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Lyon

(54) **CROWD BASED CONTENT DELIVERY**

(75) Inventor: **Barrett Gibson Lyon**, Pacifica, CA (US)

(73) Assignee: **3Crowd Technologies, Inc.**

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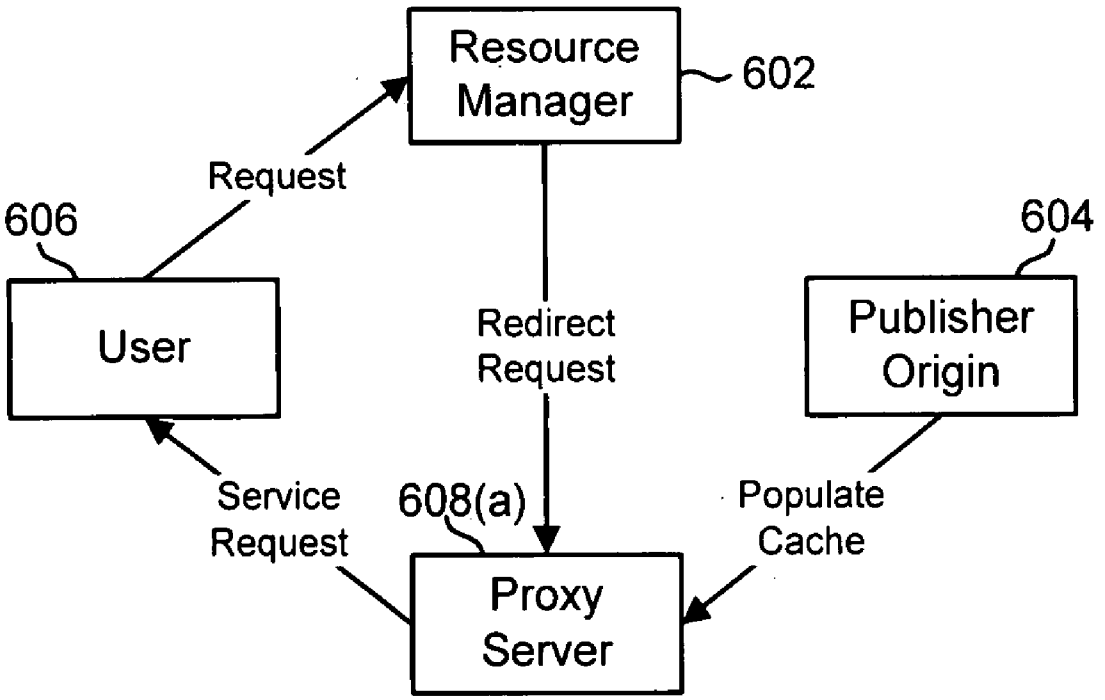
(52) **U.S. Cl.**

USPC **705/34**; 709/220; 709/226; 709/224

(57) **ABSTRACT**

Crowd based content delivery is disclosed. In some embodiments, managing content delivery includes receiving a specification from a resource provider of an availability of a content delivery service at the resource provider, selecting the resource provider to service requests for a content item, facilitating caching of the content item at the resource provider, and redirecting a request for the content item to the resource provider for servicing.



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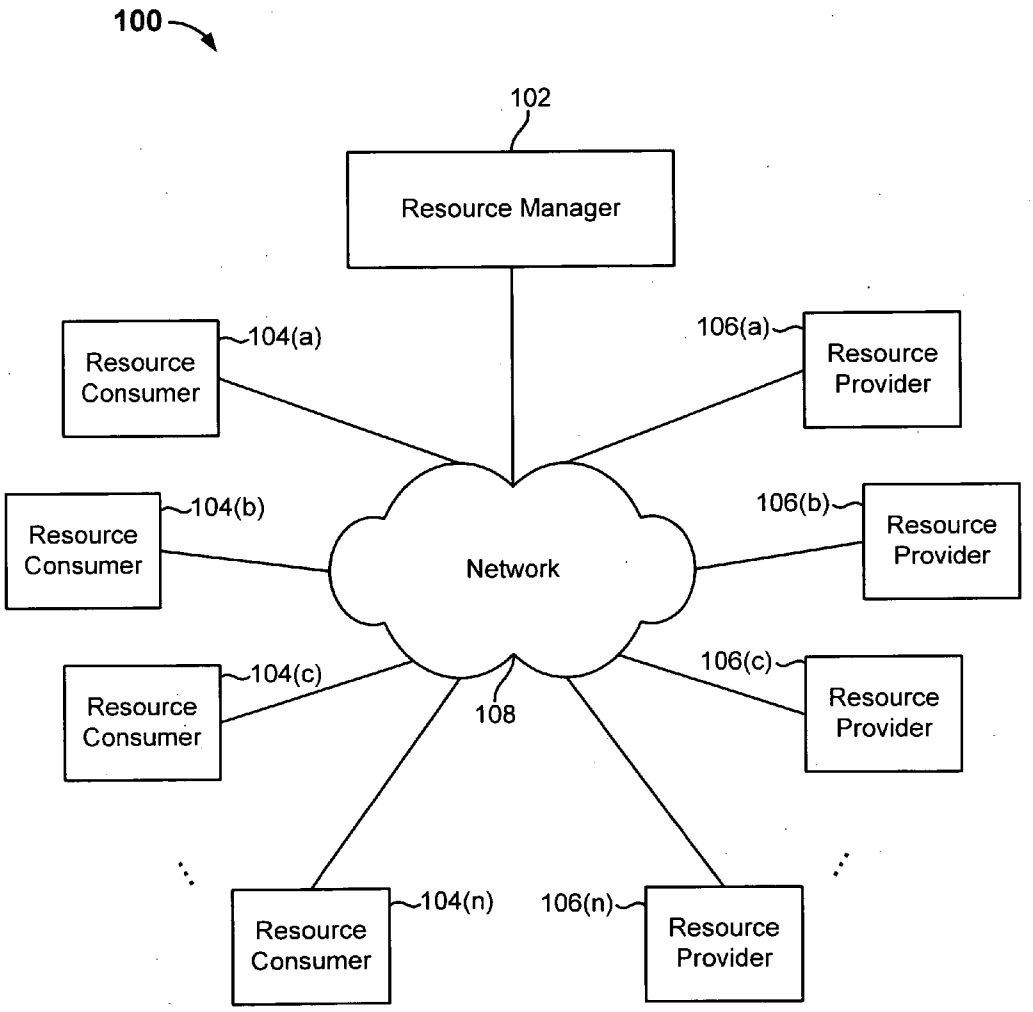
100
102
Resource Manager
Resource Consumer
104(a)
Resource Provider
106(a)
Resource Consumer
104(b)
Network
Resource Provider
106(b)
Resource Consumer
104(c)
108
Resource Provider
106(c)
Resource Consumer
104(n)
Resource Provider
106(n)

