US007333430B2

(12) **United States Patent**
Li et al.

(10) **Patent No.: US 7,333,430 B2**
(45) **Date of Patent: Feb. 19, 2008**

(54) SYSTEMS AND METHODS FOR PASSING NETWORK TRAFFIC DATA

(75) Inventors: **Hongwei Li**, Burnaby (CA); **Michael Xie**, Palo Alto, CA (US); **Junyin Li**, Burnaby (CA); **Guangwen Li**, Inner Mongolia (CN)

(73) Assignee: **Fortinet, Inc.**, Sunnyvale, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 42 days.

(21) Appl. No.: **11/176,071**

(22) Filed: **Jul. 6, 2005**

(65) **Prior Publication Data**

US 2007/0008971 A1 Jan. 11, 2007

(51) **Int. Cl.**
H04L 12/56 (2006.01)
G06F 13/00 (2006.01)

(52) **U.S. Cl.** **370/230**; 710/20; 710/36; 713/154

(58) **Field of Classification Search** 370/229, 370/230, 389, 477, 352; 713/153, 154, 160, 713/161; 726/1-3, 11-14, 21, 23, 24; 710/20, 710/36

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,867,651	A *	2/1999	Dan et al.	709/203
5,925,111	A *	7/1999	Nagasawa	710/17
6,484,209	B1 *	11/2002	Momirov	709/238
6,529,978	B1 *	3/2003	Eide et al.	710/104
6,539,439	B1 *	3/2003	Nguyen et al.	710/52
6,625,152	B1 *	9/2003	Monsen et al.	370/392
6,870,849	B1 *	3/2005	Callon et al.	370/395.32
2002/0012319	A1 *	1/2002	Rochberger et al.	370/229
2002/0085563	A1 *	7/2002	Mesh et al.	370/393
2003/0065812	A1 *	4/2003	Beier et al.	709/236
2003/0074473	A1 *	4/2003	Pham et al.	709/246
2003/0210688	A1 *	11/2003	Basso et al.	370/389
2003/0223413	A1 *	12/2003	Guerrero	370/389
2005/0053060	A1 *	3/2005	Pettey	370/385
2005/0135280	A1 *	6/2005	Lam	370/260
2005/0144282	A1 *	6/2005	Argo	709/226
2006/0242299	A1 *	10/2006	Karger et al.	709/226

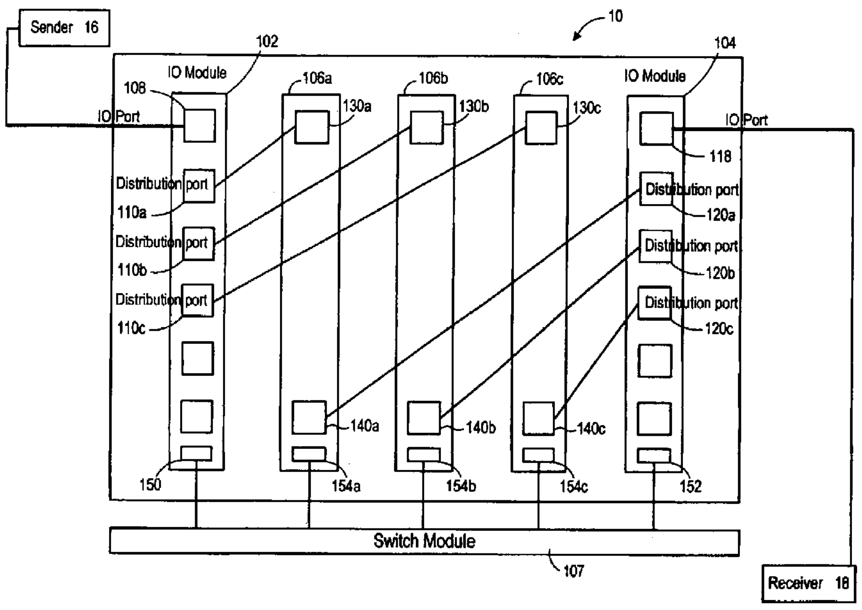
* cited by examiner

Primary Examiner—Chi Pham
Assistant Examiner—Ahmed Elallam
(74) *Attorney, Agent, or Firm*—Bingham McCutchen LLP

(57) **ABSTRACT**

A method for processing network traffic data includes receiving network traffic data, and passing the network traffic data to one of a plurality of worker modules for processing the network traffic data, wherein the step of passing is performed based at least in part on a quantity of the worker modules, and/or a number associated with a first IP address. A system for processing network traffic data includes a first IO module, a second IO module, a first worker module coupled to the first and second IO modules, a second worker module coupled to the first and second IO modules, and a switch module coupled to the first IO module, the second IO module, the first worker module, and the second worker module.

45 Claims, 10 Drawing Sheets



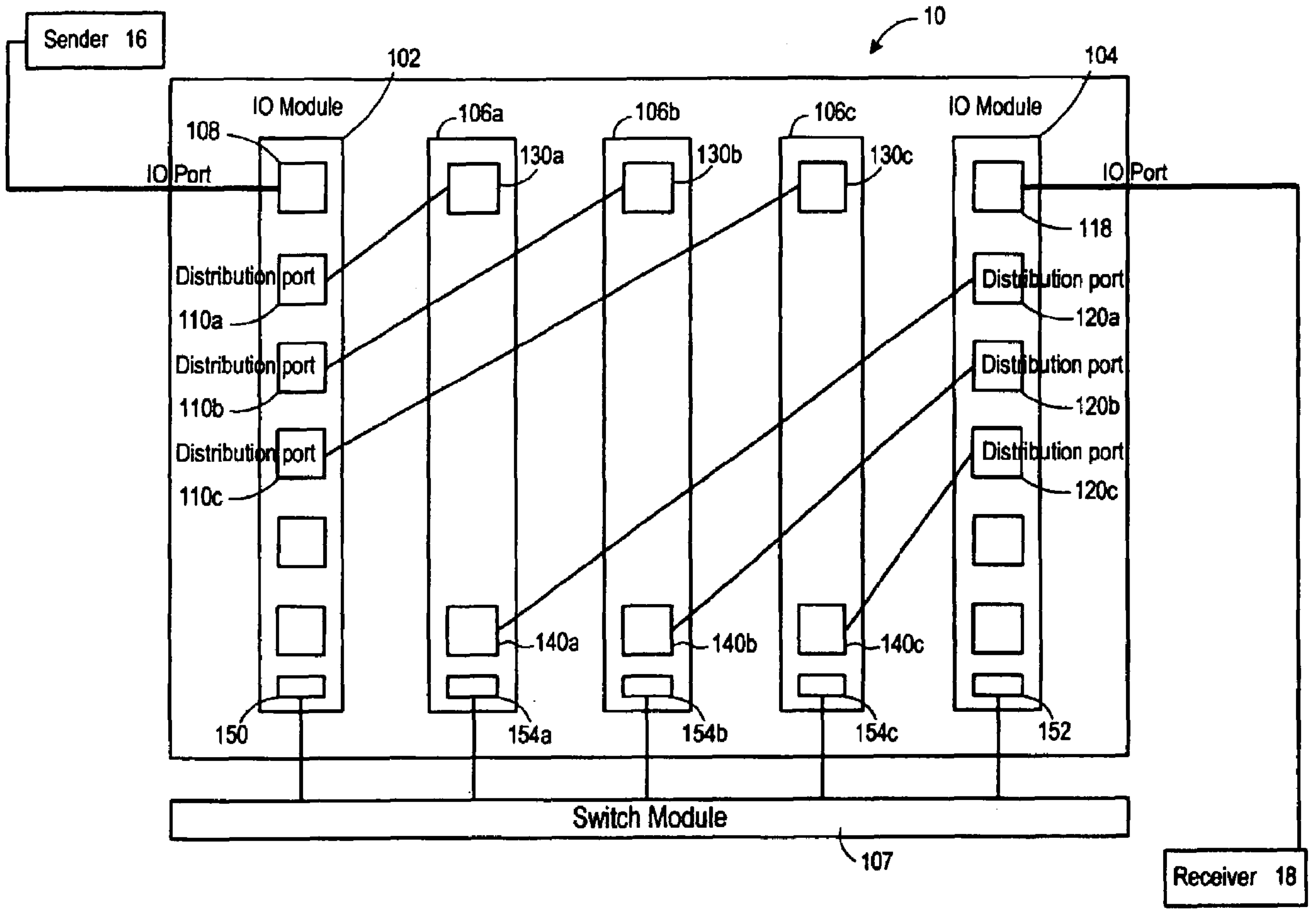

Sender 16
10
102
104
IO Module
IO Module
108
106a
106b
106c
IO Port
130a
130b
130c
IO Port
118
Distribution port
110a
Distribution port
110b
Distribution port
110c
Distribution port
120a
Distribution port
120b
Distribution port
120c
140a
140b
140c
150
154a
154b
154c
152
Switch Module
107
Receiver 18

FIG. 1

200

Original Packet

IO Module 102	Worker Module 106a	Worker Module 106b	IO Module 104
Receive packet from sender 16 202			
Determine module 204			
Pass packet to Worker Module 106a 206			
	Untag packet, and determine logical interface 208		
	Process packet 210		
	Determine module 212		
	Pass packet to Worker Module 106b 214		
		Process packet 216	
		Tag packet 218	
		Pass packet to IO module 220	
			Untag packet, and determine IO interface 222
			Send packet to receiver 18 224

FIG. 2A

240

Reply Packet

IO Module 102	Worker Module 106a	Worker Module 106b	IO Module 104
		242	Receive packet from receiver 18
		244	Determine module
		246	Pass packet to Worker Module 106b
	248	Untag packet, and determine logical interface	
	250	Process packet	
	252	Pass packet to Worker Module 106a	
	Process packet	254	
	Tag packet	256	
	Pass packet to IO module 102	258	
Untag packet, and determine IO interface	260		
Send packet to sender 16	262		

