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(54) **APPLICATION-BASED CONFIGURATION OF NETWORK DATA CAPTURE BY REMOTE CAPTURE AGENTS**

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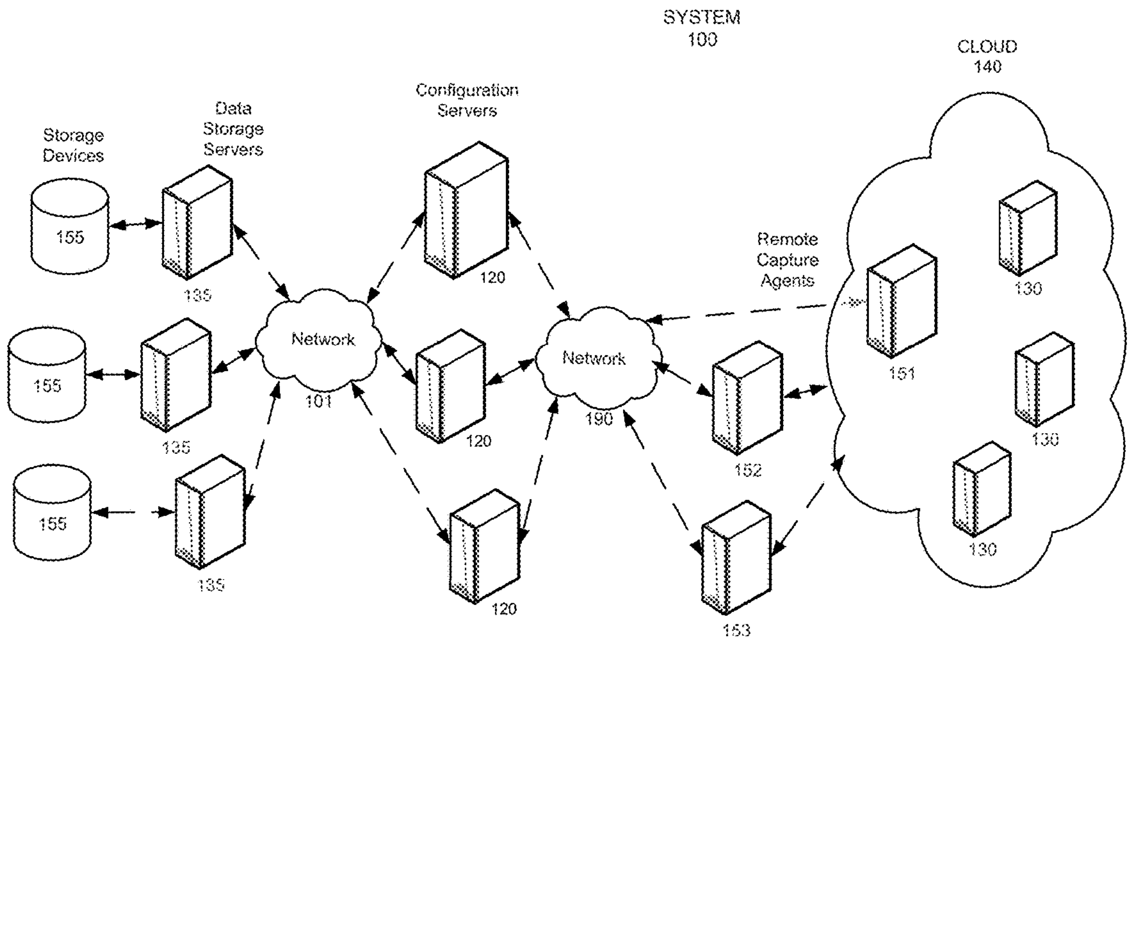
(57) **ABSTRACT**

The disclosed embodiments provide a method and system for facilitating the processing of network data. During operation, the system obtains, at a remote capture agent, configuration information for the remote capture agent from a configuration server over a network. Next, the system uses the configuration information to configure the generation of event data from network packets at the remote capture agent. Upon receiving an update to the configuration information from the configuration server, the system uses the update to reconfigure the generation of the event data by the remote capture agent during runtime of the remote capture agent.



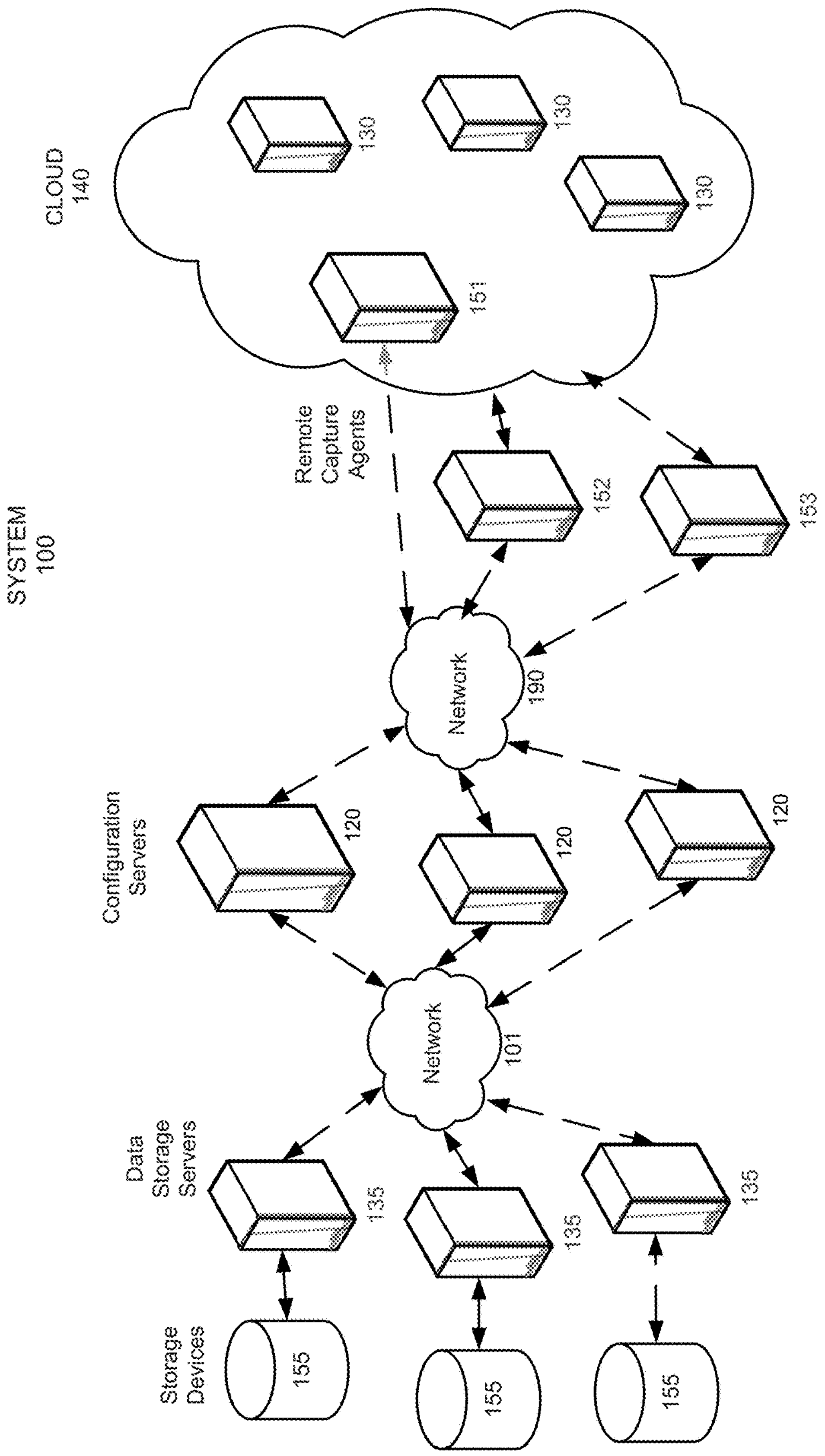

SYSTEM
100
CLOUD
140
130
130
130
151
Remote
Capture
Agents
152
153
Network
190
Configuration
Servers
120
120
120
Network
101
Data
Storage
Servers
135
135
135
Storage
Devices
155
155
155

FIG. 1

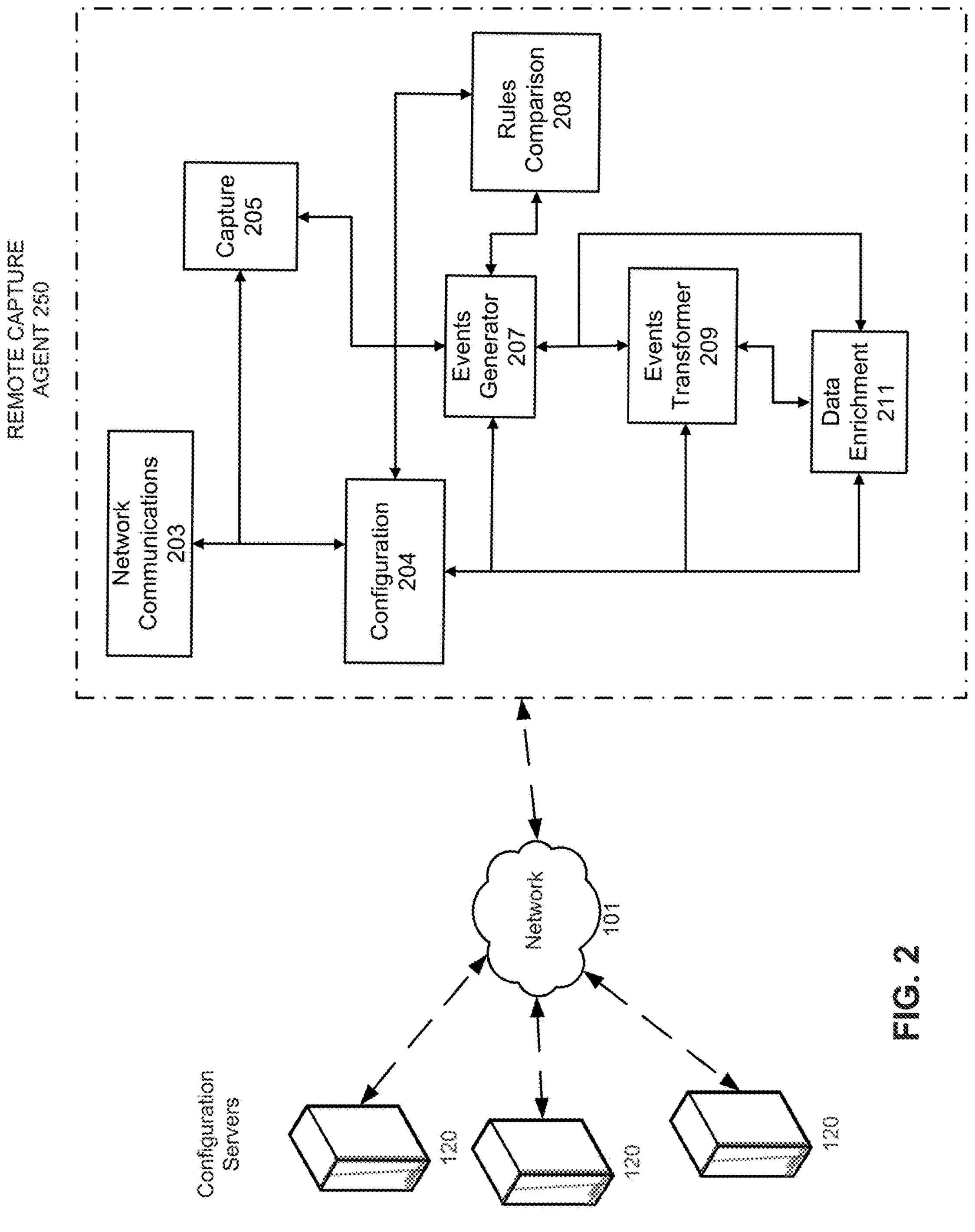

REMOTE CAPTURE AGENT 250
Network Communications 203
Capture 205
Configuration 204
Events Generator 207
Rules Comparison 208
Events Transformer 209
Data Enrichment 211
Network
101
Configuration Servers
120
120
120

FIG. 2

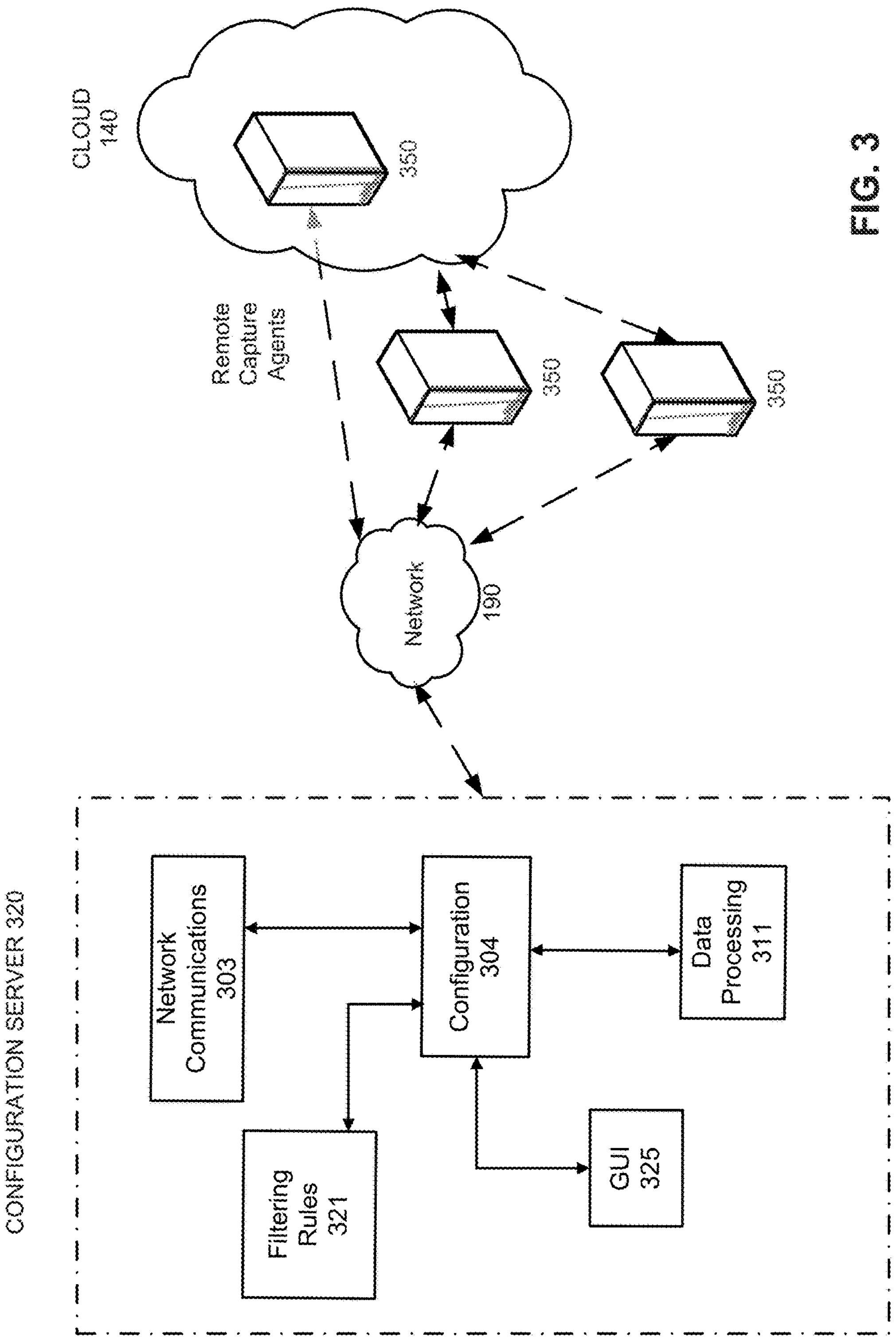

CONFIGURATION SERVER 320
Network Communications 303
Configuration 304
Data Processing 311
Filtering Rules 321
GUI 325
Network 190
Remote Capture Agents
350
350
350
CLOUD 140

