharing information is used by the system to calculate user rate of sharing data objects through the end-link server **104** and the user rate of opening files shared through the end-link server **104**. Based on this, for individual users, a user rate of collaboration is calculated. The number of users with write-access privileges to the data object is determined using the identities of the users sharing the data object and the user access privilege information. Similarly, the number of users with read-access privileges to the data object is also determined using the identities of the users sharing the data object and the user access privilege information.

[0127] The identities of users sharing the data objects and the user access privilege information is used to determine number of users in the end-link server **104** having access to data object, number of users outside the organization having access to the data object, and whether the data object is shared within the end-link server **104** group. Based on this, for individual data objects, the risk score is calculated.

[0128] The risk score is calculated for the user endpoints **102** based on the location of a user, the user endpoint **102** vulnerability characteristics of the user, the user rate of collaboration of the user, and the risk score of the data objects connected to the user endpoint **102** or the tenant. The risk score calculation also considers individual data objects connected to the users in the end-link server **104** and the identities of the user endpoints **102** sharing the data objects. The user access privilege information that is used to determine number of users outside the end-link server **104** with file write privileges and number of users outside the end-link server **104** with file write privileges is also considered. Based on this, an external surface exposure for the end-link server **104** is calculated.

[0129] The risk score is also calculated for the end-link servers **104** based on the external surface exposure of the end-link server **104**, user risk scores of the users in the end-link server **104**, occurrence recency, and severity of the latest spread of malware. The risk score for the end-link servers **104** further depends on the number of managed and unmanaged devices in a network, and a security patch level configured on the end-link server **104** devices.

[0130] Table I shows a pseudo-code for computing the risk score for the user endpoint **102**. In a single interaction with the end-link server **104**, the user endpoint **102** triggers various policies and the total score here referred as interaction score, is aggregate of the risk scores. The mid-link server **110** identifies the policies violated by the user endpoint **102** in a single interaction, and for each such policy, the mid-link server **110** repeats steps **9-20**. Some policies have more weight and thus the mid-link server **110** assigns an initial score triggered policy; the risk score is assigned by human experts based on their field experience and security research. Then, the mid-link server **110** simply sums up the scores from the triggered policies within an interaction to make up the final interaction score. Some policies are prone to trigger more across the user endpoints **102**. Policies with frequent triggers are less informative in the security aspect than those that are rarely triggered. Frequently triggered policies contribute to score inflation for interactions, resulting in an increase of false positive rate and a decrease in precision rate.

[0131] To mitigate the issue with score inflation, risk score is adjusted dynamically based on a variety of factors from the behavior profiles. Here in this embodiment, the risk score adjustment is for peer group-based policies. For example, if this is the first time for this user's peer group to trigger some policy. The corresponding risk score is adjusted based on how close the User endpoint **102** is related with the said peer group from the past activity histories.

[0132] The risk score is further modified to reduce the false positives associated with frequently triggered policies i.e., another adjustment factor is applied to the risk score. The adjustment factor is based on the Bayesian method to weigh the score contribution of policies according to their historical triggering frequencies. The more frequently the policy is observed to trigger in history, the smaller the adjustment weight is. Finally, the interaction score is the sum of the risk scores of the triggered policies, weighted by data-driven adjustment factors. The adjustments are dynamic and learned from data periodically.

TABLE I

Pseudo code for risk scores computation of user endpoint

```
1. def assign_risk_score(policy):
2. return
3. def adjust_risk_score_peer_group(policy):
4. return
5. def calculate_adjustment_factor(policy):
6. return
7. Repeat
8. Fetch P[x]
9.   For ( i : i == x : i++ ) do
10.        If P[i] =! historical_triggering_policies.list[y]
11.          frequency = 1;
12.          else
13.           frequency ++;
14.        risk_score = assign_risk_score(i);
15.        risk_score += adjust_risk_score_peer_group(i);
16.        adjustment_factors[i] = calculate_adjustment_factor(i);
17.        risk_score *= (1 − adjustment_factors[i]);
18.        risk_scores[i] = risk_score;
19.        interaction_score += risk_score;
20.    End for
21. Until P[x]
22. Output interaction_score
```

[0133] Referring next to FIG. **12**, shows an exemplary method **1200** of capturing states of activities on the end-link server **104**. The method is further designed to create a representation for performing electronic inspection by the mid-link server **110** in an embodiment. The method includes capturing the states **1202** of interactions being carried out on the model of the application layer **902** of the remote software environment. The states **1202** at the instance level in the end-link server **104** allow for easy, instant, point-in-time recovery, providing protection against any kind of malware, and accidental or intentional file deletion.

[0134] The capturing module **314** acquires different types of states depending upon the requirements. For example, capturing states of interaction keystrokes between the user endpoint **102** and the end-link server **104** and capturing tunnel states to analyze traffic. The capturing module **314** also captures the states of file being accessed and edited and captures display state of an instance at the end-link server **104**. The threat analyzer **312** detects the anomalous behavior in the User endpoint **102** and if the policy is triggered, the threat analyzer **312** raises a corresponding threat flag. The capturing module **314** upon receiving the threat flag, starts capturing the states **1202** at different time intervals based on the policies stored in the policy database **326**.

[0135] The captured states **1202** are stored in the meta database **324** of the forensic engine **112** and are used for electronic inspection later. The captured states are used for creating the representation of interactions at the application layer **902** from the data objects stored at the mid-link server **110**. The forensic investigator retrieves the states **1202** stored in the meta database **324** and creates the representation of interactions or activities of the user endpoint **102**, on the forensic interface **212**. In one case of the electronic inspection process, the representation created through the states **1202** helps the forensic investigator to identify the source who triggered a particular policy.

[0136] Accordingly, the mid-link server **110** takes policy remediation actions against a corrupt source. The corrupt source refers to the source of the policy trigger and generation or entry of any malicious entity in the network **202** or the enterprise. The malicious entity is generated or spread through the user endpoints **102**, the end-link servers **104**, the tunnels **106**, tenants or any data object. The malicious entity poses a potential threat to the security of the enterprise, the end-link servers **104** or the network **202**. In another embodiment, the states **1202** are used to identify and recreate the data objects that got compromised due to a malware attack at the end-link server **104**.

