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(54) **REQUEST ISOLATION SYSTEM**

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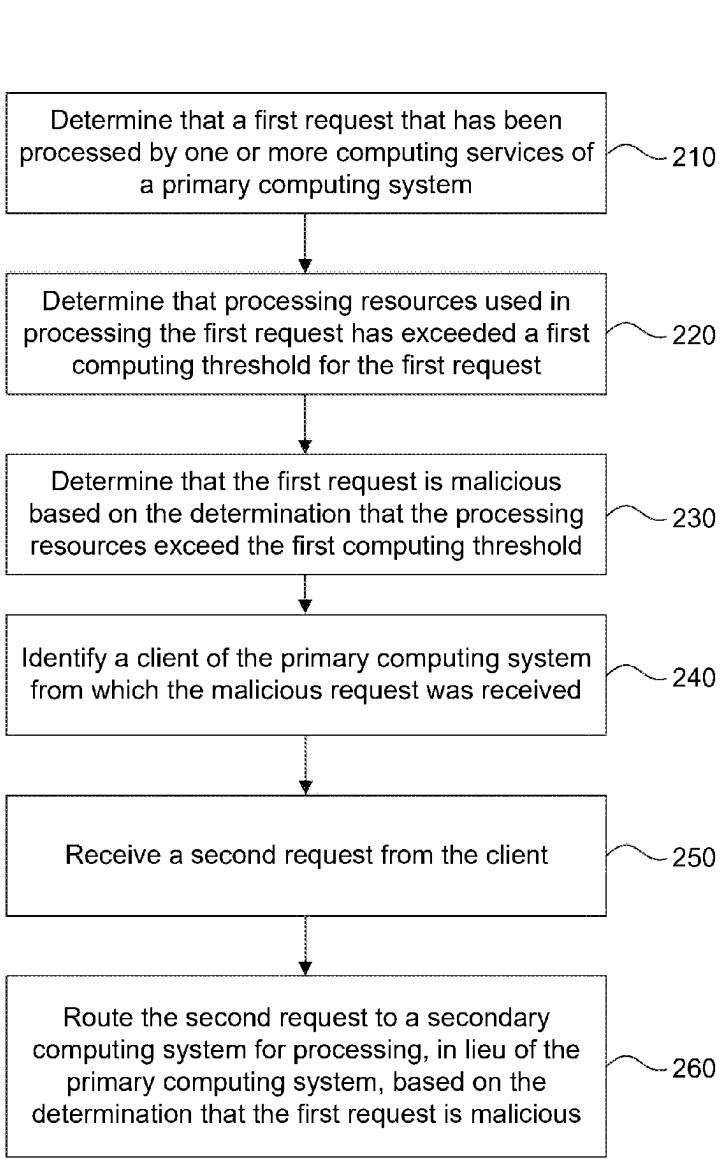
(57) **ABSTRACT**

System, method, and various embodiments for a request isolation system are described herein. An embodiment operates by determining a first request that has been processed by one or more computing services of a primary computing system. It is determined that processing resources used in processing the first request have exceeded a first computing threshold for the first request. It is determined that the first request is malicious based on the determination that the processing resources exceed the first computing threshold. A client of the primary computing system from which the malicious request was received is identified, a second request is received from the client, and the second request is routed to a secondary computing system for processing based on the determination that the first request was malicious.