FIG. 3

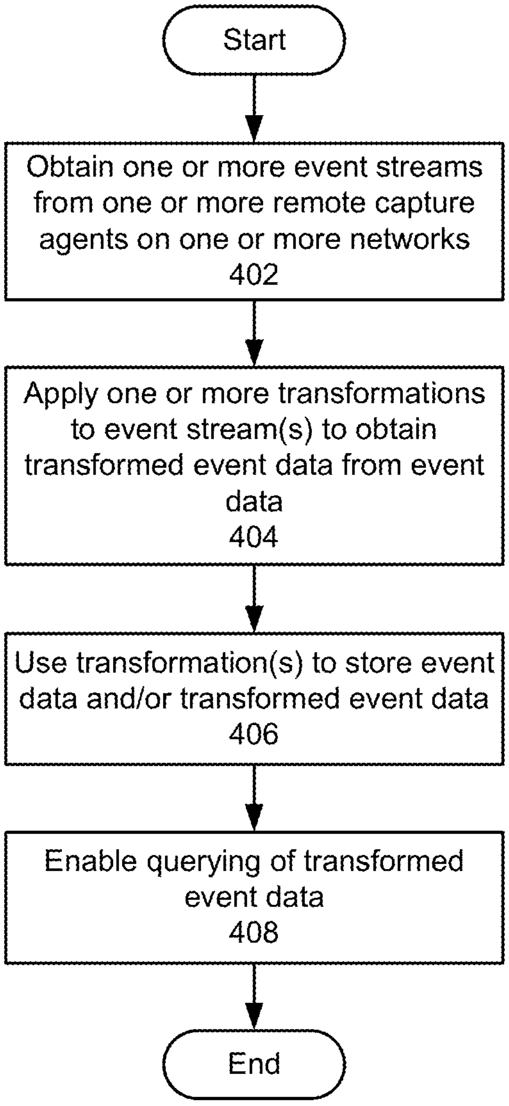

Start
Obtain one or more event streams from one or more remote capture agents on one or more networks
402
Apply one or more transformations to event stream(s) to obtain transformed event data from event data
404
Use transformation(s) to store event data and/or transformed event data
406
Enable querying of transformed event data
408
End

FIG. 4

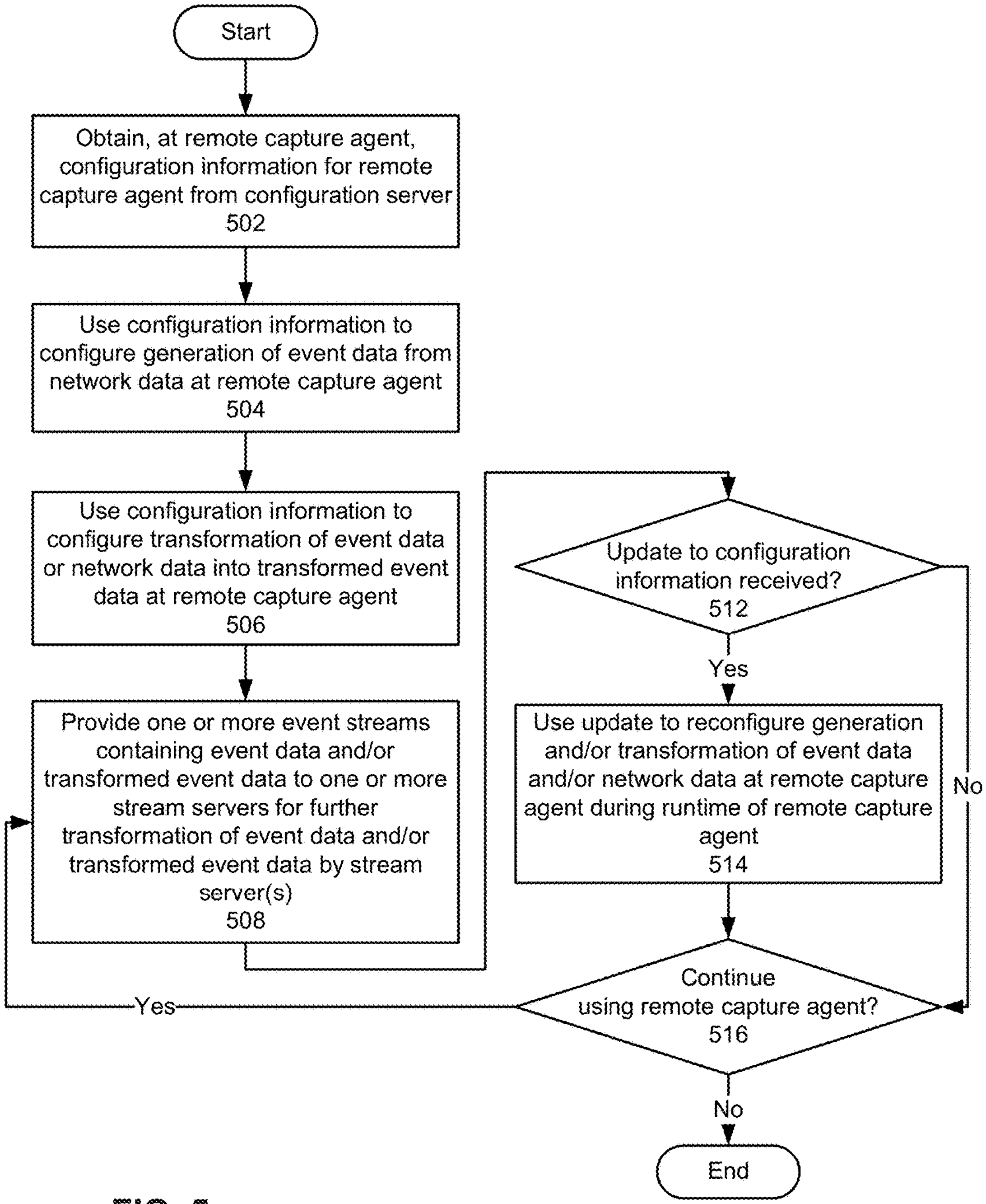

Start
Obtain, at remote capture agent, configuration information for remote capture agent from configuration server 502
Use configuration information to configure generation of event data from network data at remote capture agent 504
Use configuration information to configure transformation of event data or network data into transformed event data at remote capture agent 506
Provide one or more event streams containing event data and/or transformed event data to one or more stream servers for further transformation of event data and/or transformed event data by stream server(s) 508
Update to configuration information received? 512
Yes
No
Use update to reconfigure generation and/or transformation of event data and/or network data at remote capture agent during runtime of remote capture agent 514
Continue using remote capture agent? 516
Yes
No
End

FIG. 5

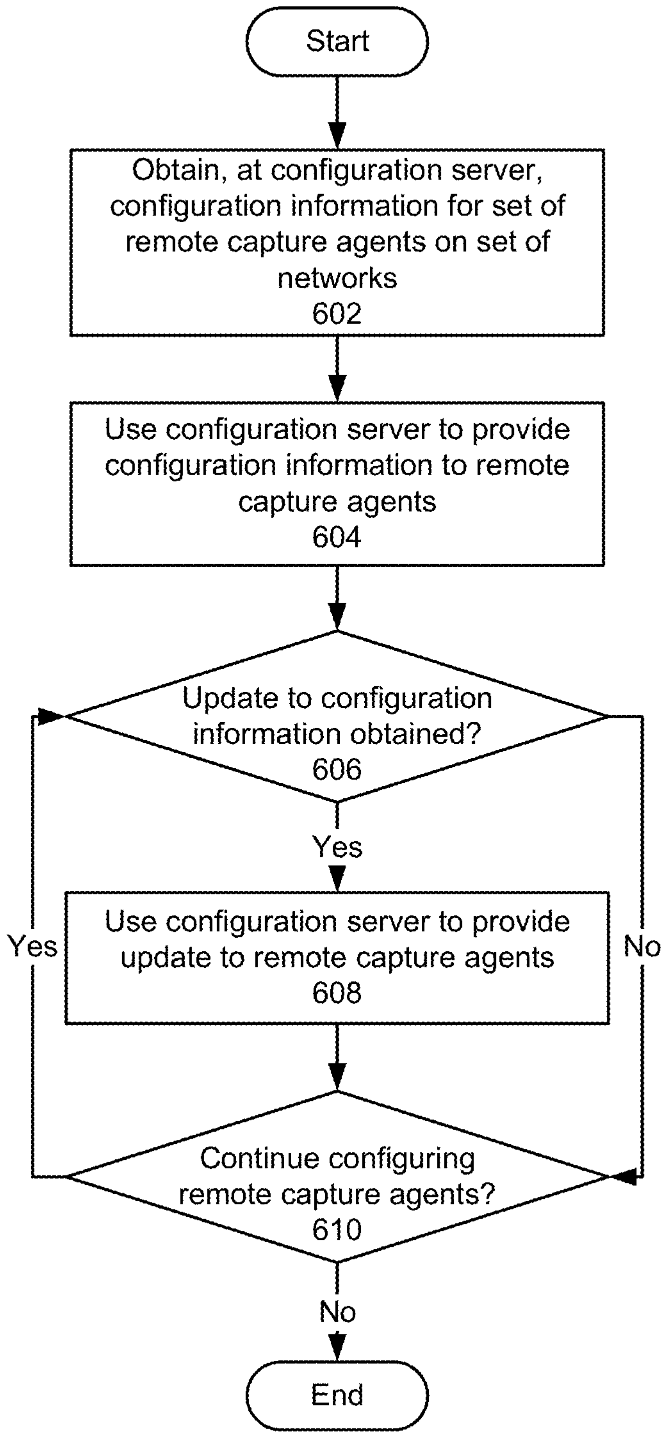

Start
Obtain, at configuration server, configuration information for set of remote capture agents on set of networks
602
Use configuration server to provide configuration information to remote capture agents
604
Update to configuration information obtained?
606
Yes
Use configuration server to provide update to remote capture agents
608
Yes
No
Continue configuring remote capture agents?
610
No
End

FIG. 6

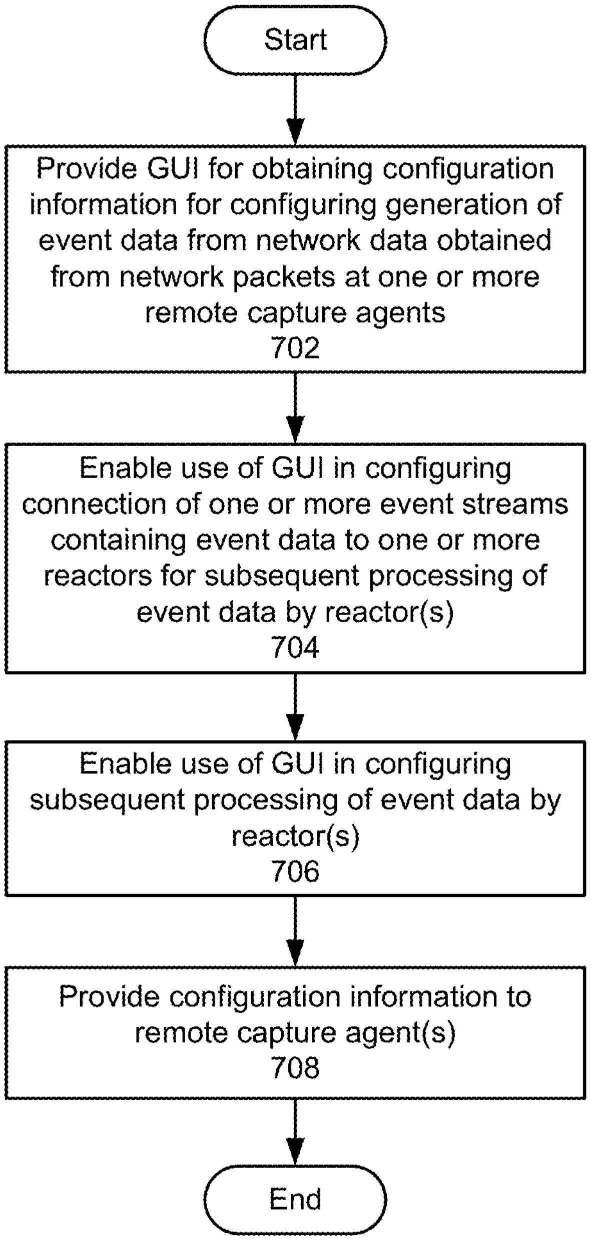

Start
Provide GUI for obtaining configuration information for configuring generation of event data from network data obtained from network packets at one or more remote capture agents
702
Enable use of GUI in configuring connection of one or more event streams containing event data to one or more reactors for subsequent processing of event data by reactor(s)
704
Enable use of GUI in configuring subsequent processing of event data by reactor(s)
706
Provide configuration information to remote capture agent(s)
708
End