FIG. 2B

200

Original Packet

IO Module 102	Worker Module 106a	Worker Module 106b	IO Module 104
Receive packet from sender 16 202			
Determine module 204			
Pass packet to Worker Module 106a 206			
	Untag packet, and determine logical interface 208		
	IPSEC VPN detunneling (if required) 402		
	DNAT (if required) 404		
	ACL check 406		
	Stateful inspection 408		
210	Intrusion detection and prevention (if required) 410		
	Antivirus (if required) 412		
	SNAT (if required) 414		
	Determine module 212		
	Pass packet to Worker Module 106b 214		
		IPSEC VPN tunneling (if required) 216	
		Tag packet 218	
		Pass packet to IO module 104 220	
			Untag packet, and determine IO interface 222
			Send packet to receiver 18 224

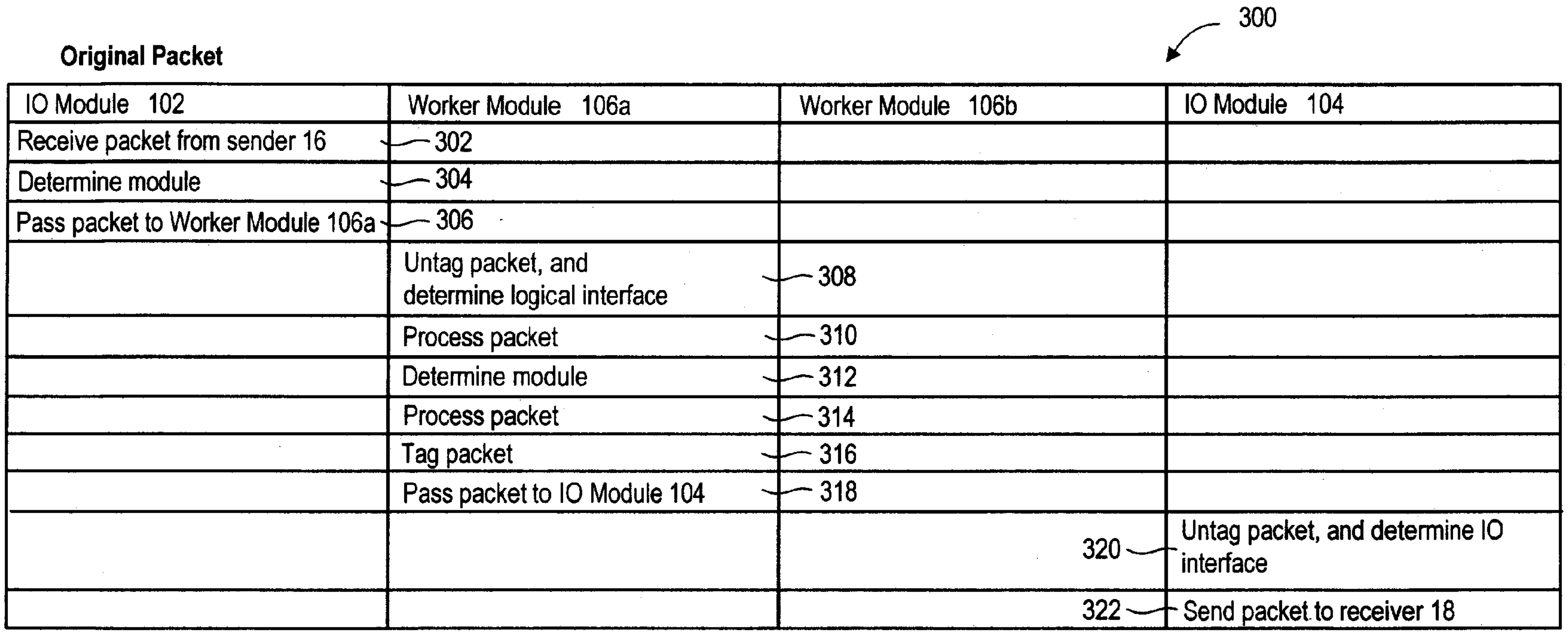
FIG. 3A

240

Reply Packet

IO Module 102	Worker Module 106a	Worker Module 106b	IO Module 104
		242	Receive packet from receiver 18
		244	Determine module
		246	Pass packet to Worker Module 106b
	248	Untag packet, and determine logical interface	
	250	IPSEC VPN detunneling (if required)	
	252	Pass packet to Worker Module 106a	
422	DNAT (if required)		
424	Stateful inspection		
426	Intrusion detection and prevention (if required) 254		
428	Antivirus (if required)		
430	SNAT (if required)		
	Tag packet	256	
	Sending packet IO Module 102	258	
Untag packet, and determine IO interface	260		
Send packet to sender 16	262		

FIG. 3B



300

Original Packet

IO Module 102	Worker Module 106a	Worker Module 106b	IO Module 104
Receive packet from sender 16	302		
Determine module	304		
Pass packet to Worker Module 106a	306		
	Untag packet, and determine logical interface	308	
	Process packet	310	
	Determine module	312	
	Process packet	314	
	Tag packet	316	
	Pass packet to IO Module 104	318	
		320	Untag packet, and determine IO interface
		322	Send packet to receiver 18