FIG. 1

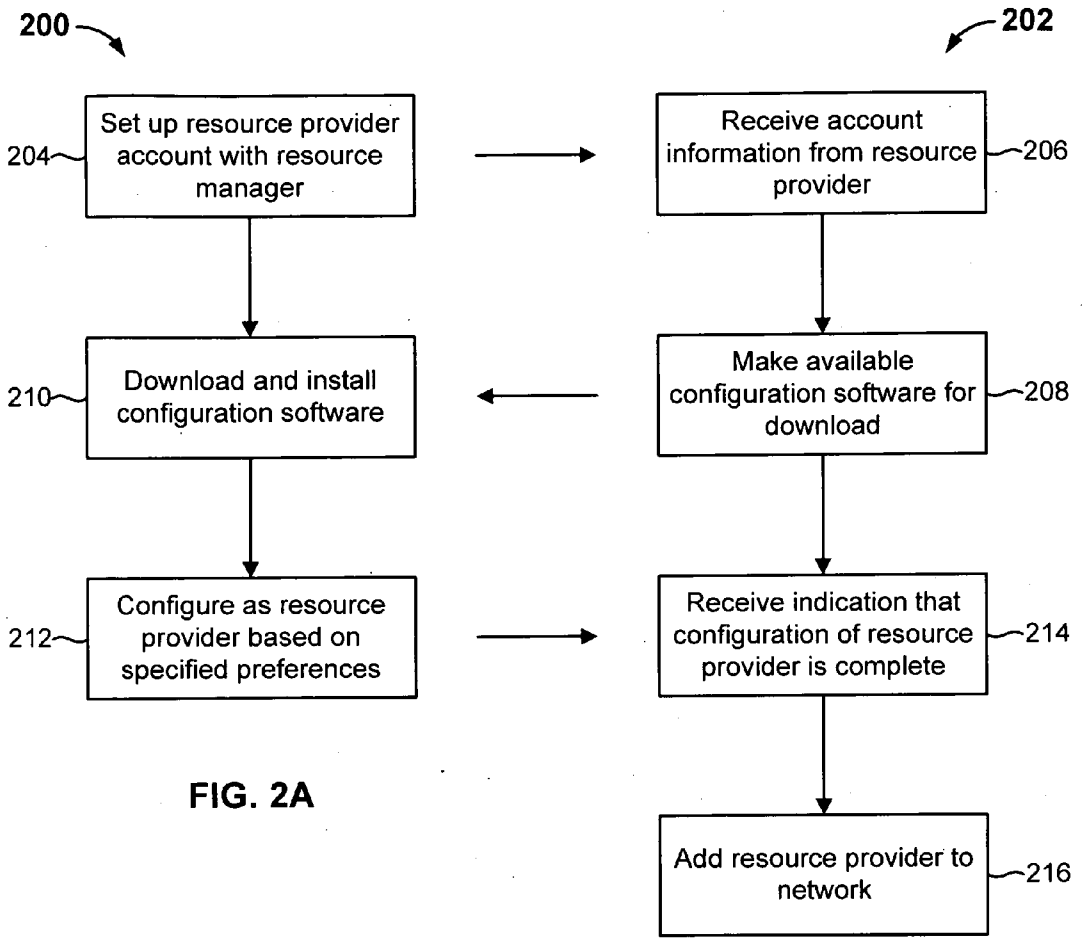
200
202
Set up resource provider account with resource manager
204
Receive account information from resource provider
206
Download and install configuration software
210
Make available configuration software for download
208
Configure as resource provider based on specified preferences
212
Receive indication that configuration of resource provider is complete
214
Add resource provider to network
216

FIG. 2A

FIG. 2B

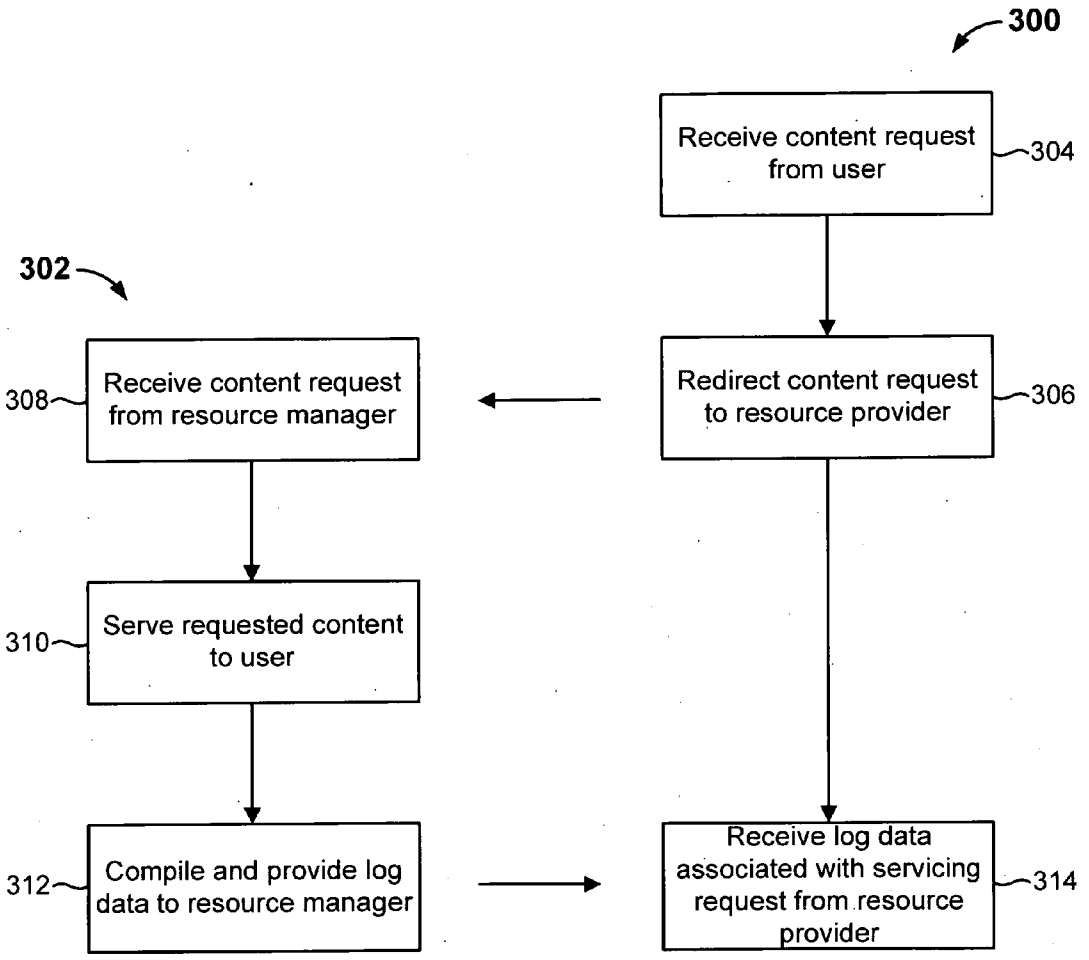
300
Receive content request from user
304
Redirect content request to resource provider
306
Receive log data associated with servicing request from resource provider
314
302
308
Receive content request from resource manager
310
Serve requested content to user
312
Compile and provide log data to resource manager

