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(54) **SELECTIVE CACHING OF SERVABLE FILES BASED AT LEAST IN PART ON A TYPE OF MEMORY**

(75) Inventor: **Bilal Alam**, Sammamish, WA (US)

Correspondence Address:
LEE & HAYES PLLC
421 W RIVERSIDE AVENUE SUITE 500
SPOKANE, WA 99201

(73) Assignee: **Microsoft Corporation**, Redmond, WA (US)

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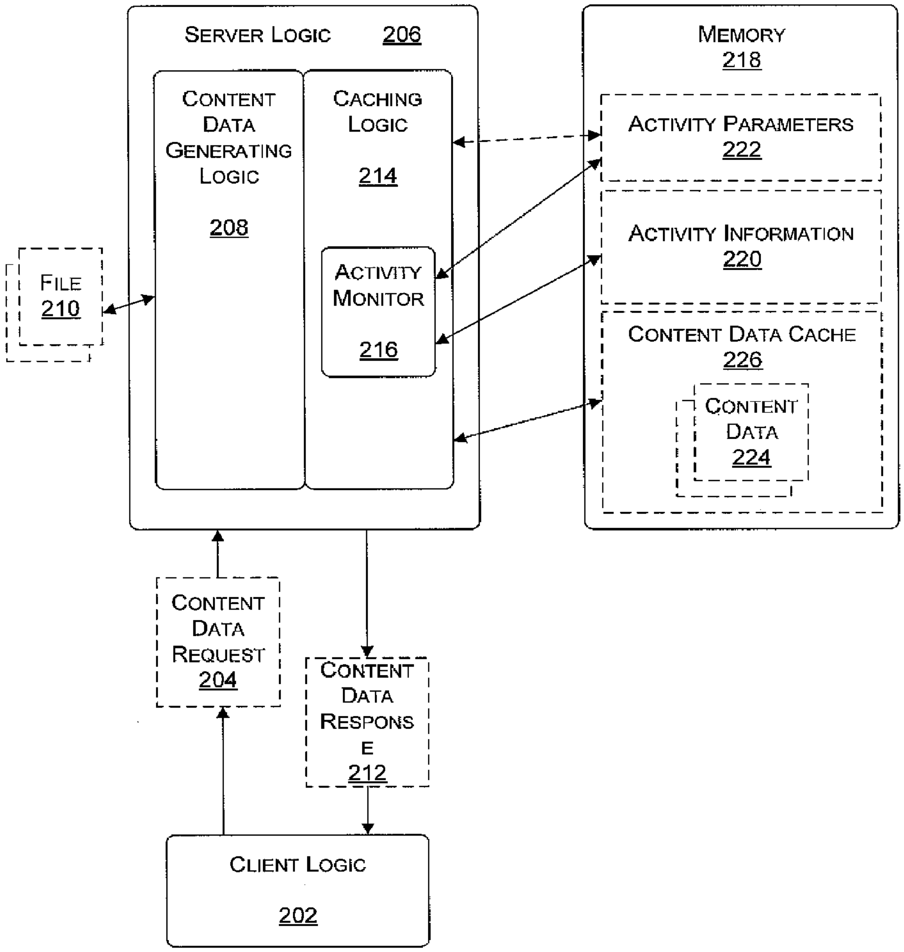
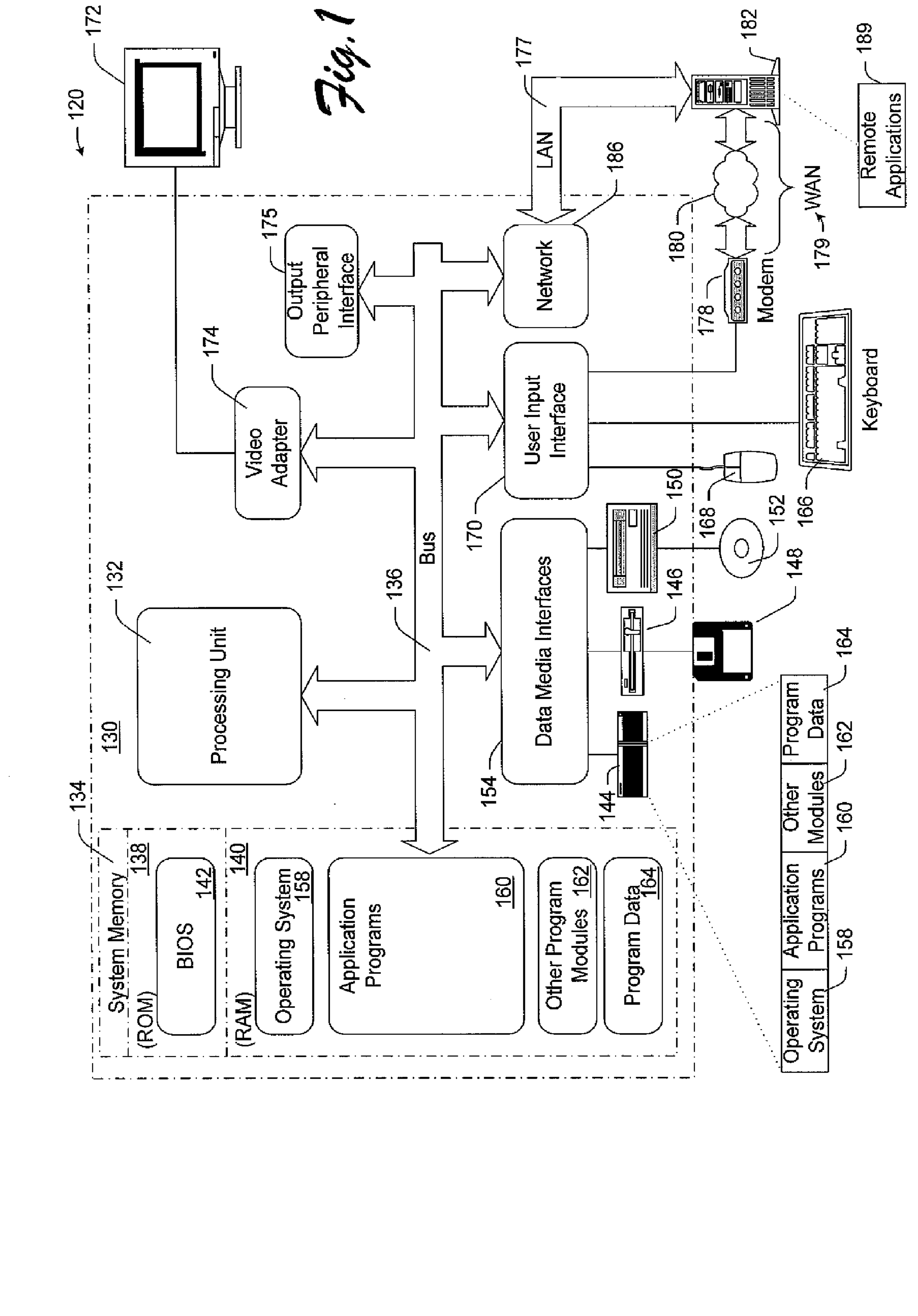
(57) **ABSTRACT**