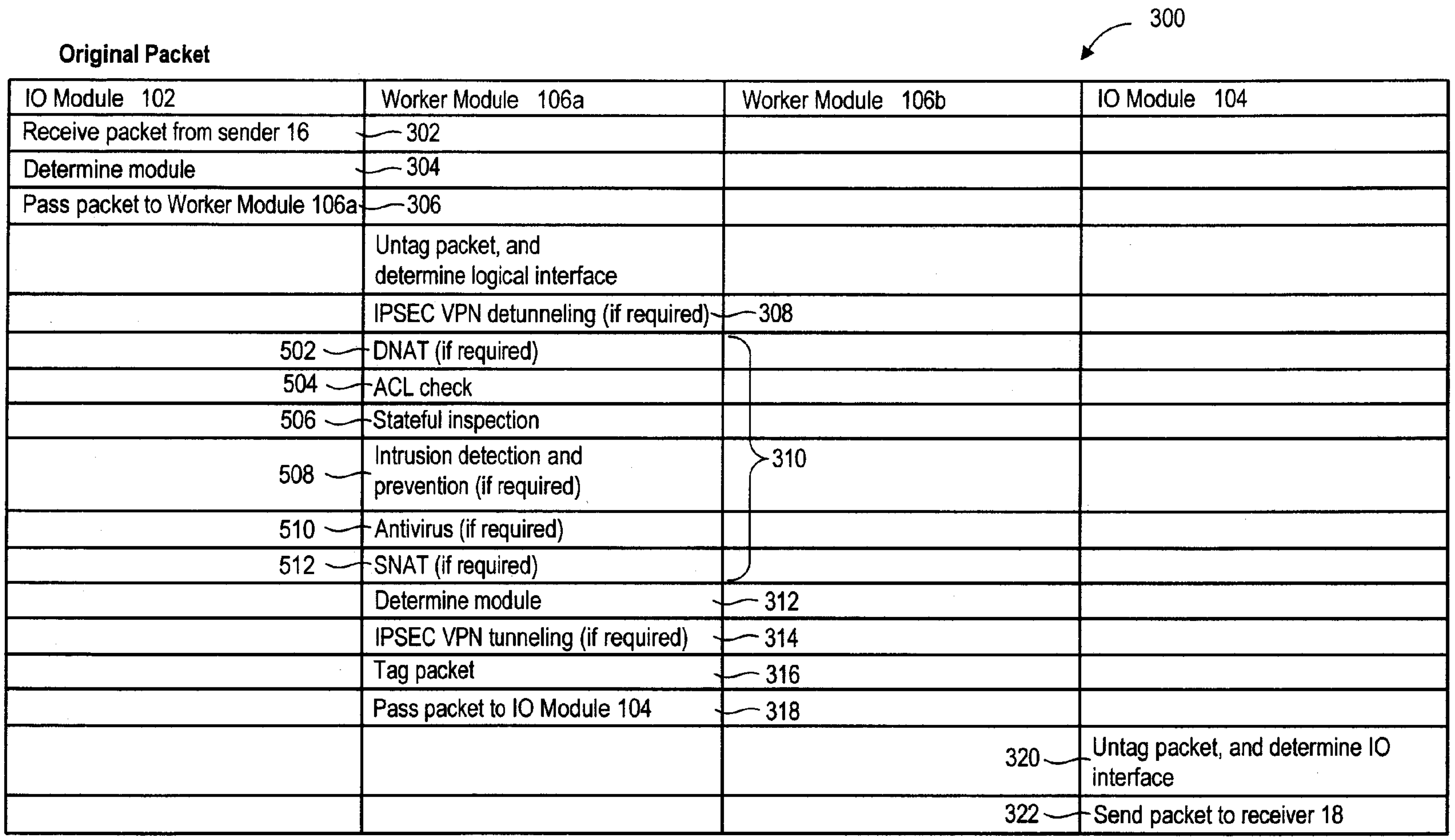
FIG. 4A

340

Reply Packet

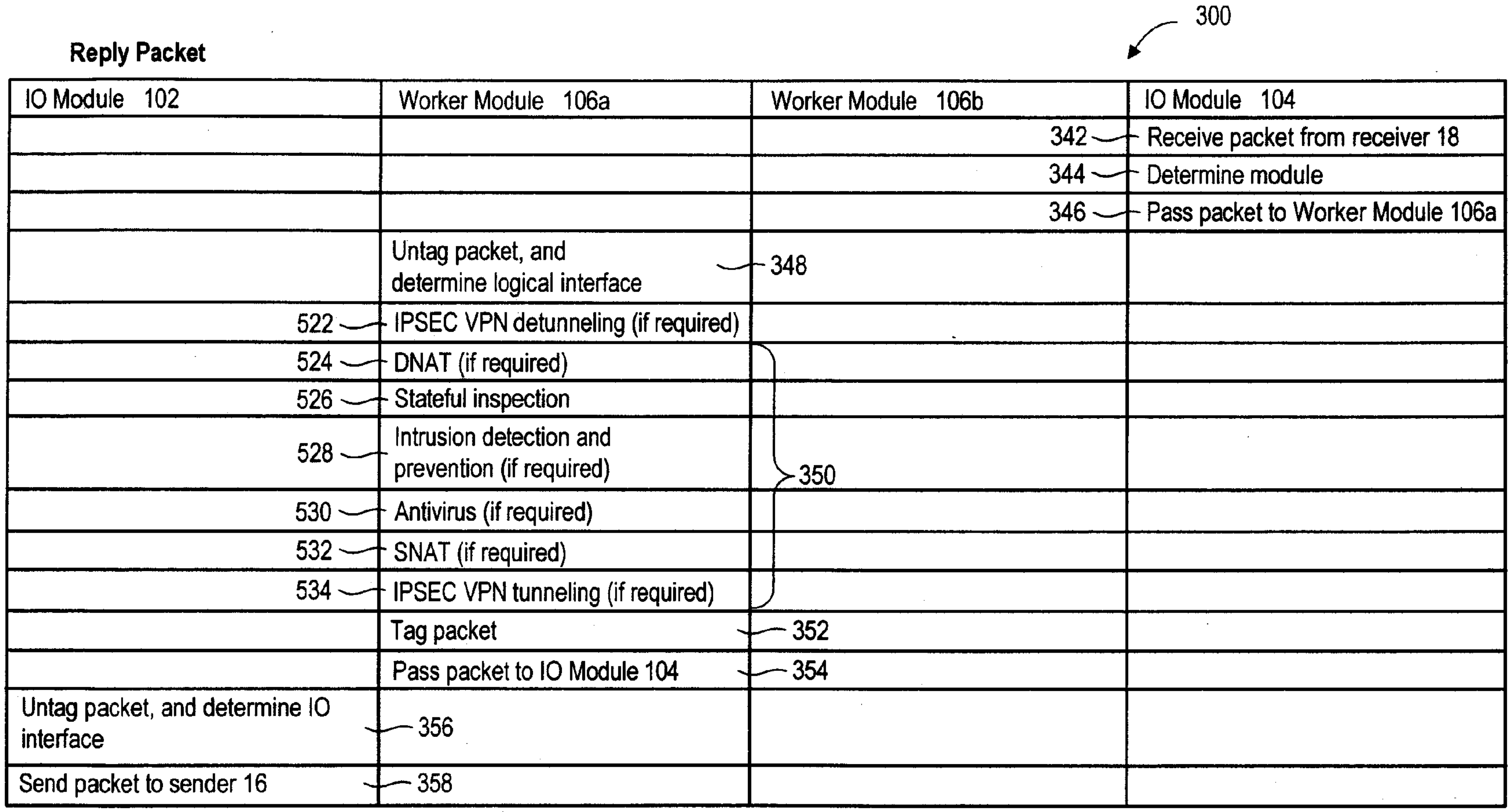
IO Module 102	Worker Module 106a	Worker Module 106b	IO Module 104
		342	Receive packet from receiver 18
		344	Determine module
		346	Pass packet to Worker Module 106a
	Untag packet, and determine logical interface	348	
	Process packet	350	
	Tag packet	352	
	Pass packet to IO Module 102	354	
Untag packet, and determine IO interface	356		
Send packet to sender 16	358		

FIG. 4B


300
Original Packet

IO Module 102	Worker Module 106a	Worker Module 106b	IO Module 104
Receive packet from sender 16	302		
Determine module	304		
Pass packet to Worker Module 106a	306		
	Untag packet, and determine logical interface		
	IPSEC VPN detunneling (if required)	308	
502	DNAT (if required)		
504	ACL check		
506	Stateful inspection		
508	Intrusion detection and prevention (if required)	310	
510	Antivirus (if required)		
512	SNAT (if required)		
	Determine module	312	
	IPSEC VPN tunneling (if required)	314	
	Tag packet	316	
	Pass packet to IO Module 104	318	
		320	Untag packet, and determine IO interface
		322	Send packet to receiver 18

FIG. 5A



300

Reply Packet

IO Module 102	Worker Module 106a	Worker Module 106b	IO Module 104
		342	Receive packet from receiver 18
		344	Determine module
		346	Pass packet to Worker Module 106a
	Untag packet, and determine logical interface	348	
522	IPSEC VPN detunneling (if required)		
524	DNAT (if required)		
526	Stateful inspection		
528	Intrusion detection and prevention (if required)	350	
530	Antivirus (if required)		
532	SNAT (if required)		
534	IPSEC VPN tunneling (if required)		
	Tag packet	352	
	Pass packet to IO Module 104	354	
Untag packet, and determine IO interface	356		
Send packet to sender 16	358		

FIG. 5B

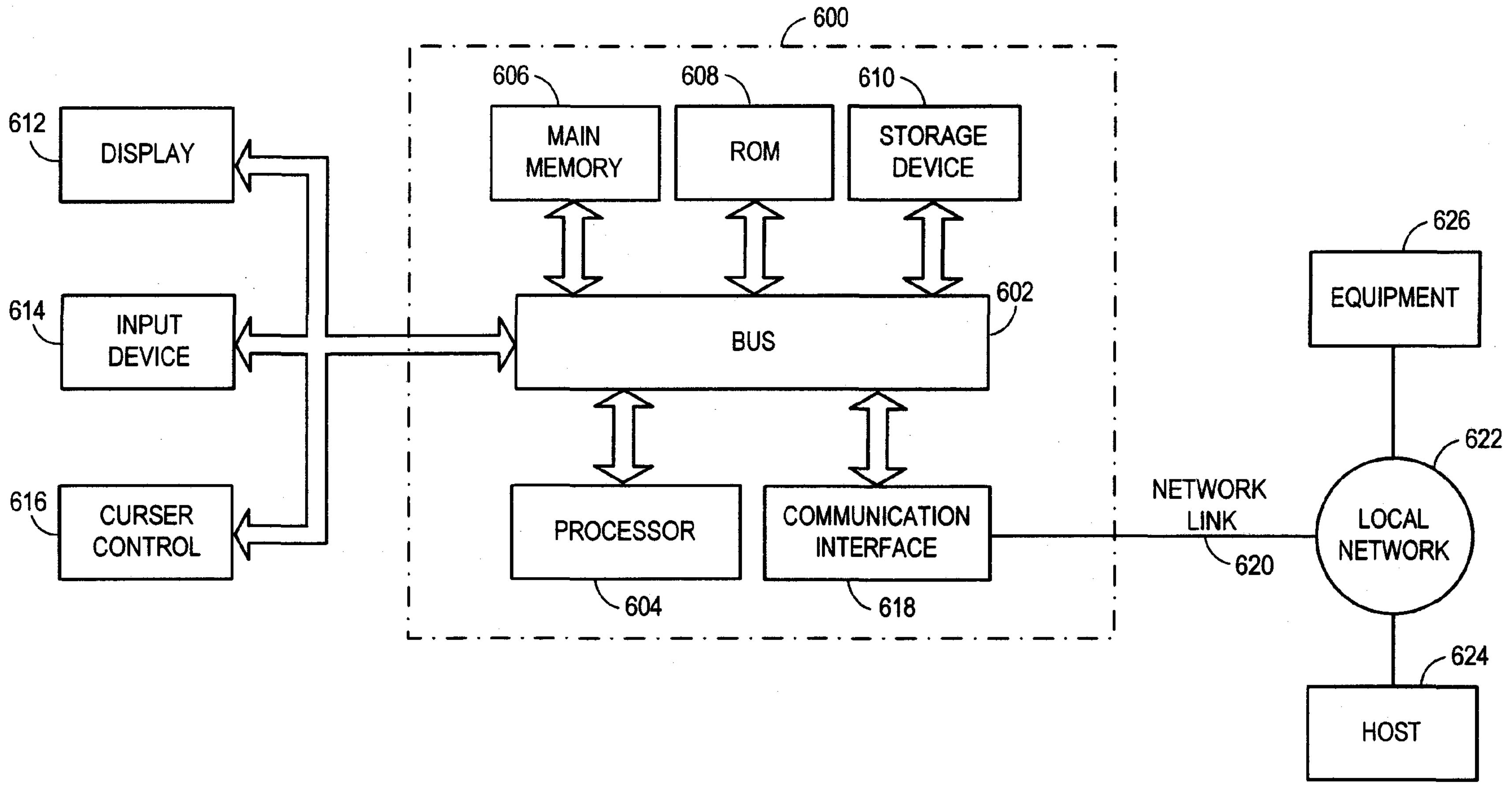

600
606
MAIN MEMORY
608
ROM
610
STORAGE DEVICE
612
DISPLAY
614
INPUT DEVICE
616
CURSER CONTROL
BUS
602
PROCESSOR
604
COMMUNICATION INTERFACE
618
NETWORK LINK
620
626
EQUIPMENT
622
LOCAL NETWORK
624
HOST

FIG. 6

SYSTEMS AND METHODS FOR PASSING NETWORK TRAFFIC DATA

BACKGROUND

1. Field of the Invention

The field of the invention relates to computer systems and computer networks, and more particularly, to systems, and methods for processing network traffic data.

2. Background

A gateway between a user and a server performs many important functions. One important function is policy enforcement. Policy enforcement performed by a gateway product may include, for examples, source verification, destination verification, user authentication, anti-virus, content scanning, content detection, and intrusion detection.

Generally, existing gateway products receive a request for policy enforcement sent by a sender, perform policy enforcement, and then transmit the request to a receiver. In response to the sender's request, the receiver sends a reply back to the gateway, which then performs further policy enforcement. After performing this second policy enforcement, the gateway passes the reply to the user.

Some of the existing gateway products use multiple processors to process packets transmitted between sender and receiver, thereby increasing an efficiency of the gateway products. However, in these gateway products, a tremendous amount of resources is utilized in managing flow of network traffic data that are being processed by the multiple processors. For example, a gateway product may prescribe complex protocols in distributing network traffic data among the processors. These protocols may require a lot of memory and processing time to process, and may render the gateway product unstable. In particular, a protocol may need to do backlog for traffic distribution, which uses a lot of memory. If this is not properly implemented, it may cause memory leak and corruption, which in turn, causes the system to be unstable. For example, if memory is run out, the protocol may either stop distributing traffic or may free previous backlog entry. This may cause service distribution as some traffic are cut.

SUMMARY

In accordance with some embodiments, a method for processing network traffic data includes receiving network traffic data, and passing the network traffic data to one of a plurality of worker modules for processing the network traffic data, wherein the step of passing is performed based at least in part on a quantity of the worker modules.

In accordance with other embodiments, a system for processing network traffic data includes means for receiving network traffic data, and means for passing the network traffic data to one of a plurality of worker modules for processing the network traffic data, wherein the means for passing is configured to perform the step of passing based at least in part on a quantity of the worker modules.