FIG. 7

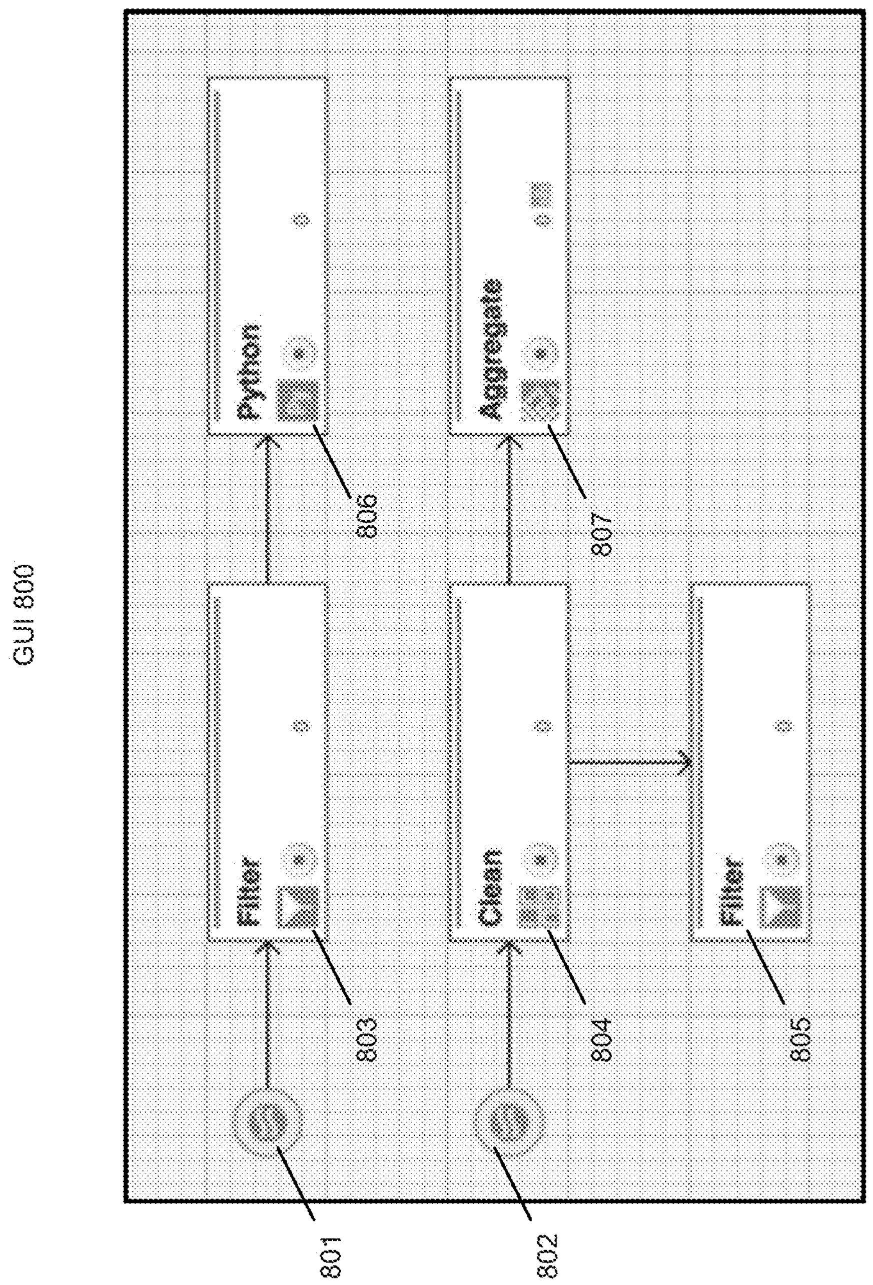
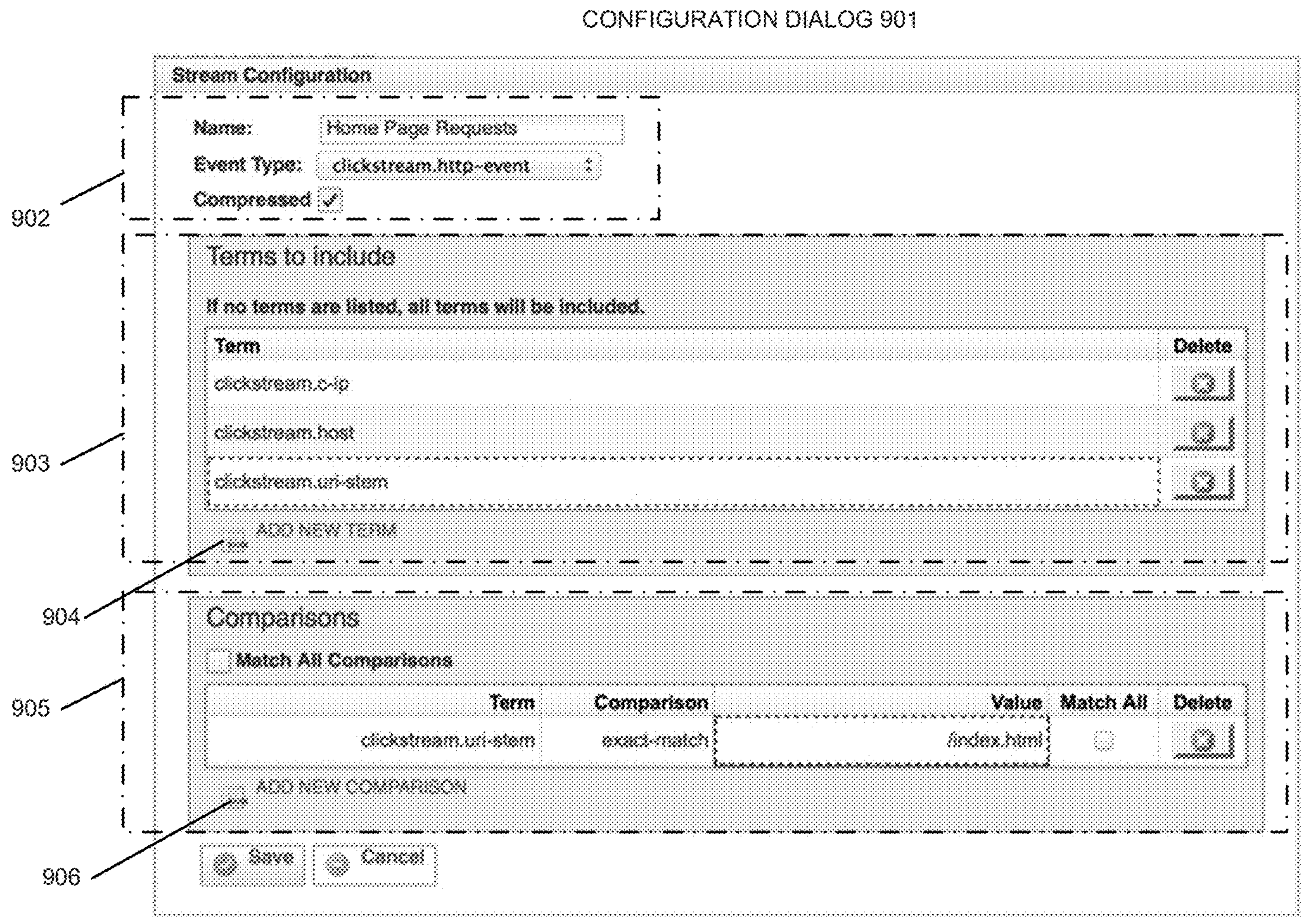

GUI 800
Filter
Python
Clean
Aggregate
Filter
801
802
803
804
805
806
807

FIG. 8

CONFIGURATION DIALOG 901



Stream Configuration

Name:	Home Page Requests
Event Type:	clickstream.http-event
Compressed	✓

Terms to include

If no terms are listed, all terms will be included.

Term	Delete
clickstream.c-ip	
clickstream.host	
clickstream.uri-stem	

ADD NEW TERM

Comparisons

Match All Comparisons

Term	Comparison	Value	Match All	Delete
clickstream.uri-stem	exact-match	/index.html		

ADD NEW COMPARISON

Save Cancel

FIG. 9

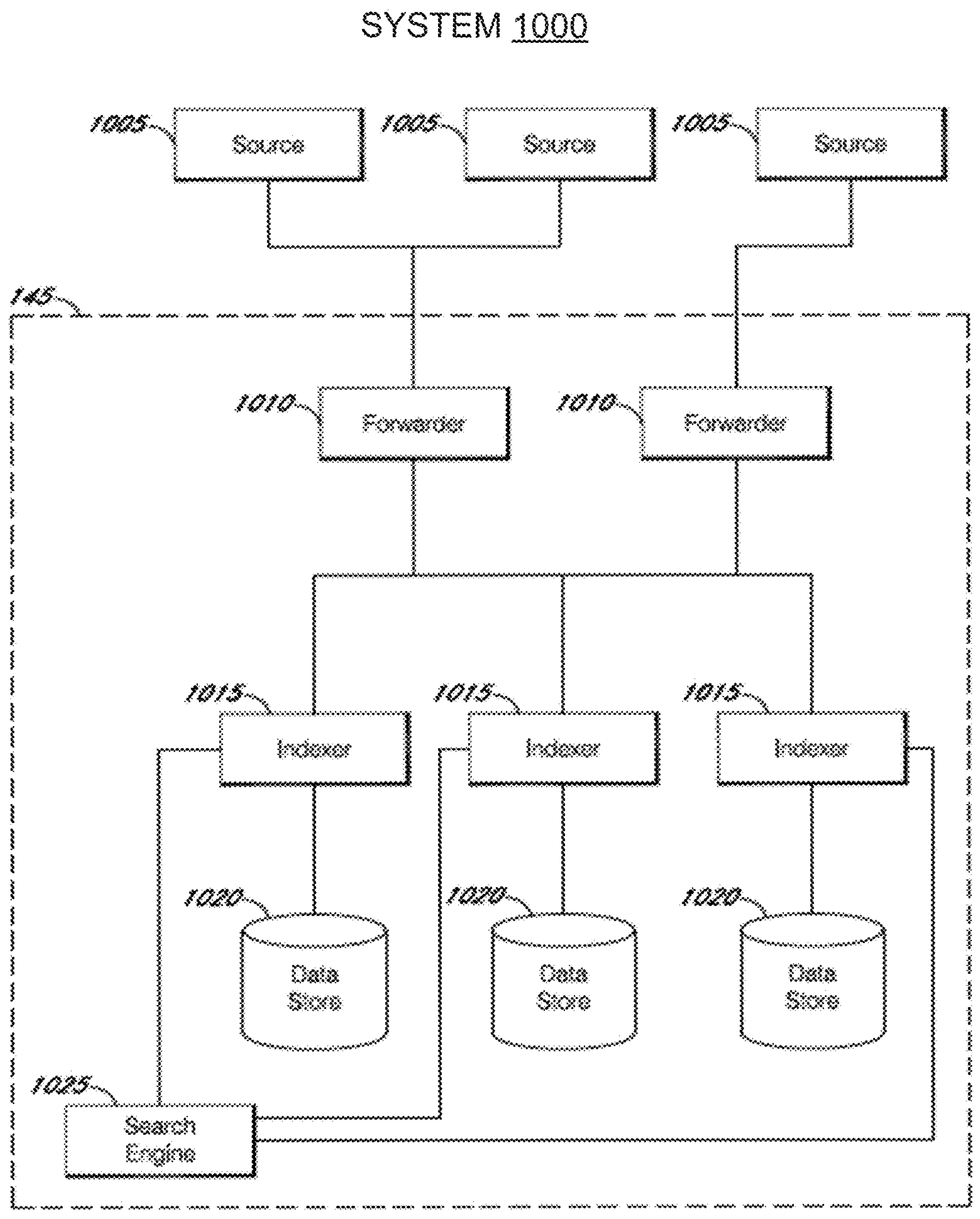

SYSTEM 1000
1005
Source
1005
Source
1005
Source
145
1010
Forwarder
1010
Forwarder
1015
Indexer
1015
Indexer
1015
Indexer
1020
Data Store
1020
Data Store
1020
Data Store
1025
Search Engine

FIG. 10

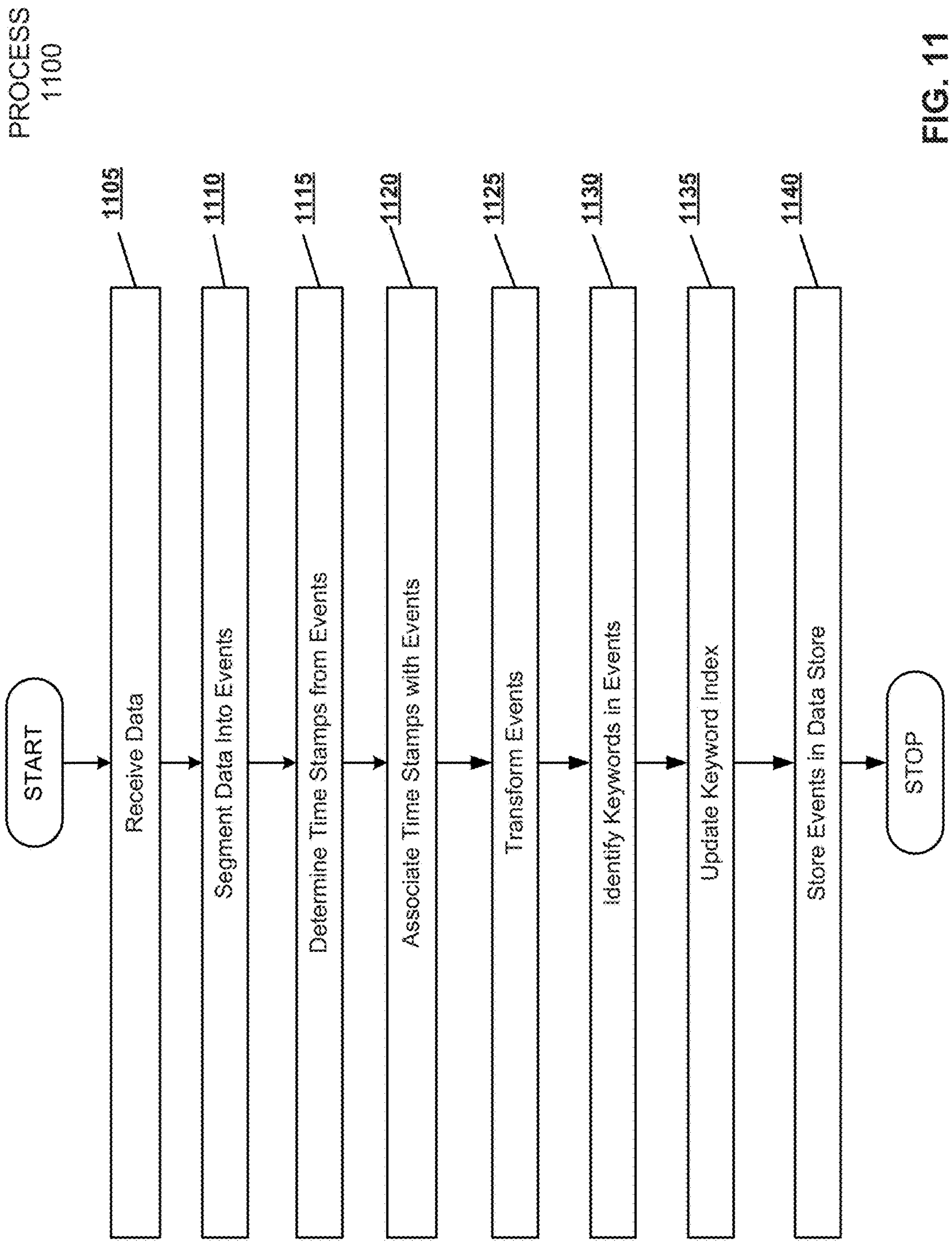

PROCESS
1100
START
Receive Data
1105
Segment Data Into Events
1110
Determine Time Stamps from Events
1115
Associate Time Stamps with Events
1120
Transform Events
1125
Identify Keywords in Events
1130
Update Keyword Index
1135
Store Events in Data Store
1140
STOP