FIG. 3A FIG. 3B

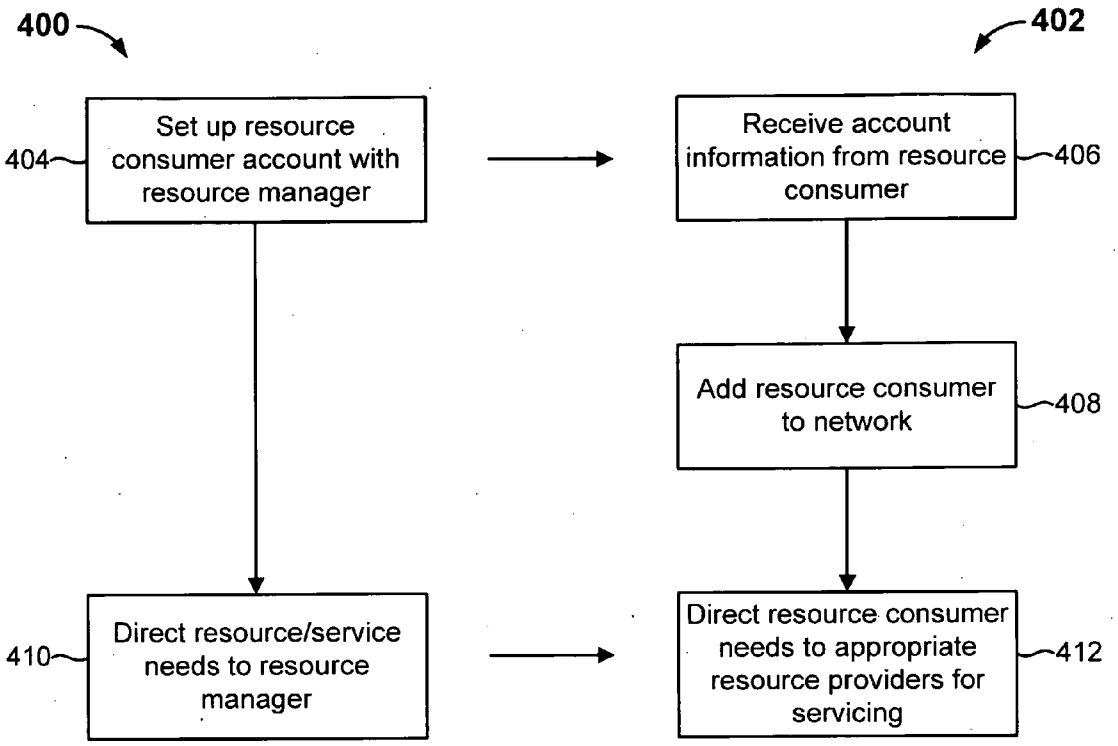
400
Set up resource consumer account with resource manager
404
Direct resource/service needs to resource manager
410

FIG. 4A

402
Receive account information from resource consumer
406
Add resource consumer to network
408
Direct resource consumer needs to appropriate resource providers for servicing
412

FIG. 4B

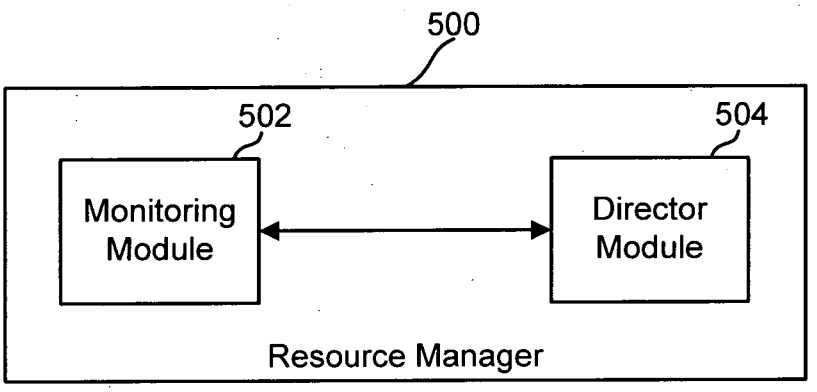
500
502
504
Monitoring Module
Director Module
Resource Manager

FIG. 5A

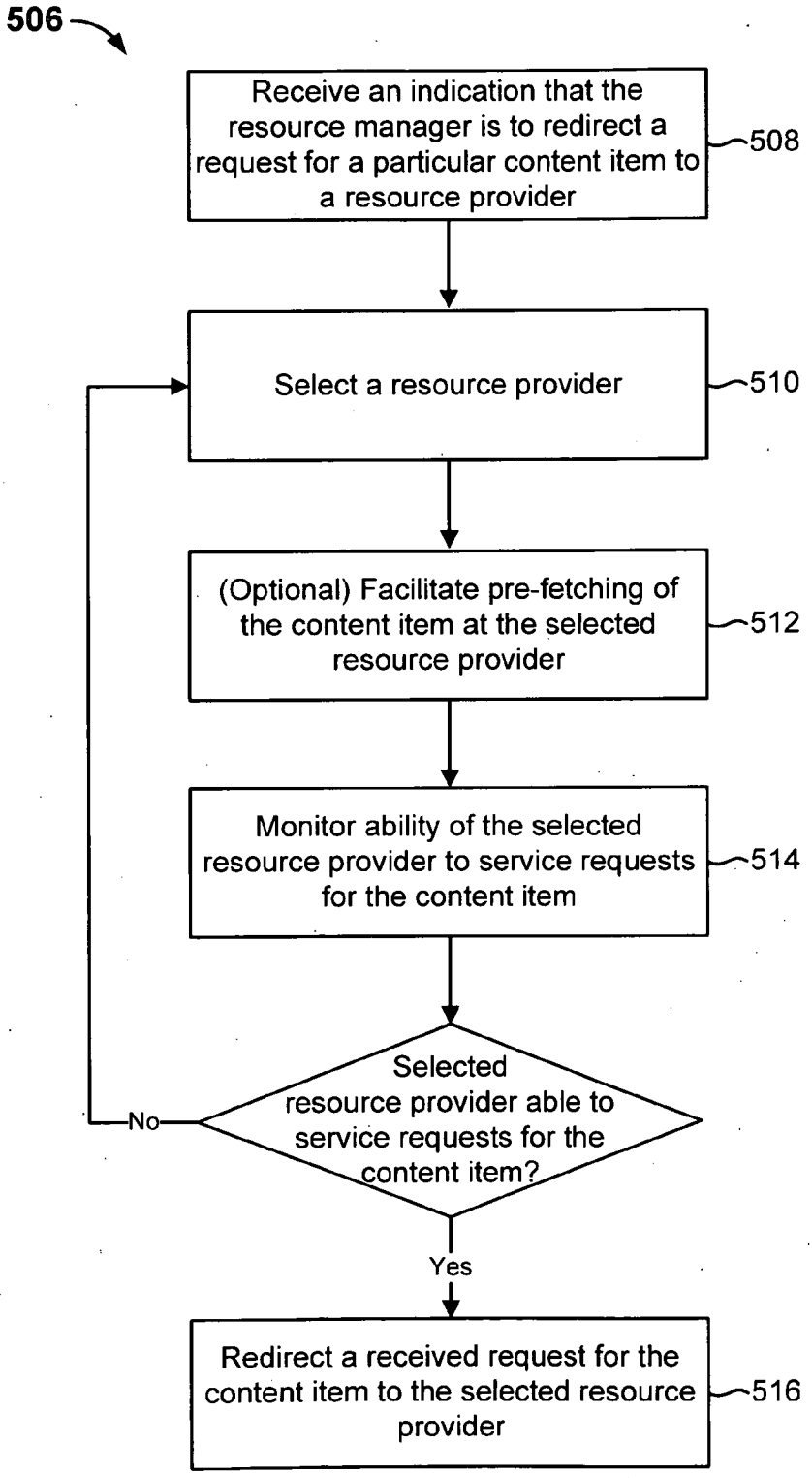
506
Receive an indication that the resource manager is to redirect a request for a particular content item to a resource provider
508
Select a resource provider
510
(Optional) Facilitate pre-fetching of the content item at the selected resource provider
512
Monitor ability of the selected resource provider to service requests for the content item
514
Selected resource provider able to service requests for the content item?
No
Yes
Redirect a received request for the content item to the selected resource provider
516

