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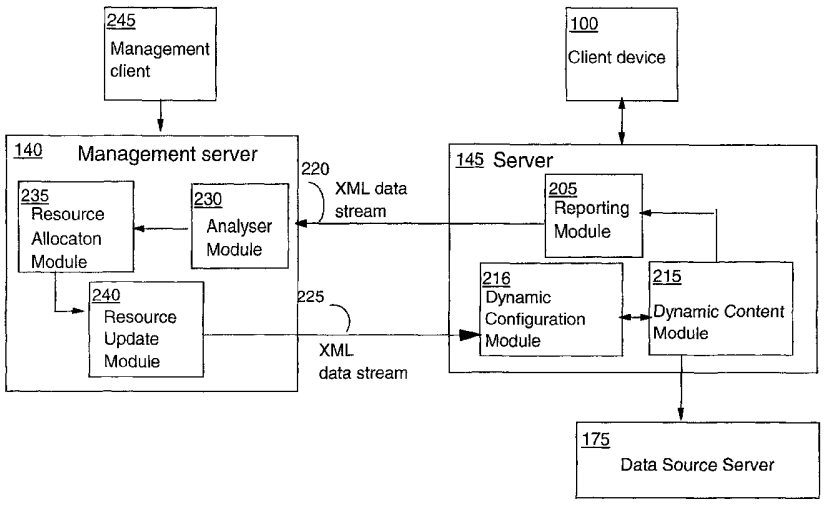
(54) **Title:** REMOTE DYNAMIC CONFIGURATION OF A WEB SERVER TO PROVIDE CAPACITY ON DEMAND



(57) **Abstract:** The present invention relates to a method and system for the remote and dynamic configuration of a webserver to facilitate capacity on demand. The present invention provides a solution to the problem of the management and administration of one or more servers within an environment such as a server farm with regards to the rigid infrastructure and architecture of the servers due to the definition of roles the servers play in relation to the data the servers are publishing. A solution is provided in the form of autonomic modular computing components to allow a server to process a URL and the server to associate it with a remote data source without the need for a restart or manual intervention of the server and to allow the introduction of new services and or hardware resources by collating and analysing performance data collected from the server to determine if the server is over or under utilised.

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REMOTE DYNAMIC CONFIGURATION OF A WEB SERVER TO PROVIDE CAPACITY ON DEMAND

Field of the Invention

The invention relates to the field of network services and in particular to the remote and dynamic configuration of a server to facilitate capacity on demand.

Background of the Invention

Many companies offer hosting services to provide customers with a secure, robust and flexible infrastructure in which to host a variety of applications for example web applications such as on-line banking, on-line shopping, information services and hosting service such as 'pay for used capacity' which, enable a customer to only pay for the processing power that they use and allows the customer to deploy the most up-to-date equipment in a cost effective manner. Hosting services provide many businesses with an alternative solution to building and running their technology infrastructure in-house by tapping into computer systems in other company's data centers to provide the management of software applications and hardware resources such as servers. The management and administration of these servers and services provide a tremendous challenge to many hosting companies, as a key problem with the management and administration of the servers within an environment such as a server farm is the rigid infrastructure and architecture of the servers due to the definition of roles the servers play in relation to the data the servers are publishing.

The rigid allocation of a resource to for example, a web server which supports a particular customer's product can result in an under utilized yet expensive web server resource not being used to it's full capability, while other web servers supporting other products are stretched to the point of breaking. Further today's current state of the art web server software is complex and flexible and can be configured and extended through Application Protocol Interfaces (API) to facilitate powerful processing beyond the standard serving of basic Hypertext Markup Language (HTML) pages. However current deployment practices and technologies require that the web servers are configured manually using either configuration files or binary registries and thus remain static during their operation, handling requests for a specific website or websites. When an additional or a different resource for a particular HTML page or a

different web site URL needs publishing or a need arises for a new server to be added to, or removed from a server pool, the servers must be restarted for any change to take effect. This requires a tremendous administration effort on the part of the server farm administrator because it takes a considerable amount of time to manually configure a server and it is not always convenient to shut down a server and restart the server to allow for any changes to take effect as this can cause loss of service for a period of time.

US patent application publication US 2002/0002602 (2602) describes a system for serving web pages to a client in response to a client request specifying a resource that aims to serve a web page in a coordinated fashion from multiple cooperating web servers and maintaining a reliable connection so that the server and clients remain synchronized and information is not lost. In order for the above to take place such that a web server processes a URL and associates the URL with a data source, the web server will require manual intervention and the web server will have to be shut down and restarted for the changes to take effect.

Disclosure of the Invention

In accordance with the present invention there is now provided a method for the remote and dynamic configuration of a server to facilitate capacity on demand comprising the steps of: (a) a client device requesting a resource from a first server in a communications network; (b)the first server receiving the request for the resource from the client device; (c) the first server routing the client request for the resource to a dynamic content module, the dynamic content module identifying an available third server from which the requested resource can be served and routing the requested resource to the client device; (d) collating performance data from the first and third server and the first server reporting the performance data to a second server; (e) a second server analysing the performance data collated in step (d) to determine performance capabilities of the first and the third server and identifying if the first or the third server has reached a predetermined threshold; and (f) the second server adjusting the allocation of the first server or the third server in response to step (e) and issuing a configuration update instruction for the first server or the third server to a dynamic configuration module of the first server and determining if a resource update is successful.

The present invention advantageously allows for the optimisation of a servers performance such that a server can be allocated or deallocated

from a server pool depending on the server's performance for example if a server is stretched to capacity or equally if a server is under utilised. Further using modular autonomic computing components the system is able to configure and reconfigure itself under varying and unpredictable conditions. Further the method allows for making a change to a hardware resource or a data resource without the need for the server to be restarted as with other prior art systems.

Preferably the invention provides for the dynamic content module requesting a connection configuration file for the third server from the dynamic configuration module. This allows for the first server to determine which data source server has the resource requested by the client.

Preferably the invention provides for the adjusting of the allocation or deallocation of one or both the first server and the third server from a free server pool or to a free server resource pool. The present invention can therefore monitor a servers performance and either add an additional resource or de-allocate a resource depending on the work load of the server.

Preferably the invention provides for the requested resource being decoupled from the first server allowing the introduction of a new service or the removal of a redundant service.