FIG. 11

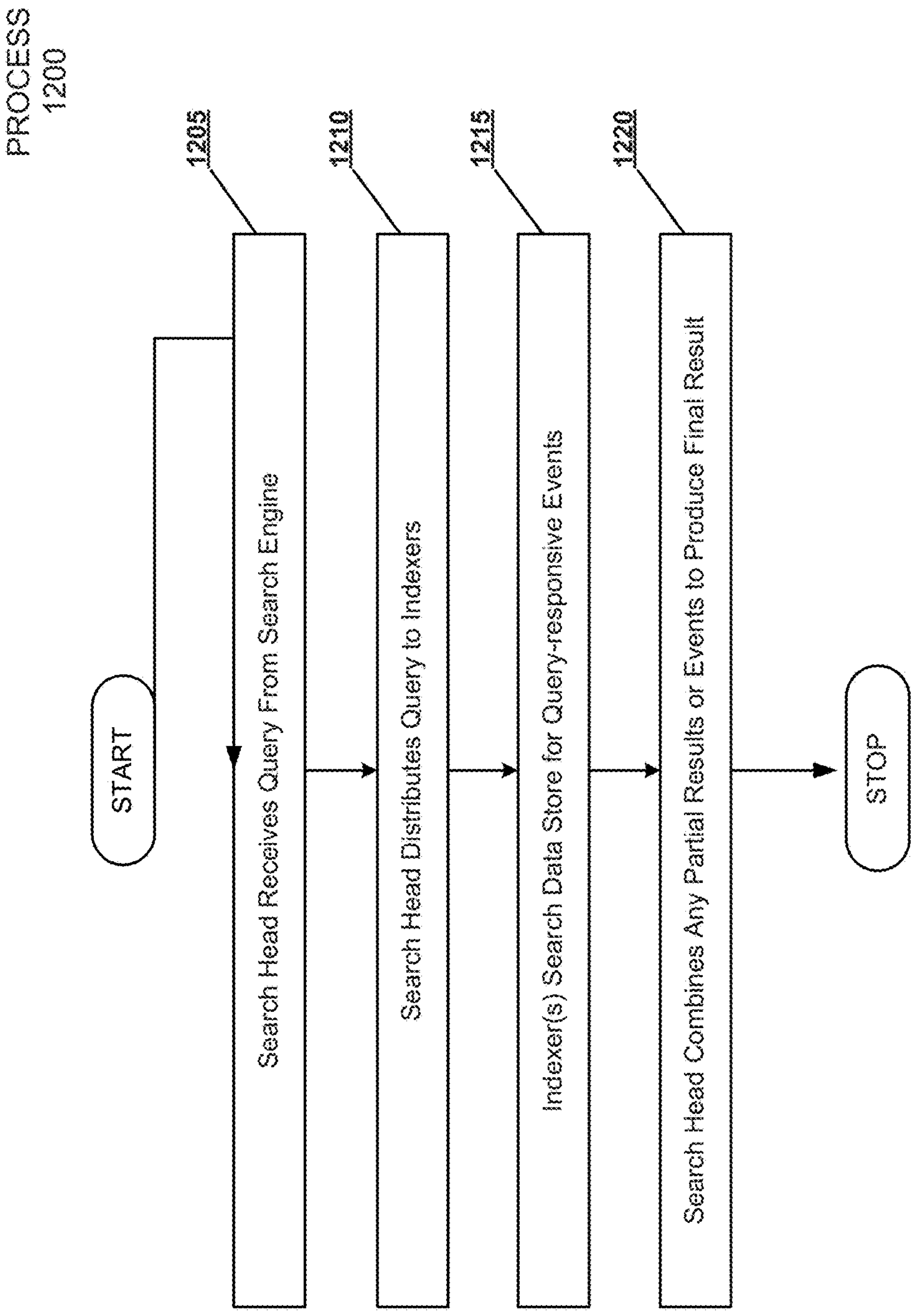

PROCESS 1200
START
1205
Search Head Receives Query From Search Engine
1210
Search Head Distributes Query to Indexers
1215
Indexer(s) Search Data Store for Query-responsive Events
1220
Search Head Combines Any Partial Results or Events to Produce Final Result
STOP

FIG. 12

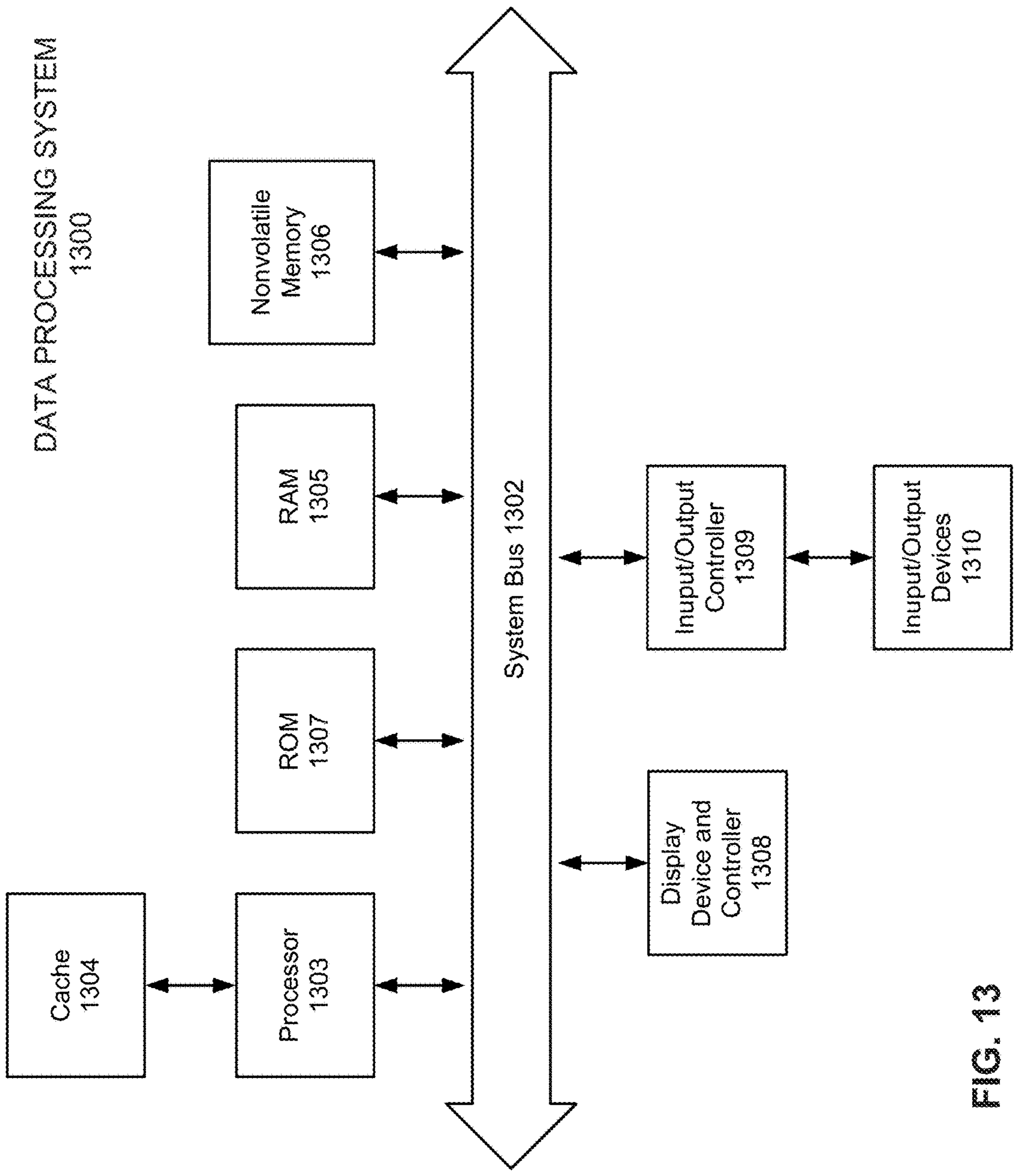

DATA PROCESSING SYSTEM 1300
Cache 1304
Processor 1303
ROM 1307
RAM 1305
Nonvolatile Memory 1306
System Bus 1302
Display Device and Controller 1308
Inuput/Output Controller 1309
Inuput/Output Devices 1310

FIG. 13

APPLICATION-BASED CONFIGURATION OF NETWORK DATA CAPTURE BY REMOTE CAPTURE AGENTS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims benefit under 35 U.S.C. § 120 as a continuation of U.S. application Ser. No. 14/253,744, filed Apr. 15, 2014, the entire contents of which is hereby incorporated by reference as if fully set forth herein. The applicant(s) hereby rescind any disclaimer of claim scope in the parent application(s) or the prosecution history thereof and advise the USPTO that the claims in this application may be broader than any claim in the parent application(s).

FIELD OF THE INVENTION

[0002] At least certain embodiments of the invention relate generally to computer networks, and more particularly to a system configured for capturing and processing network data across a distributed network environment.

BACKGROUND OF THE INVENTION

[0003] Over the past decade, the age of virtualization has triggered a sea change in the world of network data capture. Almost every network capture product available today is a physical hardware appliance that customers have to purchase and configure. In addition, most network data capture technologies are built from scratch to serve a specific purpose and address the needs of a particular vertical market. For example, network capture systems may be customized to extract data for security and intrusion-detection purposes, collect network performance data, perform Quality of Service (QoS), redirect data, block network traffic, and/or perform other analysis or management of network traffic. Such targeted and/or fixed implementation and use of network capture technologies may preclude modification of the network capture technologies to address different and changing business needs.

[0004] Moreover, customers using conventional hardware-based network capture devices typically connect the devices to other hardware devices in a network. The connections may allow the network capture devices to access the network and monitor network traffic between two or more points in the network. Examples of such devices include a network Test Access Point (TAP) or Switched Port Analyzer (SPAN) port. After the network traffic is captured, cumbersome Extraction, Transform, and Load ("ETL") processes may be performed to filter, transform, and/or aggregate data from the network traffic and enable the extraction of business value from the data.

[0005] However, customers are moving away from managing physical servers and data centers and toward public and private cloud computing environments that provide software, hardware, infrastructure, and/or platform resources as hosted services using computing, storage, and/or network devices at remote locations. For these customers, it is either impossible, or at best extremely challenging, to deploy physical network capture devices and infrastructure in the cloud computing environments.

[0006] Consequently, network data capture may be facilitated by mechanisms for deploying and configuring network capture technology at distributed and/or remote locations.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] For a better understanding of at least certain embodiments, reference will be made to the following detailed description, which is to be read in conjunction with the accompanying drawings, wherein:

[0008] FIG. **1** depicts an example block diagram embodiment of a data processing system for capturing and processing network data in a distributed network environment;

[0009] FIG. **2** depicts an example block diagram embodiment of a remote capture agent;

[0010] FIG. **3** depicts an example block diagram embodiment of a configuration server;

[0011] FIG. **4** shows a flowchart illustrating the processing of network data;

[0012] FIG. **5** shows a flowchart illustrating the process of facilitating the processing of network data;

[0013] FIG. **6** shows a flowchart illustrating the process of facilitating network data capture;

[0014] FIG. **7** shows a flowchart illustrating the process of facilitating the processing of network data;

[0015] FIG. **8** depicts an example screen shot of an embodiment of a graphical interface that is adapted to display configurable components within a distributed data capture and processing system;

[0016] FIG. **9** depicts an example screen shot of an embodiment of a configuration dialog for obtaining configuration information for configuring the generation of event data from network data at one or more remote capture agents;

[0017] FIG. **10** depicts an example block diagram of an embodiment of a time-based data storage architecture that includes a late-binding schema;

[0018] FIG. **11** illustrates a flowchart of an example embodiment of a process for storing collected data in a data storage architecture that includes a late-binding schema;

[0019] FIG. **12** illustrates a flowchart of an example embodiment of a process for generating a query result in a data storage architecture that includes a late-binding schema; and

[0020] FIG. **13** depicts an example data processing system upon which the embodiments described herein may be implemented.

DETAILED DESCRIPTION

[0021] Throughout the description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present techniques described herein. It will be apparent to one skilled in the art, however, that the present invention may be practiced without some of these specific details. In other instances, well-known structures and devices are shown in block diagram form to avoid obscuring the underlying principles of embodiments of the invention.

1.0. General Overview

[0022] 1.1. Event-Based Data Storage Systems

[0023] Generally, a data-processing system may perform data operations on data stored in one or more data repositories. Depending on the type of data-processing system, the data operations may range from simple operations such as storing and retrieving the data to more complex operations such as calculating statistics from the data, or arranging or formatting the data. One example of a data-processing system is a relational database system, in which data is stored in highly structured tables and accessed through rigid data storage rules (e.g., data storage and retrieval "schemas"). Another example of a data-processing system is a file system, such as a Network File System (NFS) server. Yet another example of a data-processing system is a web application server.

[0024] A data-processing system may also include an event-based system, such as the SPLUNK® ENTERPRISE system produced and sold for on-premise and cloud use by Splunk Inc. of San Francisco, Calif. In some event-based systems, data is derived from lines or rows of unstructured time-series data, such as data from web logs and/or machine logs. Each row and/or group of rows is generally associated with a timestamp and one or more associated data points or parameter-value pairs. A timestamp may be any sequence of characters or encoded information that identifies the time at which a certain event is recorded. For example, a timestamp may provide the date, hour, minute, and/or second at which an application is initialized on a computer system. Based on the timestamps, data structures representing events may be derived from the associated data and include some or all of the associated data. A variety of event types may be derived from such data. For example, in the context of web logs, events may be derived from errors, specific user inputs, navigation events, and so forth.

[0025] As used herein, the term "events" may refer to anything that occurs and carries information in an event-based system. Some event-based systems feature flexible data storage and retrieval schemas that may be redefined as needed and applied after the associated data is stored in a database or other memory structure of the data storage system. For example, the schemas may be applied upon receiving a request to perform an operation on such data. Such schemas may indicate how to extract one or more pieces of data from data associated with an event. In addition, in connection-oriented network communications systems, a "data stream" generally refers to a sequence of encoded signals (e.g., in network packets) used to transmit or receive information over a network.

[0026] 1.2. Remote Capture Agent Architecture

[0027] One or more embodiments include a network architecture for capturing network data in one or more networks using a configuration server working in combination with a set of remote capture agents distributed throughout the network(s). The remote capture agents may capture network packets from multiple sources (e.g., hosts, servers, etc.) and analyze the network packets to determine the packets' contents. The remote capture agents may then generate one or more events from the network packets and communicate the events to the configuration server over one or more additional networks.

[0028] In one or more embodiments, the configuration server includes configuration information used to determine how remote capture agents capture network data and build events therefrom. The remote capture agents may obtain the configuration information from the configuration server (e.g., using a push or pull mechanism) and use the configuration information to generate event data containing a series of timestamped events from the network data. The event data may be included in an event stream that is transmitted to additional network elements within the distributed network for additional processing and/or storage.

[0029] In this manner, both network traffic between the remote capture agents and other network elements and subsequent processing of the network traffic by the other network elements may be drastically reduced because capturing and pre-processing of the network data may be performed at the remote capture agents. For example, the remote capture agents may transmit events in lieu of network packets from which the events were generated to one or more centralized servers for further processing, indexing, and/or storage.

[0030] 1.3. Dynamically Configurable Remote Capture Agents

[0031] Remote capture agents may be dynamically configured based on configuration information stored at the configuration server. For example, the remote capture agents may be configured in real-time as events are processed by the remote capture agents. The remote capture agents may be dynamically configured during runtime with: (1) events (or types of events) to be included in event streams for use by other components of the remote capture agent architecture, (2) fields to be included in each of the events streams, and (3) additional parameters associated with generation of the events and/or event streams.

[0032] The configuration information may be modified on-demand by users (e.g., administrators) at the configuration server and/or at a network component in communication with the configuration server. The configuration information may also be dynamically updated during processing of event streams by one or more applications running on separate servers in communication with the configuration server, such as one or more data storage servers in communication with the configuration server. Events may then be generated from the captured network packets based on the configuration information and/or any updates to the configuration information.

[0033] When changes are made to the configuration information at the configuration server, logic in the remote capture agents may be automatically updated in response. In one embodiment, the remote capture agents poll the configuration server at periodic intervals to determine if there have been any changes to the configuration information stored therein. If changes to the configuration information have been made, the remote capture agents may pull this configuration information from the configuration server. Alternatively, changes to the configuration information may be pushed from the configuration server to the remote capture agents at periodic intervals. Such propagation of updates to the configuration information to the remote capture agents may allow the remote capture agents to be dynamically configured to store different types of network data in events, generate different types of events, aggregate event data, and/or send event data to other network components at different times and/or intervals.

[0034] 1.4. Transforming Event Data at the Remote Capture Agents

[0035] The configuration information may also be used by the remote capture agents to perform higher-level processing of the events before communicating the events to the configuration server. More specifically, the remote capture agents may use some or all of the configuration information to transform (e.g., aggregate, process, clean, filter, etc.) events into one or more sets of transformed event data. The remote capture agents may provide the transformed event data to the configuration server and/or other network components, in lieu of or in addition to the events. The network components may further process the transformed event data and/or store the transformed event data (e.g., in a data storage server).

[0036] In one or more embodiments, some or all of the configuration information related to transforming events is specified by applications running on other servers or systems and communicated to the configuration server. For example, the applications may run on a data-processing system such as the SPLUNK® ENTERPRISE system. Users may use the applications to perform queries and/or visualizations related to event data from the remote capture agents. The applications may provide the configuration server with information regarding the events (or types of events) the application is adapted to receive, along with information related to subsequent processing and/or transformation of those events. The configuration server may obtain the information from the applications for propagation to the remote capture agents, and the remote capture agents may use the information to configure or reconfigure the creation and processing of event data accordingly. In one embodiment, the applications include data storage applications running on a data storage server to facilitate optimizing data storage and retrieval operations.