FIG. 5B

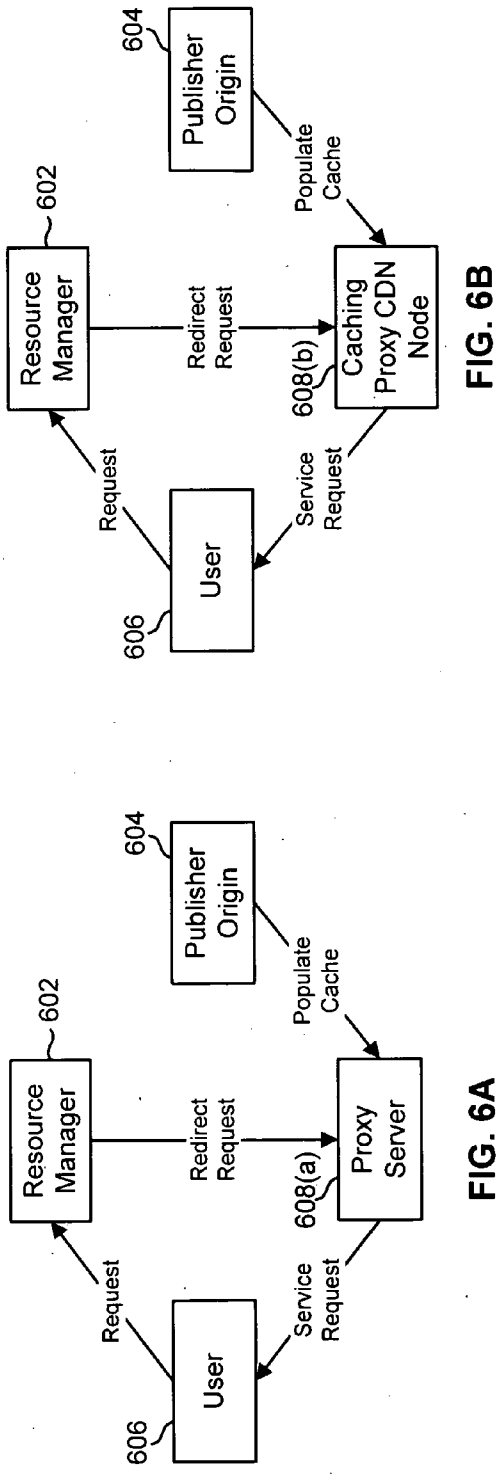

FIG. 6A

FIG. 6B

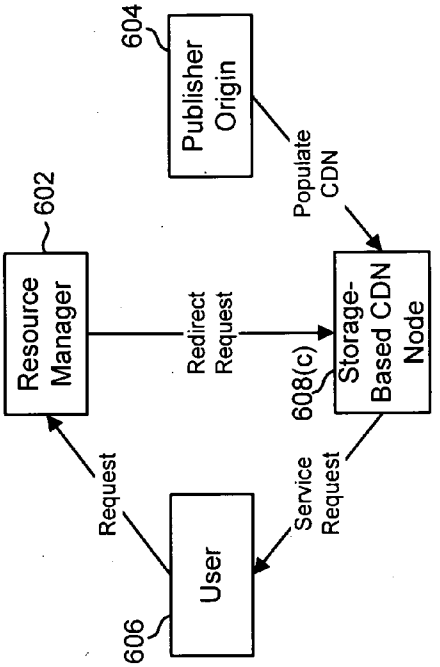

FIG. 6C

CROWD BASED CONTENT DELIVERY

CROSS REFERENCE TO OTHER APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application No. 61/269,646 entitled SYSTEM FOR OPERATING A CROWD BASED COMPUTING PLATFORM filed Jun. 25, 2009 which is incorporated herein by reference for all purposes.

BACKGROUND OF THE INVENTION

[0002] Many network entities have excess computing resources that are unused and wasted. It would be useful to create a marketplace for these otherwise untapped resources.

BRIEF DESCRIPTION OF THE DRAWINGS

[0003] Various embodiments of the invention are disclosed in the following detailed description and the accompanying drawings.

[0004] FIG. **1** is a block diagram illustrating an embodiment of a network environment for operating a crowd based computing platform.

[0005] FIGS. **2**A-**2**B illustrate embodiments of processes for adding a resource provider to the network managed by the resource manager.

[0006] FIGS. **3**A-**3**B illustrate embodiments of processes for employing a resource provider configured as a proxy server to service a content request.

[0007] FIGS. **4**A-**4**B illustrate embodiments of processes for adding a resource consumer to the network managed by the resource manager.

[0008] FIG. **5**A is a block diagram illustrating an embodiment of a resource manager.

[0009] FIG. **5**B illustrates an embodiment of a process for redirecting a request for a content item to a resource provider.

[0010] FIGS. **6**A-**6**C are block diagrams illustrating embodiments of manners in which a content request from an end user is redirected by the resource manager to a node capable of servicing the request.

DETAILED DESCRIPTION

[0011] The invention can be implemented in numerous ways, including as a process; an apparatus; a system; a composition of matter; a computer program product embodied on a computer readable storage medium; and/or a processor, such as a processor configured to execute instructions stored on and/or provided by a memory coupled to the processor. In this specification, these implementations, or any other form that the invention may take, may be referred to as techniques. In general, the order of the steps of disclosed processes may be altered within the scope of the invention. Unless stated otherwise, a component such as a processor or a memory described as being configured to perform a task may be implemented as a general component that is temporarily configured to perform the task at a given time or a specific component that is manufactured to perform the task. As used herein, the term 'processor' refers to one or more devices, circuits, and/or processing cores configured to process data, such as computer program instructions.

[0012] A detailed description of one or more embodiments of the invention is provided below along with accompanying figures that illustrate the principles of the invention. The invention is described in connection with such embodiments, but the invention is not limited to any embodiment. The scope of the invention is limited only by the claims, and the invention encompasses numerous alternatives, modifications and equivalents. Numerous specific details are set forth in the following description in order to provide a thorough understanding of the invention. These details are provided for the purpose of example, and the invention may be practiced according to the claims without some or all of these specific details. For the purpose of clarity, technical material that is known in the technical fields related to the invention has not been described in detail so that the invention is not unnecessarily obscured.

[0013] FIG. **1** is a block diagram illustrating an embodiment of a network environment **100** for operating a crowd based computing platform. Resource manager or aggregator **102** facilitates transactions between resource consumers **104** and resource providers **106**. The various entities comprising network environment **100** communicate via network **108**, which may comprise any public or private network such as a LAN, WAN, the Internet, etc., using any appropriate communication protocol such as HTTP (Hypertext Transfer Protocol), SSL (Secure Sockets Layer), RTMP (Real Time Messaging Protocol), RTMP-E (Encrypted Real Time Messaging Protocol), RTMP over HTTP, torrent style protocols, etc. Resource manager **102** manages any one or more types of computing resources for performing tasks such as, but not limited to, content distribution or delivery, parallel processing, security, storage, etc. Although depicted as a single entity in network environment **100**, resource manager **102** may comprise a plurality of interconnected computing systems that perform the various tasks associated with managing resources. Resource providers **106** comprise a crowd of members who donate or sell their resources to resource consumers **104**. Any type of member may be a part of the crowd of resource providers **106** such as individuals, groups, corporations, universities, content delivery networks (CDNs), internet service providers (ISPs), carriers, cloud computing networks, server farms, etc. Resource manager **102** handles various processes associated with the exchange of resources between resource providers **106** and resource consumers **104** such as monitoring performance, tracking statistics, enforcing provider and consumer preferences, providing security, billing, etc. Although a single resource manager **102** is depicted in network environment **100**, a plurality of networked resource managers may be deployed across various geographical regions, e.g., to manage resource providers and resource consumers across the world.

[0014] As further described herein, the resource manager establishes and manages a confederation of resource providers. A resource provider may comprise any network node that has extra capacity that can be provided or sold to consumers who need the resource. A resource provider, for example, may set a price for an available resource, and if a consumer finds that resource attractive, the consumer pays for the right to use it. In some embodiments, the resource manager assists a resource provider in becoming a CDN or CDN node that is capable of delivering content on behalf of a content publisher, i.e., the resource consumer in this case. In some such cases, for example, the resource manager provides configuration software which when installed on one or more servers of the resource provider configures the servers to behave as CDN nodes. A resource provider configured as a CDN node may be employed to serve content based on the availability of

resources at the node, which may vary based on factors such as current load, day and time, geographic location, etc.