Methods and apparatuses are provided for use in servers or other like devices that output content data based on requests. Activity and/or other like information, e.g., in the form of Metadata, is gathered/maintained for each handled request and used to determine if the corresponding content data should be cached in memory to speed up subsequent similar requests for the content data, or conversely removed from the memory cache. The activity and/or other like information can be considered in light of one or more activity or other useful parameters that define the operation of the resulting content data cache(s).

200




120
172
Fig. 1
130
132
Processing Unit
136
Bus
174
Video Adapter
175
Output Peripheral Interface
177
LAN
186
Network
170
User Input Interface
154
Data Media Interfaces
134
System Memory
138
(ROM)
BIOS
142
140
(RAM)
Operating System 158
Application Programs
160
Other Program Modules 162
Program Data 164
144
146
148
150
152
168
166
Keyboard
178
Modem
180
179
WAN
182
189
Remote Applications
Operating System
158
Application Programs
160
Other Modules
162
Program Data
164

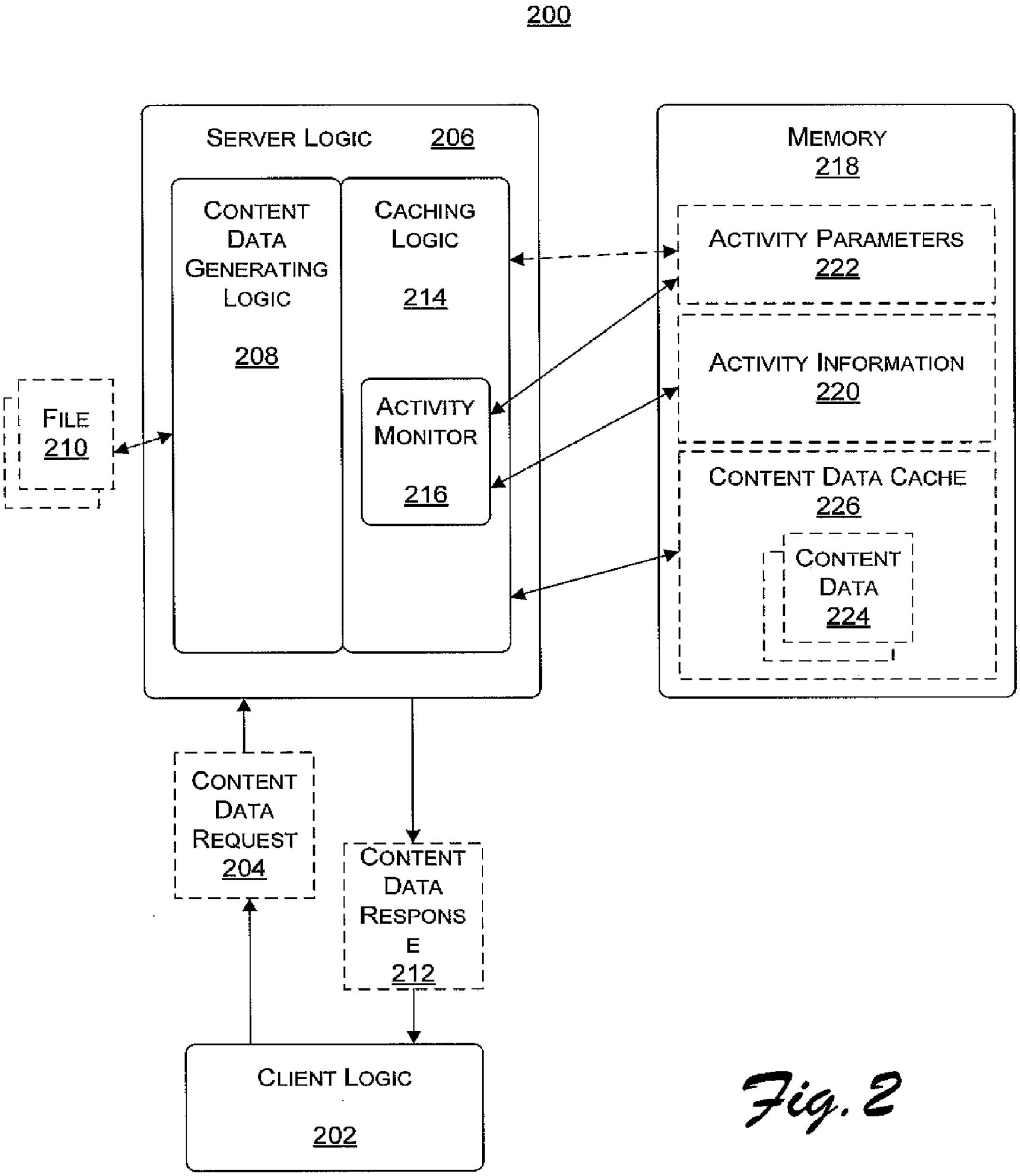

200
SERVER LOGIC 206
CONTENT DATA GENERATING LOGIC 208
CACHING LOGIC 214
ACTIVITY MONITOR 216
FILE 210
MEMORY 218
ACTIVITY PARAMETERS 222
ACTIVITY INFORMATION 220
CONTENT DATA CACHE 226
CONTENT DATA 224
CONTENT DATA REQUEST 204
CONTENT DATA RESPONS E 212
CLIENT LOGIC 202