Viewed from another aspect the present invention provides a system for the remote and dynamic configuration of a server to facilitate capacity on demand, the system comprising a client device for requesting and receiving a resource in a communications network, the system further comprising:

a first server, the first server comprising a dynamic content module, a dynamic configuration module and a reporting module; means for routing the client request for the resource to the dynamic content module; means for the dynamic content module identifying a third server from which the requested resource can be served and means for retrieving a connection configuration file associated with the third server stored in the dynamic configuration module; means for the reporting module collating performance data from the first server and the third server and means for routing the performance data to a second server;

a second server comprising an analyser module, a resource allocation module and a resource update module, the second server sending the performance data to the analyser module; means for the analyser module

determining the performance capabilities of the first server and the third server and means for identifying if the first server and third server has reached a predetermined threshold; means for the resource allocation module adjusting the allocation of one or both the first server and the third server in response to the identifying means; means for the resource update module issuing an configuration update instruction for one or both the first server and the third server to the dynamic configuration module of the first server and means for determining if a resource update is successful; and a third server comprising one or more resources and means for the third server to serve a requested resource to the first server.

A another advantage is that an HTTP URL can be processed by a server and associated with a remote data source without the need for the server to be restarted or requiring manual intervention. A further advantage of the present invention is the secure and centralised administration for the dynamic plug and play of data sources and hardware resources such that a web site can be served 'on the fly'. Another advantage of the present invention is for the provision of multiple protocol support for other mechanisms such as FTP, XML, SOAP and file sharing.

Brief description of the drawings

The invention will now be described by way of example only, with reference to the accompanying drawings, in which:

Figure 1 illustrates a server farm in which the present invention may be implemented in accordance with a preferred embodiment of the present invention;

Figure 2 illustrates a block diagram detailing an overview of the components of the system in accordance with a preferred embodiment of the present invention;

Figure 3 illustrates a flowchart detailing the function of the dynamic content module of the web server of Figure 2 in accordance with a preferred embodiment of the present invention;

Figure 4 illustrates a flowchart detailing the function of the reporting module of the web server of Figure 2 in accordance with a preferred embodiment of the present invention;

Figure 5 illustrates a flowchart detailing the function of the analyser module of the management server of Figure 2 in accordance with a preferred embodiment of the present invention;

Figure 6 illustrates a flowchart detailing the function of the resource allocation module of the management server of Figure 2 in accordance with a preferred embodiment of the present invention; and

Figure 7 illustrates a flowchart detailing the function of resource update module of the management server of Figure 2 in accordance with a preferred embodiment of the present invention.

Detailed description of the preferred embodiments of the Invention

Figure 1 illustrates a server farm in which the present invention may be implemented. The server farm includes a plurality of client devices 100 and 105 which are connected to a network such as the Internet 110. The client devices 100 and 105 perform transactions by sending and receiving requests for a resource over the network 110. Routers 115 and 120 provide a connection between the network 110 and the local area network (LAN) 125 which could be a high speed Ethernet network or any other suitable transmission medium or topology. The routers 115 and 120 receive an incoming request and forward the request over a network 135 to a router/firewall 130 which filters the request to a server 145 to 155. The present invention embodies a management server 140 for the central control point for servers 145 to 155. The servers 140 to 155 may implement one or more server technologies including, for example UNIX which is a registered trademark of The Open Group in the United States and other countries, Novell which is a registered trademark of Novell Inc in the United States and other countries, or Windows NT which is a registered trademark of Microsoft Corporation in the United States and other countries or both, and/or a peer to peer networking arrangement. Although the present invention has been described with reference to a server farm, the present invention could equally be applicable to pervasive computing environments as well as other server networking arrangements.

Application data is stored in a data store in one or more data source servers 175 and 180 which are separate from the servers 140 to 155. A request is sent from any one of the servers 145 to 155 across a network 160. The request is received by a router/firewall 165 and routed over a further network 170 to the appropriate data source server 175 and 180

storing the resource that was requested by one or more client devices 100 and 105.

Referring to Figure 2, a schematic view of the system is shown. The system comprises modular autonomic computing components to provide self diagnostic capabilities to detect performance issues with servers 145 to 155. Further by using modular components the system is able to provide the 'plug and play' of data sources for the easy introduction of new services.

The system comprises a server 145 with a reporting module 205 for collating performance and request data from each server 145 to 155 in an allocated server pool; a dynamic content module 215 which routes the request for a resource through the most appropriate interface to access a requested resource either using the native data access capability of the server 145 to 155 or by establishing and managing the connection to a remote server itself; a dynamic configuration module 216 for the update, processing and storing of a configuration file for each server in the allocated server pool and a client device 100 for requesting a resource from the server. The configuration file is used to hold the configuration settings for a particular server 145 to 155 for example a registration key, port settings, an installation path, authentication settings, user settings, SMPT settings, connection settings, web browser settings and log in settings.

The system further comprises a management server 140 for providing a central control point for all servers in an available server pool; an analyser module 230 for analysing the performance and request data from the reporting module 205; a resource allocation module 235 to determine whether there is a free resource in the free server resource pool to be added to the pool of allocated servers or if necessary to deallocate a server and place it back in the free server resource pool; a resource update module 240 for determining whether a resource has been successfully allocated or deallocated to or from the available resource pool and a management client 245 for the entry of manual configuration tasks into the system. The management client 245 can receive administration requests from a server administrator. The management client functions as a graphical user interface and provides greater flexibility in terms of providing connectivity to the management server for example providing connectivity remotely in another site via the Internet using a standard HTTP connection between the servers 145 to 155 and the management server 140. To enable only authorised administrators to make configuration changes, an interface

may be provided to a security directory for handling authentication and entitlement requests (not shown in the figures).

Data streams 220 and 225 are sent to and from the server 145 to 155 and the management server 140 using an Extensible Markup Language (XML) as the transport mechanism 220 and 225 over an HTTP session. XML is the universal format for structured documents and data on the Web. XML uses tags similar to HTML, and allows data to be structured in a manner that is understood by many people. Further information on XML can be found at the World Wide Web Consortium.