[0015] Although many of the given examples are with respect to crowd based content delivery, the techniques described herein may be employed with respect to any computing resource and/or task. The described techniques allow excess capacity of resource providers that is otherwise unused and wasted to be utilized and/or monetized. For example, even though many ISP and carrier networks are bidirectional (e.g., a 10 Gigabit connection comprises 10 Gigabit inbound and 10 Gigabit outbound), they typically have significantly more inbound traffic due to users downloading content than outbound traffic due to relatively fewer users uploading content, resulting in a large amount of unused outbound bandwidth. These networks typically only pay for one direction of traffic, either ingress or egress, whichever is greater. Since inbound traffic usually eclipses outbound traffic, the networks commonly have a large amount of free idle outbound bandwidth. It would be useful, for example, to add servers at these networks and configure them as CDN nodes so that the extra available outbound bandwidth can be utilized and/or monetized using the techniques described herein.

[0016] FIGS. **2**A-**2**B illustrate embodiments of processes for adding a resource provider to the network managed by the resource manager. In some cases, the processes may be employed to configure a network node to become a CDN node capable of delivering content on behalf of a content publisher. Process **200** is employed by a resource provider such as any of resource providers **106** of FIG. **1** or resource provider **608**(*a*) of FIG. **6**A; and process **202** is employed by a resource manager such as resource manager **102** of FIG. **1**, resource manager **500** of FIG. **5**A, or resource manager **602** of FIGS. **6**A-**6**C. Process **200** starts at **204** at which a resource provider sets up an account with the resource manager, e.g., via a web site and/or interface made available by the resource manager. Various parameters that define the terms and conditions with respect to which the resource provider is willing to provide resources or services are specified with respect to the resource provider's account. For example, the types of resources and/or the services that the resource provider is willing to deliver and/or perform may be specified. In the cases in which it is desired to configure the resource provider as a CDN node, for instance, a proxy server option is selected. The specification of resources may further include a specification of the amount or percentage of a total resource (e.g., hard drive, memory, CPU, network bandwidth, etc.) to be made available, which may be specified as a function of time. Moreover, resource consumers and/or types of resource consumers may be specified, e.g., on an inclusion or exclusion basis. The various entities permitted to use and/or excluded from using the resource provider's resources may be specified or selected by name and/or by the nature of their business. For example, in some cases, any nonprofit organization may be permitted to use the resource provider's resources while in other cases only one or more specified entities may be permitted. Similarly, content types for using the resources or services with may be specified, e.g., on an inclusion or exclusion basis. For example, in some cases, any content type other than adult content may be specified as permissible.

[0017] Furthermore, prices at which the resource provider is willing to provide resources or services may be specified. Different prices may be specified based on different criteria such as consumer or consumer type, content type, time of use, etc. For instance, resources may be donated or provided for free to nonprofit organizations but charged a specified price per unit from other consumers and different prices may be specified for different consumers; higher prices may be specified for use of resources with respect to certain types of content such as adult content; prices may be specified as functions of time and/or date, e.g., higher prices may be specified during business hours when the resource provider has peak loads than during nights, weekends, and holidays; etc. Other information such as the geographic location of the resources, environmental considerations such as the carbon footprint for providing a resource or service, etc., may also be specified. The various parameters described may be separately specified for each machine or server available at the resource provider. The account information provided at **204** is received by the resource manager at **206** of process **202**. In some embodiments, steps **204** and **206** include the resource provider acquiring and being granted by the resource manager a resource provider identifier and key or password via which the resource provider's account with the resource manager may be accessed. In various embodiments, the parameters and information described above as being specified with respect to a resource provider's account may be specified during initial registration or at a later time and may be later updated or changed as applicable. Other parameters in addition to and/or instead of those described may be specified as applicable.

[0018] Software for configuring a node as a resource provider made available by the resource manager at **208** is downloaded and installed by the resource provider at **210**. In various embodiments, the software may comprise an application, an operating system, a server instance such as a Java Virtual Machine, a specialized C proxy application such as Varnish that runs on a server, a plug-in for a browser or any other application or interface, etc. One or more parameters or preferences specified with respect to the resource provider's account with the resource manager may be retrieved during installation of the software at **210**. In some embodiments, one or more parameters or preferences may be specified during installation at **210** rather than during step **204** as described above. The configuration software is installed at **210** on each computer or machine desired to be configured as a resource provider. At **212**, the software installed on a machine appropriately configures, the machine as a resource provider based on the preferences specified. For example, a machine may be configured by the software at **212** to function as a caching proxy server. In some embodiments, the software conducts one or more performance tests at **212** to assess the quality of the available resources. For example, performance tests on the hard drive, memory, CPU, network connections, etc., may be performed. Once a node has been configured as a resource provider at **212**, an indication that the configuration is complete is communicated by the software and received by the resource manager at **214**. In some embodiments, the resource manager receives at **214** the results of the performance tests conducted at **212**. The results of the performance tests are reported to the resource manager so that the resource manager can appropriately market and provide or sell the resources to resource consumers. In some embodiments, performance tests are periodically conducted by the software at the resource provider and reported back to the resource manager so that the resource manager is always aware of changes in performance levels and can make appropriate use of the

resources of the resource provider. At **216**, the resource provider is added to the network managed by the resource manager.

[0019] FIGS. **3**A-**3**B illustrate embodiments of processes for employing a resource provider configured as a proxy server to service a content request. Process **300** is employed by a resource manager such as resource manager **102** of FIG. **1**, resource manager **500** of FIG. **5**A, or resource manager **602** of FIGS. **6**A-**6**C; and process **302** is employed by a resource provider such as any of resource providers **106** of FIG. **1** or resource provider **608**(*a*) of FIG. **6**A. Process **300** starts at **304** at which a content request is received by the resource manager from a user. The requested content, for example, is published by a content publisher that uses content delivery resources and is the resource consumer in this case. In this example, the content publisher subscribes to the services of the resource manager for facilitating the servicing of requests for content published by the content publisher, and the requests for the publisher's content from individual users are directed or redirected to the resource manager. At **306**, the content request received at **304** is redirected by the resource manager, e.g., via an HTTP **302** redirect (or similar content redirect action in other protocols such as RTMP), to a resource provider capable of servicing the request and permitted by the resource consumer to service the request. The redirected content request is received by the resource provider at **308**, and the requested content is served by the resource provider to the user who requested the content at **310**. In some embodiments, the requested content is already cached at the resource provider when it receives the request at **308**. In other embodiments, the resource provider obtains and caches the requested content from an origin of the content publisher in response to receiving the request at **308**. Log data of the transaction, which includes information associated with delivering the requested content (such as the file identifier, timestamp of delivery, the source and/or destination IP addresses, the file size, the bandwidth consumed, the price or cost for delivery, etc.), is compiled by the software at the resource provider and communicated to the resource manager at **312**. In some embodiments, the log data at least in part comprises a W3C web server log. The log data is received by the resource manager at **314**. In some embodiments, the log data received at **314** is parsed, aggregated, and/or stored at the resource manager and may, for example, be later employed for billing the associated resource consumer and reimbursing the resource provider.