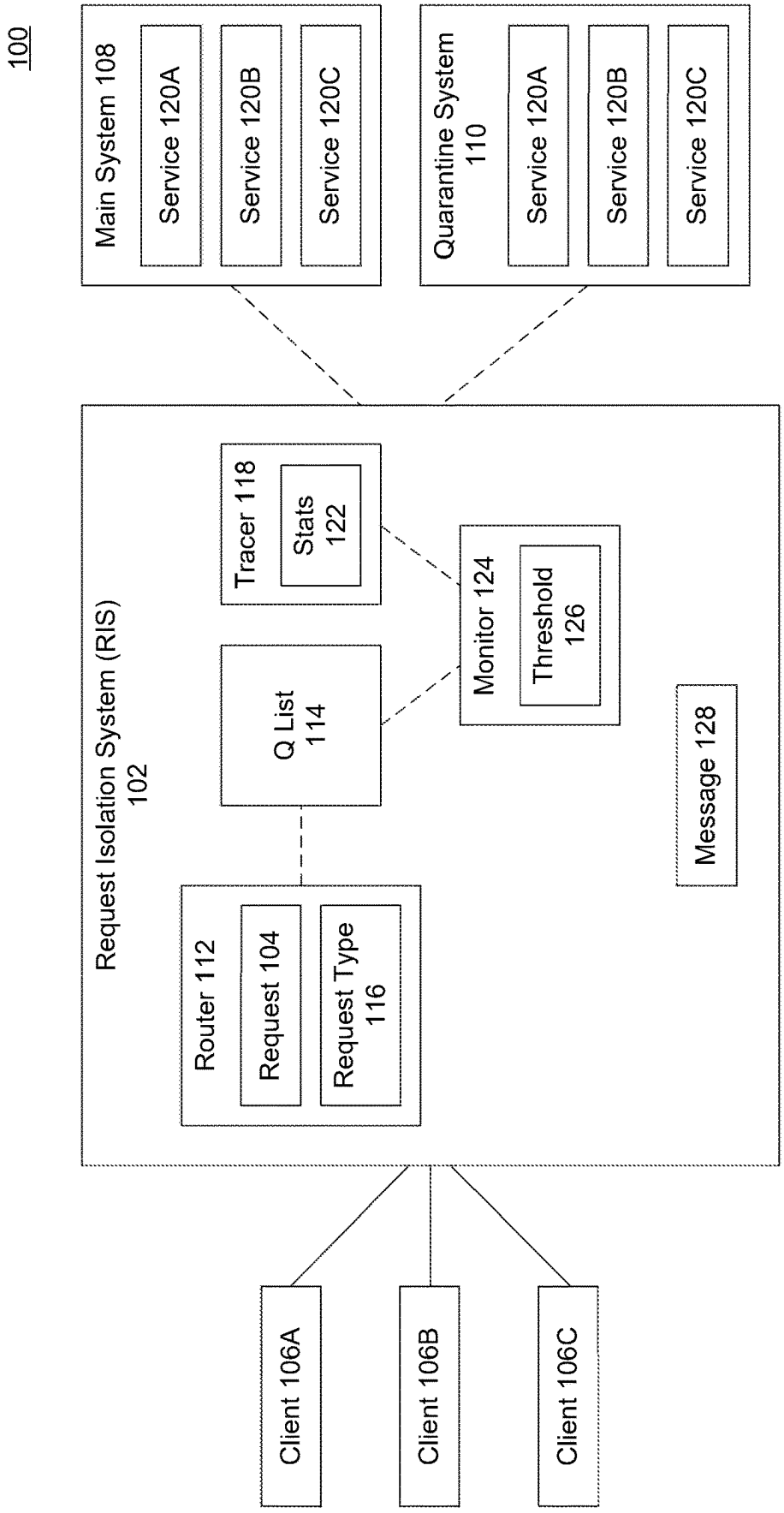

100
Main System 108
Service 120A
Service 120B
Service 120C
Quarantine System 110
Service 120A
Service 120B
Service 120C
Request Isolation System (RIS) 102
Tracer 118
Stats 122
Monitor 124
Threshold 126
Q List 114
Router 112
Request 104
Request Type 116
Message 128
Client 106A
Client 106B
Client 106C

FIG. 1

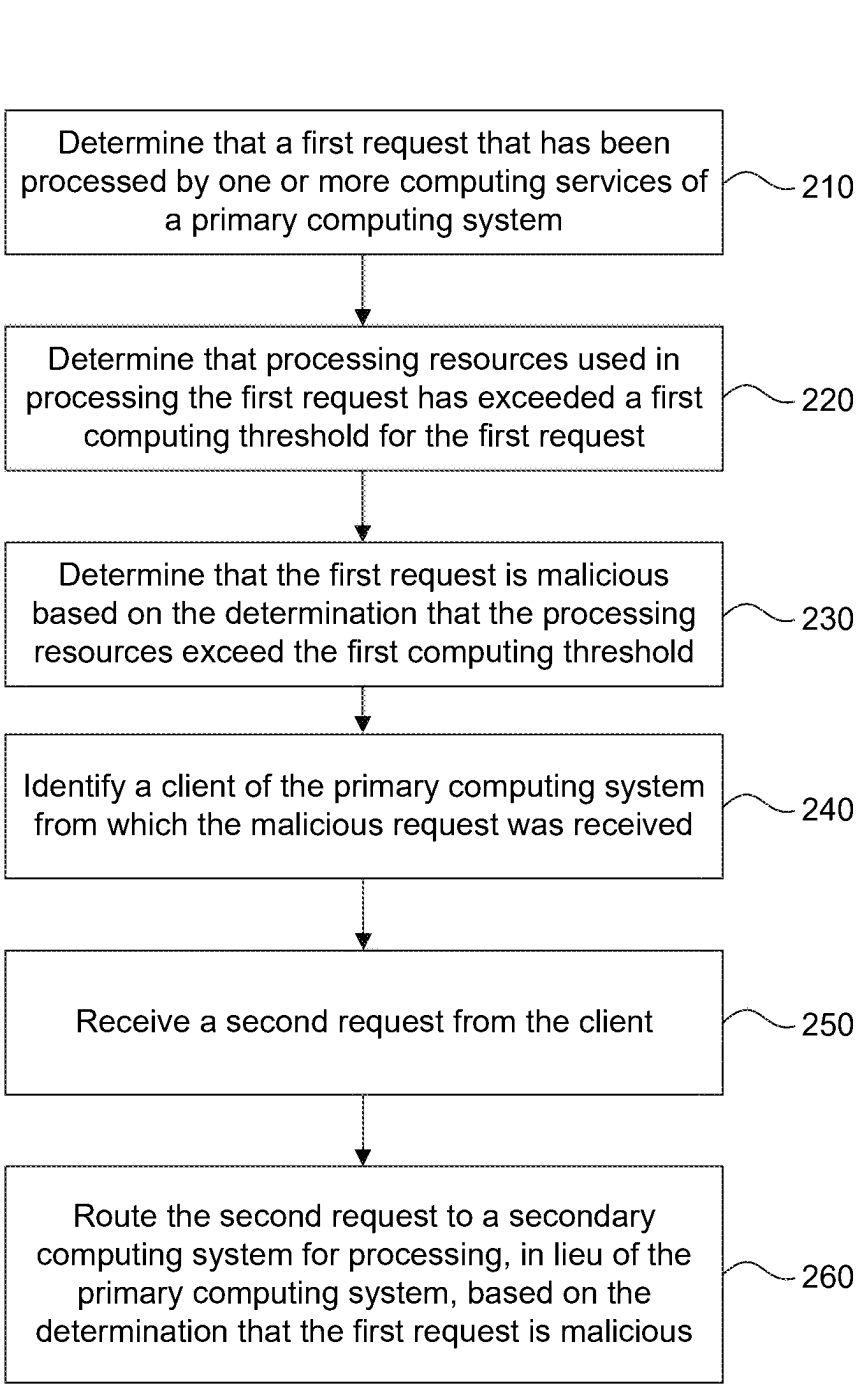

200
Determine that a first request that has been processed by one or more computing services of a primary computing system
210
Determine that processing resources used in processing the first request has exceeded a first computing threshold for the first request
220
Determine that the first request is malicious based on the determination that the processing resources exceed the first computing threshold
230
Identify a client of the primary computing system from which the malicious request was received
240
Receive a second request from the client
250
Route the second request to a secondary computing system for processing, in lieu of the primary computing system, based on the determination that the first request is malicious
260