[0137] Referring next to FIG. **13**, that shows a graphical user interface (GUI) **1300** created by the state **1202** acquired by the capturing module **314** of the mid-link server **110**. The state **1202** is the exemplary representation of details of a GUI displayed on a screen of the user endpoint **102**. Other representations of states are also created by the capturing module **314**. The timestamp of the moment when the state **1202** was captured is shown at section **1302**. The state **1202** also indicates the operations and activities of the User endpoint **102**, and the status of those activities. For example, the state of operation of the operation, whether it was successful or not, and exact timestamp along with the location of the user endpoint **102** while performing that activity section **1304**. Such information, **1302** and **1304**, extracted from the representation created by the states **1202** helps in the electronic inspection of the end-link server **104** for a particular security problem.

[0138] Referring next to FIG. **14**, that shows a mapping **1400** between the risk score **1402**, a tenant policy **1404** and the threat flag **1406**. The risk scores **1402** (**1402-1**, . . . , **1402**-*n*) of different subjects like the end-link servers **104**, the user endpoints **102** accessing the end-link server **104** and data objects, are regulated by several policies. The risk score of the user endpoints **102** is evaluated with respect to the policy. Hence, a total risk score associated with the user endpoint **102** is regulated by several policies. The risk score **1402** of data objects and the end-link servers **104** is associated with number of tenant policies **1404** (**1404-1**, . . . , **1401**-*n*) that defines the roles and rules of these subjects. The combination of these tenant policies **1404** (**1404-1**, . . . , **1401**-*n*) triggers the threat flags **1406** (**1406-1**, **1406**-*n*). A single tenant policy **1404**-*n* also triggers the threat flag **1406-1** which indicates that policy defines a significant rule that is followed.

[0139] Referring next to FIG. **15**, that shows a GUI representation **1500** of the tenant policy **1404**. FIG. **15** also shows the graphical representation **1502** of the risk scores **1402** of the user endpoint **102** along with the policies that were breached at **1508**. The mapping of policies with the risk scores **1402** and threat level is also shown in Table II.

TABLE II

Risk scores and level of threat posed based on policies of tenant of end-link server

Policy no.	Policies of tenant 1	Action	Policy breached	Risk score	Threat Level
1	Allow social media	Allow	No	2	Low
2	Prohibited sites	Block	Yes	7	High
3	File protection	Block	No	0	None
4	Restricted countries	Block	No	1	Low
5	Unsafe cloud storage	Block	Yes	8	High

[0140] The GUI representation **1502** showing the tenant policies **1404** also includes features like adding a new policy as shown at section **1504** or editing an existing policy shown in section **1506**. The enterprise can add or edit policies, as their terms and conditions are renewed. Policies are also edited by the forensic investigator. Activities of the user endpoint **102** or the tenant are scored using different scoring mechanisms. One such representation of the risk scores **1402** of the user endpoints **102** is shown in graphical representation **1508**. The horizontal axis represents the number of policies from **1502** that are violated by the user endpoints **102** while vertical axis shows the risk scores **1402** of each of the user endpoint **102**. After some pre-defined threshold is crossed, the threat flag **1406** is generated. At **1510**, it is said that some policy has been triggered. The policy remediation actions are taken for the user endpoint **102** or tenant of the end-link server **104** that has triggered a policy. Take the example of Alice from **1508**. Alice has breached policy number 2 and 5, which means that Alice has been trying to access/work on the prohibited sites and Alice has also uploaded some company documents on unsafe cloud storage. Alice has the risk score of 52, which is greater than the threshold value and thus, policy is triggered, and the threat flag **1406** is generated for Alice, at **1510**. The forensic engine **112** of the mid-link server **110** will now follow policy remediation steps, the explanation of which shall be discussed next.

[0141] Referring next to FIG. **16**, that shows a GUI representation **1600** of embedding of the unique marker in the data object using the model of the application layer **902** at the mid-link server **110**. One example of modelling of the data objects in the GUI **1600** is shown through the embedding of the unique marker by the WM engine **402** of the threat analyzer **312**. The exemplary representation of the GUI **1600** includes the user endpoint **102** accessing the end-link server **104** via the tunnels **106**, where the mid-link server **110** acts as a middle-mile and sits in between the communication path. The WM engine **402** is integrated within the threat analyzer **312** with other components but shown explicitly in **1600** for clarity. The WM engine **402** is employed to model data objects using the model of the application layer **902**. For example, embedding the unique marker in web display of the application or in hypertext markup language (HTML) of the data object present on the end-link server **104**. This data object is to be accessed by the user endpoint **102** later.

[0142] As an example, the user interface of the application running on instance of the end-link server **104** is shown in **1602**. While the user endpoint **102** accesses the application, the mid-link server **110** sitting in-between loads the tenant policies **1404**. The rendering engine **410** determines if the web display or any other data object being accessed by the user endpoint **102** needs to be embedded with the unique marker. If the web display **1602** is required to be uniquely marked according to the policies, the WM engine **402** of the mid-link server **110** creates the unique marker and embeds it in the web display. The WM engine **402** then makes the uniquely marked data object accessible to the user endpoint **102**, at section **1604**. The unique markers can be visible (logo, copyright) or invisible (spatial and frequency watermarking etc.) in the data object. Notice in the web display shown in section **1602** that has been uniquely marked, the unique marker is embedded on pixel level. It refers to the placement of cancel command **1606** is changed in section **1604**, as compared to the one in **1602**. The presence of unique marker is unknown to the user endpoint **102**. Now, consider the case where the user endpoint **102** takes picture of some data object from its cell phone and leaks it to the network **202**, to inflict harm. The mid-link server **110** compares the uniquely marked data object that is leaked, with the unique markers stored in the meta database **324** and pinpoints the source who leaked that data object.

[0143] Referring next to FIG. **17**, a flow diagram **1700** of the policy enforcement by the mid-link server **110** is shown. The flow diagram **1700** shows the user endpoint **102** that is attempting to access some data object. Since the mid-link server **110** intercepts the communication between the user endpoints **102** and the end-link server **104**. The access request **1702** of the user endpoint **102** is analyzed by the mid-link server **110**.

[0144] The mid-link server **110** retrieves the policy governing this particular interaction from the policy database **326**. The policy for accessing the data object xxx **1704** has list of user IDs that permitted to access this data object. If the user ID **6479** is present in the User_Access.list, the mid-link server **110** will categorize it as an authorize access and vice versa. If the access is unauthorized the mid-link server **110** will assign the risk score according to the gravity of the case and follow the remediation steps that are also governed by the policies.