In accordance with other embodiments, a computer product having a set of stored instructions, an execution of which causes a process to be performed, the process includes receiving network traffic data, and passing the network traffic data to one of a plurality of worker modules for processing the network traffic data, wherein the step of passing is performed based at least in part on a quantity of the worker modules.

In accordance with other embodiments, a method for processing network traffic data includes receiving network

traffic data, and passing the network traffic data to one of a plurality of worker modules for processing the network traffic data, wherein the step of passing is performed based at least in part on a number associated with a first IP address.

In accordance with other embodiments, a system for processing network traffic data includes means for receiving network traffic data, and means for passing the network traffic data to one of a plurality of worker modules for processing the network traffic data, wherein the means for passing is configured to perform the step of passing based at least in part on a number associated with a first IP address.

In accordance with other embodiments, a computer product having a set of stored instructions, an execution of which causes a process to be performed, the process includes receiving network traffic data, and passing the network traffic data to one of a plurality of worker modules for processing the network traffic data, wherein the step of passing is performed based at least in part on a number associated with a first IP address.

In accordance with other embodiments, a system for processing network traffic data includes a first IO module, a second IO module, a first worker module coupled to the first and second IO modules, a second worker module coupled to the first and second IO modules, and a switch module coupled to the first IO module, the second IO module, the first worker module, and the second worker module.

Other aspects and features will be evident from reading the following detailed description of the embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

The drawings illustrate the design and utility of various embodiments, in which similar elements are referred to by common reference numerals. In order to better appreciate how advantages and objects of the embodiments are obtained, a more particular description of the embodiments will be illustrated in the accompanying drawings.

FIG. **1** illustrates a system for processing network traffic data in accordance with some embodiments;

FIG. **2**A illustrates a method for processing network traffic data in accordance with some embodiments;

FIG. **2**B illustrates a method for processing network traffic data in accordance with other embodiments;

FIG. **3**A illustrates a method for processing network traffic data in accordance with other embodiments;

FIG. **3**B illustrates a method for processing network traffic data in accordance with other embodiments;

FIG. **4**A illustrates a method for processing network traffic data in accordance with other embodiments;

FIG. **4**B illustrates a method for processing network traffic data in accordance with other embodiments;

FIG. **5**A illustrates a method for processing network traffic data in accordance with other embodiments;

FIG. **5**B illustrates a method for processing network traffic data in accordance with other embodiments; and

FIG. **6** is a diagram of a computer hardware system with which embodiments described herein can be implemented.

DETAILED DESCRIPTION

Various embodiments are described hereinafter with reference to the figures. It should be noted that the figures are not drawn to scale and that elements of similar structures or functions are represented by like reference numerals throughout the figures. It should also be noted that the figures are only intended to facilitate the description of embodiments. They are not intended as an exhaustive description of the invention or as a limitation on the scope of the invention. In addition, an illustrated embodiment may not show all the aspects or advantages. An aspect or an advantage described in conjunction with a particular embodiment is not necessarily limited to that embodiment and can be practiced in any other embodiments, even if not so illustrated or described.

FIG. **1** illustrates a processing system **10** for processing network traffic data in accordance with some embodiments. As used in this specification, the term "network traffic data" refers to data that are transmitted between a sender and a receiver, and should not be limited by any definition of the word "network" and/or the word "traffic." System **10** is configured to receive network traffic data, such as a packet, from a sender **16**, and process the network traffic data based on a prescribed protocol before passing the network traffic data to a receiver **18**. In some embodiments, the network traffic data from sender **16** is a request for information to be retrieved from receiver **18**. In such cases, system **10** may also receive data from receiver **18**, and transmits the data to sender **16** in response to the information request.

In the illustrated embodiments, system **10** includes a first IO module **102**, a second IO module **104**, worker modules **106*a*-106*c***, and a switch module **107** coupled to worker modules **106*a*-106*c***. System **10** is configured to load balance network traffic data among worker modules **106*a*-106*c***. In some embodiments, IO module **102** receives network traffic data from sender **16**, and transmit the data to worker module(s) **106**. Worker module(s) **106** processes the data and transmits the data to IO module **104**, which then passes the data to receiver **18**. In other embodiments, IO module **104** receives network traffic data from receiver **18**, and transmit the data to worker module(s) **106**. Worker module (s) **106** processes the data and transmits the data to IO module **102**, which then passes the data to sender **16**. Although three worker modules **106*a*-106*c*** are shown, in other embodiments, the system **10** can have less than three worker modules **106** (e.g., one or two), or more than three worker modules **106**.

As shown in the figure, IO module **102** includes an IO port **108** and three distribution ports **110*a*-110*c***, and IO module **104** includes an IO port **118** and three distribution ports **120*a*-120*c***. Worker modules **106*a*-106*c*** includes first data ports **130*a*-130*c*** and second data ports **140*a*-140*c***, respectively. Distribution ports **110*a*-110*c*** of IO module **102** are communicatively coupled (e.g., via point-to-point links) to first data ports **130*a*-130*c*** of worker modules **106*a*-106*c***, respectively. Distribution ports **120*a*-120*c*** of IO module **104** are communicatively coupled (e.g., via point-to-point links) to second data ports **140*a*-140*c*** of worker modules **106*a*-106*c***, respectively. In other embodiments, IO module **102** can have more than one IO port **108**, and IO module **104** can have more than one IO port **118**. Also, in other embodiments, IO module **102** can have more or less than three distribution ports **110**, and IO module **104** can have more or less than three distribution ports **120**. In further embodiments, worker modules **106** can each have more than two data ports.

In the illustrated embodiments, switch module **107** is a layer-two (L2) switch, and is used for exchanging packet between worker modules **106**. Alternatively, switch module **107** can be other types of switch in other embodiments. As shown in the figure, IO modules **102**, **104** include switch ports **150**, **152**, respectively, which allow IO modules **102**, **104** to communicate with switch module **107**, e.g., via communication link(s). Worker modules **106*a*-106*c*** include switch ports **154*a*-154*c***, respectively, which allow worker

modules **106*a*-106*c*** to communicate with switch module **107**, e.g., via communication link(s). In the illustrated embodiments, IO modules **102**, **104** are coupled to switch module **107** so that information, such as management protocol, configuration data, or network traffic data, can be passed from IO module **102** or IO module **104** to worker modules **106**, and vice versa. In other embodiments, the IO modules **102**, **104** are not connected to switch module **107**. In some embodiments, after network traffic data is processed by one of the worker modules **106*a*-106*c***, the network traffic data can be passed to another one of the worker modules **106*a*-106*c*** (using switch module **107**) for further processing. In other embodiments, network traffic data is processed by only one of the worker modules **106*a*-106*c***. In such cases, network traffic data received by a worker module **106** from one of the IO modules **102**, **104** is processed by the worker module **106**, and is then transmitted to the other one of the IO modules **102**, **104**.

In some embodiments, each worker module **106** has one or more logical interfaces associated with each of its data ports **130**, **140**. Each logical interface is a protocol used to associate data received from an IO port **108** of IO module **102** (or an IO port **118** of IO module **104**) with data ports **130** (or **140**). As such, each logical interface of worker module **106** is provided a one-to-one mapping with IO port **108** of IO module **102**, or IO port **118** of IO module **104**. In IO module **102** (or **104**), a packet received by IO port **108** (or **118**) is distributed to worker module **106** via a point-to-point link. In worker module **106**, the received packet is assigned to a logical interface associated with the IO port **108** (or **118**) at which the packet is received at IO module **102** (or **104**), and the received packet is treated as if it is received from a corresponding logical port of worker module **106**. In other embodiments, IO module **102** and IO module **104** have a plurality of IO ports **108** and IO ports **118**, respectively. In further embodiments, each worker module **106** can have a plurality of data ports **130** and/or data ports **140**. In such cases, each logical interface provides a one-to-one mapping between an IO port **108** (or **118**) and a data port **130** (or **140**).

In some embodiments, the mapping between a logical interface at worker module **106** and an IO port (interface) **108** at IO module **102** (or IO port **118** at IO module **104**) is implemented as a tag mechanism. In such cases, a pair of IO interface and logical interface are assigned with a tag that is unique among the interface mappings. For example, for the case in which IO module **102** receives network traffic data (e.g., a packet) from sender **16**, before the packet is sent from IO module **102** to worker module **106**, the tag of IO interface is added to the packet. When worker module **106** receives the packet, the corresponding logical interface is determined, and the tag is removed from the packet. Worker module **106** then processes and treats the packet as if the packet is received via the logical interface. Before worker module **106** passes the packet to IO module **104** (or to another worker module **106**), the tag of the logical interface is added to the packet. When IO module **104** (or another worker module **106**) receives the packet, the IO interface at IO module **104** is determined via the tag, and the tag is removed. The untagged packet is then transmitted to receiver **18**. Similar technique is used when data is transmitted from receiver **18** to sender **16**.

To illustrate the above technique, assuming, for example, that ports **108*a***, **108*b*** of IO module **102** have identifiers io**1**, io**2**, respectively, and that two logical interfaces at IO module **102** are labeled as lg**1**, lg**2**, the mapping relationship in this example may be io**1**-lg**1**, io**2**-lg**2**. The tag numbers for the mapping interfaces are 0, 1, respectively. In this example, network traffic data received via port **108***a* (with identifier io**1**) at IO module **102** is sent to a worker module **106**, and is tagged as (0,packet). Worker module **106** receives the tagged packet, finds logical interface lg**1** based on the mapping relationship io**1**-lg**1**, and assigns the packet to the logical interface lg**1**. In some cases, after worker module **106** has processed the received packet, worker module **106** then sends the packet to IO module **104**. Module **104** receives the packet and assigns a logical interface for the packet using the above tagging technique, and sends the packet to receiver **18** using the assigned logical interface.

In other embodiments, system **10** does not use the above-described tagging mechanism. Instead, system **10** uses other techniques known in the art to accomplish the same result.