[0020] FIGS. **4**A-**4**B illustrate embodiments of processes for adding a resource consumer to the network managed by the resource manager. Process **400** is employed by a resource consumer such as any of resource consumers **104** of FIG. **1**; and process **402** is employed by a resource manager such as resource manager **102** of FIG. **1**, resource manager **500** of FIG. **5**A, or resource manager **602** of FIGS. **6**A-**6**C. Process **400** starts at **404** at which a resource consumer sets up an account with the resource manager, e.g., via a web site and/or interface made available by the resource manager. Various parameters that define the terms and conditions with respect to which the resource consumer is willing to use or purchase resources or services are specified with respect to the resource consumer's account. For example, the types of resources and/or services that the resource consumer desires to use or purchase as well as the types of content with respect to which the resource consumer expects to use the resources and services may be specified. For instance, the resource consumer may sign up for content delivery services for serving video content. Furthermore, other criteria such as the required quality or performance levels, the required security levels, etc., may be specified. In addition, resource providers and/or resource provider types may be specified, e.g., on an inclusion or exclusion basis. The various entities permitted to provide and/or excluded from providing resources or services to the resource consumer may be specified or selected by name and/or by type. For example, a content publisher seeking content delivery services may not allow untrusted members of the crowd such as random individual users to serve their content but may allow trusted entities, such as prominent ISPs or carriers, to serve their content. Moreover, prices or price ranges that the resource consumer is willing to pay for various resources and services may be specified. Different prices may be specified based on different criteria such as resource provider or provider type, content type, time of use, etc. Other information such as geographic location, environmental considerations such as the permissible carbon footprint for obtaining a resource or service, etc., may also be specified. The various parameters described may be separately specified for each resource or service or type of resource or service desired by the resource consumer.

[0021] The account information provided at **404** is received by the resource manager at **406** of process **402**. In some embodiments, steps **404** and **406** include the resource consumer acquiring and being granted by the resource manager a resource consumer identifier and key or password via which the resource consumer's account with the resource manager may be accessed. In various embodiments, the parameters and information described above as being specified with respect to a resource consumer's account may be specified by the resource consumer during initial registration or at a later time and may be later updated or changed as applicable. Other parameters in addition to and/or instead of those described may be specified by the resource consumer as applicable. With respect to a content publisher signing up for content delivery services, for example, content origin locations where the content is published may be specified; and/or CDN providers with which the content publisher has contracts, if any, and the terms of those contracts may be specified so that those CDN providers may be used to service content requests. The resource consumer is added to the network managed by the resource manager at **408**. Once the resource consumer subscribes with the resource manager for a particular resource and/or service, needs for that resource and/or service are directed by the resource consumer to the resource manager at **410**. With respect to content delivery, for example, when a content publisher subscribes to the services of the resource manager for servicing content requests, the content publisher ensures that user requests for content published by the content publisher are directed or redirected to the resource manager. Resource consumer needs are, in turn, directed for servicing to appropriate resource providers in the network by the resource manager at **412** based on the preferences specified by the resource consumer. In some embodiments, a network node may sign up both as a resource provider and a resource consumer for the same or different resources, e.g., using process **200** and **202** of FIGS. **2**A-**2**B and processes **400** and **402** of FIGS. **4**A-**4**B.

[0022] The resource manager comprises one or more networked modules, each of which may comprise one or more hardware and/or software components. FIG. **5**A is a block diagram illustrating an embodiment of a resource manager

500. For example, resource manager 500 may comprise resource manager 102 of FIG. 1 or resource manager 602 of FIGS. 6A-6C. In the depicted embodiment, resource manager 500 comprises a monitoring module 502 and a director module 504. Monitoring module 502 monitors the health of the network and various nodes. Data may be received by or input into monitoring module 502 from a variety of sources, e.g., on the Internet. Different types of data may be input by different sources depending on the types of data available to them. In some embodiments, the data comprises performance statistics associated with quality of service and end user experience such as average and/or maximum throughput, DNS lookup time, time to first connection, download time, etc. In some cases, dedicated monitoring servers may be placed across the network that report back various performance characteristics. In some cases, log data compiled by resource providers at the conclusion of each transaction and/or logs of open proxy servers may be input into monitoring module 502. In some cases, plug-ins may be included in sources such as web browsers, media players, download agents, etc., that ping back the performance statistics available to them. The data received by monitoring module 502 is parsed, analyzed, aggregated, and/or stored. In some embodiments, various entities may desire to obtain and/or purchase performance statistics on their nodes and/or networks. In such cases, the relevant data compiled by monitoring module 502 may be presented or reported, e.g., via a dashboard, to the entity, i.e., the resource consumer in this case. For example, a CDN may be interested in monitoring the health of its nodes so that a prescribed quality of service can be maintained, and a server farm may find a real time dashboard providing statistics on inbound and outbound traffic useful.

[0023] Director module 504 receives requests for resources or services and selects appropriate resource providers to service the requests based on the preferences specified by the resource consumers and resource providers. In some embodiments, decisions for selecting resource providers are made by director module 504 based at least in part on the data collected and/or information learned by monitoring module 502. With respect to content delivery, for example, if a portion of a CDN in a particular geographical region goes down, existence of the black spot (i.e., a poorly performing area in a network or geography) in the CDN is quickly learned by monitoring module 502 and communicated to director module 504 so that content requests are not redirected by director module 504 to at least those nodes of the CDN. A prescribed quality of service and user experience is maintained in the network managed by traffic manager 500 by making decisions based on the current state of the network and its constituent nodes as determined by monitoring module 502. In some embodiments, monitoring module 502 includes a spider process that monitors the requests coming into resource manager 500 and that crawls the network managed by resource manager 500 to determine and/or report the availability of various resource providers to service incoming requests. With respect to content delivery, for example, the spider learns and stores the locations of content items (i.e., files) in the network. For instance, the spider may interrogate a CDN using an appropriate interrogation methodology (e.g., an HTTP HEAD request or similar request in RTMP or other protocols) to determine the availability of a particular content item at the CDN. The spider may also coordinate pre-fetching of a content item at a node to warm the cache at the node before a request for that content item is redirected to the node by director module 504. Thus, the spider assists director module 504 in directing a request to a resource provider capable of servicing the request. In some embodiments, decisions for selecting resource providers are made by director module 504 based at least in part on past traffic redirected to the resource providers, e.g., to prevent any given resource provider from becoming overloaded and/or to load balance a plurality of available resource providers. In some embodiments, information associated with the requests redirected by director module 504 (such as the resource requested, the user and/or resource consumer issuing the request, the resource provider selected to service the request, the type and amount of resources expected to service the request, the resource provider price for servicing the request, etc.) may be logged and stored at the resource manager and later employed, e.g., to generate statistics or for billing purposes.

[0024] FIG. 5B illustrates an embodiment of a process for redirecting a request for a content item to a resource provider. Process 506 is employed by a resource manager such as resource manager 102 of FIG. 1, resource manager 500 of FIG. 5A, or resource manager 602 of FIGS. 6A-6C. In various embodiments, process 506 may be employed in anticipation of receiving a request for a content item or in response to receiving a request for a content item. Process 506 starts at 508 at which an indication that the resource manager is to redirect a request for a particular content item to a resource provider capable of servicing the request is received. In some embodiments, the indication is received from the publisher of the content item, i.e., the resource consumer in this case, such as via the publisher's account with the resource manager or via learning from the publisher origin the content published by the publisher. In some embodiments, the indication is received in response to a (previous) request for that content item being forwarded or redirected to and/or received by the resource manager. At 510, an appropriate resource provider capable of servicing requests for the content item is selected, e.g., based on the preferences specified by the content publisher. In some embodiments, the selected resource provider comprises a network node configured as a proxy server, e.g., via process 200 of FIG. 2A. In some embodiments, the selected resource provider comprises a CDN. In some such cases, the content publisher may have specified using the CDN to service requests, e.g., based on the terms of an existing contract with the CDN. In some embodiments, a resource provider able to service requests for the content item at a least cost to the publisher but at the required security and/or quality level is selected at 510. At 512, the resource manager may optionally facilitate pre-fetching of the content item at the selected resource provider to warm the cache at the resource provider. The ability of the selected resource provider to service requests for the content item in accordance with the preferences specified by the content publisher is monitored at 514, e.g., by a spider process of monitoring module 502 of FIG. 5A. In some embodiments, the availability of the content item at the selected resource provider is also monitored at 514; and if the content item is at some point determined to be unavailable, in some cases process 506 may be redirected to step 512 (not shown in FIG. 5B). A received request for the content item is redirected, e.g., by director module 504 of FIG. 5A, to the selected resource provider at 516 in the event that the selected resource provider is able to service the request. In the event that the selected resource provider is

unable to service a received request for the content item, a different resource provider capable of servicing the request is selected at **510**.