[0145] Referring next to FIG. **18**, that shows a dashboard **1800** for the forensic interface **212** for electronic inspection. The dashboard **1800** illustrates a list of the threat flags **1406**, that requires attention of the forensic investigator on the forensic interface **212** of the forensic engine **112**. In the dashboard **1800**, a total of 13 threat flags were raised by the forensic engine **112** that concerns **35** user endpoints **102**, and total of 67 data objects altogether. The dashboard **1800** also provides a detailed list that entails information of the threat flags **1406**. The detailed list provides specifications like time, what user it concerns, the relevant data object, tenant the user belongs to, and the action taken by the forensic engine **112** mentioned under the status heading.

[0146] Referring next to FIG. **19** that shows a swim lane diagram **1900** for flow of instructions in the electronic inspection system **100**. The swim lane diagram **1900** includes the user endpoint **102**, the mid-link server **110**, the end-link server **104** and the external applications **108**. The swim lane diagram **1900** emphasizes the configuration of the mid-link server **110** as an intermediary between the user endpoint **102** and the end-link server **104**. The user endpoint **102** accesses the end-link server **104** for its activity in **1902**.

[0147] Each incoming and outgoing information and data is passed through the forensic engine **112** of the mid-link server **110**. The mid-link server **110** tracks any potential security threats and logs and investigates activities of the user endpoint **102** on the end-link server **104**, in step **1904**. The logging and investigating provides artifacts that are used in electronic inspection and performing the IR process. The external applications **108** are configured with the mid-link server **110**, store the raw or processed data and manage security incidents on their own as shown in step **1906**. The end-link server **104** interacts with the user endpoint **102** like any other cloud-based application would do, with the mid-link server **110** sitting in the middle as shown at step **1908**. At step **1910**, the mid-link server **110** performs electronic inspection and generates an incident response. Finally in step **1912**, the mid-link server **110** exports the data objects to the external applications **108**.

[0148] Referring next to FIG. **20**, a flowchart **2000** of steps involved in setting up the tunnels **106** for communication via the mid-link server **110** is shown. The process starts at block **2002**, the traffic travelling across the user endpoints **102** and the end-link servers **104** is diverted towards the mid-link server **110**. The communication is done through the mid-link server **110** that models and stores the data objects from the interactions. The application layer **902** of the cloud OSI model **900** places a header (encapsulation) field that contains information, such as screen size and fonts, and passes the data objects to the mid-link server **110**. In this way at block **2002**, the mid-link server **110** receives traffic from the user endpoint **102** and/or the end-link server **104**.

[0149] At block **2004**, the mid-link server **110** checks the identity of the user endpoint **102** with the user IDs stored in the policy database **326**. The mid-link server **110** then determines whether the user endpoint **102** is allowed to make a connection or not. At block **2006**, if the user endpoint **102** is an authorized user and is allowed to make a connection, the mid-link server **110** sets up the tunnels **106**. The mid-link server **110** employs the data flow services **606** of the remote guard **302** to decide routes and construct the tunnels **106** for traffic of the user endpoint **102** or the tenant.

[0150] At block **2008**, the mid-link server **110** identifies the data flows from tunnel traffic and monitors a domain name system (DNS) or uniform resource locator (URL) associated with these data flows. The DNS or the URL is the source of content of the end-link server **104** accessed by the user endpoint **102**. The data objects in the application layer **902** flow in various ways including web browsing-sending hypertext transfer protocol (HTTP) request to the end-link server **104** using HTTP protocol. The data objects also flow by sending and receiving emails using simple mail transfer protocol (SMTP), pop office protocol (POP3) or Internet message access protocol (IMAP). The data objects flow using other protocols of video streaming, file transfer such as file transfer protocol (FTP), secure file transfer protocol (SFTP), voice over internet protocol (VOIP) etc.

[0151] At block **2010**, the DNS or the URL associated with websites, links, sites, browsing, installing, downloading applications is monitored. The traffic of the network **202** is monitored to identify traffic patterns.

[0152] At block **2012**, the DNS or the URL based on information collected from various sources, like websites, national vulnerability database (NVD) etc., are categorized to help determine the risk score **1402** of data objects of the corresponding DNS or the URL.

[0153] At block **2014**, the tunnel traffic is processed by which policy controlled electronic inspection is performed on the end-link server **104** via the mid-link server **110**. As a result of policy remediation, if the tunnel **106** is no longer in use or is blocked, the tunnel **106** is torn down permanently or for some specific time period at block **2016**. The tearing-down of the tunnels **106** means that the tunnels **106** are destroyed or removed if there is no communication between the user endpoints **102** and the end-link server **104**. If a new access request comes from the user endpoint **102**, or the mid-link server **110** receives new traffic from the user endpoint **102** or the end-link server **104**, then the said process is repeated at block **2002**.

[0154] Referring next to FIG. **21**, a flowchart **2100** for processing tunnel traffic **2014** with the mid-link server **110** is shown. At block **2102**, the mid-link server **110** loads the tenant policies **1404** from the policy database **326**. Based on the policies, the data objects for the application layer **902** are accessed and modelled at block **2104**. At block **2106**, the mid-link server **110** generates context based on information in the tunnels **106**. The context is used for logging and is formed by the data objects and interactions of the model of the application layer **902**. Note that if a single data object has two connections in the end-link server **104** simultaneously, each connection would be handled by a separate instance of process. For example, the data objects edited by multiple tenants of the end-link server **104** at a time will be stored relative to their user information. It will be stored in the separate tenancies subjected to their own modelling, policies, and logging.

[0155] At block **2108**, based on the context from the tunnels **106** and the policies from the policy database **326**, the data objects are stored by the mid-link server **110** for the tenancy. Multiple types of data objects are stored in different repositories in the forensic logger **308**, where frequencies of logging data objects may differ for different tenants of the end-link server **104**.

[0156] At block **2110**, the scores for the user endpoints **102**, the end-link servers **104** and the data objects are updated. Multiple mechanisms are used for assigning scores including machine learning algorithms, probability calculation algorithms, and rule breaching scores. The scores indicate the risk imposed by activities and behavior of each user endpoint **102**, the data objects, and the end-link server **104**. If the risk scores **1402** triggers the policy governing risk scores, the threat flag **1406** is generated by the mid-link server **110** indicating the policy breach.