FIG. 2

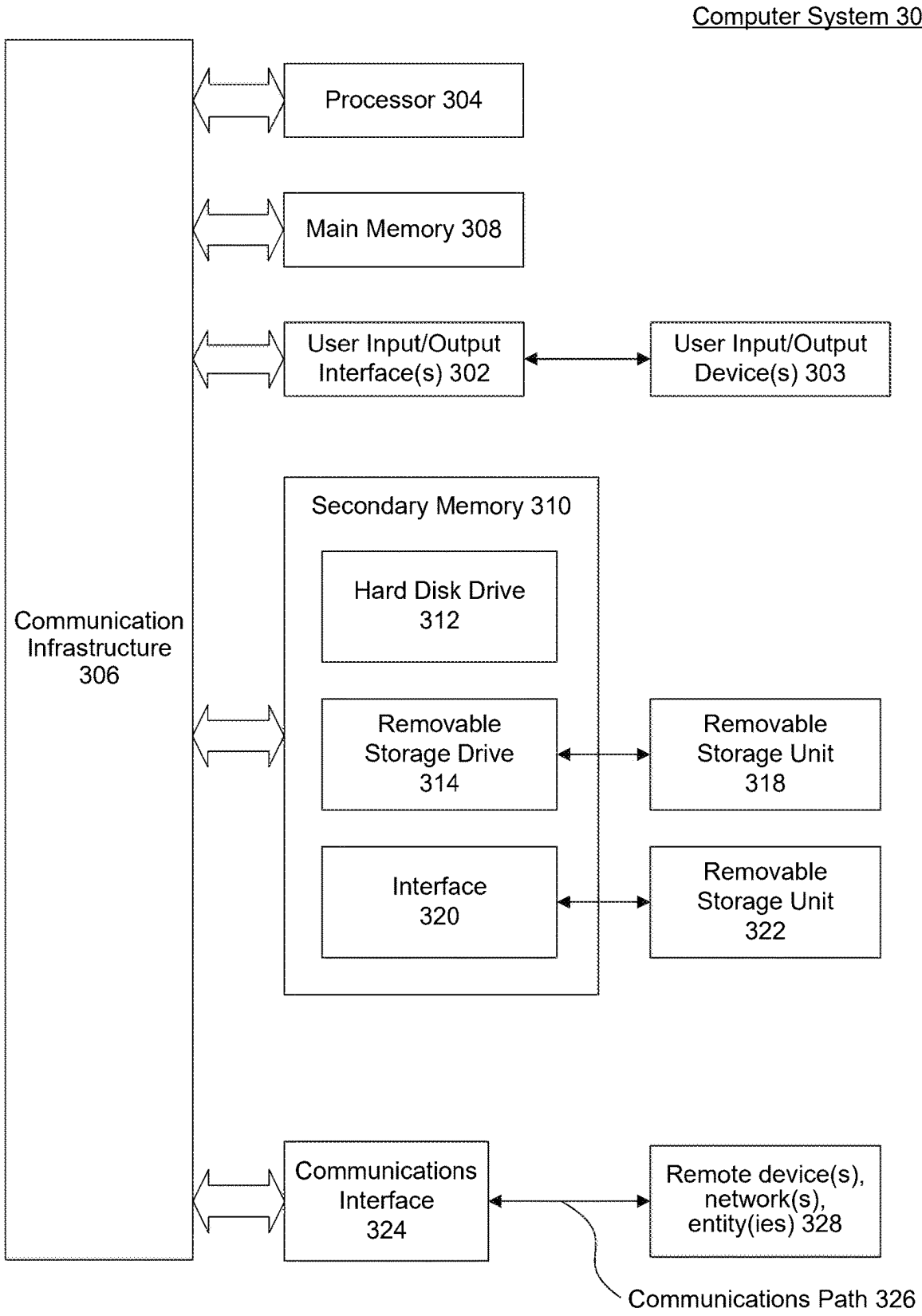

Computer System 300
Processor 304
Main Memory 308
User Input/Output Interface(s) 302
User Input/Output Device(s) 303
Secondary Memory 310
Hard Disk Drive 312
Removable Storage Drive 314
Removable Storage Unit 318
Interface 320
Removable Storage Unit 322
Communication Infrastructure 306
Communications Interface 324
Remote device(s), network(s), entity(ies) 328
Communications Path 326

FIG. 3

REQUEST ISOLATION SYSTEM

BACKGROUND

[0001] Malicious requests can range external attacks to requests that consume a large amount of computing resources. Computing systems need to have some way to manage, handle, and identify malicious requests. However, not all malicious requests are made equal. While some computing systems may stop processing any and all requests deemed malicious, this is not always a suitable response.

BRIEF DESCRIPTION OF THE DRAWINGS

[0002] The accompanying drawings are incorporated herein and form a part of the specification.

[0003] FIG. **1** is a block diagram illustrating example functionality for a request isolation system (RIS), according to some embodiments.

[0004] FIG. **2** is a flowchart illustrating example operations for providing a request isolation system (RIS), according to some embodiments.

[0005] FIG. **3** is example computer system useful for implementing various embodiments.