[0025] FIGS. **6**A-**6**C are block diagrams illustrating embodiments of manners in which a content request from an end user is redirected by the resource manager to a node capable of servicing the request. In the network environments depicted in the examples of FIGS. **6**A-**6**C, the resource consumer comprises a content publisher that has subscribed to the services of the resource manager for servicing user requests for content published by the content publisher. When signing up for the services of resource manager **602** (e.g., at **404** of process **400** of FIG. **4**A), the content publisher specifies the locations of one or more associated publisher origins **604** from which content published by the content publisher can be obtained and cached at other nodes. A request from user **606** for content (e.g., a file) published by the publisher is directed or redirected to resource manager **602**. For example, the request may comprise a hyperlink or URL that redirects to resource manager **602**. Resource manager **602** selects an appropriate node **608** to service the request based on the preferences specified by the content publisher and redirects the request to node **608**. In various embodiments, the requested content may be obtained by node **608** from publisher origin **604** (or from another node at which the content is available) either prior to receiving the redirected request or in response to receiving the redirected request. Node **608** provides the requested content to user **606**, fulfilling servicing of the original request. In some embodiments, the various redirections of the original request are transparent to the user. In some embodiments, a set of one or more initial requests for a content item may be redirected by resource manager **602** to publisher origin **604** and serviced by publisher origin **604** (not shown in FIGS. **6**A-**6**C), e.g., when the requested content item has not yet been populated at other nodes **608** or when the existence of the requested content item at various other nodes **608** is unknown to resource manager **602**.

[0026] In the example of FIG. **6**A, the request is redirected by resource manager **602** to a node **608**(*a*) configured (e.g., via process **200** of FIG. **2**A) to at least in part function as a proxy server. Proxy server **608**(*a*) comprises a confederated node of the network managed by resource manager **602** since it has willingly signed up to be a part of the network. In some embodiments, a spider process of the monitoring module of resource manager **602** coordinates pre-fetching of a content item at the proxy server cache before any request for that content item is redirected to proxy server **608**(*a*) so that the request is redirected to a warm cache. Alternatively, proxy server **608**(*a*) may obtain and cache the requested content item in response to receiving a first request for the content item or a first request for the content item after a previous copy of the content item has been purged from its cache. A cached copy of the content item at proxy server **608**(*a*) is deleted from the cache at the expiration time associated with the cached copy, and a new copy of the content item may subsequently be obtained to refresh the cache. A transaction log for servicing the request is compiled at proxy server **608**(*a*) and provided to resource manager **602**, e.g., so that it can be used by resource manager **602** to bill the content publisher and reimburse the provider of proxy server **608**(*a*).

[0027] The content publisher may require security between the proxy server cache and the publisher origin. In some embodiments, content is both transacted from the publisher origin securely and locally cached securely using an encryption algorithm to prevent spreading of the content to nodes configured to serve it and to ensure integrity of the caches at the nodes. In some embodiments, the software installed on a node to configure it as a proxy server includes a built in shared secret that is employed to encrypt files that are stored in the local cache, to access the remote origin, and to sign transaction logs. Such a security system may also include an auto-update mechanism to update the shared secret along with monitoring to disable nodes that attempt to tamper with the log signatures. The transaction logs are signed using the shared secret. Each chunklet of log data sent back to the resource manager includes a timestamp and a hash of the entire log chunklet, which includes the shared secret. When the resource manager receives the log chunklet, it verifies the data by performing the same hash and compares the received hash with its locally generated hash.

[0028] In the example of FIG. **6**B, the request is redirected by resource manager **602** to a node **608**(*b*) of a caching proxy CDN. In this example, the content publisher has a pre-existing contract with the caching proxy CDN and thus requires at least a portion or a specified amount or percentage of its traffic to be serviced by this CDN. The terms of the content publisher's contract with the CDN may be specified, for example, with respect to its account with resource manager **602** (e.g., at **404** of process **400** of FIG. **4**A). As previously described, a spider process of the resource manager may coordinate ensuring that a content item is available at a node before any request for that content item is redirected to that node so that the request is redirected to a warm cache. With respect to the example of FIG. **6**B, the availability of the requested content item at CDN node **608**(*b*) may be determined via an HTTP HEAD or other appropriate request to CDN node **608**(*b*). If the content item does not already exist at the CDN node **608**(*b*), in some cases, the spider may independently request the content item from CDN node **608**(*b*) to warm the cache at the node prior to any actual user requests for the content item being redirected to the node. The spider may need to periodically re-learn the availability of the content item at the CDN node, e.g., since the content item may be deleted from the cache at the CDN node if it has not been recently served by the CDN node or at its expiry time. Alternatively, CDN node **608**(*b*) may obtain and cache the requested content item in response to receiving a first request for the content item or a first request for the content item after a previous copy of the content item has been purged from its cache. CDN node **608**(*b*) comprises a federated node of the network managed by resource manager **602** since the caching proxy CDN has been forced to become a part of the network managed by resource manager **602** due to its contract with the content publisher. Since CDN node **608**(*b*) does not comprise a resource provider node established by resource manager **602**, no log data is compiled and provided to resource manager **602** for servicing the request, and the CDN independently bills the content publisher for servicing the request. In some embodiments, the caching proxy CDN may choose to join the confederation of resource providers managed by the resource manager, e.g., via process **200** of FIG. **2**A.

[0029] In the example of FIG. **6**C, the request is redirected by resource manager **602** to a node **608**(*c*) of a storage-based CDN. In this example, the content publisher has a pre-existing contract with the storage-based CDN and thus requires at least a portion or a specified amount or percentage of its traffic to be serviced by this CDN. The terms of the content publisher's contract with the CDN may be specified, for example,

with respect to its account with resource manager **602** (e.g., at **404** of process **400** of FIG. **4**A). The storage-based CDN may only store a subset of the content published by the content publisher. In some cases, the CDN may only store the most popular content published by the content publisher. With respect to a storage-based CDN, it is important for the resource manager to verify the availability of a content item at the CDN prior to redirecting any requests for that content item to the CDN because if the CDN does not have the requested content item a content not found error message (such as an HTTP 404 error message) is transmitted to the user who issued the request, with the resource manager remaining unaware that the request was not serviced. The availability of a content item at the CDN may, for example, be determined by a spider process of the resource manager via an HTTP HEAD or other appropriate request. The spider may need to periodically re-learn the availability of the content item, e.g., since the content item may be deleted from the CDN at its expiry time, which is learned by the spider from the HEAD request and stored at the resource manager. In some embodiments, the content publisher is instructed to not remove or delete a content item from the CDN prior to the expiry time of the content item and/or is instructed to notify the resource manager of any such action prior to expiry time so that the resource manager can ensure that a content request is only redirected to the CDN if it has the content item without having to interrogate the CDN for availability of the content item prior to redirecting every request for the content item. With respect to the example of FIG. **6**C, the request is redirected to CDN node **608**(*c*) because the requested content item is known by resource manager **602** to be available at CDN node **608**(*c*). CDN node **608**(*c*) comprises a federated node of the network managed by resource manager **602** since the storage-based CDN has been forced to become a part of the network managed by resource manager **602** due to its contract with the content publisher. Since CDN node **608**(*c*) does not comprise a resource provider node established by resource manager **602**, no log data is compiled and provided to resource manager **602** for servicing the request, and the CDN independently bills the content publisher for servicing the request. In some embodiments, the storage-based CDN may choose to join the confederation or resource providers managed by the resource manager, e.g., via process **200** of FIG. **2**A. By installing the configuration software provided by the resource manager, the nodes of a storage-based CDN may be configured to behave as proxy servers, allowing the storage-based CDN to additionally operate as a caching proxy CDN.