The client device 100 sends a request for a specific resource to the server 145. One such request that may be recieved by a server 145 to 150 is a HTTP URL for example http://www.ibm.com requesting an HTML page. To allow the server to translate the HTTP URL, the server will use a Domain Name Service (DNS) which translates Internet domain names to network addresses such as 129.42.19.99. The resource could be a standard HTML page or an .exe file. The server 145 receives the request for the resource from the client device 100 and 105 and the request is sent to the dynamic content module 215.

Although Figure 2 illustrates a management server 140 and a server 145, it should be appreciated that the system may comprise a plurality of servers 145 to 155 as shown in Figure 1, each server containing the modules as shown in Figure 2.

The operation of the dynamic content module 215 will now be explained with reference to Figure 3. It should be noted that the dotted line in Figure 3 represents data flow and the solid single line represents control flow. The dynamic content module 215 receives the request for a resource from the client device at step 300 and compares the content stored on the server 145 with the requested resource at step 305. For example if a client requested a resource from www.ibm.com/news/today.html, the dynamic content module compares the today.html page stored on the server with the today.html page stored on a source server to determine if the today.html page has been updated therefore, sending the client device the most up to date today.html page. At step 310 the server determines whether the content has been cached and if the cached content is current and up to date at step 360. If the cache is current control flows to step 355 and the requested resource is retrieved from the content cache store 350, equally if the content is not cached, the server which contains the requested resource is identified at step 315. Further at step 355

information concerning the server's 145 activities is sent to the reporting module 205. The information can include data such as the number of requests for each resource such as a product, the time it takes the server to respond or the type of service requested such as HTTP or File Transfer Protocol (FTP).

To enable the server 145 to identify the data source server 175 the server retrieves the connection configuration file for the source server at step 325 from a connection configuration store 320. Preprocessing is performed on the content request at step 330. At step 335 a request is issued to the data source server 175 and at step 340 the server 145 receives the content as requested by the client device 300 from the source server. The retrieved content is either stored in the content cache data store 350 or the existing content is refreshed with the retrieved content at step 345 and stored in the content cache data store 350.

Referring back to step 355, information regarding the resource requested from the client device 100 at step 300 along with performance information is sent to the reporting module 210. With reference to Figure 4 the reporting module 205 receives the content information from the dynamic content module 215 and records the information at step 400. These details are stored in a server statistics data store at step 405 and the server statistics (response times, number of pages requested, how many times, what pages, which server, server config details and performance data) associated with each server 145 to 155 are sent to the management server 140 at step 410 via an XML data streams 220.

Referring to Figure 5, the analyser module 230 of the management server 140 receives the server statistics in the XML data streams 220 and at step 500 the analyser module 230 analyses the server statistics to determine whether the server 145 to 155 has reached a predetermined threshold at step 505, if the server's performance has not reached the predetermined threshold control flows back to step 500, else control flows to step 510 and the analyser module 230 analyses the server's current configuration settings and the server's configuration settings are sent to the resource allocation module 235.

Referring to Figure 6 at step 600, the resource allocation module 235 determines whether a new server should be added to a current pool of allocated severs 145 to 155 if the performance threshold has been exceeded or if a server should be removed from the current pool of allocated servers and returned to the free resource pool. If the analyser module 230

determines that an additional server is to be added, control flows to step 605 and the resource allocation module identifies whether there exists a spare resource at step 610. A spare resource could be for example an additional server or equally some other hardware resource. If a spare resource can not be located control flows to step 630 and at step 635 an exception error is created and displayed in the management console 245 to alert a technician that the resource update has failed at step 635. Referring back to step 610 if a spare resource has been located control flows to step 615 and a new server is selected and information regarding the server's configuration settings file is requested from the configuration database 615 of the particular server 140 to 155. At step 620 once the configuration setting file has been received, the configuration setting file is updated with the current instruction for the selected server and sent to the resource update module 240 and the dynamic configuration module 216 via XML data streams 225.

Referring to Figure 7, at step 700 the configuration update information is issued to the dynamic configuration module 216 of the server 145 via XML data streams 225. The resource update module 240 waits for acknowledgment from the server 145 at step 710. If a configuration update is successful at step 715 control flows to step 720 and the configuration database 730 is updated. Referring back to step 720 if the acknowledgment from the server 145 is successful control also passes to step 735 and a configuration update request for a load balancing infrastructure is requested. Equally if at step 720 the update is not successful control flows to step 745 and an exception handling alert is generated and the resource update is deemed to have failed at step 750.

CLAIMS

1. A method for the remote and dynamic configuration of a server to facilitate capacity on demand comprising the steps of:

(a) a client device requesting a resource from a first server in a communications network;

(b) the first server receiving the request for the resource from the client device;

(c) the first server routing the client request for the resource to a dynamic content module, the dynamic content module identifying an available third server from which the requested resource can be served and routing the requested resource to the client device;

(d) collating performance data from the first and third server and the first server reporting the performance data to a second server;

(e) a second server analysing the performance data collated in step (d) to determine performance capabilities of the first and the third server and identifying if the first or the third server has reached a predetermined threshold; and

(f) the second server adjusting the allocation of the first server or the third server in response to step (e) and issuing a configuration update instruction for the first server or the third server to a dynamic configuration module of the first server and determining if a resource update is successful.

2. A method as claimed in claim 1 wherein the dynamic content module further comprises requesting a connection configuration file for the third server from the dynamic configuration module.

3. A method as claimed in claim 1 wherein the dynamic configuration module stores configuration settings for one or both the first server and the third server.

4. A method as claimed in claim 1, wherein the step of adjusting the allocation of one or both the first server and the third server further comprises allocating an additional server from a free server resource pool.

5. A method as claimed in claim 1, wherein the step of adjusting the allocation of one or both the first server and the third server further comprises de-allocating the first server or the third server from an allocated resource pool to a free server resource pool.

6. A method as claimed in claim 1 or 2 wherein the first server and the second server communicate with each other through XML data streams.

7. A method as claimed in claim 1 wherein the second server is a management server providing a central control point for one or more first servers.

8. A method as claimed in claim 1 wherein the requested resource is decoupled from the first server allowing the introduction of a new service or the removal of a redundant service.