In the illustrated embodiments, system **10** is implemented as a component of a gateway (or gateway product), which is configured to perform policy enforcement. As used in this specification, the term "policy enforcement" refers to a process or procedure, an execution of which creates a result that can be used to determine whether to pass data to user, and includes (but is not limited to) one or a combination of: source verification, destination verification, user authentication, virus scanning, content scanning (e.g., scanning for undesirable content), and intrusion detection (e.g., detecting undesirable content, such as worms, porno website, etc.). In other embodiments, instead of being a component of gateway, system **10** can be a separate component that is coupled to gateway. In other embodiments, system **10** can be a gateway product by itself, and can be implemented at any point along a communication path between sender **16** and receiver **18**. For example, in some embodiments, system **10** can be implemented as a device, or a network of devices, that are communicatively coupled between sender **16** and receiver **18**. The term "sender" should not be limited to a human sender, and may include a server, a module, a device, a computer program, and the like, e.g., any one of a variety of devices that can transmit information. Similarly, the term "receiver" should not be limited to a server, and may include a hardware, a database, a module, a device, a computer program, and the like, e.g., any one of a variety of devices that can receive information. In some embodiments, sender **16** can also receive information, and receiver **18** can also transmit information.

In some embodiments, IO module **102**, IO module **104**, worker modules **106**, and switch module **107** can each be implemented using a computer. Alternatively, more than one component of system **10** can be implemented using a computer. For example, in other embodiments, IO module **102** and worker module **106***a* may be implemented using a computer. As another example, IO module **102** and switch module **107** may be implemented using a computer.

It should be noted that system **10** should not be limited to the configuration described previously, and that system **10** can have other configurations in other embodiments. For example, in other embodiments, system **10** can be implemented using software. For examples, system **10** can be implemented using software that is loaded onto a computer, a server, or other types of memory, such as a disk or a CD-ROM. In some cases, system **10** can be implemented as web applications. In alternative embodiments, system **10** can be implemented using hardware. For example, in some embodiments, system **10** includes an application-specific integrated circuit (ASIC), such as a semi-custom ASIC processor or a programmable ASIC processor. ASICs, such as those described in Application-Specific Integrated Circuits by Michael J. S. Smith, Addison-Wesley Pub Co. (1st Edition, June 1997), are well known in the art of circuit

design, and therefore will not be described in further detail herein. In still other embodiments, module **10** can be any of a variety of circuits or devices capable of performing the functions described herein. For example, in alternative embodiments, system **10** can include a general purpose processor, such as a Pentium processor. In other embodiments, system **10** can be implemented using a combination of software and hardware. In some embodiments, system **10** may be implemented as a firewall, a component of a firewall, or a component that is configured to be coupled to a firewall.

FIG. **2**A illustrates a method **200** for processing network traffic data using system **10** in accordance with some embodiments. In particular, method **200** is used to process network traffic data transmitted from sender **16** to receiver **18**. First, IO module **102** of system **10** receives a packet (an example of network traffic data) from sender **16** via IO port **108** (Step **202**). For the purpose of the following discussion, it is assumed that the packet received is associated with a request for content, such as a web page requested by sender **16**. However, it should be understood by those skilled in the art that method **200** of FIG. **2**A can be used to process other types of network traffic data. After packet has been received, IO module **102** then determines which of the worker modules **206** to pass the packet and tags the packet (Step **204**).

Various distribution algorithms may be used to determine which of the worker modules **206** to pass the packet. In the illustrated embodiments, system **10** determines which of the worker modules **106** to pass the packet based on one or more IP addresses associated with the packet. In some embodiments, the sender's IP address associated with the packet and the receiver's IP address may be used to calculate a value V. For example, the sender's IP address and the receiver's IP address may be added to obtain the value V. In another example, one or both of the receiver and sender's IP addresses may be modified (e.g., by a weight value) before being used to calculate V. Regardless of how the value V is calculated/obtained, a distribution algorithm can be employed in which the value V is divided by a number N that represents a quantity of the worker modules **106** to obtain a remainder R (an assignment number). The number N can be determined by a system administrator. In other embodiments, the number N is determined automatically by a processor. For example, the number N can be determined by considering worker modules **106** that are available for processing network traffic data. After the remainder R is obtained, the remainder R is then used to determine which of the three worker modules **106** to assign for processing the packet. In one example, assuming that V=99, and the number N is "3" (because there are three worker modules **106***a*-**106***c*), the remainder R="0" (remainder of V/N). In the illustrated embodiments, worker modules **106***a*-**106***c* are each associated with an identification number A selected from N−1 to 0 (which corresponds to "2" "1" and "0" in the example). For example, worker modules **106***a*-**106***c* can have identification numbers "0" "1" and "2", respectively. IO module **102** then transmits the packet to the worker module **106** which has an identification number A that matches the calculated remainder R. In the above example, since the calculated remainder R is "0," IO module **102** determines worker module **106***a* (which has an identification number A of "0") is the worker module **106** for processing the packet.

Determining which worker module(s) **106** to pass the packet for processing based on its associated IP address(es) is advantageous because it allows system **10** to distribute sessions efficiently without the need, or at least without incurring significant system resources, to keep track of resource availability (which can consume a significant amount of computational and management resources). Passing the packet based on its associated IP address(es) is also simple and stable because no information about resource situation needs to be exchanged among modules **102**, **104**, **106**, and there is no resource requirement on IO modules **102**, **104**.

It should be noted that instead of the example of distribution algorithm described previously, system **10** can be implemented to distribute/pass network traffic data using other distribution algorithms in other embodiments. For example, in other embodiments, instead of obtaining remainder R, system **10** can use one or more IP address(es) to obtain other assignment numbers using other calculation algorithms. Also, in other embodiments, instead of associating each worker module **106** with an identification number A selected from N−1 to 0, system **10** can associate worker modules **106** with other identification numbers A. In further embodiments, system **10** can be configured to map (e.g., using a mapping table) calculated assignment numbers with identification numbers of worker modules **106**, to thereby determine which of the worker modules **106** to send the packet for processing.

Next, IO module **102** tags the packet, and passes the tagged packet to the worker module **106** as determined in step **204** (Step **206**). Following the above example, IO module **102** passes the packet to worker module **106***a*. In particular, the packet is passed from distribution port **110***a* of IO module **102** to data port **130***a* of worker module **106***a* via a communication link (e.g., a point-to-point link). In the illustrated embodiments, the packet is tagged by inserting a tag (e.g., an identification) to the packet (e.g., to a front of the packet). Alternatively, other methods of tagging the packet can also be used.

After worker module **106***a* receives the tagged packet, worker module **106***a* then untags the packet (e.g., by removing the tag attached to the packet), and determines a logical interface (Step **208**). Worker module **106***a* then processes the packet (Step **210**). For example, worker module **106***a* may perform source verification, destination verification, user authentication, anti-virus, content scanning, content detection, intrusion detection, or other functions associated with policy enforcement. Worker module **106***a* may also classify the packet based on a result of the processing from Step **210**. For example, worker module **106***a* may determine that packet is "unsafe" or "high risk" based on a prescribed protocol.

In other embodiments, instead of, or in addition to, those described previously, worker module **106***a* may also perform other functions. For example, as shown in FIG. **3**A, module **106***a* performs IPSEC (Internet Security Protocol) VPN tunneling or detunneling (Step **402**), DNAT (Step **404**), firewall policy (such as access control list (ACL) check) (Step **406**), stateful inspection (Step **408**), intrusion detection and prevention (Step **410**), antivirus (Step **412**), and SNAT (Step **414**) in accordance with other embodiments. To illustrate, assuming that the received packet has the configuration (a-b) in which "a" represents the source of the packet and "b" represents the destination of the packet, the IPSEC tunneling process adds an IPSEC header to the packet and encrypt the packet. For example, the IPSEC tunneling may change the received packet from (a-b) to (X-Y|a-b). IPSEC detunneling is a process in which the IPSEC header is removed and the packet is decrypted. For example, if an IPSEC tunneled packet is (X-Y|a-b), the IPSEC detunneling process changes the tunneled packet to (a-b). In the SNAT process, the source header is changed.

For example, in the SNAT process, packet (a-b) may be changed to (e-b). In the DNAT process, the destination header is changed. For example, in the DNAT process, packet (b-e) may be changed to (b-a).

In the illustrated embodiments, all worker modules **106** are configured such that they can perform the same functions. As such, in the event that the packet is passed to worker module **106***c* (instead of worker module **106***a*), for example, worker module **106***c* can be used to process the packet. In other embodiments, the worker modules **106** can be configured to perform different functions. In further embodiments, a first group of worker modules **106** can be configured to perform a first set of functions, and a second group of worker modules **106** can be configured to perform a second set of functions that are different from the first set.

Returning to FIG. **2**A, after step **210**, worker module **106***a* then determines which worker module to pass the packet for further processing (Step **212**). In the illustrated embodiments, the distribution algorithm discussed previously with reference to Step **204** may be used again to determine the next worker module **106** to which the packet is passed. Step **212** is desirable because in some embodiments, an IP address associated with the packet may change while being processed by system **10**. For example, a firewall may be configured to change source IP address and/or destination IP address based on a configuration of the packet in accordance with a prescribed policy. In such cases, if the packet matches the corresponding configuration, the IP address(es) associated with the packet is then changed as prescribed by the policy.

In the event that the IP address associated with the packet has changed, the above-described distribution algorithm can be used again to determine which worker module **106** to pass the packet for further processing. For example, if the calculated value V has been changed (e.g., resulted from a change of an IP address) from "99" to "100," then the value V=100 can be used to calculate a new assignment number (e.g., by dividing V=100 by the number of worker modules **106**=3, to obtain remainder R=1). The assignment number, which is "1" in the example, is then used to determine the next worker module **106** to which the packet is passed. Following the above example, since worker module **106***b* has identification number "1," the packet will be passed from worker module **106***a* to worker module **106***b*. In other embodiments, the packet may be passed to another one of worker modules **106**, depending on IP address and the distribution algorithm used. In the illustrated embodiments, the packet is transmitted from worker module **106***a* to switch module **107** via switch port **154***a*, and is passed from switch port **154***a* to worker module **106***b* via switch port **154***b* (Step **214**).

After receiving the packet from worker module **106***a*, worker module **106***b* further processes the packet (Step **216**). For example, worker module **106***b* may perform source verification, destination verification, user authentication, anti-virus, content scanning, content detection, intrusion detection, or other functions associated with policy enforcement. In other embodiments, instead of, or in addition to, those described previously, worker module **106***b* may also perform other functions. For example, in other embodiments, worker module **106***b* may classify the packet based on the step of processing. Also, in other embodiments, worker module **106***b* may perform IPSEC VPN tunneling (FIG. **3**A).