Fig. 2

SELECTIVE CACHING OF SERVABLE FILES BASED AT LEAST IN PART ON A TYPE OF MEMORY

RELATED PATENT APPLICATIONS

[0001] This U.S. patent application is a continuation of, claims the benefit of priority from, and hereby incorporates by reference the entire disclosure of, co-pending U.S. application for Letters patent Ser. No. 10/378,522, filed Mar. 3, 2003, and titled "Selective Caching of Servable Files", which itself claims the benefit of priority from, and hereby incorporates by reference the entire disclosure of, U.S. Provisional Application for Letters Patent Ser. No. 60/366,797, filed Mar. 22, 2002, and titled "Activity Period of Optimization".

BACKGROUND

[0002] The popularity of the Internet, and in particular, the portion of the Internet known as the World Wide Web, continues to grow. The World Wide Web is basically a collection of computers that are operatively linked together through a plurality of communication networks. Typically, users access the World Wide Web through a personal computer or like device, which is connected to the Internet via a modem of some type. For example, many users of the World Wide Web connect to the Internet using a dial-up telephone networked modem configured to establish data communications through an Internet Services Provider (ISP). Other users connect to the Internet with a faster modem, e.g., a cable modem, digital subscriber line (DSL) modem, etc.

[0003] Regardless of how a user ultimately connects to the Internet/World Wide Web, once connected, the user typically accesses information available therein by using a web browser or like application. A web browser is configured to access web pages that are provided through the Internet by other computers. For example, one or more web server computers may be connected to the Internet and configured with one or more web sites or other supporting web applications. A web site typically has one or more static web pages and/or is capable of supplying one or more dynamically generated web pages that the user may selectively download, view and possibly interact with.

[0004] To identify a particular web site/page, the user will typically select a hyper-link to the desired web site/page or may choose to manually enter a unique name for the web site/page. The most common name used for identifying a web site/page is known as the uniform resource locator (URL). By entering a URL, the user will be connected to an appropriate web server which hosts the applicable web application(s), and the requested web page will be downloaded, in this case using a hypertext transfer protocol (HTTP), to the web browser. Within the Internet itself, the selected URL is associated with a specific Internet Protocol (IP) address. This IP address takes the form of a unique numerical identifier, which has been assigned to the targeted web server. Thus, a user may also directly enter an IP address in the web browser. However, the majority of users tend to favor the use of the more easily remembered and entered URL.

[0005] When a typical web server receives a request, e.g., an HTTP request, from a web browser, it needs to handle the request. Hence, a web server process may be configured to handle the request itself, or may need to pass the request on to another process, e.g., a worker process, that is configured to handle the request.

[0006] Regardless as to how the request is handled, the result is that a response is generated. The response includes some type of content data and is provided to the requesting client program/device. One example of content data is a web page that is then processed and typically displayed by a browser. It takes time and computational resources for the web server to handle the request, and to generate or otherwise output the appropriate content data. Typically, a web server handles a plurality of web pages associated with one or more web sites.

[0007] One common practice is to buffer content data in memory after it has been generated. Consequently, when a subsequent request for the buffered content data is received the content data need not be generated again but rather served directly from memory to the client program/device. This usually reduces the response time and/or the processing load. In certain conventional web servers, the buffering techniques include buffering newly generated content data. Since there is only a finite amount of memory available for buffering content data, there is usually not enough memory to hold all of the content data that a web site and/or web server may need to output. As such, eventually some web content will need to be generated fresh/again.

[0008] It would be beneficial to have improved techniques for managing the buffered content data such that the web server's performance is further improved.

SUMMARY

[0009] Methods and apparatuses are provided for use in servers or other like devices that output content data based on requests. Activity and/or other like information is gathered/maintained for each handled request and used to determine if the corresponding content data should be cached in memory to speed up subsequent similar requests for the content data, or conversely not cached in memory. The activity and/or other like information can be considered in light of one or more activity parameters or other useful parameters that essentially define the operation of the resulting content data cache(s).