[0006] In the drawings, like reference numbers generally indicate identical or similar elements. Additionally, generally, the left-most digit(s) of a reference number identifies the drawing in which the reference number first appears.

DETAILED DESCRIPTION

[0007] Provided herein are system, apparatus, device, method and/or computer program product embodiments, and/or combinations and sub-combinations thereof, for providing a request isolation system.

[0008] Malicious requests can range external attacks to requests that consume a large amount of computing resources. Computing systems need to have some way to manage, handle, and identify malicious requests. However, not all malicious requests are made equal. While some computing systems may stop processing any and all requests deemed malicious, this is not always a suitable response.

[0009] FIG. **1** is a block diagram **100** illustrating example functionality for a request isolation system (RIS) **102**, according to some embodiments. RIS **102** may help increase computing system throughput of a first computing system by identifying malicious requests and routing both malicious requests and potentially malicious requests to a backup or secondary computing system until the threat has been reduced or absolved. RIS **102** enables both normal and malicious requests to be processed, but without the malicious requests interfering with the timely processing of normal requests.

[0010] In some embodiments, RIS **102** may receive a request **104** from various clients **106**A-C. Request **104** may include one or more processing requests to be handled by a main computing system **108**. For simplicity, a single request **104** is illustrated, however it is understood that RIS **102** may receive multiple requests in parallel from various clients **106**A-C. As such, the terms request **104** and requests **104** may be used interchangeably. The requests **104** may include a variety of different request types **116** such as read or write requests, or requests or commands to perform a specific functionality. In other embodiments, there may be other or different request types **116**.

[0011] Clients **106**A-C may include various organizations and/or computing systems or devices that submit requests **104**. In some embodiments, each client **106**A-C may represent multiple computing devices any one of which may submit a request **104** to RIS **102**. The term client **106** may be used to generally to refer to any combination of one or more clients **106**A-C. In other embodiments, more than three clients **106** may be capable of submitting requests **104**.

[0012] In some embodiments, the request **104** may be received by a router **112**. Router **112** may be a computing system or computing device configured to route the request **104** to either main computing system **108** or a quarantine computing system **110** for processing. In some embodiments, router **112** may be a standalone device communicatively coupled over a wired or wireless network to RIS **102**.

[0013] In some embodiments, router **112** may have access to a quarantine list (Q list) **114**. Q list **114** may include a record indicating which request(s) **104** and/or which requests **104** from which clients **106** are to be directed to quarantine system **110**. In some embodiments, Q list **114** may include a black list of which requests **104** are to be directed to quarantine system **110**, a white list of which requests **104** are allowed to be directed to main system **108**, or a black and white list of both.

[0014] For simplicity, in the examples used herein, the Q list **114** will be described as indicating which requests **104** are to be directed to the quarantine system **110**. In some embodiments, the Q list **114** may indicate a list of clients **106** for whom requests **104** received from those client(s) **106** are to be directed to the quarantine system **110** instead of the main system **108**.

[0015] In some embodiments, the Q list **114** may include a list of internet protocol (IP) addresses, MAC (media access control) addresses, names, domains, or other client identifiers. In some embodiments, the Q list **114** may indicate a request type **116**. For example, only write requests from client **106**C may be directed to quarantine system **110**, while read requests or other types of requests may be directed to main system **108**.

[0016] In some embodiments, as part of processing, router **112** or RIS **102** may detect or identify both a source of the request **104** (e.g., which client **106** the request **104** originated), and a request type **116** of the request **104**. Then, based on this information, cross referenced with Q list **114**, router **112** may route the request **104** to either main system **108** or quarantine system **110** for processing.

[0017] Main system **108** may include a computing system comprising one or more computing devices, including but not limited to servers and a database, that are configured to perform one or more services **120**A-C. The services **120**A-C, referred to herein generally as services **120**, may include applications, programs, or other functionality that may be requested or may be executed as part of processing a request **104**. Example services **120** include, but are not limited to, an authentication service, database read, database write, video generation, data transformations, etc. In some embodiments, different requests **104** or different request types **116** may access only a subset of the available services **120**. That is, each request **104** may not use every service **120**.

[0018] In some embodiments, main system **108** may be used during normal processing of requests **104** from clients **106**. However, as described in greater detail below, some requests **104** may consume more than a normal range of computing power, computing resources, computing cycles,

or computing time. These requests may be deemed malicious requests, even if they are received from an authorized client **106**. These malicious requests may indicate the beginning of an attack, or an inadvertent, innocent, or legitimate request from a client **106**.

[0019] When a malicious request is identified as coming from a particular client **106**C, future requests **104** from the client may be directed to a quarantine system **110** for processing, instead of main system **108**. In some embodiments, quarantine system **110** may include the same services **120**A-C as available with main system **108**, however quarantine system **110** may be allocated fewer resources and may operate independently (e.g., using different computing devices) from main system **108**, such that processing of malicious or potentially malicious requests **104** by quarantine system **110** does not impact the speed and throughput of main system **108** processing requests **104**.

[0020] In some embodiments, if there is a shared computing resource (e.g., such as a computing device or database) between main system **108** and quarantine system **110**, the requests from quarantine system **110** may assigned a lower priority relative to requests from main system **108**, and/or the requests from quarantine system **110** may be executed with a specific timeout period, so as not to slow processing of requests **104** from main system **108**.

[0021] Using, this dual system setup, may allow an organization, such as a cloud computing system, to continue processing requests **104** from clients **106**A-C, without allowing malicious requests to slow the processing of normal requests **104**. Further, quarantine system **110** may allocated with fewer computing resources relative to main system **108**, so that there is a cost savings relative to maintaining two identical systems. Various embodiments, in which malicious requests are identified and how requests may be moved between main system **108** and quarantine system **110** are described in greater detail below.