Worker module **106***b* then tags the packet (Step **218**), and passes the packet to IO module **104** (Step **220**). In particular, the tagged packet is passed from data port **140***b* of worker module **106***b* to distribution port **120***b* of IO module **104** (e.g., via a point-to-point link). In other embodiments, instead of passing the packet to IO module **104**, if further processing is needed, worker module **106***b* can pass the packet to a third worker module for further processing. For example, a distribution algorithm (such as the example of distribution algorithm discussed previously) can be used to determine which other worker module **106** can be used to further process the packet. In some embodiments, the same distribution algorithm is used to pass packet from IO module **102** to a worker module **106**, and from one worker module **106** (e.g., **106***a*) to another worker module **106** (e.g., **106***b*). In other embodiments, the distribution algorithm used to pass packet from IO module **102** to worker module **106** may be different from the distribution algorithm used to pass packet between worker modules **106**.

After IO module **104** receives the packet, IO module **104** untags the packet and determines an IO interface (Step **222**). IO module **104** then passes the packet to receiver **18** (Step **224**). In some embodiments, if worker module **106** determines that the packet is an undesirable network traffic data (e.g., a virus), then in Step **224**, instead of passing the packet to receiver **18**, system **10** transmits a message or a warning signal to receiver **18**, indicating that undesirable data has been detected.

In other embodiments, system **10** can perform methods that are different from that discussed previously to process network traffic data. For example, in other embodiments, method **200** may not include one or more steps (such as the tagging and un-tagging steps) discussed previously. Also, in other embodiments, one or more steps of method **200** described previously with reference to a module may be performed by another module instead. For example, in other embodiments, step **212** of classifying packet may be performed by worker module **106***b* (instead of by worker module **106***a*). In further embodiments, any of the steps **202**-**224** discussed previously may be performed as a series of sub-steps, which may be performed by one or more modules (e.g., IO module **102**, worker module(s) **106**, and IO module **104**).

FIG. **2**B illustrates a method **240** for processing network traffic data using system **10** in accordance with other embodiments. In particular, method **240** is used to process network traffic data transmitted from receiver **18** to sender **16**. In the illustrated embodiments, the network traffic data includes content requested by sender **16**, and the network traffic data is sent by receiver **18** in response to a content request (such as the example discussed with reference to method **200**). However, it should be understood by those skilled in the art that method **240** of FIG. **2**B can be used to process other types of network traffic data.

First, IO module **104** of system **10** receives a packet (an example of network traffic data) from receiver **18** via IO port **118** (Step **242**). After packet has been received, IO module **104** then determines which worker module **106** to pass the packet for processing (Step **244**), and passes the packet to worker module **106** (Step **246**). The packet may be tagged before it is passed to worker module **106**.

In the illustrated embodiments, IO module **104** determines which worker module **106** to pass the packet based on the path from which the original packet is transmitted in method **200** (FIG. **2**A). Various techniques can be used to keep track with the path of the original packet in method **200**. In some embodiments, system **10** creates a record of the path traveled by the original packet (e.g., during method **200**), and transmits the reply packet back the same path from which the original packet comes based on the record. For example, if an original packet is exchanged from worker module **106***a* to worker module **106***b*, worker module **106***b* then creates a record of such an exchange. In such cases, when worker module **106***b* receives a reply packet (e.g., in response to the original packet), worker module **106***b* then looks up the record (e.g., by accessing a log) to determine that the original packet comes from worker module **106***a*, and passes the reply packet to worker module **106***a* based on the record. Following the above example, because the original packet was passed from worker module **106***b* to IO module **104** in method **200**, (FIG. **2**A), the reply packet is passed from IO module **104** back to worker module **106***b* in step **244**. In particular, the packet is passed from the distribution port **120***b* of IO module **104** to data port **140***b* of worker module **106***b*. In other embodiments, instead of using a previous path to pass the packet, IO module **104** can use the above described distribution algorithm to calculate a value, which is then used to determine which worker module **106** to pass for processing the packet. Steps **242**-**246** are similar to steps **202**-**206** discussed previously with reference to method **200**.

After worker module **106***b* receives the packet, worker module **106***b* untags the packet and determines a logical interface (Step **248**). Worker module **106***b* next processes the packet (Step **250**). In particular, worker module **106***b* can perform any of the functions described herein. For example, in some embodiments, worker module **106***b* performs IPSEC VPN detunneling (FIG. **3**B). After the packet is processed, worker module **106***b* passes the packet to another worker module for further processing (Step **252**). In the illustrated embodiments, the packet is passed from worker module **106***b* to worker module **106***a* because this is the path from which the original packet is transmitted in method **200** (FIG. **2**A). In particular, the packet is transmitted from worker module **106***b* to switch module **107** via switch port **154***b*, and is passed from switch module **107** to worker module **106***a* via switch port **154***a*. In other embodiments, worker module **106***b* can use the above described distribution algorithm to calculate a value, which is then used to determine which worker module **106** to pass for processing the packet. In such cases, the worker module **106** to pass the packet for processing will depend on the distribution algorithm being employed. Steps **248**-**252** are similar to steps **208**, **210**, and **214**, respectively, discussed previously with reference to method **200**.

After worker module **106***a* received the packet, worker module **106***a* processes the packet (Step **254**). Worker module **106***a* may perform any of the functions described herein. For example, as shown in FIG. **3**B, module **106***a* performs DNAT (Step **422**), stateful inspection (Step **424**), intrusion detection and prevention (Step **426**), antivirus (Step **428**), and SNAT (Step **430**) in accordance with other embodiments.

Worker module **106***a* then tags the packet (Step **256**), and passes the packet to IO module **102** (Step **258**). In the illustrated embodiments, the packet is passed from worker module **106***a* to IO module **102** because this is the path from which the original packet is transmitted in method **200** (FIG. **2**A). In other embodiments, instead of passing the packet to IO module **102**, if further processing is needed, worker module **106***a* can use the above described distribution algorithm to calculate a value, which is then used to determine which worker module **106** to pass for further processing the packet. Steps **254**-**258** are similar to steps **216**-**220** discussed previously with reference to method **200**.

After IO module **102** receives the packet, IO module **102** untags the packet and determines an IO interface (Step **260**), and sends the packet to sender **16** (Step **262**). Steps **260** and **262** are similar to steps **222** and **224** discussed previously with reference to method **200**.

In other embodiments, system **10** can perform methods that are different from that discussed previously to process network traffic data. For example, in other embodiments, method **240** may not include one or more steps (such as the tagging and un-tagging steps) discussed previously. Also, in other embodiments, one or more steps of method **240** described previously with reference to a module may be performed by another module instead. For example, in other embodiments, step **254** of processing packet may be performed by another worker module **106** (instead of by worker module **106***a*). In further embodiments, any of the steps **242-262** discussed previously may be performed as a series of sub-steps, which may be performed by one or more modules (e.g., IO module **102**, worker module(s) **106**, and IO module **104**).

In the above embodiments, packet is passed from one worker module **106** to another worker module **106** for processing. However, in other embodiments, a packet may not be passed from one worker module **106** to another worker module **106**, depending on a result of a distribution algorithm employed. For example, if the above described remainder-algorithm is employed, it is possible that a result of the algorithm may prescribe the same worker module **106** to continue processing a packet. In such cases, the packet is not passed from the worker module **106** to another worker module **106**.

FIG. **4**A illustrates a method **300** for processing network traffic data using system **10** in accordance with other embodiments. In particular, method **300** is used to process network traffic data transmitted from sender **16** to receiver **18**. First, IO module **102** of system **10** receives a packet (an example of network traffic data) from sender **16** via IO port **108** (Step **302**). For the purpose of the following discussion, it is assumed that the packet received is associated with a request for content, such as a web page requested by sender **16**. However, it should be understood by those skilled in the art that method **300** of FIG. **4**A can be used to process other types of network traffic data. After packet has been received, IO module **102** then determines which worker module **106** to pass the packet for processing (Step **304**).

Various distribution algorithms may be used to determine which of the worker modules **206** to pass the packet. For example, in some embodiments, system **10** determines which of the worker modules **206** to pass the packet based on one or more IP address(es) associated with the packet, as discussed previously. For the purpose of the following discussion, it will be assumed that the packet is passed to worker module **106***a*. However, it should be understood by those skilled in the art that the packet can be passed to another worker module **206**, depending on the distribution algorithm used.

Next, the IO module **102** passes the packet to worker module **106***a* (Step **306**). The packet may be tagged before it is passed to worker module **106***a*.

After worker module **106***a* receives the tagged packet, worker module **106***a* then untags the packet (e.g., by removing the tag attached to the packet), and determines a logical interface (Step **308**). Worker module **106***a* then processes the packet (Step **310**). For example, worker module **106***a* may perform source verification, destination verification, user authentication, anti-virus, content scanning, content detection, intrusion detection, or other functions associated with policy enforcement. In other embodiments, instead of, or in addition to, those described previously, worker module **106***a* may also perform other functions. Worker module **106***a* may also classify the packet based on a result of the processing from Step **210**. Steps **302**, **304**, **306**, **308**, **310** are similar to steps **202**, **204**, **206**, **208**, **210**, **212** of method **200**, and therefore, would not be described in details.

In other embodiments, instead of, or in addition to, those described previously, worker module **106***a* may also perform other functions. For example, as shown in FIG. **5**A, module, **106***a* performs DNAT (Step **520**), ACL check (Step **504**), stateful inspection (Step **506**), intrusion detection and prevention (Step **508**), antivirus (Step **510**), and SNAT (Step **512**) in accordance with other embodiments.

After step **310**, worker module **106***a* determines which worker module **106** to pass the packet for further processing (Step **312**). Again, the above distribution algorithm can be used for such purpose. For the purpose of discussion, it is assumed that the calculated remainder R=0. Since worker module **106***a* has identification number "0" that is associated with R=0, worker module **106***a* is continued to be used to process the packet. As such, unlike method **200**, the packet is not passed from worker module **106***a* to another worker module **106** for further processing. Instead, worker module **106***a* itself performs further processing for the packet (Step **314**), such as performs IPSEC VPN tunneling.