[0037] 1.5. Graphical Interface for Configuring Event Streams

[0038] A graphical user interface (GUI) may facilitate the configuration of the remote capture agents and/or other network components in generating and/or processing event streams containing event data. The GUI may provide a visual way to create, manage, and/or process event streams based on configuration information associated with each event stream. The GUI may be provided by the configuration server and/or by a network element in communication with the configuration server. The GUI may display representations of one or more components associated with creating and/or processing event streams generated from network traffic. The components may be configured or reconfigured using various icons and/or other user-interface elements in the GUI.

2.0. Structural Overview

[0039] 2.1. Operating Environment

[0040] The data processing techniques described herein are suitable for use by systems deployed in a variety of operating environments. FIG. **1** depicts an example block diagram embodiment of a data-processing system **100** for capturing and processing network data in a distributed network environment. In the illustrated embodiment, system **100** includes a set of configuration servers **120** in communication with a set of remote capture agents **151-153** over one or more networks **190**.

[0041] Although system **100** only depicts three configuration servers **120** and three remote capture agents **151-153**, any number of configuration servers **120** and/or remote capture agents **151-153** may be configured to operate and/or communicate with one another within the data-processing system. For example, a single physical and/or virtual server may perform the functions of configuration servers **120**. Alternatively, multiple physical and/or virtual servers or network elements may be logically connected to provide the functionality of configuration servers **120**. The configuration server(s) may direct the activity of multiple distributed remote capture agents **151-153** installed on various client computing devices across one or more networks. In turn, remote capture agents **151-153** may be used to capture network data from multiple remote network data sources.

[0042] Further, embodiments described herein can be configured to capture network data in a cloud-based environment, such as cloud **140** depicted in the illustrated embodiment, and to generate events such as clickstream events and/or business transactions out of the network data. Remote capture agents **151-153** may capture network data originating from numerous distributed network servers, whether they are physical hardware servers or virtual machines running in cloud **140**. In cloud-based implementations, remote capture agents **151-153** will generally only have access to information that is communicated to and received from machines running in the cloud-based environment. This is because, in a cloud environment, there is generally no access to any of the physical network infrastructure, as cloud computing may utilize a "hosted services" delivery model where the physical network infrastructure is typically managed by a third party.

[0043] Embodiments further include the capability to separate the data capture technology into a standalone component that can be installed directly on client servers, which may be physical servers or virtual machines residing on a cloud-based network (e.g., cloud **140**), and used to capture and generate events for all network traffic that is transmitted in and out of the client servers. This eliminates the need to deploy and connect physical hardware to network TAPS or SPAN ports, thus allowing users to configure and change their data capture configuration on-the-fly rather than in fixed formats.

[0044] In the illustrated embodiment, remote capture agents **152-153** are in communication with network servers **130** residing in cloud **140**, and remote capture agent **151** is located in cloud **140**. Cloud **140** may represent any number of public and private clouds, and is not limited to any particular cloud configuration. Network servers **130** residing in cloud **140** may be physical servers and/or virtual machines in cloud **140**, and network traffic to and from network servers **130** may be monitored by remote capture agent **151** and/or other remote capture agents connected to network servers **130**. Further, remote capture agents **152-153** may also run in cloud **140** on physical servers and/or virtual machines. Those skilled in the art will appreciate that any number of remote capture agents may be included inside or outside of cloud **140**.

[0045] Remote capture agents **151-153** may analyze network packets received from the networks(s) to which remote capture agents **151-153** are connected to obtain network data from the network packets and generate a number of events from the network data. For example, each remote capture agent **151-153** may listen for network traffic on network interfaces available to the remote capture agent. Network packets transmitted to and/or from the network interfaces may be intercepted by the remote capture agent and analyzed, and relevant network data from the network packets may be used by the remote capture agent to create events related to the network data. Such events may be generated by aggregating network data from multiple network packets, or each event may be generated using the contents of only one network packet. A sequence of events from a remote capture agent may then be included in one or more event streams that are provided to other components of system **100**.

[0046] Configuration servers **120**, data storage servers **135**, and/or other network components may receive event data (e.g., event streams) from remote capture agents **151-153** and further process the event data before the event data is stored by data storage servers **135**. In the illustrated embodiment, configuration servers **120** may transmit event data to data storage servers **135** over a network **101** such as a local area network (LAN), wide area network (WAN), personal area network (PAN), virtual private network, intranet, mobile phone network (e.g., a cellular network), WiFi network, Ethernet network, and/or other type of network that enables communication among computing devices. The event data may be received over a network (e.g., network **101**, network **190**) at one or more event indexers (see FIG. **10**) associated with data storage servers **135**.

[0047] In addition, system **100** may include functionality to determine the types of network data collected and/or processed by each remote capture agent **151-153** to avoid data duplication at the indexers, data storage servers **135**, and/or other components of system **100**. For example, remote capture agents **152-153** may process network traffic from the same network. However, remote capture agent **152** may generate page view events from the network traffic, and remote capture agent **153** may generate request events (e.g., of HyperText Transfer Protocol (HTTP) requests and responses) from the network traffic.

[0048] In one or more embodiments, configuration servers **120** include configuration information that is used to configure the creation of events from network data on remote capture agents **151-153**. In addition, such configuration may occur dynamically during event processing (e.g., at runtime). Conversely, because most conventional network capture technologies target specific end uses, they have been designed to operate in a fixed way and generally cannot be dynamically or easily modified to address different and changing business needs.

[0049] At least certain embodiments described herein are adapted to provide a distributed remote capture platform in which the times at which events are communicated to the configuration servers **120** and the fields to be included in the events are controlled by way of user-modifiable configuration rather than by "hard coding" fixed events with predetermined fields for a given network capture mechanism. The remote configuration capability described herein also enables additional in-memory processing (e.g., filtering, transformation, normalization, aggregation, etc.) on events at the point of capture (e.g., remote capture agents **151-153**) before the events are transmitted to other components of system **100**.

[0050] Configuration information stored at each configuration server **120** may be created and/or updated manually at the configuration server and/or at a network element in communication with the configuration server. For example, a user may upload a configuration file containing configuration information for a remote capture agent to one or more configuration servers **120** for subsequent propagation to the remote capture agent. Alternatively, the user may use a GUI to provide the configuration information, as described in further detail below with respect to FIGS. **8-9**. The configuration information may further be provided by one or more applications running on a separate server or network element, such as data storage servers **135**.

[0051] Remote capture agents **151-153** may then use the configuration information to generate events from captured network packets. When changes in the configuration information at the configuration server are detected at the remote capture agents, logic in the remote capture agents may be automatically reconfigured in response. This means the remote capture agents may be configured dynamically to produce different events, transform the events, and/or communicate event streams to different components of system **100**.

[0052] To detect changes in configuration information at configuration servers **120**, remote capture agents **151-153** may poll configuration servers **120** at periodic intervals for updates to the configuration information. The updates may then be pulled from configuration servers **120** by remote capture agents **151-153**. Conversely, updates to the configuration information may be pushed from configuration servers **120** to remote capture agents **151-153** at periodic intervals and/or when changes to the configuration information have been made.

[0053] In one embodiment, configuration servers **120** include a list of event streams generated by remote capture agents **151-153**, as well as the configuration information used to generate the event streams at remote capture agents **151-153**. The configuration information may include a unique identifier for each event stream, the types of events to be included in the event stream, one or more fields to be included in each event, and/or one or more filtering rules for filtering events to be included in the event stream. Configuration information for dynamically modifying network data capture by remote capture agents (e.g., remote capture agents **151-153**) is described in further detail below with respect to FIG. **2**.

[0054] The configuration information may also specify transformations of network data and/or events into transformed events. Such transformations may include, for example, aggregations of network data and/or events, generation of statistics and/or metrics from the network data or events, and/or cleaning and/or filtering of the network data and/or events. As with other event streams, event streams containing transformed event data may be transmitted from remote capture agents **151-153** to configuration servers **120**, data storage servers **135**, and/or other components of system **100** for further processing, storage, and/or use.

[0055] Configuration information associated with transformed events may be obtained from end users and/or applications running on various network elements that receive the events. For example, an application executing on a data storage server (e.g., data storage servers **135**) may provide statistics associated with network usage in cloud **140**. To reduce overhead associated with real-time processing of event data by the application into the statistics, the application may provide configuration information for generating some or all of the statistics at one or more remote capture agents (e.g., remote capture agents **151-153**) connected to cloud **140**. The configuration information may be transmitted to configuration servers **120** and subsequently propagated to the relevant remote capture agents. In turn, the remote capture agents may use the configuration information to generate transformed events containing statistics associated with events captured by the remote capture agents, and the transformed events may be provided to the application to enable access to the statistics by users of the application without requiring the application to calculate the statistics at query time.

[0056] Such use of distributed remote capture agents **151-153** may offload processing tasks from configuration servers **120** and/or other components of system **100** to remote capture agents **120** (e.g., similar to parallelizing a network), while avoiding overloading of client network servers at remote networks by burdening the client network servers with the full functionality of configuration servers **120**. System **100** may further reduce network traffic between remote capture agents **151-153** and the other components of system **100** because remote capture agents **120** convert a potentially large volume of raw network traffic into a smaller volume of events and further filter the event data as directed by the configuration information before transmitting the event data to other components of system **100**.

[0057] Another advantage is that the work performed by system **100** may be distributed among multiple remote capture agents **151-153** on one or more networks. Remote capture agents **151-153** may occupy small footprints on remote client servers, thus mitigating resource usage by remote capture agents **151-153** on the client servers. For example, remote capture agents **151-153** may execute as background processes on physical and/or virtualized servers. On the other hand, configuration servers **120** may execute from one or more centralized locations and/or on one or more sets of dedicated resources because the operation of configuration servers **120** may require significantly more computing resources than the operation of remote capture agents **151-153**.

[0058] As depicted in FIG. **1**, system **100** further includes one or more data storage servers **135**. Data storage servers **135** may be general or special-purpose computers configured to process and manipulate data within one or more data repositories. As depicted, data storage servers **135** may be coupled to data storage devices **155** using any suitable mechanism, such as a Fiber Channel network, a Serial ATA (SATA) link, a Universal Serial Bus (USB) connection, an Infiniband link, an Ethernet connection, and/or other type of interface. Data storage servers **135** can be configured to communicate input/output (I/O) requests to storage devices **155**. These I/O requests may be communicated via messages in protocols such as Server Message Block protocol, Network File System (NFS) protocol, Small Computer System Interface (SCSI) protocol, and/or Fibre Channel. In response to the requests, data storage servers **135** may read and write data structures such as data blocks, files, tables, and/or result sets from storage devices **155**. In an embodiment, data storage servers **135** may include some or all of storage devices **155**.

[0059] Instructions for processing and manipulating data (e.g., event data) may be executed by data storage servers **135**. For example, data storage servers **135** may perform data operations with respect to one or more data repositories. Data operations supported by these processes may include relatively simple operations such as adding or retrieving lines or rows of data from the data storage devices. The supported data operations may further include operations such as filtering the contents of retrieved data and./or performing transformations (e.g., aggregations, calculations, processing, cleaning, filtering, etc.) of the retrieved data.

[0060] In one or more embodiments, data storage servers **135** and/or configuration servers **120** provide one or more transformation servers that perform additional processing of event data from remote capture agents **151-153**. Conversely, one or more configuration servers **120** and/or data storage servers **135** may be installed within a transformation server and/or execute independently from transformation servers in the data-processing system **100**. The transformation servers may be used to aggregate, filter, format, query, transform, store, and/or otherwise manipulate event data, as described in further detail below with respect to FIG. **8**.

[0061] In another embodiment, data storage servers **135** may constitute one or more conventional database servers, such as a relational database server. These processes need not necessarily support the entire functionality of a database server or operate on conventional database structures.

[0062] Data repositories accessed by data storage servers **135** may be stored on data storage devices **155**. Data storage devices **155** may be, for instance, nonvolatile computer-readable media such as hard disk drives, flash/SSD drives, nonvolatile memory, optical storage devices, disk arrays, storage area network devices, networked-attached storage devices, and/or file server devices. Storage devices **155** may store the data repositories in any suitable underlying form (s), such as disk blocks, file structures, or database tables. If multiple storage devices **155** are used in system **100**, different portions of a data repository may be stored on different storage devices **155**. Optionally, certain storage devices **155** may be configured to store some or all portions of a data repository redundantly, using any suitable backup or synchronization mechanism(s).

[0063] In an embodiment, each storage device **155** is equally accessible to each data storage server **135**, and thus any data storage server **135** may perform operations on any data stored within the data repositories. In other embodiments, each data storage server **135** is assigned to only some or even one of the data storage devices **155**, and is only configured to perform operations on data storage device(s) **155** to which it is assigned.

[0064] System **100** is only one example of the many types of operating environments in which the techniques described herein may be practiced. Other suitable operating environments may include additional or fewer elements, in varying arrangements. For instance, some or all data storage servers **135** may be replaced by virtual computing environments (e.g., virtual machines), some or all of which may execute on a single computing device.

[0065] System **100** further utilizes data repositories provided by storage devices **155**. The data repositories may include one or more data collections, and each data collection may be a collection of data structures having a variety of forms. For example, a data collection may include a collection of time-based event data structures (e.g., one or more event streams), a group of data rows, a relational database, a relational database table, set of Extended Markup Language (XML) elements, and/or one or more files. Different data collections within the same repository may support different data structure types. In an embodiment, a data collection containing of any of the foregoing data structures is augmented with system-defined or user-defined variables that can be updated to describe certain characteristics of the data stored in the data collection. Examples of such variables may include counters or metrics. In an embodiment, each data collection is stored redundantly on multiple data storage devices **155**, and synchronized therebetween. In an embodiment, each data collection is found on only some or even one of the data storage devices **155**.

[0066] FIG. **2** depicts an example block diagram embodiment of a remote capture agent **250**. In the illustrated embodiment, remote capture agent **250** is adapted to receive configuration information from one or more configuration servers **120** over network **101**. Remote capture agent **250** may be installed at a customer's premises on one or more of the customer's computing resources. For example, remote capture agent **250** may be installed on a physical server and/or in a virtual computing environment (e.g., virtual machine) that is distributed across one or more physical machines.

[0067] Remote capture agent **250** includes a network communications component **203** configured to communicate with network elements on one or more networks (e.g., network **101**) and send and receive network data (e.g., network packets) over the network(s). As depicted, network communications component **203** may communicate with configuration servers **120** over network **101**. Network communications component **203** may also communicate with one or more sources of network data, such as network servers **130** of FIG. **1**.

[0068] Network data received at network communications component **203** may be captured by a capture component **205** coupled with network communications component **203**. Capture component **205** may capture some or all network data from network communications component **203**. For example, capture component **205** may capture network data based on the sources and/or destinations of the network data, the types of network data, the protocol associated with the network data, and/or other characteristics of the network data.

[0069] In addition, the network data may be captured based on configuration information stored in a configuration component **204** of remote capture agent **250**. As mentioned above, the configuration information may be received from configuration servers **120** over network **101**. The configuration information may then be used to dynamically configure or reconfigure remote capture agent **250** in real-time. For example, newly received configuration information in configuration component **204** may be used to configure the operation of remote capture agent **250** during processing of events from network data by remote capture agent **250**.

[0070] To dynamically configure remote capture agent **250**, configuration information received by configuration component **204** from configuration servers **120** may be provided to other components of remote capture agent **250**. More specifically, remote capture agent **250** includes an events generator **207** that receives network data from network data capture component **205** and generates events from the network data based on configuration information from configuration component **204**.