[0157] Upon generation of the threat flag **1406** at block **2112**, states are captured for the application layer **902**. The frequency and time period of capturing the states **1202** depends on the policies. The stored data objects, in correspondence with the respective scores and captured states, are analyzed to detect anomalous activity or threat at block **2114**.

[0158] At block **2116**, the threat analyzer **312** analyzes the data objects and checks if the policy is triggered. If the policy is not triggered, the mid-link server **110** accesses and models the data objects again at block **2104** and repeats the following steps repeatedly until the policy trigger is detected. On the other hand, if the policy is triggered, the policy is modified at block **2118**. The newly modified policy is loaded again at block **2102** at the mid-link server **110**, and the said process is run again.

[0159] At block **2118**, the policies are modified only if the enterprise permits. For example, if there is some policy that users can only access a website from 3 pm to 6 pm. But the mid-link server **110** detects that this particular policy is breached repeatedly which is affecting the scores of the user endpoints **102** and the triggering policies. However, if this breach in policy is not imposing any threat to the enterprise, the mid-link server **110** modifies the policy and adjusts the timings from 1 pm to 6 pm.

[0160] At block **2120**, policy remediation steps are taken after the policy modification to reduce the impact of policy breach and to alert the user or the enterprise of a potential threat or security attack.

[0161] Referring to FIG. **22** that shows a flowchart **2104** of accessing and modeling the data objects using the model of application layer **902** at the mid-link server **110**. At block **2202**, the mid-link server **110** accesses data objects from the tunnels **106** for the model of the application layer **902**. At block **2204**, the mid-link server **110** models the data object for the application layer **902**. The modelling of the model of the Application layer **902** is done using dynamic or static HTML, JavaScript (JS), or document object model (DOM) protocols. At block **2206**, based on the data object and the activity of the user endpoint **102** or tenant, related Tenant policies **1404** are retrieved from the policy database **326**.

[0162] At block **2208**, the tenant policies **1404** dictate whether the data object is to be uniquely marked or not. For example, the policy declares the data object as confidential or sensitive, and so it is embedded by the unique marker. If the data object is not required to be uniquely marked, the mid-link server **110** keeps on accessing and modelling the next data objects.

[0163] At block **2210**, if the data object is required to be uniquely marked by the policy, the WM engine **402** of the threat analyzer **312** creates the unique marker. At block **2212**, the unique marker is embedded in the data object. The unique markers associated with the data object are stored in the meta database **324**.

[0164] Referring next to FIG. **23** that shows a flowchart **2108** of storing the data objects based on policies with the mid-link server **110**. The data objects at the mid-link server **110** are stored in the forensic logger **308**. At block **2302**, the policies stored in the policy database **326** of the forensic engine **112** are retrieved. The policies define the frequency of logging of the data objects. According to each policy dictating the interaction, the mid-link server **110** determines the type of data object to log and its frequency. The policies differ for each tenant and subsequently for each end-link server **104**.

[0165] At block **2304**, the context of data objects travelling through the tunnels **106** is retrieved. In case of storing the data objects, the context is helpful where a single file is being edited or saved etc. across multiple tenants of the end-link server **104**.

[0166] At block **2306** based on the policies and the context retrieved in the logging process described at block **2302**, the type of logging is determined. Different types of logging are performed at the forensic logger **308**. The forensic logger **308** stores one or more types of the data objects at a time, as instructed by the policy. The storing includes storing the activities being performed over the network **202** at block **2308** and storing unique markers of the data objects at block **2310**.

[0167] At block **2312**, the tenant information associated with the end-link server **104** is stored. The tenant information is the user ID of the tenant, roles, and responsibilities of the tenant which affects the storing of tenant information in the forensic logger **308**. Hence, frequency of storing data objects for a tenant may differ from frequency of logging data objects for another tenant.

[0168] At block **2314**, the behavior information of the user endpoint **102** is stored in the forensic logger **308**. The traffic of the tunnels **106** between the user endpoint **102** and the end-link server **104** is stored at block **2316**, while the mid-link server **110** sits in-between the interactions and creates logs of data objects and other relevant information. By being associated with the forensic logger **308** at the mid-link server **110** (middle mile), the forensic logger **308** performs the logging for the end-link server **104**, which is not possible for any ordinary logger. At block **2318**, the data objects are stored, maintained, and updated in their relevant inventories.

[0169] Referring next to FIG. **24**, is a scoring method **2110-1** for the user endpoint **102** based on the threat posed by an unusual behavior of the user endpoint **102**. At block **2402**, the UEBA **316** receives the user behavior information, for a given policy or several different policies using the score. The policy may look at multiple different scores before triggering the threat flag.

[0170] At block **2404**, the UEBA **316** uses machine learning algorithms to construct the baseline for the pattern of the user endpoint **102** interactions with the end-link server **104**. The machine learning algorithm is trained on historical patterns of baseline user behavior and historical logs retrieved from the meta database **324** and the forensic logger **308** respectively.

[0171] When the user endpoint **102** exhibits unusual behavior that is not in accordance with the behavior pattern that the user endpoint **102** previously displayed, the UEBA **316** categorizes it as an anomaly in block **2406**. If no unusual behavior is detected the UEBA **316** moves on to next user endpoint **102**. At block **2408**, the indexing module **1108**

assigns the risk score **1402** that reflects the level of threat posed by the new behavior of the user endpoint **102**.

[0172] For instance, consider a user which has the behavior pattern of logging into the system within two login attempts typically. If this user ever deviates from this pattern and takes more than two attempts to successfully login to the system, the UEBA **316** will categorize it as an anomaly. Furthermore, depending upon the amount of deviation of the activity from the baseline behavior, the indexing module **1108** modifies the risk score **1402** for the user endpoint **102**. If the user takes three attempts, for example, unlike the usual number of attempts (i.e., two attempts to login), the chances of a foreign party impersonating the authorized user are low.

[0173] Consequently, the indexing module **1108** will assign the risk score according to the threat posed. Here, the score would be calculated based on the probability of the foreign party impersonating the authorized user and the data objects the foreign party would have access to if they successfully login. If the user takes seven attempts to login unlike the usual two, the possibility of foreign party impersonating the authorized user is greater with the score being high. The risk score **1402** assigned indicates the acuteness of the threat posed. Other embodiments could score any user behaviors whose deviation would indicate a threat for a particular policy.