9. A method as claimed in claim 1 wherein the first server is plurality of servers.

10. A method as claimed in claim 1 wherein the third server is plurality of servers.

11. A system for the remote and dynamic configuration of a server to facilitate capacity on demand, the system being for use with a client device which requests and receives a resource in a communications network, the system comprising:

a first server, the first server comprising a dynamic content module, a dynamic configuration module and a reporting module;

the first server further comprising:

means for routing the client request for the resource to the dynamic content module;

means for the dynamic content module identifying a third server from which the requested resource can be served and means for retrieving a connection configuration file associated with the third server stored in the dynamic configuration module; and

means for the reporting module collating performance data from the first server and the third server and means for routing the performance data to a second server;

a second server comprising an analyser module, a resource allocation module and a resource update module, the second server sending the performance data to the analyser module; the second server further comprising:

means for the analyser module determining the performance capabilities of the first server and the third server and means for identifying if the first server and the third server has reached a predetermined threshold;

means for the resource allocation module adjusting the allocation of one or both the first server and the third server in response to the identifying means; and

means for the resource update module issuing a configuration update instruction for one or both the first server and the third server to the dynamic configuration module of the first server and means for determining if the allocation or de-allocation of one or both the first server and the third server has been successful; and

a third server comprising one or more resources and means for the third server to serve a requested resource to the first server.

12. A system as claimed in claim 11 wherein means for adjusting the allocation of one or both the first server and the third server further comprises means for allocating an additional server from a free server resource pool.

13. A system as claimed in claim 11 wherein means for adjusting the allocation of the first server or the third server further comprises means for de-allocating one or both the first server and the third server from an allocated resource pool to a free server resource pool.

14. A system as claimed in claim 11 wherein means for communication between the first server and the second server is through XML data streams.

15. A system as claimed in claim 11 wherein means for the connection configuration file comprises connection settings for the first and the third server.

16. A system as claimed in claim 11 wherein the dynamic configuration module provides means for storing configuration settings for a first server and a third server.

17. A system as claimed in claim 11 wherein the second server is a management server providing means for a central control point for the first and the third server.

18. A system as claimed in claim 11 wherein means for the requested resource is decoupled from the first server allowing means for the introduction of a new service or the removal of a redundant service.

19. A system as claimed in claim 11 wherein means for the first server is plurality of servers.

20. A system as claimed in claim 11 wherein means for the third server is plurality of servers.

21. A computer program product comprising computer program code stored on a computer readable storage medium, which when executed on a data processing system, instructs the data processing system to carry out the method as claimed in claim 1.

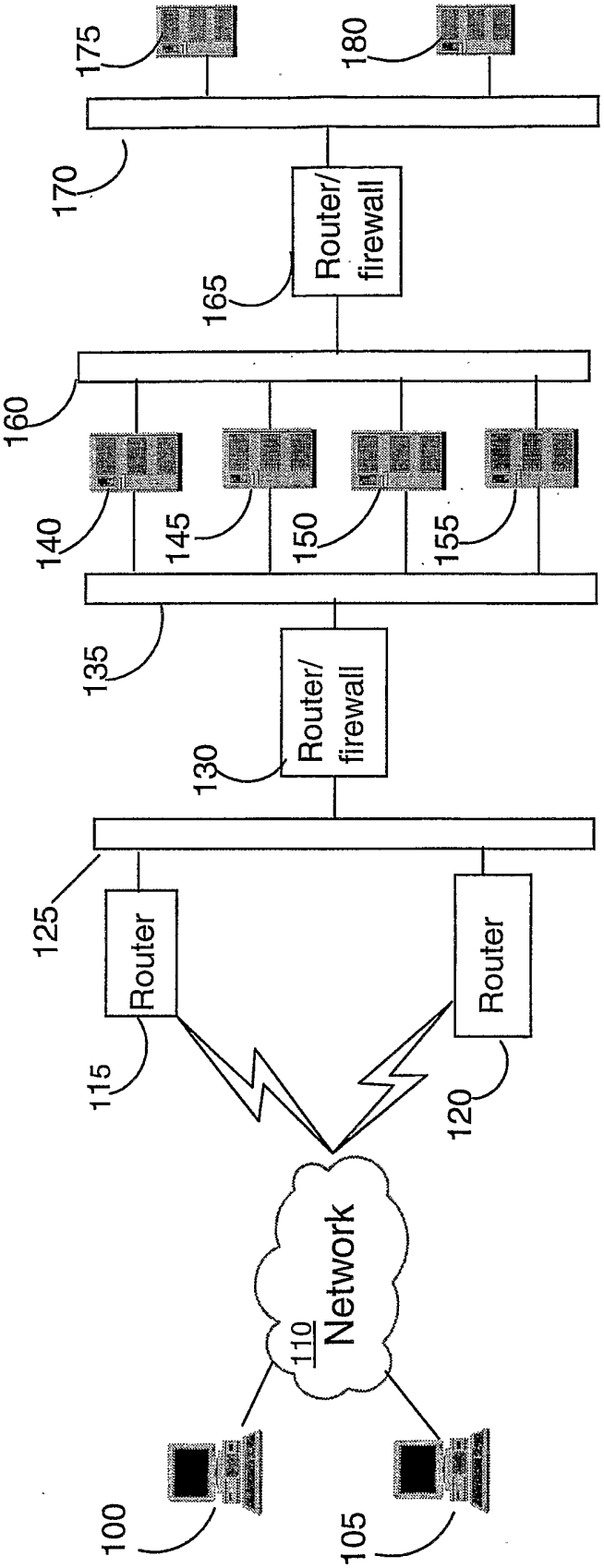
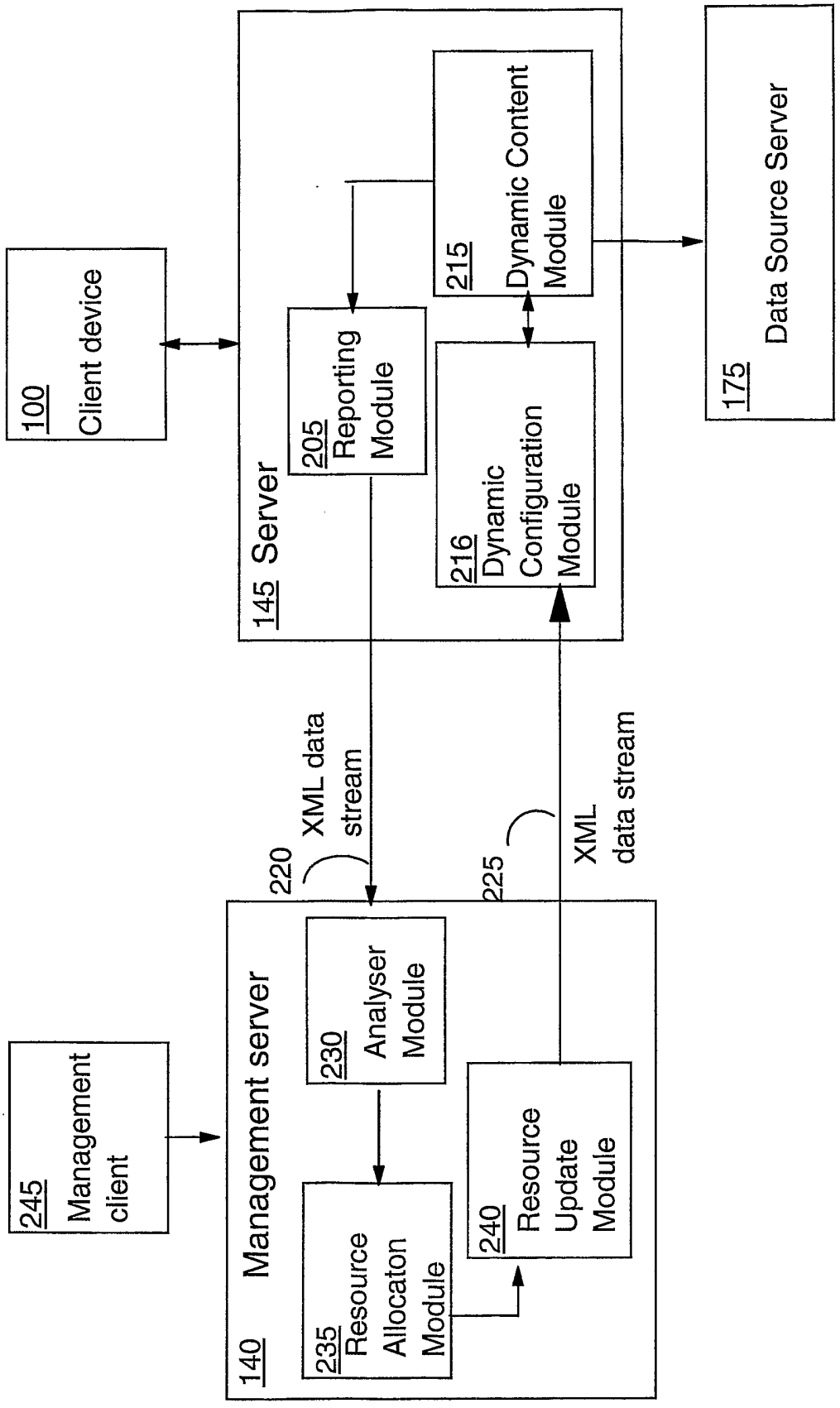