[0071] Using configuration information provided by configuration servers **120**, remote capture agent **250** can be instructed to perform any number of event-based processing operations. For example, the configuration information may specify the generation of event streams associated with network (e.g., HTTP, Simple Mail Transfer Protocol (SMTP), Domain Name System (DNS)) transactions, business transactions, errors, alerts, clickstream events, and/or other types of events. The configuration information may also describe custom fields to be included in the events, such as values associated with specific clickstream terms. The configuration information may include additional parameters related to the generation of event data, such as an interval between consecutive events and/or the inclusion of transactions and/or errors matching a given event in event data for the event.

[0072] An events transformer **209** may further use the configuration information to transform some or all of the network data from capture component **205** and/or events from events generator **207** into one or more sets of transformed events. In one or more embodiments, transformations performed by events transformer **209** include aggregating, filtering, cleaning, and/or otherwise processing events from events generator **207**. Configuration information for the transformations may thus include a number of parameters that specify the types of transformations to be performed, the types of data on which the transformations are to be performed, and/or the formatting of the transformed data.

[0073] For example, configuration information for generating an event stream from network data (e.g., at events generator **207**) may include the following Javascript Object Notation (JSON) data:

```
{
  "id" : "trans_class",
  "name": "auto-classified transactions",
  "streamType" : "trans_class"
}
```

[0074] The JSON data may include a unique identifier (e.g., "id") of "trans_class" for the event stream, a descriptive name (e.g., "name") of "auto-classified transactions" for the event stream, and an event stream type (e.g., "streamType") of "trans_class." Event data in the event stream may be identified by the identifier and/or descriptive name. The "trans_class" event stream type may indicate that events in the event stream represent automatically classified transactions such as user logins and logouts, shopping cart checkouts, new user signups, and/or file transfers, with a new event generated per automatically classified transaction. In addition, the event may include a unique identifier for the classified transaction type, as well as a Uniform Resource Identifier (URI) stem, a query string, a host name, and/or a page title for the transaction.

[0075] In another example, configuration information for performing transformations on events from events generator **207** (e.g., at events transformer **209**) may include the following JSON data:

```
{
  "id" : "trans_metrics",
  "name": "transaction metrics aggregated by id",
  "streamType" : "agg_trans",
  "fields" : [
    {
        "name" : "sessions",
        "desc" : "total number of visitor sessions",
        "term" : "clickstream.new-session",
        "aggType" : "sum"
    },
    {
        "name" : "hits",
        "desc" : "total number of HTTP transactions",
        "term" : "clickstream.page-hits",
```

-continued

```
        "aggType" : "sum"
    },
    {
        "name" : "cs_bytes",
        "desc" : "total octets from client to server (ingress)",
        "term" : "clickstream.cs-bytes",
        "aggType" : "sum"
    },
    {
        "name" : "sc_bytes",
        "desc" : "total octets from server to client (egress)",
        "term" : "clickstream.sc-bytes",
        "aggType" : "sum"
      },
      {
        "name" : "total_time",
        "desc" : "total clock time from start to end of the transaction
(microsec)",
        "term" : "clickstream.page-load",
        "aggType" : "sum"
      },
      {
        "name" : "redirect_time",
        "desc" : "total clock time spent processing HTTP redirects
(microsec)",
        "term" : "clickstream.page-load-redirect",
        "aggType" : "sum"
      },
      {
        "name" : "base_time",
        "desc" : "total clock time spent loading the base HTML file
(microsec)",
        "term" : "clickstream.page-load-base",
        "aggType" : "sum"
      },
      {
        "name" : "content_time",
        "desc" : "total clock time spent loading everything else
(microsec)",
        "term" : "clickstream.page-load-content",
        "aggType" : "sum"
      },
      {
        "name" : "time_taken",
        "desc" : "sum of measurements from start to end of each HTTP
transaction (microsec)",
        "term" : "clickstream.time-taken",
        "aggType" : "sum"
      },
      {
        "name" : "client_rtt_sum",
        "desc" : "sum of round trip time measurements between client
& agent (microsec)",
        "term" : "clickstream.cp-rtt-sum",
        "aggType" : "sum"
      },
      {
        "name" : "client_rtt_count",
        "desc" : "count of round trip time measurements between client
& agent",
        "term" : "clickstream.cp-rtt-packets",
        "aggType" : "sum"
      },
      {
        "name" : "server_rtt_sum",
        "desc" : "sum of round trip time measurements between server
& agent (microsec)",
        "term" : "clickstream.ps-rtt-sum",
        "aggType" : "sum"
      },
      {
        "name" : "server_rtt_count",
        "desc" : "count of round trip time measurements between server
& agent",
        "term" : "clickstream.ps-rtt-packets",
        "aggType" : "sum"
```

-continued

```
      },
      {
        "name" : "refused",
        "desc" : "total number of HTTP transactions that were refused
by
the server",
        "term" : "clickstream.refused",
        "aggType" : "sum"
      },
      {
        "name" : "canceled",
        "desc" : "total number of HTTP transactions that were canceled
by the client",
        "term" : "clickstream.canceled",
        "aggType" : "sum"
      },
      {
        "name" : "cached",
        "desc" : "total number of HTTP transactions that had cached
responses",
        "term" : "clickstream.cached",
        "aggType" : "sum"
      }
  ]
}
```

[0076] The JSON data may include a unique identifier (e.g., "id") of "trans_metrics" for the set of transformed events and a descriptive name (e.g., "name") of "transaction metrics aggregated by id" for the transformed events. The JSON data may also provide an event stream type (e.g., "streamType") of "agg_trans," indicating that the configuration relates to transformations that aggregate transactions from other event data, such as event data generated using the "trans_class" configuration above. The JSON data may additionally include a list of custom fields (e.g., "fields") that specify the types of data to be aggregated, such as numbers of visitor sessions or HTTP transactions, octets between clients and servers, clock times associated with page loads, and/or round-trip time (RTT) measurements between various network components. Each field may include a name (e.g., "name") for the corresponding aggregation, a description (e.g., "desc") of the aggregation, a clickstream term (e.g., "term") representing the data to be aggregated, and an aggregation type (e.g., "aggType"). While the exemplary configuration information above shows an aggregation type of "sum" (e.g., summing of values represented by "term" across all events within an aggregation interval) for all aggregations, other aggregation types may be supported by remote capture agent **250**. Such aggregation types may include, for example, a key (e.g., hash) for each set of aggregated values, statistics (e.g., mean, median, variance, standard deviation, minimum value, maximum value, etc.) associated with the aggregated values, a uniqueness count for each unique value within an aggregation interval, and/or calculations used to aggregate values from two or more fields.

[0077] A rules comparison engine **208** in remote capture agent **250** may receive events from event generator **207** and compare one or more fields from the events to a set of filtering rules in the configuration information to determine whether to include the events in an event stream. For example, the configuration information may specify packet-level, protocol-level, and/or application-level filtering of event data from event streams generated by remote capture agent **250**.

[0078] Finally, a data enrichment component **211** may further transform event data to a different form or format based on the configuration information from configuration component **204**. For example, data enrichment component **211** may use the configuration information to normalize the data so that multiple representations of the same value (e.g., timestamps, measurements, etc.) are converted into the same value in transformed event data.

[0079] Data can be transformed by data enrichment component **211** in any number of ways. For example, remote capture agent **250** may reside on a client server in Cupertino, Calif., where all the laptops associated with the client server have been registered with the hostname of the client server. Remote capture agent **250** may use the registration data to look up an Internet Protocol (IP) address in a look-up table (LUT) that is associated with one or more network elements of the client server's local network. Remote capture agent **250** may then resolve a user's IP address into the name of the user's laptop, thereby enabling inclusion of the user's laptop name in transformed event data associated with the IP address. The transformed event data may then be communicated to configuration servers **120** and/or a central transformation server residing in San Francisco for further processing, indexing, and/or storage.

[0080] A further advantage of the techniques described herein includes relates to the transformation of network data at least at two distinct levels, including at the remote capture agents during generation of the events and at the configuration server and/or other components during subsequent processing of event data. FIG. **3** depicts an example block diagram embodiment of a configuration server **320**. As shown in the illustrated embodiment, configuration server **320** is in communication with multiple remote capture agents **350** over network **190**, and remote capture agents **350** are distributed throughout network **190** and cloud **140**. Configuration server **320** includes a network communications component **303** that receives events from remote capture agents **350** over networks **190** and/or **140**. Communications component **303** may also communicate with one or more data storage servers, such as data storage servers **135** of FIG. **1**.

[0081] Configuration server **320** also includes a configuration component **304** that stores configuration information for remote capture agents **350**. As described above, the configuration information may specify the types of events to produce, data to be included in the events, and/or transformations to be applied to the data and/or events to produce transformed events. Some or all of the transformations may be specified in a set of filtering rules **321** that may be applied to event data at remote capture agents **350** to determine a subset of the event data to be included in one or more event streams that are sent to configuration server **320** and/or other components.

[0082] Configuration server **320** also includes a data processing component **311** that performs additional processing of the event streams based on configuration information from configuration component **304**. As discussed in the above example with respect to FIG. **2**, event data may be transformed at a remote capture agent (e.g., remote capture agent **250**) during resolution of the user's IP address was into the name of the user's laptop. The transformed event data may be sent to configuration server **320** and/or a transformation server for additional processing and/or transformation, such as taking the host name from the transformed event data, using an additional LUT to obtain a user identifier (user ID) of the person to which the laptop is registered, and further transforming the event data by including the user ID in the event data before forwarding the event data to a third server (e.g., a transformation server) for another round of processing.

[0083] Configuration server **320** may also provide a GUI **325** that can be used to configure or reconfigure the information contained in configuration component **304**. The operation of GUI **325** is discussed in further detail below with respect to FIGS. **7-9**.

3.0. Functional Overview

[0084] 3.1. Remote Capture Agent Architecture

[0085] The techniques described in this section can be performed by the data processing system for capturing and processing network data in a distributed network environment as shown in FIG. **1**. FIG. **4** shows a flowchart illustrating the processing of network data. More specifically, FIG. **4** shows a flowchart of network data capture and processing in accordance with the disclosed embodiments. In one or more embodiments, one or more of the steps may be omitted, repeated, and/or performed in a different order. Accordingly, the specific arrangement of steps shown in FIG. **4** should not be construed as limiting the scope of the embodiments.

[0086] Initially, one or more event streams are obtained from one or more remote capture agents on one or more networks (operation **402**). The event streams may include event data that is generated from network data (e.g., network packets) captured by the remote capture agent(s) on the network(s). For example, the event streams may include a series of sequentially timestamped events, with each event generated from data in one or more network packets related to the event. As a result, event data for the event may include information such as an identifier, a transaction type (e.g., for an HTTP transaction and/or business transaction), a timestamp, and/or any errors associated with the event. In addition, the event data may be associated with (e.g., represent) clickstream data, transactions, business transactions, errors, and/or alerts.

[0087] The event streams may additionally include transformed event data generated from the network data and/or event data by the remote capture agent(s). For example, the event streams may include transformed event data that is obtained by performing aggregations, calculations, filtering, normalization, and/or formatting of the network data and/or event data at the remote capture agent(s).

[0088] Next, one or more transformations are applied to the event stream(s) to obtain transformed event data from the event data (operation **404**). As with any transformations already applied at the remote capture agent(s), the transformation(s) may include aggregations, calculations, filtering, normalization, and/or formatting of the network data and/or event data at the remote capture agent(s). Moreover, the transformation(s) may be applied on top of previous transformations performed by the remote capture agent(s), so that one round of transformations may initially be applied at the remote capture agent(s) during generation of the event streams and another round after the event streams are received from the remote capture agent(s). Such transformation(s) may be performed by one or more reactors on one or more transformation servers, as described in further detail below with respect to FIG. **7**.

[0089] The transformation(s) may also be used to store the event data and/or transformed event data (operation **406**). For example, the transformation(s) may be used to store the event data and/or transformed event data in a database and/or log file. Finally, querying of the transformed event data is enabled (operation **408**). For example, the transformed event data may be indexed, and queries may be executed on the indexed, transformed event data. The queries may further be performed in parallel on different subsets of the transformed event data. For example, a set of indexers may be used to index mutually exclusive time spans of the transformed event data and query the transformed event data using a map-reduce technique that operates on the time spans in parallel, as described in further detail below with respect to FIGS. **10-12**.

[0090] Similarly, capturing of the network data may be divided among the remote capture agents to avoid data duplication. In addition, the remote capture agents may execute in and/or capture the network data from one or more virtual machines running in a cloud-based environment. This avoids the necessity of using a network TAP or SPAN port connection for access to and/or capturing of network data from physical network infrastructure.

[0091] 3.2. Dynamically Configurable Remote Capture Agents for Capturing Network Data

[0092] FIG. **5** shows a flowchart illustrating the process of facilitating the processing of network data. More specifically, FIG. **5** shows a flowchart of configuring a remote capture agent in accordance with the disclosed embodiments. In one or more embodiments, one or more of the steps may be omitted, repeated, and/or performed in a different order. Accordingly, the specific arrangement of steps shown in FIG. **5** should not be construed as limiting the scope of the embodiments.

[0093] First, configuration information for a remote capture agent is obtained at the remote capture agent from a configuration server (operation **502**). The remote capture agent may be located on a separate network from that of the configuration server. For example, the remote capture agent may be installed on a physical and/or virtual machine on a remote network and/or cloud. As discussed above, the remote capture agent and other remote capture agents may be used to capture network data from a set of remote networks in a distributed manner. The captured network data may then be converted into event data that is included in a number of event streams by the remote capture agent(s). For example, a remote capture agent may generate an event to be included in an event stream by identifying one or more network packets associated with a packet and using the network data from the network packet(s) to generate event data corresponding to the event.

[0094] The configuration information may include a unique numeric or string identifier for each event stream to be generated by the remote capture agent. The configuration information may also include a description and/or a descriptive name of the event stream. The configuration information may further specify an event stream type that identifies the type of event data (e.g., clickstream events, HTTP transactions, business transactions, errors, alerts, classified transactions, etc.) to be included in the event stream. Finally, the configuration information may include a list of custom fields (e.g., for including specific pieces of network data in the events) and/or one or more additional parameters associated with generating the event data (e.g., time interval between events, maximum number of cached and/or aggregated events, inclusion of matching transactions or errors in the event data, types of events used by the event stream, etc.).

[0095] Next, the configuration information is used to configure the generation of event data from network data (e.g., from network packets) at the remote capture agent (operation **504**). For example, the configuration information may be used to configure the remote capture agent to identify certain types of network packets, extract network data from the network packets, and/or include the network data in the event data. The configuration information may also be used to configure the transformation of event data or network data into transformed event data at the remote capture agent (operation **506**).

[0096] For example, the configuration information may specify that the event data and/or network data be aggregated into a sum, statistic (e.g., mean, median, minimum, maximum, etc.), and/or uniqueness count (e.g., number of times a unique value is found in an aggregation interval). To aggregate the event data and/or network data, a time interval associated with aggregation of the event data and/or network data may be obtained, and the event data and/or network data within the time interval may be aggregated into an event count, statistic, and/or uniqueness count. The configuration information may also specify a calculation (e.g., mathematical function, mathematical formula, etc.) to be performed on the network data and/or event data to produce the transformed event data. The configuration information may further provide a filter (e.g., regular expression, range of values, exact value, etc.) for removing a subset of the event data and/or network data to produce the transformed event data. The configuration information may additionally specify a normalization that is used to transform different representations of the same value (e.g., timestamp, host name, resource name, location, etc.) into the same normalized value. Finally, the configuration information may provide a formatting that may be applied to the event data and/or network data to generate transformed event data that adheres to a specific format.