[0022] In some embodiments, RIS **102** may be configured to perform a tracing of how requests **104** are processed by main system **108** and quarantine system **110**, using a tracer **118**. In some embodiments, tracer **118** may perform distributed tracing of a request **104** as it is processed or causes processing by various services **120**A-C. In some embodiments, the tracing may include tracking various metrics or other types of information such as events that are logged while a request **104** is executed, structural information about which services **120**A-C were traversed, and how much time was spent on each service **120**A-C. The results of the tracing may be stored as statistics (stats **122**). In some embodiments, tracer **118** may employ sampling to generate stats **122**.

[0023] Stats **122** may include any metrics that are collected from the tracing performed by tracer **118**. In some embodiments, the stats **122** may include the amount of resource consumption, the time it took to process a request **104** by each or a combination of services **120**A-C, and/or error codes or other intermediate output that may have been generated during the processing of a request **104**, or other metrics.

[0024] In some embodiments, tracer **118** or a monitor **124** may generate a threshold **126**. Threshold **126** may indicate a range of normal processing and/or malicious processing, and may be generated based on stats **122**. For example, RIS **102** may collects stats **122** for a period of time, and generate a range of normal processing (e.g., normal time or computing resources it takes to process a request **104** by each service **120**A-C or a combination of services **120**A-C, or specific type of request **104**, by one or more of the services **120**A-C). RIS **102** may then define a threshold **126** indicating that any request **104** that consumes more than the normal time or computing resources is to be deemed a malicious request.

[0025] A malicious request may include any request or requests **104** that consume more than the threshold **126** amount of time or resources (by one or more services **120**), even if received from an authorized source or client **106**. In some embodiments, threshold **126** may include a collection of values that signify thresholds. For example, threshold **126** may indicate that the average processing time for a request **104** is 10 seconds, 5 seconds and 3 seconds across services **120**A-C, respectively, and that any request **104** that exceeds 11seconds, 6 seconds, and 4 seconds, respectively is to be determined a malicious request.

[0026] In some embodiments, threshold **126** may further indicate that at least two of the three (or more than 50%) of the service thresholds may need to be exceeded for the request to be determined as malicious. For example, if a request **104** takes 13 seconds, 5 seconds, and 2 seconds, the request **104** may not be malicious. Or, for example, threshold **126** may indicate that any request **104** causing any service **120** to exceed the threshold **126** for that service **120** may be enough to deem the request as malicious.

[0027] In some embodiments, threshold **126** may also indicate how many malicious requests from a particular client (and/or of a particular request type **116**) are allowed in a certain period of time, or over a range of requests before the client is deemed malicious. In some embodiments, a single malicious request **104** may be enough to deem the client as malicious and add the client to the Q list **114**. In some embodiments, if RIS **102** detects 2 malicious requests **104** within a 24 hour period of time, or over **100** requests that are processed, the client **106** may be deemed as malicious. Then, for example, monitor **124** may maintain a count of how many malicious requests are identified from each client **106** and over what period of time or over how many requests. In other embodiments, other thresholds **126** and/or threshold combinations may be used.

[0028] Once monitor deems a client **106** as malicious, based on one or more requests **104** from the client **106** exceeding threshold **126**, the client may be added to Q list **114**. In some embodiments, the monitor **124** may further specify a request type **116** to add to Q list **114** for the malicious client, such that only those types of requests are routed to quarantine system **110**. So, if a new request **104** is received from the malicious client **106**, the request type **116** of new request **104** may be checked, and if the same request type **116** for that client **106** is located on the Q list **114**, the new request **104** may be routed to the quarantine system **110**. If the request type **116** for any new requests **104** is not on the Q list **114**, then those new requests **104** may be processed by the main system **108**.

[0029] In some embodiments, Q list **114** may indicate that all requests **104** from a malicious client are directed to quarantine system **110**. Then, as noted above, when a subsequent request **104** is received from a malicious client (e.g., client **106**), those requests **104** may be routed to quarantine system **110**, instead of main system **108**.

[0030] As noted above, tracer **118** may continue tracing or monitoring how malicious requests from a client **106** are being processed by quarantine system **110**. This tracing of

quarantine system **110** may include its own set of metrics and stats **122**, similar to those described above. This tracing may allow RIS **102** to add and remove clients **106** from Q list **114**. For example, if the tracing reveals that the subsequent requests from a malicious client are within a threshold **126**, then, RIS **102** may remove the client from the Q list **114**, and any further requests **104** from the client may be directed back to main system **108**.

[0031] In some embodiments, a first threshold **126** may indicate when a client **106** (and corresponding request type **116** in some embodiments) is placed onto the Q list **114**, and a second threshold **126** may indicate when the client **106** (and corresponding request type **116**) is removed from the Q list **114**. In some embodiments, the first and second thresholds **126** may be identical, while in other embodiments, the values for the first and second threshold **126** may vary.

[0032] In some embodiments, one a client **106** is moved to Q list **114** it may be required to remain on Q list **114** for a specific period of time (e.g. 1 hour) or for a minimum number of requests (e.g., 50 requests) before it is eligible to be removed from Q list **114**. Once the required time period has expired, monitor **124** may determine if the stats **122** from tracing the processing of the malicious requests from the client **106** as processed by quarantine system **110** are below the threshold **126**. If the stats **122** are below the threshold **126**, then the client may be removed from Q list **114**. If the stats **122** continue to exceed the threshold **126**, then the minimum period may be reset.

[0033] In some embodiments, threshold **126** may include a suspension threshold, such that is requests from a malicious client **106** generate stats **122** exceeding threshold **126** for a certain period of time, requests **104** from the client may be suspended and/or a network administrator may be notified of a possible threat condition.