[0010] By way of example, the above stated needs and others are met by an apparatus for use in a server device. Here, the apparatus includes logic that is operatively coupled to memory and configured to gather information about at least one request for content data, and selectively store the content data in at least one content data cache in the memory based on the gathered information.

[0011] The gathered information may include activity information associated with a defined period of time. The gathered information may include content data type information and/or content data size information.

[0012] The logic may be configured to selectively store the content data in the least one content data cache based on at least one parameter. Here, for example, the parameter may define a period of time associated with the gathered information, define at least one activity level threshold value, define a content data type, and/or define at least one content data size threshold value.

[0013] In certain implementations, the logic can be configured to selectively modify at least one parameter. The logic may even dynamically modify at least one parameter.

[0014] In other implementations, the logic can be configured to selectively store the content data in the at least one content data cache based on a type of the memory being used or available.

[0015] The logic can be configured to output the content data stored in at least one content data cache.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] A more complete understanding of the various methods, apparatuses and systems of the present invention may be had by reference to the following detailed description when taken in conjunction with the accompanying drawings wherein:

[0017] FIG. **1** is a block diagram that depicts an exemplary device, in the form of a computer, which is suitable for use with certain implementations of the present invention.

[0018] FIG. **2** is a block diagram depicting a selective content data caching arrangement, in accordance with certain exemplary implementations of the present invention.

DESCRIPTION

[0019] FIG. **1** depicts a computing environment **120** that includes a general-purpose computing device in the form of a computer **130**. The components of computer **130** may include one or more processors or processing units **132**, a system memory **134**, and a bus **136** that couples various system components including system memory **134** to processor **132**.

[0020] Bus **136** represents one or more of any of several types of bus structures, including a memory bus or memory controller, a peripheral bus, an accelerated graphics port, and a processor or local bus using any of a variety of bus architectures. By way of example, and not limitation, such architectures include Industry Standard Architecture (ISA) bus, Micro Channel Architecture (MCA) bus, Enhanced ISA (EISA) bus, Video Electronics Standards Association (VESA) local bus, and Peripheral Component Interconnects (PCI) bus also known as Mezzanine bus.

[0021] Computer **130** typically includes a variety of computer readable media. Such media may be any available media that is accessible by computer **130**, and it includes both volatile and non-volatile media, removable and non-removable media.

[0022] In FIG. **1**, system memory **134** includes computer readable media in the form of volatile memory, such as random access memory (RAM) **140**, and/or non-volatile memory, such as read only memory (ROM) **138**. A basic input/output system (BIOS) **142**, containing the basic routines that help to transfer information between elements within computer **130**, such as during start-up, is stored in ROM **138**. RAM **140** typically contains data and/or program modules that are immediately accessible to and/or presently being operated on by processor **132**.

[0023] Computer **130** may further include other removable/non-removable, volatile/non-volatile computer storage media. For example, FIG. **1** illustrates a hard disk drive **144** for reading from and writing to a non-removable, non-volatile magnetic media (not shown and typically called a "hard drive"), a magnetic disk drive **146** for reading from and writing to a removable, non-volatile magnetic disk **148** (e.g., a "floppy disk"), and an optical disk drive **150** for reading from or writing to a removable, non-volatile optical disk **152** such as a CD-ROM/R/RW, DVD-ROM/R/RW/+R/RAM or other optical media. Hard disk drive **144**, magnetic disk drive **146** and optical disk drive **150** are each connected to bus **136** by one or more interfaces **154**.

[0024] The drives and associated computer-readable media provide nonvolatile storage of computer readable instructions, data structures, program modules, and other data for computer **130**. Although the exemplary environment described herein employs a hard disk, a removable magnetic disk **148** and a removable optical disk **152**, it should be appreciated by those skilled in the art that other types of computer readable media which can store data that is accessible by a computer, such as magnetic cassettes, flash memory cards, digital video disks, random access memories (RAMs), read only memories (ROM), and the like, may also be used in the exemplary operating environment.