175
180
170
Router/
firewall
165
160
140
145
150
155
135
Router/
firewall
130
125
Router
Router
115
120
Network
110
100
105

Fig 1

Fig 2


100
Client device
145 Server
205
Reporting
Module
215
Dynamic Content
Module
216
Dynamic
Configuration
Module
175
Data Source Server
220
XML data
stream
225
XML
data stream
245
Management
client
140 Management server
230
Analyser
Module
235
Resource
Allocaton
Module
240
Resource
Update
Module

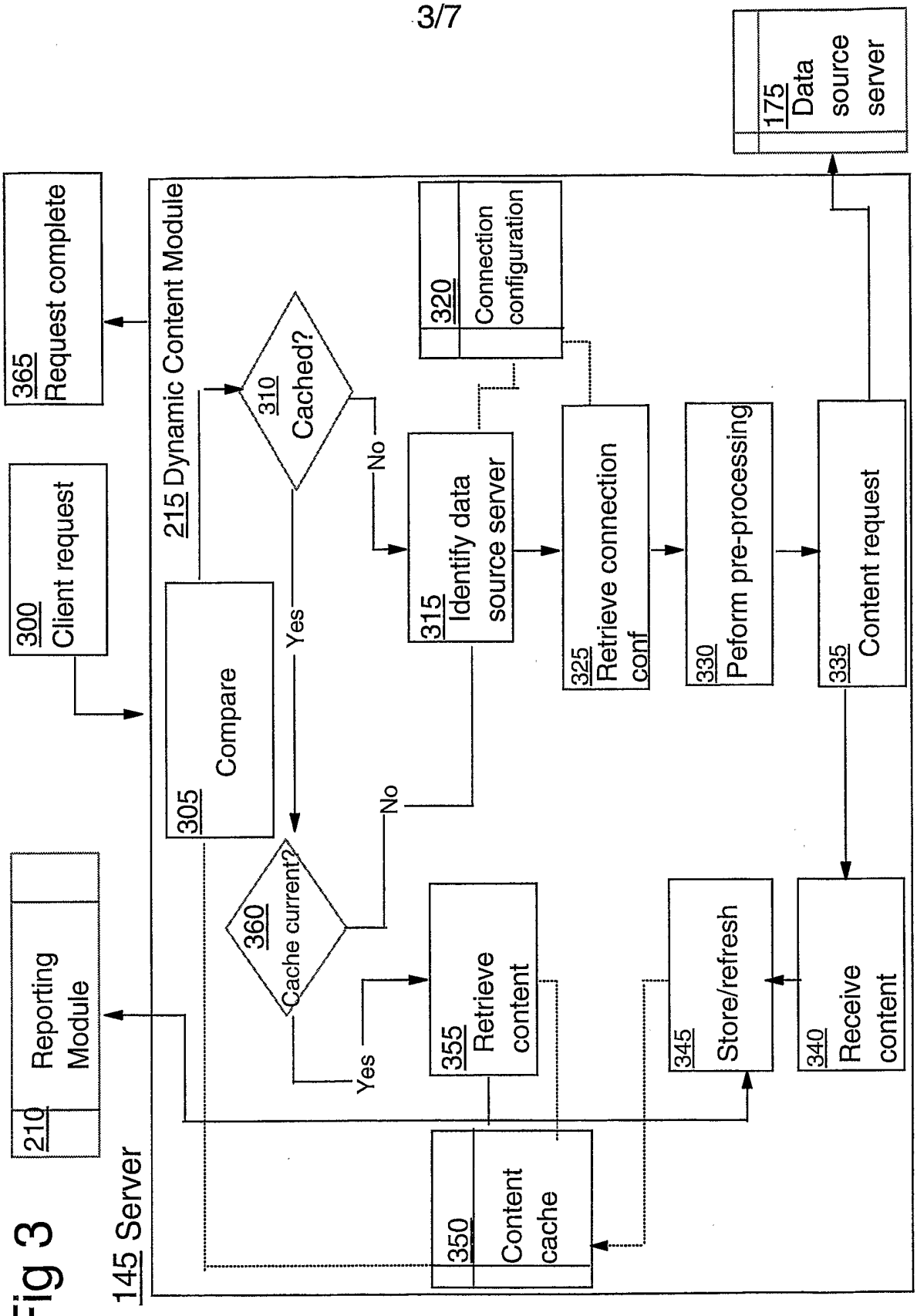