[0034] In some embodiments, a malicious request may share or use one or more services **120**A-C from main system **108** and one or more services **120**A-C from quarantine system **110**. For example, if a write request from client **106**B operates normally on service A and service C, but exceeds threshold **126** for service B, then, the subsequent write requests from client **106**B may be use service **120**A and **120**C from main system **108** and service **120**B from quarantine system **110**. In some embodiments, service **120**A may be an authentication service which may be used by all requests, and service **120**A may not exist on quarantine system **110**, thus minimizing the amount of duplication necessary.

[0035] In some embodiments, RIS **102** may be in communication with other similarly arranged computing systems (not shown) similar to system **100**. For example, the system **100** may be the New York processing location, but there may also be an Austin processing location and a Los Angeles processing system. The Austin location may receive and process requests from client **106**B, and other clients (not shown), and the Los Angeles location may receive and process requests from all of clients **106**A-C.

[0036] Then, for example, if client **106**B is deemed as malicious by the New York system, RIS **102** may generate and provide a message **128** to both the Austin location and the Los Angeles location to treat requests from client **106**B as malicious and to add the client **106**B to their respective Q lists **114**. If client **106**C is deemed as malicious, message **128** may only be transmitted to the Los Angeles location, since Austin does not process requests from client **106**C. Then, for example, whichever system receives the message **128**, may begin routing requests from the malicious client to their own local quarantine system, instead of processing those requests on their own local main system.

[0037] In some embodiments, different main systems **108** may share a dedicated quarantine system **110**. For example, both Los Angeles and New York may share the same quarantine system **110**, such that requests received at Los Angeles main system that are determined to be quarantined, may be provided to the same dedicated quarantine system **110** as quarantined requests received at the New York main system. In some embodiments, the main systems **108** and quarantine systems **110** across different locals may vary from each other in their configuration, except that the quarantine systems **110** may be isolated from the main systems **108** and be allocated with less computing power or resources relative to the main system **108**.

[0038] This messaging may help prevent widespread slowdowns or attacks caused by the malicious client(s) **106**B or **106**C. Then, for example, each location may independently monitor the quarantine system **110** processing to determine when to remove the client from their respective Q lists **114**. In some embodiments, the other locations (Austin, Los Angeles) may wait until they receive a subsequent message **128** from New York (the originating location) indicating that New York has removed the client from the Q list **114**, and then the locations may continue with normal processing of requests from the client (e.g., removing the client from their own local Q lists **114**).

[0039] FIG. **2** is a flowchart **200** illustrating example operations for providing a request isolation system (RIS) **102**, according to some embodiments. Method **200** can be performed by processing logic that can comprise hardware (e.g., circuitry, dedicated logic, programmable logic, microcode, etc.), software (e.g., instructions executing on a processing device), or a combination thereof. It is to be appreciated that not all steps may be needed to perform the disclosure provided herein. Further, some of the steps may be performed simultaneously, or in a different order than shown in FIG. **2**, as will be understood by a person of ordinary skill in the art. Method **200** shall be described with reference to FIG. **1**.

[0040] In **210**, it is determined that a first request that has been processed by one or more computing services of a primary computing system. For example, RIS **102** may receive request **104** from a client **106**A, and router **112** may transmit the request **104** to main system **108** for processing.

[0041] In **220**, it is determined that processing resources used in processing the first request has exceeded a first computing threshold for the first request. For example, tracer **118** may trace the processing of request **104** by the various services **120**A-C of main system **108**, and collect stats **122** about the processing.

[0042] In **230**, it is determined that the first request is malicious based on the determination that the processing resources exceed the first computing threshold. For example, monitor **124** may determine that the stats **122** of main system **108** processing request **104** exceed one or more thresholds **126**, on a service-level and/or overall system throughput or multiple-service level. This determination that some subset of the stats **122** for processing the request **104** exceed one or more thresholds **126**, may cause monitor to deem the request **104** as being malicious.

[0043] In **240**, a client of the primary computing system from which the malicious request was received, is identified. For example, monitor **124** may add client **106**A to the Q list **114**. In some embodiments, monitor **124** may determine the request type **116**, and add both client **106**A and the corresponding request type **116** for the malicious request to the Q list **114**. In some embodiments, a message **128** may be transmit to other systems that may be receiving requests from client **106**A, that client **106**A is potentially malicious.

[0044] In **250**, a second request is received from the client. For example, RIS **102** may receive a second or subsequent request from client **106** at router **112**.

[0045] In **260**, the second request is routed to a secondary computing system for processing, in lieu of the primary computing system, based on the determination that the first request is malicious. For example, router **112** may check the client **106**A (and in some embodiments, request type **116**) against the Q list **114**, and route the second request to the quarantine system **110**. RIS **102** may continue monitoring the processing of both main system **108** and quarantine system **110**, and continue to add/remove clients **106** and/or request types **116** from the Q list **114**.

[0046] Various embodiments may be implemented, for example, using one or more well-known computer systems, such as computer system **300** shown in FIG. **3**. One or more computer systems **300** may be used, for example, to implement any of the embodiments discussed herein, as well as combinations and sub-combinations thereof.

[0047] Computer system **300** may include one or more processors (also called central processing units, or CPUs), such as a processor **304**. Processor **304** may be connected to a communication infrastructure or bus **306**.

[0048] Computer system **300** may also include user input/output device(s) **303**, such as monitors, keyboards, pointing devices, etc., which may communicate with communication infrastructure **306** through user input/output interface(s) **302**.

[0049] One or more of processors **304** may be a graphics processing unit (GPU). In an embodiment, a GPU may be a processor that is a specialized electronic circuit designed to process mathematically intensive applications. The GPU may have a parallel structure that is efficient for parallel processing of large blocks of data, such as mathematically intensive data common to computer graphics applications, images, videos, etc.