[0097] After the remote capture agent is configured, one or more event streams containing the event data and/or transformed event data from the remote capture agent are provided to one or more transformation servers for further transformation of the event data and/or transformed event data by the transformation server(s) (operation **508**). For example, the event stream(s) may be transmitted over one or more networks to the transformation server(s), and the transformation server(s) may perform additional aggregations, calculations, filtering, normalization, and/or formatting associated with the event data and/or transformed event data.

[0098] An update to the configuration information may be received (operation **512**) by the remote capture agent. For example, the update may be detected by the remote capture agent after polling the configuration server and determining that the version of configuration information at the configuration server is newer than the version at the remote capture agent. The remote capture agent may then pull the update from the configuration server. Alternatively, the update may be pushed from the configuration server to the remote capture agent. If no update is received, the remote capture agent may continue to be used (operation **516**) to capture network data as-is.

[0099] If an update to the configuration information is received, the update is used to reconfigure the generation and/or transformation of event data and/or network data at the remote capture agent during runtime of the remote capture agent (operation **514**). For example, the remote capture agent may be reconfigured to generate and/or transform the event data and/or network data while the remote capture agent continues to generate event streams containing event data and/or network data according to the old configuration.

[0100] The remote capture agent may continue to be used (operation **516**) to capture network data with or without reconfiguring the remote capture agent using updates to the configuration information. If the remote capture agent is to be used, one or more event streams from the remote capture agent are continually provided to one or more transformation servers for further transformation by the transformation server(s) (operation **508**), and any updates to the configuration information are used to reconfigure the operation of the remote capture agent (operations **512**-**514**) during generation of the event stream(s). Capture of network data by the remote capture agent may continue until the remote capture agent is no longer used to generate event data and/or transformed event data from network data at the network to which the remote capture agent is connected.

[0101] In one or more embodiments, some or all of the configuration information is provided to the configuration server by an application used to access the transformed event data. The application may be designed around one or more specific use cases associated with network data captured by the remote capture agent, such as managing virtual machines, assessing network security, performing web analytics, and/or managing web application performance. The application may also execute on the SPLUNK® ENTERPRISE platform and have access to both the configuration server and event data generated by the remote capture agent.

[0102] To offload processing of the event data at the application (e.g., during real-time querying and/or visualization of the event data), the application may provide configuration information for performing the processing at the remote capture agent to the configuration server, and the configuration server may propagate the configuration information to the remote capture agent. In turn, the remote capture agent may use the configuration to perform the processing as the event data is generated and/or transformed instead of requiring the application to perform significant processing the event data in real-time. In other words, subsequent real-time processing of event data by the application and the associated overhead associated with such processing may be reduced by providing configuration information that causes the remote capture agent to transform event data into a form that can be used by the application.

[0103] This may integrate better with a late-binding schema, such as the late-binding schema implemented by Splunk Inc. of San Francisco, Calif., because significant resources may be required to aggregate, format, and/or otherwise transform event data and extract fields at run-time. The term "late-binding schema" refers to a system, such as SPLUNK® ENTERPRISE, where the schema need not be defined at index time, as with database technology. Rather, in a system involving late-binding schema, the schema can be developed on an ongoing basis up until a query, during execution, applies (binds) the schema to data to evaluate the data. As a user learns more about the data in stored events, in a late-binding schema, he/she can continue to develop the schema up until the next time it is needed for a query. Because SPLUNK® ENTERPRISE maintains the underlying raw data and enables application of a late-binding schema, SPLUNK® ENTERPRISE may have greater capability to enable deep exploration of the data to solve problems reflected in the data and answer questions about the data than conventional databases or data-processing systems that merely store summaries or portions of data.

[0104] For example, a security application monitoring login attempts on a web application may use incorrect password entries by users during the login attempts to assess the security of the web application. The security application may provide configuration information for generating event data corresponding to login failures, with the event data containing usernames, IP addresses, timestamps, and/or passwords entered for the login failures. Because the security application may receive events only when failed login attempts occur, the security application may not be required to filter the event data for failed login attempts.

[0105] Continuing with the above example, the configuration information may specify the aggregation of failed login attempts into failed login attempts per minute. Thus, instead of receiving an event every time a failed login attempt occurs, the security application may receive event data every minute that indicates the number of failed login attempts for the last minute.

[0106] 3.3. Operation of Configuration Server

[0107] FIG. **6** shows a flowchart illustrating the process of facilitating data capture. In particular, FIG. **6** shows a flowchart illustrating the process of operating a configuration server in accordance with the disclosed embodiments. In one or more embodiments, one or more of the steps may be omitted, repeated, and/or performed in a different order. Accordingly, the specific arrangement of steps shown in FIG. **6** should not be construed as limiting the scope of the embodiments.

[0108] First, configuration information for a set of remote capture agents on a set of networks is obtained at the configuration server (operation **602**). The configuration information may be obtained from a user e, g, an administrator) and/or an application used to access event data generated by the remote capture agents. Next, the configuration server is used to provide the configuration information to the remote capture agents (operation **604**). For example, the configuration server may use a push and/or pull mechanism to transmit the or more event streams to generate visualizations based onhe configuration information may then be used by the remote capture agents to configure the generation and/or transformation of event data, as described above.

[0109] An update to the configuration information may be obtained (operation **606**). For example, an update to the configuration information may be obtained to enable the generation of new event streams at one or more of the remote capture agents for use with one or more new use cases associated with network data capture by the remote capture agent(s). If an update to the configuration information is obtained, the configuration server is used to provide the update to the remote capture agents (operation **608**), and the update is used to reconfigure the generation and/or transformation of the event data at the remote capture agents during runtime of the remote capture agents. If no update is received, no additional configuration information may be transmitted between the configuration server and remote capture agents.

[0110] The remote capture agents may continue to be configured (operation **610**) using configuration information from the configuration server. If the remote capture agents are to be configured using the configuration server, any updates to the configuration information are transmitted from the configuration server to the remote capture agents (operation **606-608**) to enable reconfiguration of the remote capture agents. Such transmission of updates to the configuration information to the remote capture agents may continue until the configuration server is no longer used to dynamically configure the remote capture agents.

[0111] 3.4. GUI for Configuring Event Streams

[0112] FIG. **7** shows a flowchart illustrating the process of facilitating the processing of data. More specifically, FIG. **7** shows a flowchart of using a GUI to obtain configuration information for managing event streams in accordance with the disclosed embodiments. In one or more embodiments, one or more of the steps may be omitted, repeated, and/or performed in a different order. Accordingly, the specific arrangement of steps shown in FIG. **5** should not be construed as limiting the scope of the embodiments.

[0113] Initially, the GUI is provided for obtainining configuration information for configuring the generation of event data from network data obtained from network packets at one or more remote capture agents (operation **702**). The configuration information may be obtained using a configuration dialog of the GUI, as discussed in further detail below with respect to FIG. **9**.

[0114] Next, use of the GUI in configuring the connection of one or more event streams containing the event data to one or more reactors for subsequent processing of the event data by the reactor(s) is enabled (operation **704**). For example, graphical representations of the event stream(s) and reactor(s) may be displayed in the GUI, and directed edges for connecting the graphical representations may be provided by the GUI. A directed edge from one component (e.g., event stream or reactor) to another may thus represent the passing of output from the component as input to the second component. Using GUIs to connect event streams and reactors is described in further detail below with respect to FIG. **8**.

[0115] Use of the GUI in configuring the subsequent processing of the event data by the reactor(s) is also enabled (operation **706**). For example, the GUI may provide a separate configuration dialog for configuring each type of reactor used to process event streams. Finally, the configuration information is provided to the remote capture agent (s), where the configuration information is used to configure the generation of the event data at the remote capture agent(s) during runtime of the remote capture agent(s).

[0116] In one or more embodiments, reactors are provided by one or more transformation servers that transform the event data after the event data is created and/or initially transformed at the remote capture agent(s). As noted above, configuration servers may be transformation servers. Alternatively, a configuration server may be included within a transformation server and/or execute independently from the transformation server. The reactors may include collection reactors that collect event and/or network data, processing reactors that process event and/or network data, and/or storage reactors that store event and/or network data. Within the GUI, the reactors may be represented by icons and/or other user-interface elements that may be selected to configure the operation of the reactors.

[0117] FIG. **8** depicts an example screen shot of an embodiment of a GUI **800** that is adapted to display configurable components within a distributed data capture and processing system. GUI **800** may be provided by a configuration server, such as configuration servers **120** of FIG. **1**.

[0118] In the illustrated embodiment, GUI **800** includes two stream icons **801** and **802** that correspond to graphical representations of two event streams. Icon **801** is connected to a filter reactor icon **803** using a directed edge, which is further connected to a python reactor icon **806** using another directed edge. Filter reactor icon **803** may be a graphical representation of a filter reactor that filters event streams provided as input to the filter reactor according to one or more filtering rules (e.g., regular expressions, network data types, event types, time spans, etc.) and outputs the filtered event streams. Python reactor icon **806** may be a graphical representation of a python reactor that creates, processes, or stores events using the Python programming language. As a result, event data from the event stream represented by stream icon **801** may be filtered by the filter reactor before being processed by the python reactor.

[0119] Another series of directed edges in GUI **800** may connect stream icon **802** to a cleansing transformation reactor icon **804**, which in turn is connected to both a filter reactor icon **805** and an aggregator reactor icon **807**. Cleansing transformation reactor icon **804** may be a graphical representation of a cleansing transformation reactor that normalizes different representations of the same value into the same normalized value. For example, the cleansing transformation reactor may convert different timestamp formats into the same normalized timestamp format. Aggregator reactor icon **807** may be a graphical representation of an aggregator reactor that aggregates event data for multiple events received during a time interval and produces new events representing the aggregated information. The new events may include event counts, statistics, and/or uniqueness counts related to the aggregated information. For example, the aggregated event data may include total page views, average numbers of requests, minimum RTT, and/or counts of requests for uniquely named resources.

[0120] Other examples of reactors usable with the techniques described herein include:

Collection Reactors

[0121] LogInputReactor: Uses a Codec to store events into log files.

[0122] SnifferReactor: Passively sniffs network packets, reassembles TCP and decrypts SSL/TLS. Protocol plugins allow you to generate events from any type of network traffic.

Processing Reactors

[0123] AggregateReactor: Aggregates information across multiple events received during an interval of time. Produces new events representing the aggregated information. Can also store historical information into external database tables and produce real-time reports.

[0124] ClickstreamReactor: Sessionizes a stream of HTTP request events (or clickstream hits) by grouping them into page views and sessionizes. Appends additional session attributes to the request events and produces two new types of events, one each for page views and sessions.

[0125] ContentHashReactor: Performs a hashing algorithm on a content field and uses the result to populate field. This Reactor controls which content is stored in the Stream Replay database.

[0126] FilterReactor: Uses configurable rules to detect new events, sequences or patterns. Delivers events to the reactors it is connected to only when these occur.

[0127] FissionReactor: Used to generate multiple events derived from a single source event. Primarily used to extract RSS and Atom content from individual HTTP requests.

[0128] PythonReactor: The PythonReactor allows you to build fully-featured Reactors that can create, process, or store events using the Python programming language.

[0129] ScriptReactor: Executes a shell script to process each event it receives.

[0130] SessionFilterReactor: Uses rules to detect patterns within visitor sessions. Events for a session are queued in memory until a match is found. If a match is found, all the session's events are passed through as output to other Reactors. If no match is found, the events are discarded.

[0131] SQLReactor: Uses Database plugins to perform real-time SQL queries derived from the events that it receives. The results of the queries can be used to add additional information to the original event.

[0132] TransformReactor: Creates new events which are derived from the events that it receives. This can be used to create entirely new types of complex events (for example, to signify that a pattern has been detected), or to derive new attributes which are based on attributes in existing events (i.e. assign a new attribute to "Internet Explorer" if an existing attribute contains "MSIE").

Storage Reactors

[0133] DatabaseOutputReactor: Stores events directly into database tables using Database plugins

[0134] GoogleAnalyticsReactor: Replicates website page tags by delivering real-time clickstream events to Google Analytics using their HTTP interface.

[0135] HTTPOutputReactor: Converts incoming events into HTTP requests.

[0136] LogOutputReactor: Uses a Codec to store events into log files.

[0137] MultiDatabaseReactor: Stores events into a collection of partitioned database tables. Used by Stream Replay to store traffic into an embedded database.

[0138] OmnitureAnalyticsReactor: Replicates website page tags by delivering real-time clickstream events to Omniture using their XML/HTTP data insertion API.

[0139] UnicaAnalyticsReactor: Replicates website page tags by delivering real-time clickstream events to Webtrends Analytics using their On Demand HTTP API.

[0140] WebtrendsReactors: Replicates website page tags by delivering real-time clickstream events to Webtrends Analytics using their On Demand HTTP API.

[0141] GUI **800** may thus provide a visual mechanism for configuring event streams that are generated from network traffic. Users may connect graphical representations of event streams and reactors to allow filtering, cleaning, aggregating, transforming, and/or other processing of events in the event streams. Output from the reactors may then be provided to other reactors using connections (e.g., directed edges) specified in GUI **800** for further processing.

[0142] In addition, selecting (e.g., double-clicking) on stream icons **801-802** may invoke the configuration dialog for the corresponding event stream, which allows users to configure the generation of event data in the event stream. FIG. **9** depicts an example screen shot of an embodiment of a configuration dialog **901** for obtaining configuration information for configuring the generation of event data from network data at one or more remote capture agents.

[0143] In the illustrated embodiment, configuration dialog **901** includes a section **902** for specifying a descriptive stream name (e.g., "Home Page Requests") and an event type (e.g., "clickstream.http-event") associated with the event stream. Another section **903** may be used to provide terms (e.g., for clickstream data) to be included in event data the event stream. For example, section **903** may display a list of terms (e.g., "clickestream.c-ip," "clickstream.host," "clickstream.uri-stem") to be included in the event data, as well as a mechanism **904** for adding a new term to the list.

[0144] Configuration dialog **901** further includes a section **905** that enables the definition of one or more filtering rules. For example, section **905** may include a filtering rule that requires an exact match between a URI stem of an event and the value "/index.html." Section **905** may also include a mechanism **906** for adding new filtering rules for the event stream.

4.0. Implementation Mechanisms

[0145] 4.1. Exemplary Systems for Storing and Retrieving Events

[0146] As noted above, the visualization techniques described herein can be applied to a variety of types of events, including those generated and used in SPLUNK® ENTERPRISE. Further details of underlying architecture of SPLUNK® ENTERPRISE are now provided. FIG. **10** depicts an example block diagram of an embodiment of a time-based data storage architecture that includes a late-binding schema.

[0147] Generally, the system includes one or more forwarders **1010** that collect data from a variety of different data sources **1005** and forwards the data using forwarders **1010** to one or more data indexers **1015**. In one embodiment, forwarders **1010** and indexers **1015** can be implemented in one or more hardware servers. Moreover, the functionality of one or more forwarders **1010** may be implemented by one or more remote capture agents (e.g., remote capture agents **151-153** of FIG. **1**) and/or transformation servers. For example, event data from a set of remote capture agents may be sent over a network to a set of transformation servers and/or reactors (e.g., collection reactors, processing reactors, storage reactors) that implement the indexing, storage and querying functionality of SPLUNK® ENTERPRISE. The data typically includes streams of time-series data. Time-series data refers to any data that can be associated with a time stamp. The data can be structured, unstructured, or semi-structured and come from files or directories. Unstructured data may be data that is not organized to facilitate extraction of values for fields from the data, as is often the case with machine data and web logs. The data indexers **1015** may provide the time-stamped data for storage in one or more data stores **1020**.