145 Server
210 Reporting Module
215 Dynamic Content Module
300 Client request
305 Compare
310 Cached?
315 Identify data source server
320 Connection configuration
325 Retrieve connection conf
330 Peform pre-processing
335 Content request
340 Receive content
345 Store/refresh
350 Content cache
355 Retrieve content
360 Cache current?
365 Request complete
175 Data source server
Yes
No
Yes
No

Fig 3

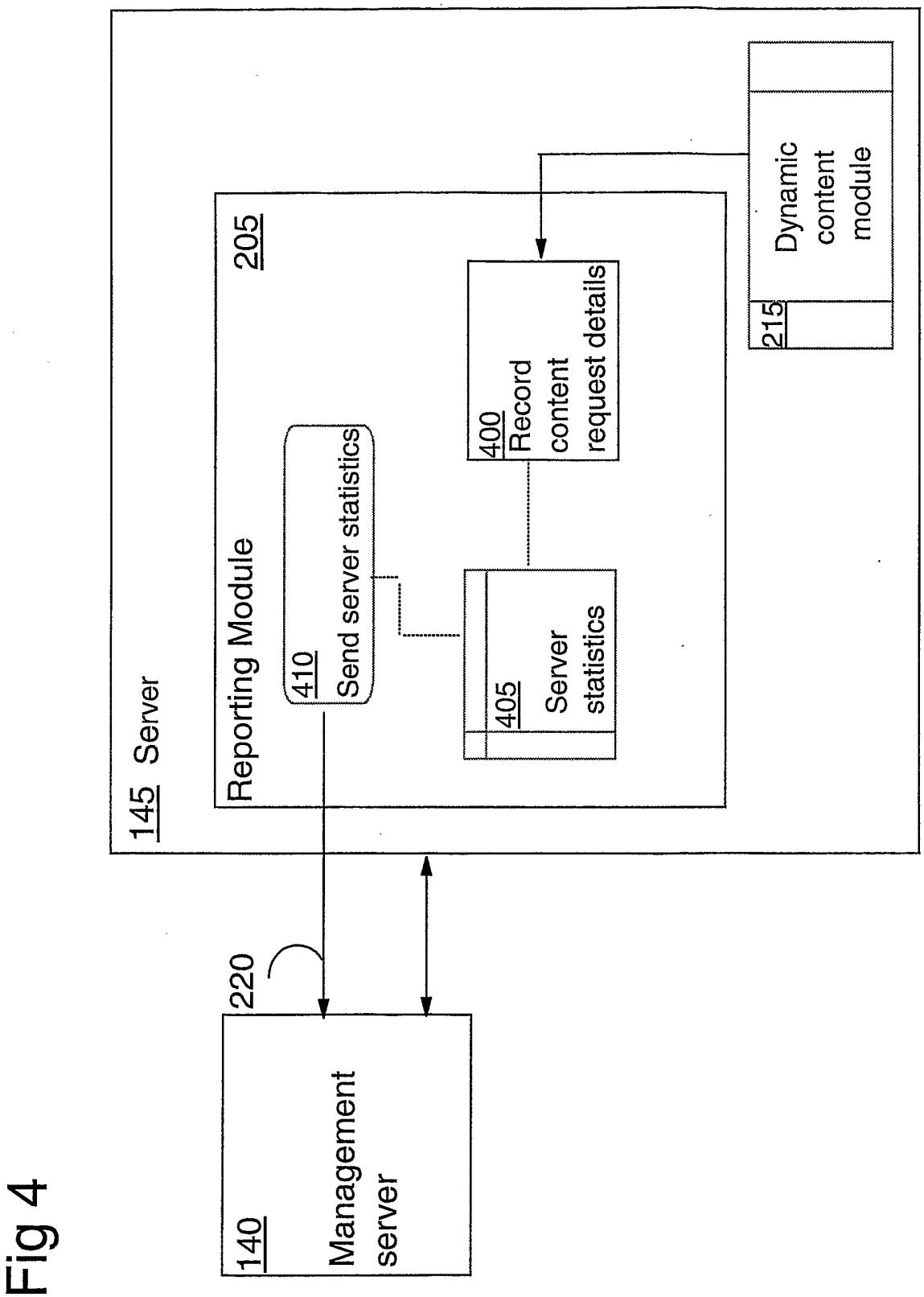
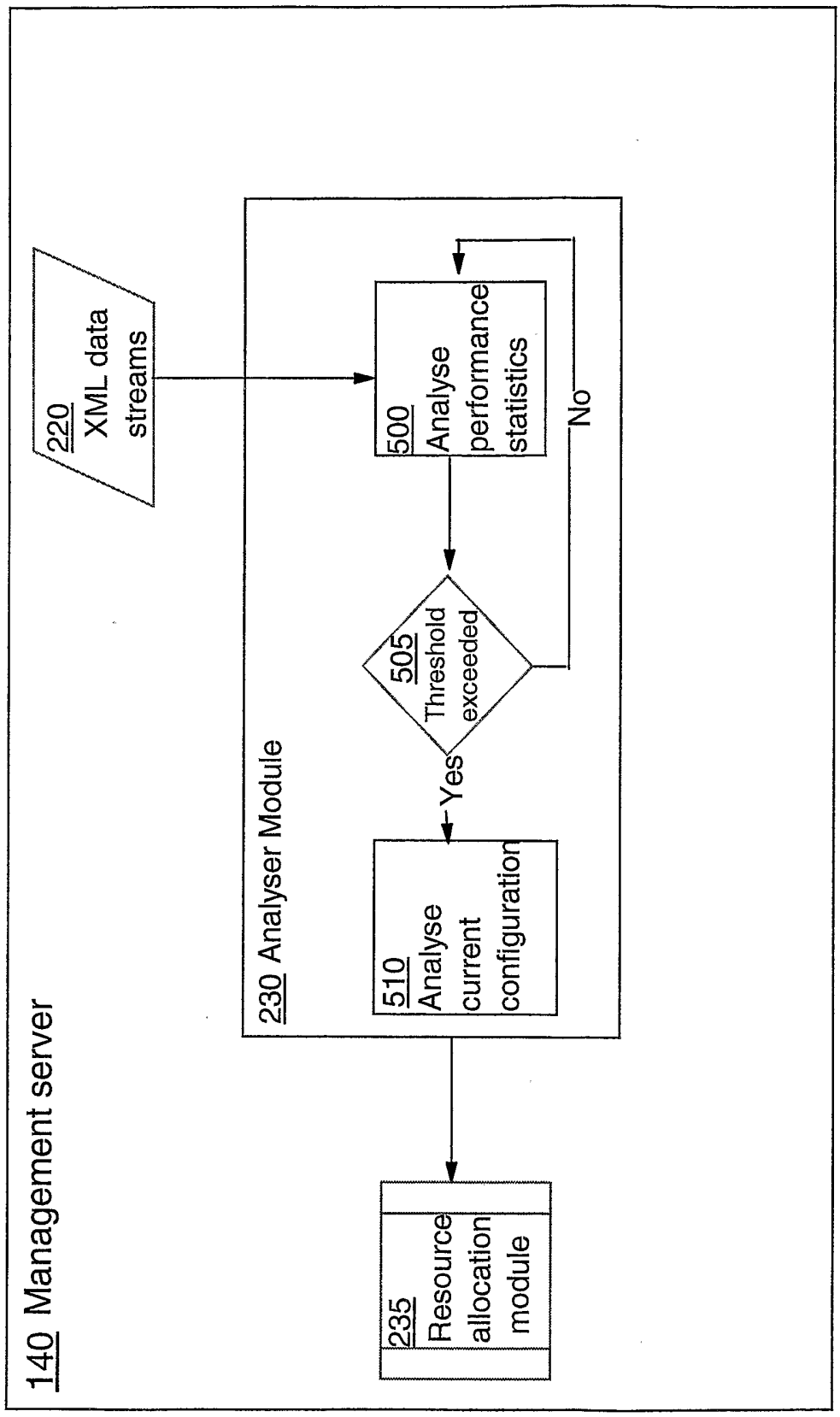