[0050] Computer system **300** may also include a main or primary memory **308**, such as random access memory (RAM). Main memory **308** may include one or more levels of cache. Main memory **308** may have stored therein control logic (i.e., computer software) and/or data.

[0051] Computer system **300** may also include one or more secondary storage devices or memory **310**. Secondary memory **310** may include, for example, a hard disk drive **312** and/or a removable storage device or drive **314**. Removable storage drive **314** may be a floppy disk drive, a magnetic tape drive, a compact disk drive, an optical storage device, tape backup device, and/or any other storage device/drive.

[0052] Removable storage drive **314** may interact with a removable storage unit **318**. Removable storage unit **318** may include a computer usable or readable storage device having stored thereon computer software (control logic) and/or data. Removable storage unit **318** may be a floppy disk, magnetic tape, compact disk, DVD, optical storage disk, and/any other computer data storage device. Removable storage drive **314** may read from and/or write to removable storage unit **318**.

[0053] Secondary memory **310** may include other means, devices, components, instrumentalities or other approaches for allowing computer programs and/or other instructions and/or data to be accessed by computer system **300**. Such means, devices, components, instrumentalities or other approaches may include, for example, a removable storage unit **322** and an interface **320**. Examples of the removable storage unit **322** and the interface **320** may include a program cartridge and cartridge interface (such as that found in video game devices), a removable memory chip (such as an EPROM or PROM) and associated socket, a memory stick and USB port, a memory card and associated memory card slot, and/or any other removable storage unit and associated interface.

[0054] Computer system **300** may further include a communication or network interface **324**. Communication interface **324** may enable computer system **300** to communicate and interact with any combination of external devices, external networks, external entities, etc. (individually and collectively referenced by reference number **328**). For example, communication interface **324** may allow computer system **300** to communicate with external or remote devices **328** over communications path **326**, which may be wired and/or wireless (or a combination thereof), and which may include any combination of LANs, WANs, the Internet, etc. Control logic and/or data may be transmitted to and from computer system **300** via communication path **326**.

[0055] Computer system **300** may also be any of a personal digital assistant (PDA), desktop workstation, laptop or notebook computer, netbook, tablet, smart phone, smart watch or other wearable, appliance, part of the Internet-of-Things, and/or embedded system, to name a few non-limiting examples, or any combination thereof.

[0056] Computer system **300** may be a client or server, accessing or hosting any applications and/or data through any delivery paradigm, including but not limited to remote or distributed cloud computing solutions; local or on-premises software ("on-premise" cloud-based solutions); "as a service" models (e.g., content as a service (CaaS), digital content as a service (DCaaS), software as a service (SaaS), managed software as a service (MSaaS), platform as a service (PaaS), desktop as a service (DaaS), framework as a service (FaaS), backend as a service (BaaS), mobile backend as a service (MBaaS), infrastructure as a service (IaaS), etc.); and/or a hybrid model including any combination of the foregoing examples or other services or delivery paradigms.

[0057] Any applicable data structures, file formats, and schemas in computer system **300** may be derived from standards including but not limited to JavaScript Object Notation (JSON), Extensible Markup Language (XML), Yet Another Markup Language (YAML), Extensible Hypertext Markup Language (XHTML), Wireless Markup Language (WML), MessagePack, XML User Interface Language (XUL), or any other functionally similar representations alone or in combination. Alternatively, proprietary data structures, formats or schemas may be used, either exclusively or in combination with known or open standards.

[0058] In some embodiments, a tangible, non-transitory apparatus or article of manufacture comprising a tangible, non-transitory computer useable or readable medium having

control logic (software) stored thereon may also be referred to herein as a computer program product or program storage device. This includes, but is not limited to, computer system **300**, main memory **308**, secondary memory **310**, and removable storage units **318** and **322**, as well as tangible articles of manufacture embodying any combination of the foregoing. Such control logic, when executed by one or more data processing devices (such as computer system **300**), may cause such data processing devices to operate as described herein.

[0059] Based on the teachings contained in this disclosure, it will be apparent to persons skilled in the relevant art(s) how to make and use embodiments of this disclosure using data processing devices, computer systems and/or computer architectures other than that shown in FIG. **3**. In particular, embodiments can operate with software, hardware, and/or operating system implementations other than those described herein.

[0060] It is to be appreciated that the Detailed Description section, and not any other section, is intended to be used to interpret the claims. Other sections can set forth one or more but not all exemplary embodiments as contemplated by the inventor(s), and thus, are not intended to limit this disclosure or the appended claims in any way.

[0061] While this disclosure describes exemplary embodiments for exemplary fields and applications, it should be understood that the disclosure is not limited thereto. Other embodiments and modifications thereto are possible, and are within the scope and spirit of this disclosure. For example, and without limiting the generality of this paragraph, embodiments are not limited to the software, hardware, firmware, and/or entities illustrated in the figures and/or described herein. Further, embodiments (whether or not explicitly described herein) have significant utility to fields and applications beyond the examples described herein.

[0062] Embodiments have been described herein with the aid of functional building blocks illustrating the implementation of specified functions and relationships thereof. The boundaries of these functional building blocks have been arbitrarily defined herein for the convenience of the description. Alternate boundaries can be defined as long as the specified functions and relationships (or equivalents thereof) are appropriately performed. Also, alternative embodiments can perform functional blocks, steps, operations, methods, etc. using orderings different than those described herein.