[0148] FIG. **11** illustrates a flowchart of an example embodiment of a process for storing collected data in a data storage architecture that includes a late-binding schema. FIG. **11** depicts a process that indexers **1015** may use to process, index, and store data received from the forwarders **1010**. At operation **1105**, an indexer **1015** receives data from a forwarder **1010**. At operation **1110**, the data is segmented into events. The events can be broken at event boundaries, which can include character combinations and/or line breaks. In some instances, the software discovers event boundaries automatically, and in other instances the event boundaries may be configured by the user. A time stamp is determined for each event at operation **1115**. The time stamp can be determined by extracting the time from data in an event or by interpolating the time based on time stamps from other events. In alternative embodiments, a time stamp may be determined from the time the data was received or generated. The time stamp is associated with each event at operation **1120**. For example, the time stamp may be stored as metadata for the event.

[0149] At operation **1125**, the data included in a given event may be transformed. Such a transformation can include such things as removing part of an event (e.g., a portion used to define event boundaries) or removing redundant portions of an event. A client data processing system may specify a portion to remove using a regular expression or any similar method.

[0150] Optionally, a keyword index can be built to facilitate fast keyword searching of events. To build such an index, in operation **1130**, a set of keywords contained in the events is identified. At operation **1135**, each identified keyword is included in an index, which associates with each stored keyword pointers to each event containing that keyword (or locations within events where that keyword is found). When a keyword-based query is received by an indexer, the indexer may then consult this index to quickly find those events containing the keyword without having to examine again each individual event, thereby greatly accelerating keyword searches.

[0151] The events are stored in a data store at operation **1140**. The data can be stored in working, short-term and/or long-term memory in a manner retrievable by query. The time stamp may be stored along with each event to help optimize searching the events by time range.

[0152] In some instances, the data store includes a plurality of individual storage buckets, each corresponding to a time range. An event can then be stored in a bucket associated with a time range inclusive of the event's time stamp. This not only optimizes time based searches, but it can allow events with recent time stamps that may have a higher likelihood of being accessed to be stored at preferable memory locations that lend to quicker subsequent retrieval (such as flash memory instead of hard-drive memory).

[0153] As shown in FIG. **10**, data stores **1020** may be distributed across multiple indexers, each responsible for storing and searching a subset of the events generated by the system. By distributing the time-based buckets among them, the indexers may find events responsive to a query from a search engine **1025** in parallel using map-reduce techniques, each returning their partial responses to the query to a search head that combines the results together to answer the query. This query handling is illustrated in FIG. **12**.

[0154] FIG. **12** illustrates a flowchart of an example embodiment of a process for generating a query result in a data storage architecture that includes a late-binding schema. At operation **1205**, a search heard receives a query from a search engine. At operation **1210**, the search head distributes the query to one or more distributed indexers. These indexers can include those with access to data stores having events responsive to the query. For example, the indexers can include those with access to events with time stamps within part or all of a time period identified in the query. At operation **1215**, each of one or more indexers to which the query was distributed searches its data store for events responsive to the query. To determine events responsive to the query, a searching indexer finds events specified by the criteria in the query. This criteria can include that the events have particular keywords or contain a specified value or values for a specified field or fields (because this employs a late-binding schema, extraction of values from events to determine those that meet the specified criteria occurs at the time this query is processed).

[0155] It should be appreciated that, to achieve high availability and to provide for disaster recovery, events may be replicated in multiple data stores, in which case indexers with access to the redundant events would not respond to the query by processing the redundant events. The indexers **1015** may either stream the relevant events back to the search head or use the events to calculate a partial result responsive to the query and send the partial result back to the search head. At operation **1220**, the search head combines all the partial results or events received from the parallel processing together to determine a final result responsive to the query.

[0156] Data intake and query system **145** and the processes described with respect to FIGS. **10-12** are further discussed and elaborated upon in Carasso, David. *Exploring Splunk Search Processing Language* (*SPL*) *Primer and Cookbook*. New York: CITO Research, 2012 and in Ledion Bitincka, Archana Ganapathi, Stephen Sorkin, and Steve Zhang. *Optimizing data analysis with a semi-structured time series database*. In SLAML, 2010. Each of these references is hereby incorporated by reference in its entirety for all purposes.

[0157] 4.2. Hardware Overview

[0158] FIG. **13** depicts an example data processing system upon which the embodiments described herein may be implemented. As shown in FIG. **13**, the data processing system **1301** includes a system bus **1302**, which is coupled to a processor **1303**, a Read-Only Memory ("ROM") **1307**, a Random Access Memory ("RAM") **1305**, as well as other nonvolatile memory **1306**, e.g., a hard drive. In the illustrated embodiment, processor **1303** is coupled to a cache memory **1304**. System bus **1302** can be adapted to interconnect these various components together and also interconnect components **1303**, **1307**, **1305**, and **1306** to a display controller and display device **1308**, and to peripheral devices such as input/output ("I/O") devices **1310**. Types of I/O devices can include keyboards, modems, network interfaces, printers, scanners, video cameras, or other devices well known in the art. Typically, I/O devices **1310** are coupled to the system bus **1302** through I/O controllers **1309**. In one embodiment the I/O controller **1309** includes a

Universal Serial Bus ("USB") adapter for controlling USB peripherals or other type of bus adapter.

[0159] RAM **1305** can be implemented as dynamic RAM ("DRAM"), which requires power continually in order to refresh or maintain the data in the memory. The other nonvolatile memory **1306** can be a magnetic hard drive, magnetic optical drive, optical drive, DVD RAM, or other type of memory system that maintains data after power is removed from the system. While FIG. **13** shows that nonvolatile memory **1306** as a local device coupled with the rest of the components in the data processing system, it will be appreciated by skilled artisans that the described techniques may use a nonvolatile memory remote from the system, such as a network storage device coupled with the data processing system through a network interface such as a modem or Ethernet interface (not shown).

5.0. Extensions and Alternatives

[0160] With these embodiments in mind, it will be apparent from this description that aspects of the described techniques may be embodied, at least in part, in software, hardware, firmware, or any combination thereof. It should also be understood that embodiments can employ various computer-implemented functions involving data stored in a computer system. The techniques may be carried out in a computer system or other data processing system in response executing sequences of instructions stored in memory. In various embodiments, hardwired circuitry may be used independently or in combination with software instructions to implement these techniques. For instance, the described functionality may be performed by specific hardware components containing hardwired logic for performing operations, or by any combination of custom hardware components and programmed computer components. The techniques described herein are not limited to any specific combination of hardware circuitry and software.

[0161] Embodiments herein may also be implemented in computer-readable instructions stored on an article of manufacture referred to as a computer-readable medium, which is adapted to store data that can thereafter be read and processed by a computer. Computer-readable media is adapted to store these computer instructions, which when executed by a computer or other data processing system such as data processing system **1300**, are adapted to cause the system to perform operations according to the techniques described herein. Computer-readable media can include any mechanism that stores information in a form accessible by a data processing device such as a computer, network device, tablet, smartphone, or any device having similar functionality. Examples of computer-readable media include any type of tangible article of manufacture capable of storing information thereon including floppy disks, hard drive disks ("HDDs"), solid-state devices ("SSDs") or other flash memory, optical disks, digital video disks ("DVDs"), CD-ROMs, magnetic-optical disks, ROMs, RAMs, erasable programmable read only memory ("EPROMs"), electrically erasable programmable read only memory ("EEPROMs"), magnetic or optical cards, or any other type of media suitable for storing instructions in an electronic format. Computer-readable media can also be distributed over a network-coupled computer system stored and executed in a distributed fashion.

[0162] Throughout the foregoing description, for the purposes of explanation, numerous specific details were set forth in order to provide a thorough understanding of the invention. It will be apparent, however, to persons skilled in the art that these embodiments may be practiced without some of these specific details. Although various embodiments incorporating the teachings of the present invention have been shown and described in detail herein, those skilled in the art can readily devise many other varied embodiments that still incorporate these techniques. Embodiments of the invention may include various operations as set forth above or fewer operations or more operations; or operations in an order, which is different from the order described herein. Accordingly, the scope and spirit of the invention should be judged in terms of the claims that follow as well as the legal equivalents thereof.

1-30. (canceled)

31. A computer-implemented method performed by a configuration server coupled to a network, the method comprising:

obtaining configuration information generated by an application coupled to the configuration server, the configuration information specifying one or more event streams to be generated by one or more remote capture agents, the one or more event streams including timestamped event data generated by the one or more remote capture agents based on network traffic monitored by the one or more remote capture agents; and

sending the configuration information to the one or more remote capture agents, the configuration information causing the one or more remote capture agents to:

generate the one or more event streams including timestamped event data generated based on network traffic monitored by the one or more remote capture agents, and

send the one or more event streams to another component on the network for storage in a data store accessible to the application.

32. The computer-implemented method of claim **31**, wherein the configuration information causes the one or more remote capture agents to generate each event of the timestamped event data by:

identifying boundaries of the event in the network traffic;

extracting network packet data from at least one network packet of the network traffic and associating the network packet data with the event;

determining a timestamp associated with the event; and

associating the timestamp with the event.

33. The computer-implemented method of claim **31**, wherein the configuration information further causes the one or more remote capture agents to generate each event of the timestamped event data by:

extracting network packet data from at least one network packet of the network traffic and associating the network packet data with the event;

applying a filtering rule to the network packet data to determine an event type associated with the event; and

adding, based on the determined event type, the event to at least one event stream of one or more event streams.

34. The computer-implemented method of claim **31**, wherein the application uses the one or more event streams to satisfy search requests for data contained in the one or more event streams.

35. The computer-implemented method of claim **31**, wherein the application uses the one or more event streams to generate visualizations based on timestamped event data contained in the one or more event streams.

36. The computer-implemented method of claim **31**, wherein the configuration information specifies one or more transformations to be applied to the timestamped event data, and wherein the one or more transformations comprise at least one of an aggregation, a calculation, a filter, a normalization, and a formatting.

37. The computer-implemented method of claim **31**, wherein the application is running on a server separate from the configuration server and coupled to the configuration server via the network.

38. The computer-implemented method of claim **31**, wherein the configuration information comprises at least one of an identifier for an event stream, a description for the event stream, an event stream type for the event stream, a custom field for the event stream, and an additional parameter for the event stream.

39. The computer-implemented method of claim **31**, wherein the configuration information comprises an additional parameter, and wherein the additional parameter is at least one of a time interval between events, a maximum number of aggregated events, and an inclusion of a matching transaction or matching error in the event data.

40. The computer-implemented method of claim **31**, wherein the one or more remote capture agents are installed in a virtual computing environment.

41. A configuration server coupled to a network, the configuration server comprising:

a processor;

a non-transitory computer readable storage medium storing instructions which, when executed by the processor, cause the configuration server to:

receive configuration information generated by an application coupled to the configuration server, the configuration information specifying one or more event streams to be generated by one or more remote capture agents, the one or more event streams including timestamped event data generated by the one or more remote capture agents based on network traffic monitored by the one or more remote capture agents; and

send the configuration information to the one or more remote capture agents, the configuration information causing the one or more remote capture agents to:

generate the one or more event streams including timestamped event data generated based on network traffic monitored by the one or more remote capture agents, and

send the one or more event streams to another component on the network for storage in a data store accessible to the application.

42. The configuration server of claim **41**, wherein the configuration information further causes the one or more remote capture agents to generate each even of the timestamped event data by:

identifying boundaries of the event in the network traffic;

extracting network packet data from at least one network packet of the network traffic and associating the network packet data with the event;

determining a timestamp associated with the event; and

associating the timestamp with the event.

43. The configuration server of claim **41**, wherein the configuration information further causes the one or more remote capture agents to generate each event of the timestamped event data by:

extracting network packet data from at least one network packet of the network traffic and associating the network packet data with the event;

applying a filtering rule to the network packet data to determine an event type associated with the event; and

adding, based on the determined event type, the event to at least one event stream of one or more event streams.

44. The configuration server of claim **41**, wherein the application uses the one or more event streams to satisfy search requests for data contained in the one or more event streams.

45. The configuration server of claim **41**, wherein the application uses the one or more event streams to generate visualizations based on timestamped event data contained in the one or more event streams.

46. The configuration server of claim **41**, wherein the configuration information specifies one or more transformations to be applied to the timestamped event data, and wherein the one or more transformations comprise at least one of an aggregation, a calculation, a filter, a normalization, and a formatting.

47. The configuration server of claim **41**, wherein the application is running on a server separate from the configuration server and coupled to the configuration server via the network.

48. The configuration server of claim **41**, wherein the configuration information comprises at least one of an identifier for an event stream, a description for the event stream, an event stream type for the event stream, a custom field for the event stream, and an additional parameter for the event stream.

49. The configuration server of claim **41**, wherein the configuration information comprises an additional parameter, and wherein the additional parameter is at least one of a time interval between events, a maximum number of aggregated events, and an inclusion of a matching transaction or matching error in the event data.

50. The configuration server of claim **41**, wherein the one or more remote capture agents are installed in a virtual computing environment.

51. A non-transitory computer-readable storage medium storing instructions that when executed by a computer cause a configuration server to perform operations comprising:

receiving configuration information generated by an application coupled to the configuration server, the configuration information specifying one or more event streams to be generated by one or more remote capture agents, the one or more event streams including timestamped event data generated by the one or more remote capture agents based on network traffic monitored by the one or more remote capture agents; and

sending the configuration information to the one or more remote capture agents, the configuration information causing the one or more remote capture agents to:

generate the one or more event streams including timestamped event data generated based on network traffic monitored by the one or more remote capture agents, and send the one or more event streams to another component on the network for storage in a data store accessible to the application.

52. The non-transitory computer-readable storage medium of claim **51**, wherein the configuration information causes the one or more remote capture agents to generate each event of the timestamped event data by:

identifying boundaries of the event in the network traffic;

extracting network packet data from at least one network packet of the network traffic and associating the network packet data with the event;

determining a timestamp associated with the event; and

associating the timestamp with the event.

53. The non-transitory computer-readable storage medium of claim **51**, wherein the configuration information further causes the one or more remote capture agents to generate each event of the timestamped event data by:

extracting network packet data from at least one network packet of the network traffic and associating the network packet data with the event;

applying a filtering rule to the network packet data to determine an event type associated with the event; and

adding, based on the determined event type, the event to at least one event stream of one or more event streams.

54. The non-transitory computer-readable storage medium of claim **51**, wherein the application uses the one or more event streams to satisfy search requests for data contained in the one or more event streams.

55. The non-transitory computer-readable storage medium of claim **51**, wherein the application uses the one or more event streams to generate visualizations based on timestamped event data contained in the one or more event streams.

56. The non-transitory computer-readable storage medium of claim **51**, wherein the configuration information specifies one or more transformations to be applied to the timestamped event data, and wherein the one or more transformations comprise at least one of an aggregation, a calculation, a filter, a normalization, and a formatting.

57. The non-transitory computer-readable storage medium of claim **51**, wherein the application is running on a server separate from the configuration server and coupled to the configuration server via the network.

58. The non-transitory computer-readable storage medium of claim **51**, wherein the configuration information comprises at least one of an identifier for an event stream, a description for the event stream, an event stream type for the event stream, a custom field for the event stream, and an additional parameter for the event stream.

59. The non-transitory computer-readable storage medium of claim **51**, wherein the configuration information comprises an additional parameter, and wherein the additional parameter is at least one of a time interval between events, a maximum number of aggregated events, and an inclusion of a matching transaction or matching error in the event data.

60. The non-transitory computer-readable storage medium of claim **51**, wherein the one or more remote capture agents are installed in a virtual computing environment.

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