[0174] Referring next to FIG. **25**, a flowchart of the block **2404** for training the machine learning algorithm is shown. The flowchart **2404** shows a manner in which the machine learning is utilized by the forensic engine **112** to construct the baseline for the user endpoint **102** for the given policy. At block **2502**, the UEBA **316** retrieves the policy corresponding to the user endpoint **102** from the policy database **326**.

[0175] At block **2504**, the UEBA **316** fetches the historical interactions and user behavior information from the meta database **324** corresponding to this particular policy.

[0176] At block **2506**, the UEBA **316** then initializes the machine learning model for the training. The machine learning model can be any machine learning algorithm designed to recognize patterns like random forest algorithms, k-means clustering, neural networks etc.

[0177] At block **2508**, the machine learning algorithm functions by normalizing the variables and splitting a dataset. The dataset is typically divided into two or more subsets: a training set and a validation set. The training set is used to train the machine learning model while the validation set helps in model selection and hyperparameter tuning. The machine learning models often have hyperparameters that are tuned to optimize performance.

[0178] At block **2510**, the hyperparameters are tuned for optimized performance. Note that the hyperparameters are not learned from the data but are set before training. Techniques like grid search, random search, or Bayesian optimization are used to find the optimal combination of hyperparameters. The machine learning model has an objective function, which depends on the specific problem and the goals of the optimization task. The objective function typically takes one or more parameters or variables as input and produces a scalar value as output.

[0179] At block **2512**, the machine learning model learns to capture patterns and relationships in the dataset while training by adjusting and optimizing its internal parameters. This is often an iterative process and various optimization algorithms are used to update model parameters.

[0180] At block **2514**, the optimization process finds the parameters or configurations that minimize or maximize the value of the objective function. Various optimization algorithms are used to iteratively adjust the parameters to improve performance of the machine learning model. These algorithms can include gradient descent, stochastic gradient descent (SGD), genetic algorithms, or Bayesian optimization.

[0181] At block **2516**, the machine learning model is run in loops for tuning hyperparameters, evaluating objective function, and optimizing parameters until a specified stopping criterion is achieved. The objective function is often evaluated using the training dataset, which includes input data and their corresponding ground truth or target values. At block **2518**, the values are chosen at which the stopping criterion is met.

[0182] Referring next to FIG. **26**, a flowchart **2406** for classification of user behavior using the machine learning algorithm is shown. At block **2602**, the mid-link server **110** determines the policy that dictates the user endpoint **102** interaction. At block **2604**, the retro analyzer **318** receives the user behavior information. The UEBA **316** loads the trained machine learning model from the meta database **324**, at block **2606**.

[0183] At block **2608**, the UEBA **316** tests the activity of the user endpoint **102** to evaluate if the activity is in accordance with the behavior pattern previously observed in the user endpoint **102**. The model then classifies the activity as an unusual behavior if it does not fit with the behavior pattern of the user endpoint **102**, at block **2610**.

[0184] Referring next to FIG. **27**, a flowchart of the scoring **2110-2** of the user endpoint **102** behavior according to the rules is shown. In flowchart **2110-2** of assigning the scores, the unusual behavior is determined based on the rules defined by the policies for the user endpoint **102**. The rules do not require the machine learning models because rules are followed by every user endpoint **102** to be considered the baseline behavior of the user endpoint **102**. At block **2702**, the retro analyzer **318** retrieves the policy defining the rule for the interaction from the policy database **326**.

[0185] At block **2704**, the retro analyzer **318** retrieves the user activity information from the forensic logger **308**. At block **2706**, the retro analyzer **318** evaluates if the user activity is unusual based on the rule the user was supposed to follow. If the activity is in accordance with the rule defined in the policy, the retro analyzer **318** moves on to the next interaction. Otherwise, the indexing module **1108** of the retro analyzer **318** assigns the risk score **1402** to the user activity at block **2708**.

[0186] For instance, the enterprise has defined the rule that does not permit the users of the end-link server **104** from the research and development department to comment on any social media platforms. But the users of the marketing department are allowed to comment on the social media platforms. The mid-link server **110** differentiates the user activity depending upon the roles of each of the users of the user endpoints **102** and evaluates the activity based on the rule. If the user endpoint **102** does not belong to marketing department comments on social media, the retro analyzer **318** considers it as the anomaly. The retro analyzer **318** then assigns the risk score **1402** to the user endpoint **102**, for violating the rule.

[0187] Referring next to FIG. **28** a flowchart of the scoring method **2110-3** of assigning the risk score **1402** to the end-link servers **104** is shown. The process of scoring **2110-3** assigns the risk score **1402** to the end-link server **104** based on different attributes. The mid-link server **110** considers multiple attributes in the calculation of the risk score **1402** of the end-link server **104**. At block **2802**, the retro analyzer **318** retrieves the end-link server **104** information from the meta database **324**. At block **2804**, the retro analyzer **318** fetches the risk scores **1402** of the user endpoints **102** belonging to the end-link server **104**. An aggravated risk score of the user endpoints **102** suggests increased probability of threat to the end-link server **104** therefore, the risks scores **1402** are significant factor for the risk score of the end-link server **104**.

[0188] At block **2806**, the retro analyzer **318** retrieves the information of any previous malware spread, severity, and source of the malware spread. At block **2808**, the security patch level configured on user endpoints **102** of the end-link server **104** is used in determining the possibility of the threat. Finally at block **2810**, the indexing module **1108** assigns the risk score **1402** to the end-link server **104**, depending upon the above attributes.

[0189] Referring next to FIG. **29**, a flowchart **2110-4** of assigning the risk scores **1402** to the data object within the tunnels **106** is shown. At block **2902**, the retro analyzer **318** retrieves the information for the data object from the forensic logger **308**. The retro analyzer **318** retrieves the user access privilege information for the data object, at block **2904**. If the user has written privileges over a shared data object the risk of malware spreading is increased as compared to read-only privileges. The degree to which the file is shared internally or externally also impacts the risk score **1402**.

[0190] The identities of users sharing the data objects and the user access privilege information is used to determine the number of users in the end-link server **104** having access to the data object, at block **2906**.

[0191] At block **2908**, the identities of users sharing the data objects and the user access privilege information are used to determine the number of users outside the organization having access to the file object. The indexing module **1108** evaluates these factors and assigns the risk score **1402** accordingly, at block **2910**.