After the packet has been processed, worker module **106***a* tags the packet (Step **316**), and passes the packet to IO module **104** (Step **318**). In the illustrated embodiments, the packet is transmitted from data port **140***a* of worker module **106***a* to distribution port **120***a* of IO module **104**. In other embodiments, instead of sending the packet to IO module **104**, if further processing is needed, the above-described distribution algorithm may be used to determine which worker module **106** to pass for further processing the packet.

After IO module **104** receives the packet from worker module **106***a*, IO module **104** untags the packet and determines an IO interface (Step **320**). IO module **104** then sends the packet to receiver **18** (Step **322**). Steps **320** and **322** are similar to steps **222** and **224**, respectively, discussed previously with reference to method **200**.

In other embodiments, system **10** can perform methods that are different from that discussed previously to process network traffic data. For example, in other embodiments, method **300** may not include one or more steps (such as the tagging and un-tagging steps) discussed previously. Also, in other embodiments, one or more steps of method **300** described previously with reference to a module may be performed by another module instead. In further embodiments, any of the steps **302-322** discussed previously may be performed as a series of sub-steps, which may be performed by one or more modules (e.g., IO module **102**, worker module(s) **106**, and IO module **104**).

FIG. **4**B illustrates a method **340** for processing network traffic data using system **10** in accordance with other embodiments. In particular, method **340** is used to process network traffic data transmitted from receiver **18** to sender **16**. In the illustrated embodiments, the network traffic data includes content requested by sender **16**, and the network traffic data is sent by receiver **18** in response to a content request (such as the example discussed with reference to method **300**). However, it should be understood by those skilled in the art that method **340** of FIG. **4**B can be used to process other types of network traffic data.

First, IO module **104** of system **10** receives a packet (an example of network traffic data) from receiver **18** via IO port **118** (Step **342**). After packet has been received, IO module **104** then determines which worker module **106** to pass the packet for processing (Step **344**), and passes the packet to worker module **106** (Step **346**). The packet may be tagged before it is transmitted to worker module **106**. In the illustrated embodiments, the packet is passed from IO module **104** to worker module **106***a* because this is the path from which the original packet is transmitted in method **300** (FIG. 4A). In particular, the tagged packet is passed from the distribution port **120***a* of IO module **104** to data port **140***a* of worker module **106***a*. In other embodiments, IO module **104** can use the above described distribution algorithm to calculate a value, which is then used to determine which worker module **106** to pass for processing the packet. In such cases, the worker module **106** to pass the packet for processing will depend on the distribution algorithm being employed. After worker module **106***a* received the packet, worker module **106***a* untags the packet and determines a logical interface (Step **348**).

Worker module **106***a* next processes the packet (Step **350**). For example, worker module **106***a* may perform source verification, destination verification, user authentication, anti-virus, content scanning, content detection, intrusion detection, or other functions associated with policy enforcement. In other embodiments, instead of, or in addition to, those described previously, worker module **106***a* may also perform other functions. For example, in other embodiments, module **106***a* performs IPSEC VPN detunneling (Step **522**), DNAT (Step **524**), stateful inspection (Step **526**), intrusion detection and prevention (Step **528**), antivirus (Step **530**), and SNAT (Step **532**), and IPSEC VPN tunneling (Step **534**) (FIG. 5B). Steps **342**, **344**, **346**, **348**, **350**, **352** are similar to respective steps **242**, **244**, **246**, **248**, **250**, **252** of method **240**, and therefore, would not be described in details.

Next, worker module **106***a* tags the packet (Step **352**), and passes the packet to IO module **102** (Step **354**). In the illustrated embodiments, the packet is passed from worker module **106***a* to IO module **102** because this is the path from which the original packet is transmitted in method **300** (FIG. 4A). In particular, the packet is transmitted from data port **140***a* of worker module **106***a* to distribution port **110***a* of IO module **102**. In other embodiments, if further processing is needed, worker module **106***a* can use the above described distribution algorithm to calculate a value, which is then used to determine which worker module **106** to pass for further processing the packet. In such cases, the worker module **106** to pass the packet for processing will depend on the distribution algorithm being employed.

After IO module **102** receives the packet from worker module **106***a*, IO module **102** untags the packet and determines an IO interface (Step **356**). IO module **102** then sends the packet to sender **16** (Step **358**). Steps **356** and **358** are similar to steps **260** and **262**, respectively, discussed previously with reference to method **240**.

In other embodiments, system **10** can perform methods that are different from that discussed previously to process network traffic data. For example, in other embodiments, method **340** may not include one or more steps (such as the tagging and un-tagging steps) discussed previously. Also, in other embodiments, one or more steps of method **340** described previously with reference to a module may be performed by another module instead. In further embodiments, any of the steps **342-358** discussed previously may be performed as a series of sub-steps, which may be performed by one or more modules (e.g., IO module **102**, worker module(s) **106**, and IO module **104**).

Although several embodiments of a method for processing network traffic data between sender **16** and receiver **18** have been described, the scope of the invention should not

be so limited. In other embodiments, system **10** can be configured to process (e.g., distribute) network traffic data using other algorithms such that network traffic data can be transmitted between sender **16** and receiver **18** in an efficient manner. Also, in other embodiments, one or more steps described previously can be combined with other step(s). In addition, in further embodiments, a method needs not include all of the steps discussed previously.

Although embodiments of system **10** and various methods have been described with reference to processing network traffic data that is associated with web content, it should be understood that the same or similar methods and modules may also be used to pass other content, such as emails (being sent or being received), FTP, HTTP, and any electronic information. In some embodiments, system **10** includes a protocol differentiator (not shown), which examines headers of the network traffic and determines the types of data being passed. System **10** then passes content data based on prescribed protocol for the type of data.

In some embodiments, each type of network traffic data is pre-assigned to a port of a network gateway by a default configuration. For example, HTTP, SMTP, POP, IMAP, and FTP data may each be pre-assigned to be transmitted through a designated port. In such a case, a protocol differentiator can determine a type of content based on an identification of a port transmitting the network content. In other embodiments, protocol differentiator can be configured to scan all available ports in order to determine a type of content being screened.

In some embodiments, system **10** includes a user interface that allows a user to select criteria or parameters for passing network traffic data. For example, system **10** can allow a user to determine which passing protocol/algorithm to use for passing data. For example, the user interface can provide a plurality of passing algorithms (e.g., data passing based on IP address(es), data passing based on available resources, or data passing based on data type) for a user or an administrator to select. In alternative embodiments, the user interface can allow a user to formulate and/or program customized passing protocol. In further embodiments, the user interface can allow a user to select which passing protocol/algorithm to use for a certain type of network data. The user interface can be implemented using a computer in some embodiments.

Computer Architecture

FIG. **6** is a block diagram that illustrates an embodiment of a computer system **600** upon which embodiments described herein may be implemented. For example, computer system **600** may be used to implement one or more of IO module **102**, IO module **104**, and worker modules **106**. Computer system **600** includes a bus **602** or other communication mechanism for communicating information, and a processor **604** coupled with bus **602** for processing information. Computer system **600** also includes a main memory **606**, such as a random access memory (RAM) or other dynamic storage device, coupled to bus **602** for storing information and instructions to be executed by processor **604**. Main memory **606** also may be used for storing temporary variables or other intermediate information during execution of instructions to be executed by processor **604**. Computer system **600** may further include a read only memory (ROM) **608** or other static storage device(s) coupled to bus **602** for storing static information and instructions for processor **604**. A data storage device **610**, such as a magnetic disk or optical disk, is provided and coupled to bus **602** for storing information and instructions.

Computer system **600** may be coupled via bus **602** to a display **612**, such as a cathode ray tube (CRT), for displaying information to a user. An input device **614**, including alphanumeric and other keys, is coupled to bus **602** for communicating information and command selections to processor **604**. Another type of user input device is cursor control **616**, such as a mouse, a trackball, cursor direction keys, or the like, for communicating direction information and command selections to processor **604** and for controlling cursor movement on display **612**. This input device typically has two degrees of freedom in two axes, a first axis (e.g., x) and a second axis (e.g., y), that allows the device to specify positions in a plane.

Embodiments described herein are related to the use of computer system **600** for processing network traffic data. According to some embodiments, such use may be provided by computer system **600** in response to processor **604** executing one or more sequences of one or more instructions contained in the main memory **606**. Such instructions may be read into main memory **606** from another computer-readable medium, such as storage device **610**. Execution of the sequences of instructions contained in main memory **606** causes processor **604** to perform the process steps described herein. One or more processors in a multi-processing arrangement may also be employed to execute the sequences of instructions contained in main memory **606**. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions. Thus, embodiments described herein are not limited to any specific combination of hardware circuitry and software.

The term "computer-readable medium" as used herein refers to any medium that participates in providing instructions to processor **604** for execution. Such a medium may take many forms, including but not limited to, non-volatile media, volatile media, and transmission media. Non-volatile media includes, for example, optical or magnetic disks, such as storage device **610**. Volatile media includes dynamic memory, such as main memory **606**. Transmission media includes coaxial cables, copper wire and fiber optics, including the wires that comprise bus **602**. Transmission media can also take the form of acoustic or light waves, such as those generated during radio wave and infrared data communications.

Common forms of computer-readable media include, for example, a floppy disk, a flexible disk, hard disk, magnetic tape, or any other magnetic medium, a CD-ROM, any other optical medium, punch cards, paper tape, any other physical medium with patterns of holes, a RAM, a PROM, and EPROM, a FLASH-EPROM, any other memory chip or cartridge, a carrier wave as described hereinafter, or any other medium from which a computer can read.

Various forms of computer-readable media may be involved in carrying one or more sequences of one or more instructions to processor **604** for execution. For example, the instructions may initially be carried on a magnetic disk of a remote computer. The remote computer can load the instructions into its dynamic memory and send the instructions over a telephone line using a modem. A modem local to computer system **600** can receive the data on the telephone line and use an infrared transmitter to convert the data to an infrared signal. An infrared detector coupled to bus **602** can receive the data carried in the infrared signal and place the data on bus **602**. Bus **602** carries the data to main memory **606**, from which processor **604** retrieves and executes the instructions. The instructions received by main memory **606** may optionally be stored on storage device **610** either before or after execution by processor **604**.