[0025] A number of program modules may be stored on the hard disk, magnetic disk **148**, optical disk **152**, ROM **138**, or RAM **140**, including, e.g., an operating system **158**, one or more application programs **160**, other program modules **162**, and program data **164**.

[0026] The improved methods and systems described herein may be implemented within operating system **158**, one or more application programs **160**, other program modules **162**, and/or program data **164**.

[0027] A user may provide commands and information into computer **130** through input devices such as keyboard **166** and pointing device **168** (such as a "mouse"). Other input devices (not shown) may include a microphone, joystick, game pad, satellite dish, serial port, scanner, camera, etc. These and other input devices are connected to the processing unit **132** through a user input interface **170** that is coupled to bus **136**, but may be connected by other interface and bus structures, such as a parallel port, game port, or a universal serial bus (USB).

[0028] A monitor **172** or other type of display device is also connected to bus **136** via an interface, such as a video adapter **174**. In addition to monitor **172**, personal computers typically include other peripheral output devices (not shown), such as speakers and printers, which may be connected through output peripheral interface **175**.

[0029] Computer **130** may operate in a networked environment using logical connections to one or more remote computers, such as a remote computer **182**. Remote computer **182** may include many or all of the elements and features described herein relative to computer **130**.

[0030] Logical connections shown in FIG. **1** are a local area network (LAN) **177** and a general wide area network (WAN) **179**. Such networking environments are commonplace in offices, enterprise-wide computer networks, intranets, and the Internet.

[0031] When used in a LAN networking environment, computer **130** is connected to LAN **177** via network interface or adapter **186**. When used in a WAN networking environment, the computer typically includes a modem **178** or other means for establishing communications over WAN **179**. Modem **178**, which may be internal or external, may be connected to system bus **136** via the user input interface **170** or other appropriate mechanism.

[**0032**] Depicted in FIG. **1**, is a specific implementation of a WAN via the Internet. Here, computer **130** employs modem **178** to establish communications with at least one remote computer **182** via the Internet **180**.

[**0033**] In a networked environment, program modules depicted relative to computer **130**, or portions thereof, may be stored in a remote memory storage device. Thus, e.g., as depicted in FIG. **1**, remote application programs **189** may reside on a memory device of remote computer **182**. It will be appreciated that the network connections shown and described are exemplary and other means of establishing a communications link between the computers may be used.

[**0034**] Attention is now drawn to FIG. **2**, which is a block diagram illustrating an exemplary client-server arrangement **200** that includes a selective content caching capability in accordance with certain implementations of the present invention. While the following description includes an exemplary web server such as might be found on the Internet, an intranet, etc., it should be understood that other non-web based client-server arrangements and other like configurations can also benefit from the improved methods and apparatuses provided herein.

[**0035**] With this in mind, client server arrangement **200** includes client logic **202** which is configured to provide a content data request **204** to server logic **206**. Here, for example, content data request **204** may include a web page request that is sent over a network from a client computer to one or more server devices.

[**0036**] Let this be the first time that content data request **204** has been received by server logic **206**. This means that the requested content data is not readily available in a content data cache, at least not yet. As such, server logic **206** needs to generate a corresponding content data response. To accomplish this task, sever logic **206** includes content data generating logic **208** which is configured to generate content data response **212**, which is provided by server logic **206** to client logic **202**.

[**0037**] Content data generating logic **208**, in this example, accesses one or more files **210**. Here, file **210** may be stored on a hard drive or other like storage mechanism(s). File **210** may include static data, script data, dynamic data, etc. Content data generating logic **208** processes this data, as/if needed, to produce content data that is included in content data response **212**.

[**0038**] Server logic **206** also includes caching logic **214**. Within caching logic **214** there is an activity monitor **216**. As illustrated by the solid-lined arrows, server logic **206** is configured to access memory **218**. For example, activity monitor **216** is configured to access activity information **220** and at least one activity parameter **222** stored within memory **218**, and caching logic **214** is configured to access content data **224** within at least one content data cache **226** in memory **218**.