[0192] Referring next to FIG. **30**, a flowchart **2112** illustrating the method of capturing the states **1202** for the model of the application layer **902** based on the policy in an embodiment. Either by triggering of the policy or the risk score **1402** of the user endpoint **102**, the threat flag **1406** is raised by the mid-link server **110**. At block **3002**, the capturing module **314** receives the threat flag **1406**. At block **3004**, the mid-link server **110** retrieves the policy that was triggered from the policy database **326**. At block **3006**, the policy dictates what type of state capturing is required. The capturing module **314** can capture one or more types of states depending on the policy that is triggered.

[0193] The capturing module **314** captures various types of states of the end-link server **104** or the user endpoint **102**. For example, capturing the display states of an instance of the user endpoint **102** or the end-link server **104** at block **3008**.

[0194] At block **3010** capturing the interaction keystrokes between the end-link server **104** and the user endpoint **102**. The state capturing by the capturing module **314** further includes capturing states of file at block **3012** and capturing states of the tunnels **106** at block **3014**.

[0195] At block **3016**, the states are stored for a specific time period as defined by the policy. The frequency of storing the states **1202** is also instructed by the policy. The states **1202** captured by the capturing module **314** of the mid-link server **110** are stored in the meta database **324**.

[0196] Referring next to FIG. **31**, remediation steps of block **2120** of the mid-link server **110** as dictated by the policies is shown. At block **3102**, the mid-link server **110** retrieves the user interaction information. At block **3104**, the risk scores **1402** corresponding to the user interaction are also fetched from the meta database **324**. The mid-link server **110** analyzes the user interaction and determines if the user endpoints **102** trigger any policies.

[0197] At **3106**, the policies of the unique marker are determined if the user interacted with the data object having the unique marker. If not, the remediation process is terminated. At **3108**, the risk scores relevant to the user endpoint **102**, and the data objects the user interacted with, and the end-link server **104** the user belongs to are considered. The risk scores are further analyzed to determine if they have reached some trigger. If not, the remediation process is terminated.

[0198] At block **3112**, if the policy for the unique marker or the risk score is triggered, the mid-link server **110** blocks the access of the user endpoint **102** by tearing-down the tunnel **106** thus limiting the threat propagation.

[0199] At block **3110**, the policies for the state capture are evaluated. At block **3114**, the states **1202** are analyzed to determine if the user endpoint **102** or the tenant was engaged in suspicious activity and whether a data intensive state capture is required or not. If not, the remediation process is terminated. At block **3116**, the forensic engine **112** generates the threat flag that is later analyzed by the forensic investigator.

[0200] Referring next to FIG. **32**, a flowchart **3200** of a method of electronic inspection through the states **1202** is shown. At block **3202**, according to one implementation of an electronic inspection through captured states, the mid-link server **110** receives the threat flag **1406**. At block **3204** based on the policy that was triggered, the states **1202** relevant to the tenant or the user endpoint **102** are retrieved from the meta database **324**.

[0201] At block **3206**, an exemplary representation of interactions and activities on the model of the application layer **902** is created which is helpful in determining what went wrong, from where and when. For example, the ransomware enters the enterprise network **1102** and decapacitates some instances. The mid-link server **110** raises the threat flags for presence of malware. Since the mid-link server **110** has stored states of tunnel traffic, as discussed at **3014**, in the meta database **324**. The mid-link server **110** uses the states of tunnel traffic to create the representation of what was travelling in the tunnels **106** at a particular instant. At block **3208**, the representation is used to locate the source from where ransomware entered the enterprise network **1102**.

[0202] At block **3210**, the enterprise determines if the tunnels **106** or the user endpoints **102** entails to be blocked and/or the user endpoints **102** are reported to the concerned authorities. In another embodiment B, at block **3212**, while inspecting the end-link server **104** through stored states, the forensic investigator uses the representation created from the states to identify the data objects that got compromised or deleted. For example, the user endpoint **102** has deleted some files of the end-link server **104** permanently but now needs those files.

[0203] At block **3214**, the forensic investigator retrieves the stored data objects that are to be recovered and matches the hash of deleted file, from the file states **3012**, with the hash of files stored in the forensic logger **308**. Finally at **3218**, the forensic investigator makes copies of the deleted data objects and sends them to the user endpoint **102**. In this way, the user endpoint **102** restores and recreates the files that were deleted on the end-link server **104** via the mid-link server **110**. This application of the mid-link server **110** also helps the enterprises to recover and recreate its data objects that were compromised or got deleted by the activity of a rogue employee or the ransomware.

[0204] Referring next to FIG. **33**, a flowchart **3300** that represents the process of electronic inspection through the unique markers carried out by the mid-link server **110** is shown. At block **3302**, the mid-link server **110** searches the network traffic and the tunnels **106** for the unauthorized sharing of the uniquely marked data object. If the mid-link server **110** finds such data object, it investigates at block **3304** else, the mid-link server **110** continues with the searching.

[0205] At block **3306**, the threat analyzer **312** analyzes the data object and retrieves the unique marker from the data object. The threat analyzer **312** retrieves the unique marks stored in the meta database **324**. At block **3308**, the correlator **408** compares the stored unique markers with the unique marker of the data object found on the network **202**. If the correlator **408** finds a match based on the comparison, it implies the data object was leaked and the breach will be mitigated, at **3310**. The match may be same as the unique marker found on the network data object, but match may be the unique marker with inarguably similar appearance. The mid-link server **110** retrieves the user ID of the user endpoint **102** that was the source of the uniquely marked data object that was leaked and reports it to the forensic investigator, at block **3312**. The mid-link server **110** tracks the network traffic to identify the source that leaked the data object and blocks the tunnel **106** of the corrupt source, at block **3314**.

[0206] Referring next to FIG. **34**, a flowchart **3400** that represents the process of electronic inspection through the unique markers carried out by the forensic investigator is shown. At block **3402**, a determination of searching for the leakage of the uniquely marked data object. The forensic investigator provides the uniquely marked data object that was found on the network **202**. At block **3404**, the threat analyzer **312** retrieves the unique marker from the leaked data object.