Computer system **600** also includes a communication interface **618** coupled to bus **602**. Communication interface **618** provides a two-way data communication coupling to a network link **620** that is connected to a local network **622**. For example, communication interface **618** may be an integrated services digital network (ISDN) card or a modem to provide a data communication connection to a corresponding type of telephone line. As another example, communication interface **618** may be a local area network (LAN) card to provide a data communication connection to a compatible LAN. Wireless links may also be implemented. In any such implementation, communication interface **618** sends and receives electrical, electromagnetic or optical signals that carry data streams representing various types of information.

Network link **620** typically provides data communication through one or more networks to other devices. For example, network link **620** may provide a connection through local network **622** to a host computer **624**. Network link **620** may also transmits data between an equipment **626** and communication interface **618**. The data streams transported over the network link **620** can comprise electrical, electromagnetic or optical signals. The signals through the various networks and the signals on network link **620** and through communication interface **618**, which carry data to and from computer system **600**, are exemplary forms of carrier waves transporting the information. Computer system **600** can send messages and receive data, including program code, through the network(s), network link **620**, and communication interface **618**. Although one network link **620** is shown, in alternative embodiments, communication interface **618** can provide coupling to a plurality of network links, each of which connected to one or more local networks. In some embodiments, computer system **600** may receive data from one network, and transmit the data to another network. Computer system **600** may process and/or modify the data before transmitting it to another network.

Although particular embodiments have been shown and described, it will be understood that they are not intended to limit the present inventions, and it will be obvious to those skilled in the art that various changes and modifications may be made. The specification and drawings are, accordingly, to be regarded in an illustrative rather than restrictive sense. The present inventions are intended to cover alternatives, modifications, and equivalents, which may be included within the spirit and scope of the present inventions as defined by the claims.

What is claimed:

1. A method for processing network traffic data, comprising:

receiving network traffic data; and

passing the network traffic data to one of a plurality of worker modules for processing the network traffic data;

wherein the step of passing is performed based at least in part on a quantity of the worker modules; and

wherein each of the worker modules has an identification number, and the network traffic data is passed based on a matching between a value and the identification number of one of the worker modules, the value obtained using at least an IP address associated with a receiver of the network traffic data.

2. The method of claim **1**, wherein the network traffic data is passed based on the value obtained from a process, the process including:

dividing a number by the quantity of the worker modules; and determining a remainder based on a result from the dividing.

3. The method of claim **2**, wherein the number is calculated using the IP addresses associated with the receiver of the network traffic data, and an IP address associated with a sender of the network traffic data.

4. The method of claim **2**, wherein the number is obtained by adding the IP address associated with the sender of the network traffic data, and the IP address associated with the receiver of the network traffic data.

5. The method of claim **1**, further comprising using the one of the plurality of worker modules to perform stateful inspection, intrusion detection, or antivirus.

6. The method of claim **1**, wherein the quantity is determined by a system administrator.

7. The method of claim **1**, wherein the quantity is determined automatically by a processor.

8. The method of claim **7**, further comprising mapping an IO port from which the network traffic data is received with a logical interface of the one of the plurality of worker modules.

9. The method of claim **1**, further comprising tagging the network traffic data.

10. The method of claim **1**, further comprising passing the network traffic data from the one of the plurality of worker modules to another one of the plurality of worker modules.

11. The method of claim **10**, wherein the step of passing the network traffic data from the one of the plurality of worker modules to another one of the plurality of worker modules is performed based on the value.

12. The method of claim **1**, wherein the step of passing is performed by an IO module.

13. The method of claim **1**, wherein the step of passing is performed by another one of the plurality of the worker modules.

14. A system for processing network traffic data, comprising:

means for receiving network traffic data; and

means for passing the network traffic data to one of a plurality of worker modules for processing the network traffic data;

wherein the means for passing is configured to perform the step of passing based at least in part on a quantity of the worker modules; and

wherein each of the worker modules has an identification number, and the means for passing passes the network traffic data based on a matching between a value and the identification number of one of the worker modules, the value obtained using an IP address associated with a receiver of the network traffic data.

15. A computer product having a set of stored instructions, an execution of which causes a process to be performed, the process comprising:

receiving network traffic data; and

passing the network traffic data to one of a plurality of worker modules for processing the network traffic data;

wherein the step of passing is performed based at least in part on a quantity of the worker modules; and

wherein each of the worker modules has an identification number, and the network traffic data is passed based on a matching between a value and the identification number of one of the worker modules, the value obtained using an IP address associated with a receiver of the network traffic data.

16. A method for processing network traffic data, comprising:

receiving network traffic data;

passing the network traffic data to one of a plurality of worker modules for processing the network traffic data; and

tagging the network traffic data for mapping a logical interface at the one of the plurality of worker modules with a port at an IO module;

wherein the step of passing is performed based at least in part on a number associated with a first IP address.

17. The method of claim **16**, wherein the number is obtained using the first IP address and a second IP address.

18. The method of claim **17**, wherein the first IP address is associated with a sender of the network traffic data, and the second IP address is associated with a receiver of the network traffic data.

19. The method of claim **16**, wherein the number is obtained from a process that includes:

adding a first IP address to a second IP address to obtain an aggregate value;

dividing the aggregate value by a quantity of the worker modules; and

obtaining a remainder based on a result from the dividing.

20. The method of claim **16**, further comprising mapping the IO port with the logical interface of the one of the plurality of worker modules.

21. The method of claim **16**, further comprising passing the network traffic data from the one of the plurality of worker modules to another one of the plurality of worker modules.

22. The method of claim **21**, wherein the step of passing the network traffic data from the one of the plurality of worker modules to another one of the plurality of worker modules is performed based on another number associated with a second IP address.

23. The method of claim **16**, wherein the step of passing is performed by the IO module.

24. The method of claim **16**, wherein the step of passing is performed by another one of the plurality of the worker modules.

25. A system for processing network traffic data, comprising:

means for receiving network traffic data;

means for passing the network traffic data to one of a plurality of worker modules for processing the network traffic data; and

means for tagging the network traffic data for mapping a logical interface at the one of the plurality of worker modules with a port at an IO module;

wherein the means for passing is configured to perform the step of passing based at least in part on a number associated with a first IP address.

26. A computer product having a set of stored instructions, an execution of which causes a process to be performed, the process comprising:

receiving network traffic data;

passing the network traffic data to one of a plurality of worker modules for processing the network traffic data; and

tagging the network traffic data for mapping a logical interface at the one of the plurality of worker modules with a port at an IO module;

wherein the step of passing is performed based at least in part on a number associated with a first IP address.

27. A system for processing network traffic data, comprising:

a first IO module;

a second IO module;

a first worker module coupled to the first and second IO modules;

a second worker module coupled to the first and second IO modules; and

a switch module coupled to the first IO module, the second IO module, the first worker module, and the second worker module;

wherein the first IO module comprises a first IO port, and a first distribution port communicatively coupled to the first worker module; and

wherein the first worker module comprises a first data port and a second data port, the first distribution port of the first IO module communicatively coupled to the first data port of the first worker module, and the second data port of the first worker module communicatively coupled to a distribution port of the second IO module.

28. The system of claim **27**, wherein the first distribution port of the first IO module is communicatively coupled to the first data port of the first worker module via a point-to-point link.

29. The system of claim **27**, wherein the first IO module comprises a second distribution port communicatively coupled to the second worker module.

30. The system of claim **27**, wherein the first IO module is configured to pass network traffic data to the first or the second worker module based on a number associated with an IP address.

31. The system of claim **30**, wherein the number is obtained using a sender's IP address and a receiver's IP address.

32. The system of claim **27**, wherein the first IO module is configured to pass network traffic data to the first or the second worker module based on a number, the number obtained by:

adding a sender's IP address to a receiver's IP address to obtain an aggregate value; and

determining a remainder by dividing the aggregate value by a quantity of worker modules that include the first and second worker modules.

33. The system of claim **32**, wherein the first worker module has an identification number, and the first IO module is configured to pass the network traffic data based on a matching between the number and the identification number.

34. The system of claim **27**, wherein the first IO module is configured to tag the network traffic data.

35. The system of claim **34**, wherein a tagged portion of the tagged network traffic data is for mapping a logical interface at the one of the first and second worker modules with the first IO port.

36. The system of claim **27**, wherein the first worker module is configured to tag the network traffic data.

37. The system of claim **27**, wherein the first IO module and second IO module are separate components.

38. A system for processing network traffic data, comprising:

a first IO module comprising a plurality of ports;

a second IO module;

a first worker module coupled to the first and second IO modules;

a second worker module coupled to the first and second IO modules; and

a switch module coupled to the first IO module, the second IO module, the first worker module, and the second worker module;

wherein the first IO module is configured to pass network traffic data to the first or the second worker module based on a number, the number obtained by:

adding a sender's IP address to a receiver's IP address to obtain an aggregate value; and

determining a remainder by dividing the aggregate value by a quantity of worker modules that include the first and second worker modules;

wherein the first worker module has an identification number, and the first IO module is configured to pass the network traffic data based on a matching between the number and the identification number.

39. A system for processing network traffic data, comprising:

a first IO module comprising a plurality of ports;

a second IO module;

a first worker module coupled to the first and second IO modules;

a second worker module coupled to the first and second IO modules; and

a switch module coupled to the first IO module, the second IO module, the first worker module, and the second worker module;

wherein the first IO module is configured to tag the network traffic data, and a tagged portion of the tagged network traffic data is for mapping a logical interface at the one of the first and second worker modules with one of the ports.

40. The system of claim **39**, wherein the switch module is configured for passing data between the first and the second worker modules.

41. The system of claim **39**, wherein the plurality of ports comprises a first IO port, and a first distribution port communicatively coupled to the first worker module.

42. The system of claim **41**, wherein the plurality of ports comprises a second distribution port communicatively coupled to the second worker module.

43. The system of claim **39**, wherein the first IO module is configured to pass network traffic data to the first or the second worker module based on a number associated with an IP address.

44. The system of claim **43**, wherein the number is obtained using a sender's IP address and a receiver's IP address.

45. The system of claim **39**, wherein the first IO module and the second IO module are separate components.

* * * * *