[0030] As described in the examples of FIGS. **6**B-**6**C, the resource manager may redirect traffic to a CDN based on the preferences and usage instructions specified by the content publisher. In some embodiments, the resource manager manages publisher contracts with a plurality of different CDNs and redirects publisher traffic based on the terms of the contracts, e.g., in a manner that minimizes content delivery costs to the publisher. For example, the resource manager may minimize or at least reduce a publisher's content delivery costs by intelligently using the bandwidth of one or more contracted CDNs that bill with the 95^{th} percentile billing model. With CDNs that use such burstable billing models, the resource manager may also maximize use of free burstable bandwidth, which on a monthly billing cycle translates to up to 36 hours of free bandwidth per CDN.

[0031] In various embodiments, any appropriate billing and settlement model may be employed in the system of resource consumers and resource providers managed by the resource manager. The resource manager keeps track of the participants involved in each transaction as well as details of the transaction, e.g., via the log data received at the conclusion of each transaction from the resource provider. During a (e.g., monthly) settlement process, payments are received from resource consumers and distributed to resource providers as applicable. The resource manager may take a small transaction fee or a small percentage of the payment for facilitating the transaction. In some cases, the resource manager may track and bill for the total number of managed requests. In addition, the resource manager may bill for special services such as cache warming, use of certain protocols, etc. In some embodiments, an a la carte billing model may be employed where each type of resource managed by the resource manager is billed on a per transaction basis, a feature basis, or a statistics basis. Alternatively, various types of resources may be bundled together to create packages and different service level offerings. With respect to content delivery, a resource consumer may be billed based on the volume or total bytes of traffic served. In such cases, for example, the cost of each transaction may be computed from the product of the price per byte at delivery time and the total bytes delivered for the transaction, which values may be obtained from the log data of the transaction provided by the resource provider at the time of the transaction. In some such cases, the resource manager may add a small surcharge to the price per byte or may bill a flat fee for facilitating the transaction. In other embodiments, the 95^{th} percentile value of a resource consumer may be determined across all resource providers over a billing cycle, e.g., by aggregating the data from the transaction logs provided by the resource providers. In some such cases, the 95^{th} percentile value is multiplied by the fraction of the total traffic over the billing cycle that a particular resource provider delivered to obtain the bandwidth value billable by that resource provider. In such cases, the resource manager may take a small percentage of the amount billed by the resource provider.

[0032] Although crowd based content delivery is described in many of the examples provided herein, the resource manager may be similarly employed to facilitate any crowd based computing platform. For example, in some embodiments, the resource manager may facilitate crowd based storage by which content items are replicated for storage across the crowd. In some embodiments, the resource manager may facilitate crowd based computing by which compute modules are distributed across the crowd to perform tasks such as video compression and encoding, encryption cracking, distributed web hosting and/or application execution, etc. In some embodiments, the resource manager may facilitate military purposes such as distributed network defense and offense mechanisms. For example, as a defense mechanism, the crowd may be employed as a distributed DDoS filter to protect from a DDoS attack. Likewise, as an offense mechanism, the crowd may be employed to generate such attacks.

[0033] Although the foregoing embodiments have been described in some detail for purposes of clarity of understanding, the invention is not limited to the details provided. There are many alternative ways of implementing the invention. The disclosed embodiments are illustrative and not restrictive.

What is claimed is:

1-14. (canceled)

15. A method for managing content delivery, comprising:

receiving at a resource manager from a resource consumer desiring content delivery services a specification of a plurality of contracted content delivery networks (CDNs) and contract terms associated with each of the plurality of CDNs;

receiving a request for a content item published by the resource consumer;

selecting a CDN from the plurality of contracted CDNs based on contract terms associated with the CDN and an availability of the requested content item at the CDN; and

redirecting the request for the content item to the selected CDN for servicing.

16. The method of claim **15**, wherein selecting a CDN comprises interrogating the CDN using a HEAD request for the content item to determine availability of the content item at the CDN.

17. The method of claim **15**, wherein the selected CDN comprises a caching proxy CDN.

18. The method of claim **15**, further comprising facilitating pre-fetching of the requested content item at the selected CDN in the event that the requested content item is determined to not be available at the selected CDN.

19. The method of claim **15**, wherein the requested content item is cached at the selected CDN in response to receiving the redirected request.

20. The method of claim **15**, further comprising monitoring an ability of the selected CDN to service requests for the content item.

21. The method of claim **15**, wherein the selected CDN is selected from the plurality of contracted CDNs because the selected CDN is able to service the request for the content item at a least cost to the resource consumer.

22. (canceled)

23. A system for managing content delivery, comprising:

a processor configured to:

receive from a resource consumer desiring content delivery services a specification of a plurality of contracted content delivery networks (CDNs) and contract terms associated with each of the plurality of CDNs;

receive a request for a content item published by the resource consumer;

select a CDN from the plurality of contracted CDNs based on contract terms associated with the CDN and an availability of the requested content item at the CDN; and

redirect the request for the content item to the selected CDN for servicing; and

a memory coupled to the processor and configured to provide the processor with instructions.

24. (canceled)

25. A computer program product for managing content delivery, the computer program product being embodied in a computer readable storage medium and comprising computer instructions for:

receiving from a resource consumer desiring content delivery services a specification of a plurality of contracted content delivery networks (CDNs) and CDN contract terms associated with each of the plurality of CDNs;

receiving a request for a content item published by the resource consumer;

selecting a CDN from the plurality of contracted CDNs based on contract terms associated with the CDN and an availability of the requested content item at the CDN; and

redirecting the request for the content item to the selected CDN for servicing.

26. The system of claim **23**, wherein to select a CDN comprises to interrogate the CDN using a HEAD request for the content item to determine availability of the content item at the CDN.

27. The system of claim **23**, wherein the selected CDN comprises a caching proxy CDN.

28. The system of claim **23**, wherein the processor is further configured to facilitate pre-fetching of the requested content item at the selected CDN in the event that the requested content item is determined to not be available at the selected CDN.

29. The system of claim **23**, wherein the requested content item is cached at the selected CDN in response to receiving the redirected request.

30. The system of claim **23**, wherein the processor is further configured to monitor an ability of the selected CDN to service requests for the content item.

31. The system of claim **23**, wherein the selected CDN is selected from the plurality of contracted CDNs because the selected CDN is able to service the request for the content item at a least cost to the resource consumer.

32. The computer program product of claim **25**, wherein selecting a CDN comprises interrogating the CDN using a HEAD request for the content item to determine availability of the content item at the CDN.

33. The computer program product of claim **25**, wherein the selected CDN comprises a caching proxy CDN.

34. The computer program product of claim **25**, further comprising computer instructions for facilitating pre-fetching of the requested content item at the selected CDN in the event that the requested content item is determined to not be available at the selected CDN.

35. The computer program product of claim **25**, wherein the requested content item is cached at the selected CDN in response to receiving the redirected request.

36. The computer program product of claim **25**, further comprising computer instructions for monitoring an ability of the selected CDN to service requests for the content item.

37. The computer program product of claim **25**, wherein the selected CDN is selected from the plurality of contracted CDNs because the selected CDN is able to service the request for the content item at a least cost to the resource consumer.

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