[0207] At block **3406**, The unique marker is compared with the unique markers stored in the meta database **324**. If a match is found it implies that the data object belongs to the end-link server **104** and was indeed leaked, at block **3408**. If the match is not found the mid-link server **110** moves on to the next unique marker. The image of data object when subjected to editing tempers with the unique marker. The match found does not have to be same as the unique marker on the document, but significant similarity is enough to imply that they are the same unique markers. At block **3410**, the mid-link server **110** retrieves the user ID of the user endpoint **102** that was the source of leaking the uniquely marked data object. Finally at block **3412**, the mid-link server **110** tracks the network traffic to identify the source that leaked the data object and blocks the tunnel **106** for the corrupt source of the user endpoint **102**.

[0208] Specific details are given in the above description to provide a thorough understanding of the embodiments. However, it is understood that the embodiments may be practiced without these specific details. For example, components may be shown in block diagrams in order not to obscure the embodiments in unrequired detail. In other instances, well-known circuits, processes, algorithms, structures, and techniques may be shown without unrequired detail in order to avoid obscuring the embodiments.

[0209] Also, it is noted that the embodiments may be described as a process which is depicted as a flowchart, a flow diagram, a swim diagram, a data flow diagram, a structure diagram, or a block diagram. Although a depiction may describe the operations as a sequential process, many of the operations can be performed in parallel or concurrently. In addition, the order of the operations may be re-arranged. A process is terminated when its operations are completed but could have additional steps not included in the figure. A process may correspond to a method, a function, a procedure, a subroutine, a subprogram, etc. When a process corresponds to a function, its termination corresponds to a return of the function to the calling function or the main function.

[0210] For a firmware and/or software implementation, the methodologies may be implemented with modules (e.g., procedures, functions, and so on) that perform the functions described herein. Any machine-readable medium tangibly embodying instructions may be used in implementing the methodologies described herein. For example, software codes may be stored in a memory. Memory may be implemented within the processor or external to the processor. As used herein the term “memory” refers to any type of long term, short term, volatile, nonvolatile, or other storage medium and is not to be limited to any particular type of memory or number of memories, or type of media upon which memory is stored.

[0211] In the embodiments described above, for the purposes of illustration, processes may have been described in a particular order. It may be appreciated that in alternate embodiments, the methods may be performed in a different order than that described. It may also be appreciated that the methods and/or system components described above may be performed by hardware and/or software components (including integrated circuits, processing units, and the like), or may be embodied in sequences of machine-readable, or computer-readable, instructions, which may be used to cause a machine, such as a general-purpose or special-purpose processor or logic circuits programmed with the instructions to perform the methods. Moreover, as disclosed herein, the term “storage medium” may represent one or more memories for storing data, including read memory (ROM), random access memory (RAM), magnetic RAM, core memory, magnetic disk storage mediums, optical storage mediums, flash memory devices and/or other machine-readable mediums for storing information. The term “machine-readable medium” includes but is not limited to portable or fixed storage devices, optical storage devices, and/or various other storage mediums capable of storing that contain or carry instruction(s) and/or data. These machine-readable instructions may be stored on one or more machine-readable mediums, such as compact disc read-only memory (CD-ROMs) or other type of optical disks, solid-state drives, tape cartridges, magnetic or optical cards, flash memory, or other types of machine-readable mediums suitable for storing electronic instructions. Alternatively, the methods may be performed by a combination of hardware and software.

[0212] Implementation of the techniques, blocks, steps and means described above may be done in various ways. For example, these techniques, blocks, steps and means may be implemented in hardware, software, or a combination thereof. For a digital hardware implementation, the processing units may be implemented within one or more application specific integrated circuits (ASICs), digital signal processors (DSPs), digital signal processing devices (DSPDs), programmable logic devices (PLDs), field programmable gate arrays (FPGAs), processors, controllers, micro-controllers, microprocessors, other electronic units designed to perform the functions described above, and/or a combination thereof. For analog circuits, they can be implemented with discreet components or using monolithic microwave integrated circuit (MMIC), radio frequency integrated circuit (RFIC), and/or micro electro-mechanical systems (MEMS) technologies.

[0213] Furthermore, embodiments may be implemented by hardware, software, scripting languages, firmware, middleware, microcode, hardware description languages, and/or any combination thereof. When implemented in software, firmware, middleware, scripting language, and/or microcode, the program code or code segments to perform the required tasks may be stored in a machine-readable medium such as a storage medium. A code segment or machine-executable instruction may represent a procedure, a function, a subprogram, a program, a routine, a subroutine, a module, a software package, a script, a class, or any combination of instructions, data structures, and/or program statements. A code segment may be coupled to another code segment or a hardware circuit by passing and/or receiving information, data, arguments, parameters, and/or memory contents. Information, arguments, parameters, data, etc. may be passed, forwarded, or transmitted via any suitable means including memory sharing, message passing, token passing, network transmission, etc.

[0214] The methods, systems, devices, graphs, and tables discussed herein are examples. Various configurations may omit, substitute, or add various procedures or components as appropriate. For instance, in alternative configurations, the methods may be performed in an order different from that described, and/or various stages may be added, omitted, and/or combined. Also, features described with respect to some configurations may be combined in various other configurations. Different aspects and elements of the configurations may be combined in a similar manner. Also, technology evolves and, thus, many of the elements are examples and do not limit the scope of the disclosure or claims. Additionally, the techniques discussed herein may provide differing results with different types of context awareness classifiers.

[0215] Unless defined otherwise, the technical and scientific terms used herein have the same meaning as commonly or conventionally understood. As used herein, the articles "a" and "an" refer to one or to more than one (i.e., to at least one) of the grammatical object of the article. By way of example, "an element" means one element or more than one element. "About" and/or "approximately" as used herein when referring to a measurable value such as an amount, a temporal duration, and the like, encompasses variations of ±20% or ±10%, ±5%, or ±0.1% from the specified value, as such variations are appropriate when discussing the systems, devices, circuits, methods, and other implementations described herein. "Substantially" as used herein when referring to a measurable value such as an amount, a temporal duration, a physical attribute (such as frequency), and the like, also encompasses variations of ±20% or ±10%, ±5%, or ±0.1% from the specified value, as such variations are appropriate when discussing the systems, devices, circuits, methods, and other implementations described herein.

[0216] As used herein, including in the claims, "and" as used in a list of items prefaced by "at least one of" or "one or more of" indicates that any combination of the listed items may be used. For example, a list of "at least one of A, B, and C" includes any of the combinations A or B or C or AB or AC or BC and/or ABC (i.e., A and B and C). Furthermore, to the extent more than one occurrence or use of the items A, B, or C is possible, multiple uses of A, B, and/or C may form part of the contemplated combinations. For example, a list of "at least one of A, B, and C" may also include AA, AAB, AAA, BB, etc.