[**0039**] Returning to the exemplary request handing process started earlier, once content data generating logic **208** has generated content data for content data response **212**, activity monitor **216** modifies activity information **220** to record that the particular content data was requested. In this manner, activity information **220** begins to collect information regarding the demand for the particular content data that was requested.

[**0040**] In accordance with certain implementations, for example, caching logic **214** can be configured to determine whether a particular content data **224** is to be stored in content data cache **226** based on one or more activity parameters **222** including the level of continuing and/or sustained demand for the content data over a period of time.

[**0041**] At this point in this exemplary request handing process, it is assumed that the content data generated for this initial request does not qualify for storage in content data cache **226**.

[**0042**] Assume now that a subsequent content data request **204** is received by server logic **206**. Server logic **206**, using caching logic **214**, determines if the content data for this subsequent request is available within content data cache **226**. Here, the requested content data is not yet in content data cache **226**. As such, server logic **206** needs to generate the content data once again and server logic **206** needs to output content data response **212** as it did before. Activity monitor **216** will once again modify activity information **220** to record this subsequent request for the same content data.

[**0043**] Caching logic **214** along with activity monitor **216** will determine, based on one or more activity parameters **222** and activity information **220**, if the content data generated for the subsequent request should be stored in content data cache **226**. There are a variety of decisional techniques that may be employed to determine when to add (or remove) content data **224** to (from) content data cache **226**. Several decisional techniques are described in greater detail below. For now, in this example, assume that caching logic **214** and activity monitor **216** are configured to store the content data **224** in content data cache **226** because activity information **220** shows that there have been enough requests for this particular content data within a specified period of time. Here, for example, activity parameters **222** may include a threshold demand storage value and/or a threshold demand removal value that is used to determine is content data **224** is stored or removed, respectively, from content data cache **226**. Activity parameters **222** may include information establishing the period of time over which demand is measured. These and other activity parameters may be programmably set and in certain implementations dynamically adjusted to further optimize or otherwise change the operation of server logic **206** and/or memory **218**.

[**0044**] In the above exemplary process, assume that receiving two requests within a period of ten seconds qualifies content data **224** to be stored in content data cache **226**. Then assume that a third content data request **204** is received. Now caching logic **214** will be able to quickly access content data **224** from content data cache **226** and therefore server logic **206** can output a corresponding content data response **212** without requiring content data generating logic **208** to again generate such content data.

[**0045**] Thus, as described above, activity monitor **216** and caching logic **214** can be configured to store content data **224** having "high enough" demand in content data cache

226, and also to remove/erase content data **224** from content data cache **226** when demand is not high enough.

[**0046**] In this example, activity information **220** is modified for each request that is handled regardless as to whether the content data was generated or read from content data cache **226**. In the exemplary demand level decision process described above, activity information for any given request for content data need only be stored in activity information **220** for the defined period of time. Thus, for example, in certain implementations, a unique identifier and timestamp can be recorded in activity information **220** for a given request for content data. After the defined period of time has passed within enough subsequent similar requests, then the unique identifier and associated timestamp become stale and can be removed/erased from activity information. What this illustrates is that with the proper settings of activity parameters **222**, the amount of memory required for activity information **220** can be significantly controlled and also only a small amount of information need be recorded in activity information **220**.

[**0047**] One of the benefits to this arrangement is that content data cache **226** may be configured to only include content data **224** that is in high enough demand. This tends to make the server run more efficiently as it is not buffering content data that is seldom requested.

[**0048**] As mentioned, caching logic **214** in certain implementations is configured to dynamically change one or more activity parameters **222** that are used to determine what content data is added to, or removed from, content data cache **226** and when. This dynamic relationship is illustrated in FIG. **2** by the dashed-line arrow between caching logic **214** and activity parameters **222**. Thus, for example, caching logic **214** may increase the demand measuring period at times when fewer requests are being received, and/or decrease the demand measuring period at times when more requests are being received to optimize use of the processing and/or memory resources in the server. Similarly, the threshold demand levels can be dynamically adjusted to promote certain efficiencies.