[0063] References herein to "one embodiment," "an embodiment," "an example embodiment," or similar phrases, indicate that the embodiment described can include a particular feature, structure, or characteristic, but every embodiment can not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it would be within the knowledge of persons skilled in the relevant art(s) to incorporate such feature, structure, or characteristic into other embodiments whether or not explicitly mentioned or described herein. Additionally, some embodiments can be described using the expression "coupled" and "connected" along with their derivatives. These terms are not necessarily intended as synonyms for each other. For example, some embodiments can be described using the terms "connected" and/or "coupled" to indicate that two or more elements are in direct physical or electrical contact with each other. The term "coupled," however, can also mean that two or more elements are not in direct contact with each other, but yet still co-operate or interact with each other.

[0064] The breadth and scope of this disclosure should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

What is claimed is:

1. A method comprising:

determining a first request that has been processed by one or more computing services of a primary computing system;

determining that processing resources used in processing the first request have exceeded a first computing threshold for the first request;

determining that the first request is malicious based on the determination that the processing resources exceed the first computing threshold;

identifying a client of the primary computing system from which the malicious request was received;

receiving a second request from the client; and

routing the second request to a secondary computing system for processing, in lieu of the primary computing system, based on the determination that the first request is malicious.

2. The method of claim **1**, wherein the secondary computing system comprises fewer computing resources relative to the primary computing system, and wherein the second computing system operates the one or more computing services with the fewer computing resources.

3. The method of claim **1**, further comprising:

determining that the first request comprises a first type of request from a plurality of request types; and

determining that the second request comprises the first type of request.

4. The method of claim **3**, further comprising:

receiving a third request from the client;

determining that the third request is a second type of request from the plurality of request types; and

routing the third request to the primary computing system, in lieu of the secondary computing system, based on the determination that the third request is the second type of request and the determination that the first request is malicious.

5. The method of claim **1**, further comprising:

determining, after the routing, that processing resources used by the secondary computing system in processing the second request are below a second computing threshold; and

routing a third request received from the client to the primary computing system, in lieu of the secondary computing system, based on the determination that the second request is below the second computing threshold.

6. The method of claim **5**, wherein the first computing threshold and the second computing threshold are identical.

7. The method of claim **1**, further comprising:

providing a message to a third computing system configured to receive requests from the client indicating that the first request, from the client, is malicious, wherein the third computing system is configured to route a subsequent request received from the client to a fourth computing system responsive to receiving the message.

8. The method of claim 1, wherein the determining that processing resources used in processing the first request have exceeded the first computing threshold for the first request comprises:

receiving statistics about which processing resources were used in processing the first request based on a trace of the first request as it was processed by the first computing system.

9. A system comprising:

a memory; and

at least one processor coupled to the memory and configured to perform operations comprising:

determining a first request that has been processed by one or more computing services of a primary computing system;

determining that processing resources used in processing the first request have exceeded a first computing threshold for the first request;

determining that the first request is malicious based on the determination that the processing resources exceed the first computing threshold;

identifying a client of the primary computing system from which the malicious request was received;

receiving a second request from the client; and

routing the second request to a secondary computing system for processing, in lieu of the primary computing system, based on the determination that the first request is malicious.

10. The system of claim 9, wherein the secondary computing system comprises fewer computing resources relative to the primary computing system, and wherein the second computing system operates the one or more computing services with the fewer computing resources.

11. The system of claim 9, the operations further comprising:

determining that the first request comprises a first type of request from a plurality of request types; and

determining that the second request comprises the first type of request.

12. The system of claim 11, the operations further comprising:

receiving a third request from the client;

determining that the third request is a second type of request from the plurality of request types; and

routing the third request to the primary computing system, in lieu of the secondary computing system, based on the determination that the third request is the second type of request and the determination that the first request is malicious.

13. The system of claim 9, the operations further comprising:

determining, after the routing, that processing resources used by the secondary computing system in processing the second request are below a second computing threshold; and

routing a third request received from the client to the primary computing system, in lieu of the secondary computing system, based on the determination that the second request is below the second computing threshold.

14. The system of claim 13, wherein the first computing threshold and the second computing threshold are identical.

15. The system of claim 9, the operations further comprising:

providing a message to a third computing system configured to receive requests from the client indicating that the first request, from the client, is malicious, wherein the third computing system is configured to route a subsequent request received from the client to a fourth computing system responsive to receiving the message.

16. The system of claim 9, wherein the determining that processing resources used in processing the first request have exceeded the first computing threshold for the first request comprises:

receiving statistics about which processing resources were used in processing the first request based on a trace of the first request as it was processed by the first computing system.

17. A non-transitory computer-readable medium having instructions stored thereon that, when executed by at least one computing device, cause the at least one computing device to perform operations comprising:

determining a first request that has been processed by one or more computing services of a primary computing system;

determining that processing resources used in processing the first request have exceeded a first computing threshold for the first request;

determining that the first request is malicious based on the determination that the processing resources exceed the first computing threshold;

identifying a client of the primary computing system from which the malicious request was received;

receiving a second request from the client; and

routing the second request to a secondary computing system for processing, in lieu of the primary computing system, based on the determination that the first request is malicious.

18. The non-transitory computer-readable medium of claim 17, wherein the secondary computing system comprises fewer computing resources relative to the primary computing system, and wherein the second computing system operates the one or more computing services with the fewer computing resources.

19. The non-transitory computer-readable medium of claim 17, the operations further comprising:

determining that the first request comprises a first type of request from a plurality of request types; and

determining that the second request comprises the first type of request.

20. The non-transitory computer-readable medium of claim 19, the operations further comprising:

receiving a third request from the client;

determining that the third request is a second type of request from the plurality of request types; and

routing the third request to the primary computing system, in lieu of the secondary computing system, based on the determination that the third request is the second type of request and the determination that the first request is malicious.

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