[0217] While illustrative and presently preferred embodiments of the disclosed systems, methods, and machine-readable media have been described in detail herein, it is to be understood that the inventive concepts may be otherwise variously embodied and employed, and that the appended claims are intended to be construed to include such variations, except as limited by the prior art. While the principles of the disclosure have been described above in connection with specific apparatuses and methods, it is to be clearly understood that this description is made by way of example and not as limitation on the scope of the disclosure.

1. (canceled)

2. A method for an electronic inspection between a plurality of end-link servers and a plurality of user endpoints of a plurality of tenants by a mid-link server, the method including:

receiving a communication at the mid-link server passing between the plurality of end-link servers and the plurality of user endpoints using a plurality of tunnels, wherein the mid-link server is configured between the plurality of user endpoints and the plurality of end-link servers;

transmitting the communication from a user endpoint and the end-link server to the mid-link server;

embedding a unique marker in a plurality of modelled data objects based on a plurality of policies;

storing meta data of a plurality of unique markers in a meta database;

matching unique markers of a leaked data object with the plurality of unique markers stored in the meta database,

identifying a source of leaked data objects based on the matching, wherein retrieves a user identifier (ID) of the user endpoint that was the source of the leaked data objects;

tracking network traffic to identify the source of the leaked data object and blocking a tunnel for the user endpoint of the leaked data object; and

establishing the plurality of tunnels for transmitting the communication from the mid-link server to the plurality of user endpoints and the plurality of end-link servers.

3. The method of claim **2**, wherein rendering of a plurality of sensitive data objects is based on the plurality of policies.

4. The method of claim **2**, wherein storing the unique marker in the meta database is based on corresponding identifier (ID) of a data object and the user endpoint.

5. The method of claim **2**, wherein identifying and retrieving an identifier (ID) of the user endpoint with access to the leaked data object is based on the unique marker.

6. The method of claim **2**, wherein the unique markers generated at the mid-link server are either visible or invisible in a data object.

7. The method of claim **2**, wherein a match identified for the unique marker of the leaked data object can either be same or similar to the unique marker of the leaked data object.

8. The method of claim **2**, wherein analyzing the user endpoint with access to the leaked data object and performing remediation according to a set of policies are performed at the mid-link server.

9. A system for an electronic inspection between a plurality of end-link servers and a plurality of user endpoints of a plurality of tenants by a mid-link server, the system comprising:

a first tunnel between a user endpoint and the mid-link server;

a second tunnel between an end-link server and the mid-link server, the first tunnel and the second tunnel are operable to transmit a communication from the user endpoint and the end-link server to the mid-link server; and

the mid-link server is operable to:

receive the communication at the mid-link server passing between the plurality of end-link servers and the plurality of user endpoints using a plurality of tunnels,

embed a unique marker in a plurality of modelled data object based on a plurality of policies,

store meta data of a plurality of unique markers in a meta database,

match unique markers of a leaked data object with the plurality of unique markers stored in the database,

identify a source of the leaked data object based on the match, wherein retrieves a user identifier (ID) of the user endpoint that was the source of the leaked data objects;

tracking network traffic to identify the source of the leaked data object and blocking a tunnel for the user endpoint of the leaked data object; and

establish the plurality of tunnels for transmitting the communication from the mid-link server to the plurality of user endpoints and the plurality of end-link servers.

10. The system for the electronic inspection of claim **9**, wherein the mid-link server is further operable to render a plurality of sensitive data objects based on the plurality of policies.

11. The system for the electronic inspection of claim **9**, wherein the mid-link server is further operable to store the unique marker in the meta database corresponding to an identifier (ID) of a data object and the user endpoint.

12. The system for the electronic inspection of claim **9**, wherein the mid-link server is further operable to identify and retrieve an identifier (ID) of the user endpoint with access to the leaked data object.

13. The system for the electronic inspection of claim **9**, wherein the unique markers generated at mid-link server can be visible or invisible in the data objects.

14. The system for the electronic inspection of claim **9**, wherein a match identified for the unique marker of the leaked data object can either be same or similar to the unique marker of the leaked data object.

15. The system for the electronic inspection of claim **9**, wherein the mid-link server is further operable to analyze the user endpoint with access to the leaked data object and perform remediation according to a set of policies.

16. A non-transitory computer-readable media having computer-executable instructions embodied thereon that when executed by one or more processors, facilitate a method for an electronic inspection system between a plurality of end-link servers and a plurality of user endpoints of a plurality of tenants by a mid-link server, the computer-readable media comprising:

receiving a communication at the mid-link server passing between the plurality of end-link servers and the plurality of user endpoints using a plurality of tunnels, wherein the mid-link server is positioned between an interaction of the plurality of user endpoints and the plurality of end-link servers;

transmitting the communication from a user endpoint and an end-link server to the mid-link server;

embedding a unique marker in a plurality of modelled data objects based on plurality of policies;

storing meta data of a plurality of unique markers in a meta database;

matching unique markers of a leaked data object with the plurality of unique markers stored in the meta database;

identifying a source of leaked data objects based on the matching, wherein retrieves a user identifier (ID) of the user endpoint that was the source of the leaked data objects;

tracking network traffic to identify the source of the leaked data object and blocking a tunnel for the user endpoint of the leaked data object; and

establishing the plurality of tunnels for transmitting the communication from the mid-link server to the plurality of user endpoints and the plurality of end-link servers.

17. The non-transitory computer-readable media of claim **16**, wherein rendering of a plurality of sensitive data objects is based on the plurality of policies.

18. The non-transitory computer-readable media of claim **16**, wherein storing the unique marker in the meta database is based on corresponding identifier (ID) of a data object and the user endpoint.

19. The non-transitory computer-readable media of claim **16**, wherein identifying and retrieving of an identifier (ID) of the user endpoint with access to the leaked data object is based on the unique marker.

20. The non-transitory computer-readable media of claim **16**, wherein the unique markers generated at the mid-link server are either visible or invisible in a data object.

21. The non-transitory computer-readable media of claim **16**, wherein analyzing the user endpoint with access to the leaked data object and performing remediation according to a set of policies are performed at the mid-link server.

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