[**0049**] The above examples are directed towards demand-based caching decisions. Arrangement **200**, may also take into account still other decisional information. Thus, for example, in certain implementations caching logic **214** and/or activity monitor **216** can be configured to base caching decisions on other activity parameters **222** such as the type of content data. Here, some types of content data may be considered better caching candidates than other types of content data. For example, content data that requires additional processing time may be a better caching candidate than content data that is easier to generate. In another example, the size of the content data can be considered. Thus, for example, in certain implementations it may prove beneficial to cache larger sized content data, while in other implementations smaller sized content data may be better caching candidates.

[**0050**] In still other implementations, caching logic **214** and/or activity monitor **216** also consider the type(s) of memory **218** that content data cache **226** is stored in. Thus, for example, content data cache **226** may extend across different memory structures and certain content data **224** may be better off if stored in particular memory locations.

[**0051**] In one example, content data cache(s) may include both user-mode and kernel-mode memory, and content data **224** that is in very high demand may be stored in kernel-mode memory for even quicker handling. Similarly, certain types or sizes of content data may be better stored in either kernel-mode or user-mode memory.

[**0052**] In other implementations, the memory includes different levels (e.g., L1, L2, etc,) memory based on the hardware structure of the server device. Here, again, certain high-demand, low-demand, types, and/or sizes of content data may be better stored in content data cache within certain memory levels.

[**0053**] Although some preferred implementations of the various methods and apparatuses of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it will be understood that the invention is not limited to the exemplary embodiments disclosed, but is capable of numerous rearrangements, modifications and substitutions without departing from the spirit of the invention.

What is claimed is:

1. An apparatus for use in a server device having memory, the apparatus comprising:

logic operatively coupled to said memory and configured to gather information about at least one request for content data, and selectively store said content data in at least one content data cache in said memory based on said gathered information,

wherein said logic is configured to selectively store said content data in said at least one content data cache by determining a type of said memory in said server device.

2. The apparatus as recited in claim 1, wherein said gathered information includes activity information.

3. The apparatus as recited in claim 2, wherein said activity information is associated with a defined period of time.

4. The apparatus as recited in claim 1, wherein said gathered information includes content data type information.

5. The apparatus as recited in claim 1, wherein said gathered information includes content data size information.

6. A method for use in a server device, the method comprising:

determining content data;

gathering information about at least one request for said content data; and

selectively storing said content data in at least one content data cache in memory based on said gathered information,

wherein selectively storing said content data in said at least one content data cache is based at least in part on a type of said memory.

7. The method as recited in claim 6, where said memory in said server device includes varying levels for selectively storing content data with varying levels of demand.

8. A computer-readable medium having computer implementable instructions for configuring at least one processing unit in a server device, to perform acts comprising:

determining content data;

gathering information about at least one request for said content data; and selectively storing said content data in at least one content data cache in memory based on said gathered information,

wherein selectively storing said content data in said at least one content data cache is based at least in part on a type of said memory.

9. The computer-readable medium as recited in claim 8, wherein said gathered information includes activity information.

10. The computer-readable medium as recited in claim 9, wherein said activity information is associated with a defined period of time.

11. The computer-readable medium as recited in claim 8, wherein said gathered information includes content data type information.

12. The computer-readable medium as recited in claim 8, wherein said gathered information includes content data size information.

13. The computer-readable medium as recited in claim 8, further comprising:

selectively storing said content data in said at least one content data cache based at least in part on at least one parameter.

14. The computer-readable medium as recited in claim 13, wherein said at least one parameter defines a period of time associated with said gathered information.

15. The computer-readable medium as recited in claim 13, wherein said at least one parameter defines an activity level threshold value.

16. The computer-readable medium as recited in claim 13, wherein said at least one parameter defines a content data type.

17. The computer-readable medium as recited in claim 13, wherein said at least one parameter defines a content data size threshold value.

18. The computer-readable medium as recited in claim 13, further comprising:

selectively or dynamically modifying said at least one parameter.

20. The computer-readable medium as recited in claim 8, further comprising:

outputting said content data stored in said at least one content data cache.

* * * * *