145 Server
Reporting Module
205
Dynamic content module
215
400 Record content request details
410 Send server statistics
405 Server statistics
220
140 Management server

Fig 4

Fig 5


140 Management server
220 XML data streams
230 Analyser Module
500 Analyse performance statistics
505 Threshold exceeded
No
Yes
510 Analyse current configuration
235 Resource allocation module

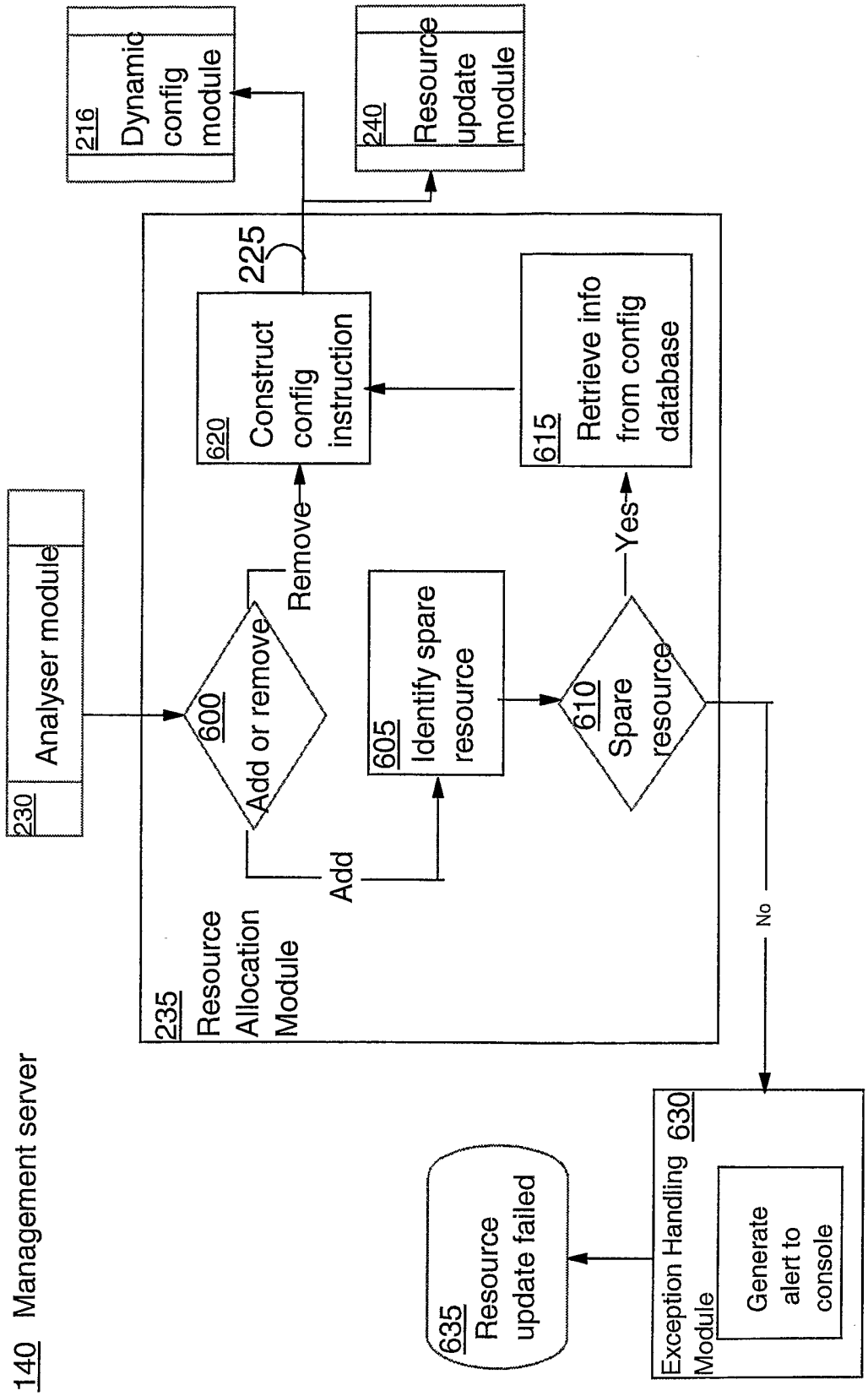
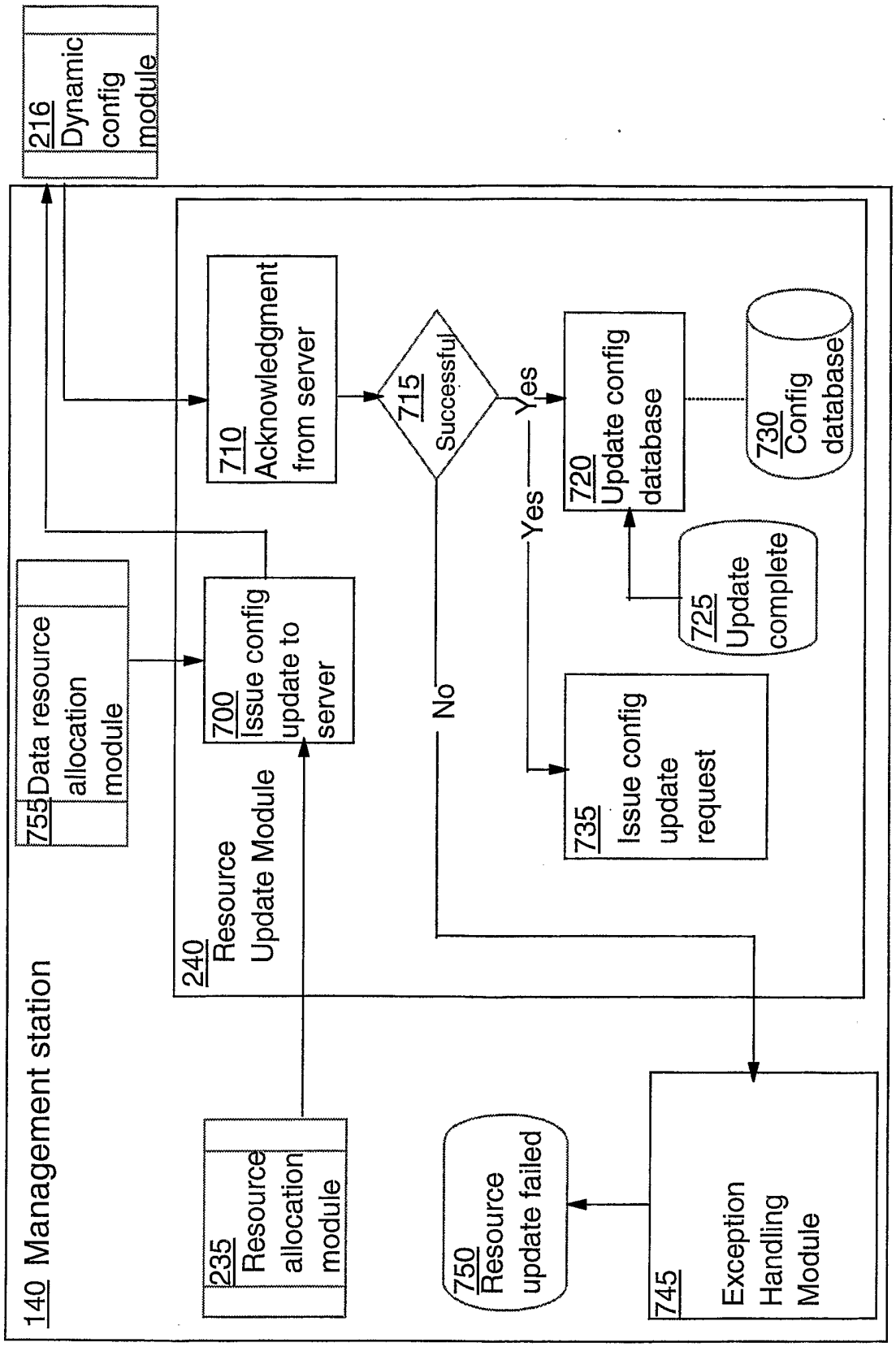

140 Management server
230 Analyser module
600 Add or remove
Remove
Add
605 Identify spare resource
610 Spare resource
Yes
No
615 Retrieve info from config database
620 Construct config instruction
225
235 Resource Allocation Module
216 Dynamic config module
240 Resource update module
635 Resource update failed
Exception Handling Module 630
Generate alert to console

Fig 6

Fig 7


140 Management station
216 Dynamic config module
755 Data resource allocation module
240 Resource Update Module
700 Issue config update to server
710 Acknowledgment from server
715 Successful
Yes
No
720 Update config database
730 Config database
725 Update complete
735 Issue config update request
235 Resource allocation module
750 Resource update failed
745 Exception Handling Module

INTERNATIONAL SEARCH REPORT

Internal Application No
PCT/ 03/03745

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04L29/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, INSPEC, COMPENDEX, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	US 2002/002611 A1 (VANGE MARK) 3 January 2002 (2002-01-03) abstract; figures 2,3 paragraphs '0001!,'0002!,'0005!,'0007!,'0012!,'0013!, '0021!,'0033!-'0039!,'0051!-'0053!,'0097!-'0100! ---	1-21
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[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 December 2003	23/12/2003

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Lopez Monclus, I.

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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